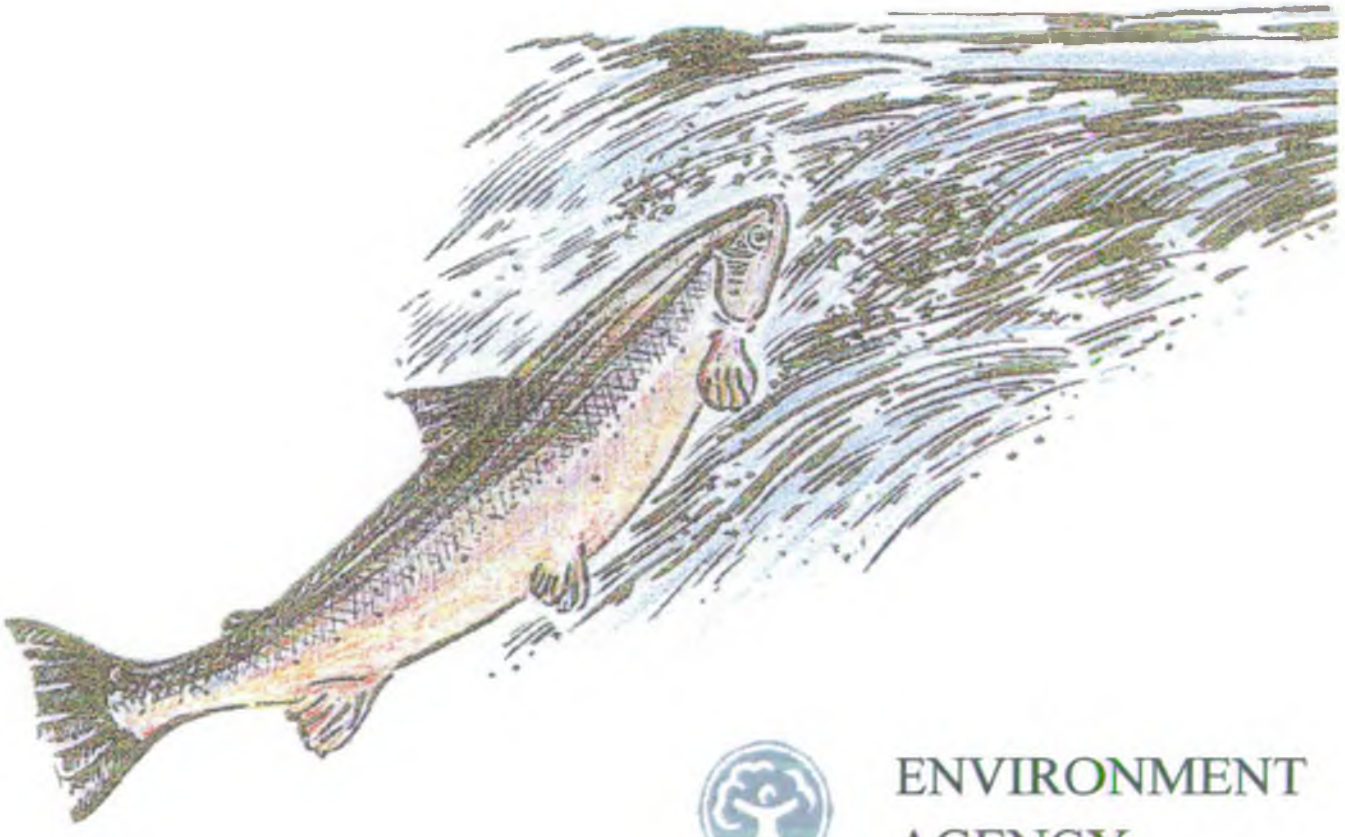
ACTION PLAN FOR THE MANAGEMENT OF

SALMON

IN THE RIVER TEST

CONSULTATION DOCUMENT

APRIL 1997



ENVIRONMENT AGENCY

Guardians of the Environment

Consultation Document on the Action Plan for the Management of Salmon in the River Test

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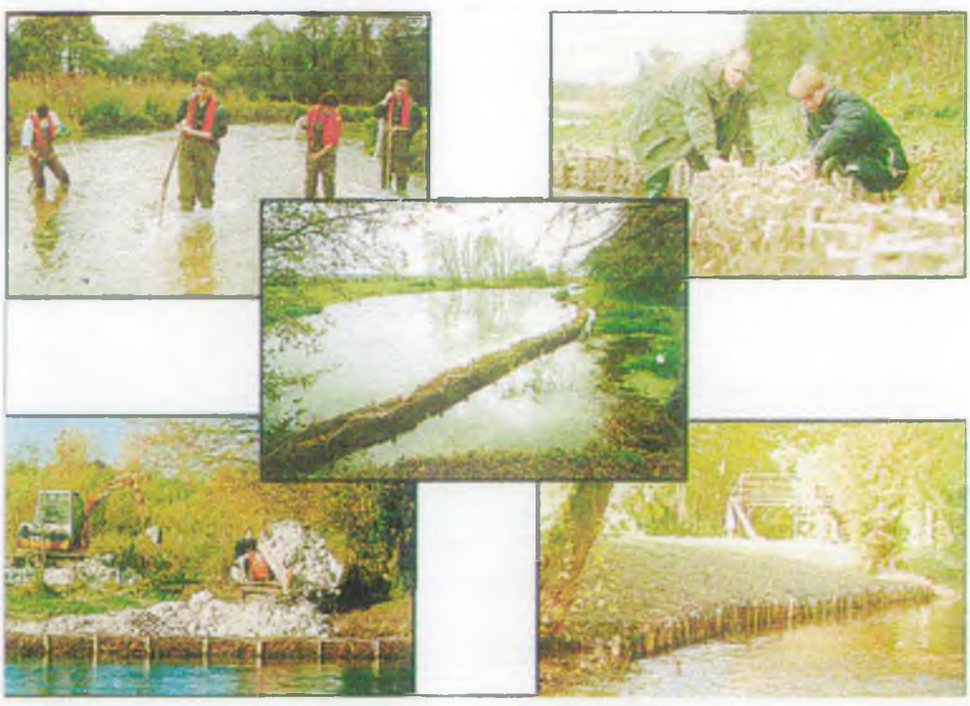

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"Over the years, we have learnt more and more about the life of the salmon in our rivers, both as juveniles and as returning adults, and this has helped in the development of methods of improving conditions and controlling exploitation in order to maintain numbers and improve spawning levels. Despite all this, there has been a drastic decline in the numbers of returning fish in recent years, on both sides of the Atlantic. We can no longer take the survival of viable populations of salmon for granted."

HRH The Prince Charles, Prince of Wales.

Message to the International Salmon Symposium, 1992.
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FOREWORD

The salmon stock of the River Test is in real danger of extinction, unless significant measures can be undertaken to conserve and promote a recovery of the stock. Salmon are part of Hampshire's natural heritage, with their presence being an important indicator of a healthy aquatic system. We have already undertaken considerable works in collaboration with our partners, the fishery owners, anglers and The Centre for Environment, Fisheries and Aquaculture Science (CEFAS) among others. However the information presented in this plan demonstrates that extensive and significant actions are required to re-establish the salmon stock as a thriving population.

The salmon stock of the River Test is of national importance as one of only six remaining chalk stream salmon fishery catchments in England. Furthermore the geographic location of the River Test is of particular significance since, along with the River Itchen, it provides the closest salmon fisheries to serve the large population of London and the South East.

We are committed to the recovery of the salmon stock to preserve the river's bio-diversity, the heritage and sport of the salmon fisheries. However it is clear that to achieve this will require significant resources, greater than the Environment Agency local funding currently available. Partnership and sponsorship opportunities are being exploited but without widespread support the long term future of the River Test salmon remains in doubt.

To date we have been fortunate in having the support both of the fisheries and of the salmon anglers of the River Test, who have been involved as collaborative partners in a number of the projects undertaken. This support and the contributions made are recognised as being critical to whether the stock recovers or continues to decline. The donation of fish to a propagation scheme and an increasing tendency to release rod-caught fish alive to the river have already resulted in the anglers reducing the rod exploitation from about 30% of the adult run some 5 years ago to 3% in 1996.

This action plan details the measures we consider appropriate for the recovery of the stock to a biologically sustainable level, whilst allowing the continued sport of the salmon fisheries. It is clear from the current state of the stock that impacting factors and mortalities must be minimised, and these are addressed within the plan. Furthering our knowledge of chalk stream salmon has been and continues to be an important part of our work and the Agency recognises the considerable support CEFAS gives to this programme.

We view this action plan as a living document which will evolve and be refined as further knowledge is gained and expertise developed. This will enable us to deliver an action plan which is based on updated information and remains focussed on promoting the recovery of the Test salmon.

Finally, I would ask all those who read this document to provide us with any appropriate observations or information for possible addition to the plan, thus personally contributing towards the recovery of the stock.

David Jordan
Hampshire & Isle of Wight Area Manager

April 1997.

ACKNOWLEDGEMENTS

The Environment Agency wishes to thank all those involved in helping to protect and re-establish the River Test's salmon population.

Thanks are given to the Directorate of Fisheries Research, (MAFF), now called the Centre for Environment, Fisheries and Aquaculture Science (CEFAS); Sparsholt College; the team who run the River Test hatchery programme; the Test and Itchen Association; the Salmon Fisheries of the River Test; Riparian Owners and the Anglers.

Executive Summary

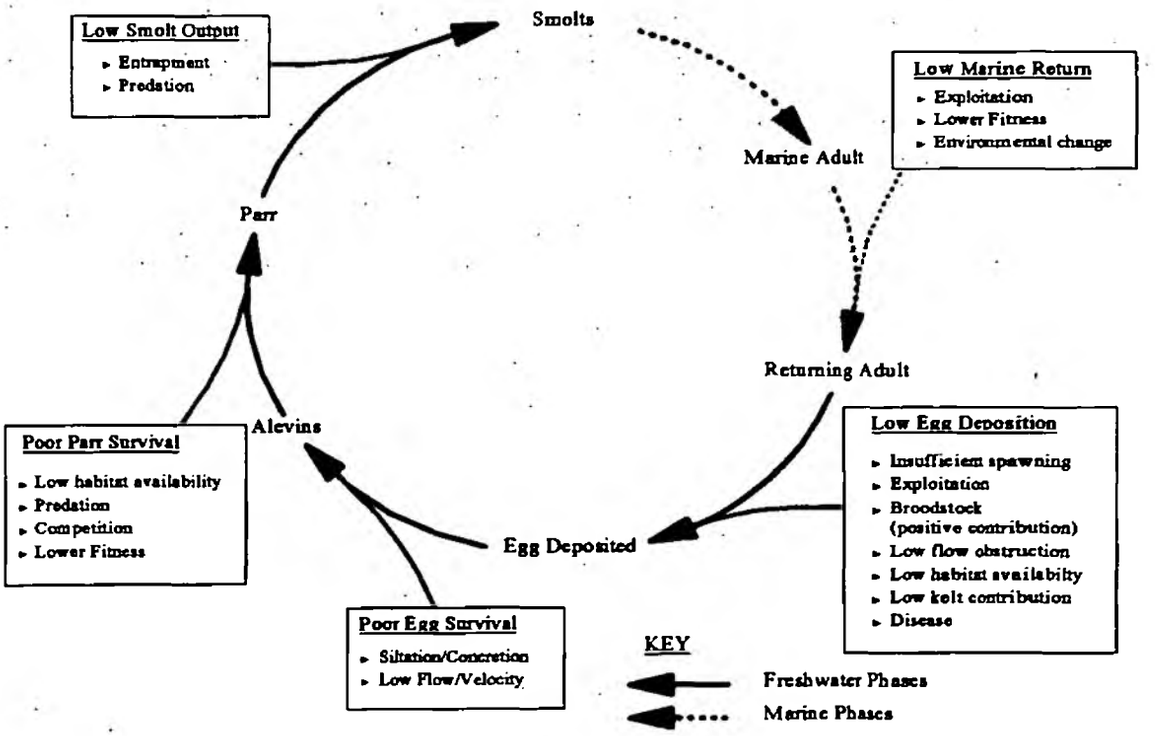
The salmon population of the River Test is of national importance as one of only six remaining chalk stream salmon fishery catchments in England. **The stock has declined dramatically from an estimated adult run of 4,000 fish in 1975 to 623 fish in 1996.** The composition of the stock has also changed with large multiple sea winter salmon (MSW) contributing to a smaller proportion of the stock than historically. **The minimum adult run to sustain the current salmon stock is estimated to be about 2000 salmon**, giving potential rod catches of about 600 salmon compared with the 146 caught in 1996. A greater MSW component will be required to re-establish the adult run to 1975 levels of 4000 fish.

The River Test Salmon Action Plan identifies:

- *The factors thought to be causing the decline in the salmon stock.*
- *The actions and finance necessary to re-establish the salmon stock to the Minimum Biologically Acceptable Level of Abundance.*

Present adult runs are estimated to be 32% of the minimum required for the current salmon stock to be self-sustainable. Egg deposition and the smolt run are estimated to be 35% and 28% respectively of the minimum required for a self sustaining salmon population. Egg to smolt survival is considered to be a key limiting life stage. Current egg to smolt survival is estimated at less than 0.3%. Habitat surveys of the Test have identified that 58% of the accessible habitat is potentially suitable for salmon spawning but that much of the catchment is impacted by silt deposition and/or concretion of spawning gravel. Thus degradation of spawning and parr habitats also impacts upon much of the Test's native brown trout population.

The key limiting factors acting upon Test salmon during its life cycle are considered to be:-



SUMMARY OF ACTIONS RANKED BY PRIORITY

Issue	Limiting Factors	Options	Priority
Poor egg survival	Gravel siltation/concretion & low flow.	Promote catchment wide soil conservation and buffer strips. Protect water resources. Clean and improve 8500m^2 of spawning gravels per year.	VH
Insufficient smolt output, (poor parr survival)	Lack of fast riffle nursery habitat, competition & entrapment, predation.	Create fast flowing riffle nursery habitat. Use of protected carriers. Screening of intakes.	VH
Insufficient spawning escapement, (low egg deposition)	High exploitation: Poaching, rod exploitation, low flows, obstructions, disease.	Promote catch and release. Intelligence driven anti-poaching.	VH
Inadequate marine return	High Exploitation, poaching, straying, genetic integrity & environmental change.	Influence Fisheries Policy. Intelligence driven anti-poaching operations.	H
Lowered fitness and reduced genetic pool	Historic stocking - now addressed Hatchery production, fish for the wild?	Identify donor broodline. Use of protected carriers. Exposure of hatchery fish to 'natural' conditions.	H

The Agency currently spends approximately £160K per annum on the salmon fisheries of the River Test. The riparian owners currently spend £200K per annum on the salmon fisheries of which £70K is contributed directly to the propagation scheme. The actions proposed by this plan would require an additional expenditure in excess of £1.7 million over a ten year period, which the Agency is unable to fund on its own. Therefore there is a significant requirement for additional funding both directly and through partnership sources.

The Agency has a duty to maintain fisheries as well as an overall conservation duty. Salmon in particular are an Annex II listed species in the EC Habitats Directive which further enforces the need for their conservation. **The River Test salmon are currently at conservation critical levels and require immediate attention to assure their continued existence**. The Agency will achieve this through its collaborative approach with its many partners, thus reducing costs whilst benefiting international research, the economic potential derived from the river and fulfilling its conservation and heritage duties. **Failure to act is likely to result in the potential extinction of the salmon stock in the Test.**

PART 1 : INTRODUCTION

The Environment Agency has a duty, under the Environment Act 1995, to maintain, improve and develop the salmon, trout, freshwater and eel fisheries under its jurisdiction. It also has a duty to regulate these fisheries, to prevent their illegal exploitation and to take account of the cost and benefits of any action or in-action it undertakes.

The majority of the Agency's powers to regulate and protect fisheries are defined in the Salmon and Freshwater Fisheries Act 1975, supplemented by the Salmon Act 1986. The Agency also has powers to: ensure the unobstructed migrations of salmon and sea trout through the river; control the movement and introduction of these species; monitor catches, fish stocks and the occurrence of disease; and to raise income through duties on rod and net licences as well as contributions from fishery owners.

The Agency has International obligations, through representation at the European Union, to further the works of the North Atlantic Salmon Conservation Organisation (NASCO), and to take account of advice and recommendations from the International Council for the Exploration of the Seas (ICES) on the management of salmon stocks.

To meet its duties and obligations, the National Salmon Strategy for England and Wales was launched by the National Rivers Authority in February 1996 (NRA 1996). This has subsequently been adopted by the Environment Agency.

The basis of the Strategy is the collaborative management of individual rivers with the active involvement of all interested parties. Local Salmon Action Plans, (SAPs), are designed to show how this is to be achieved, clearly detailing the aspirations for the catchment, the issues limiting their achievement and the means to resolve identified problems.

SAPs will support the salmon management element of their specific Local Environment Agency Plans, (LEAPs), and will provide information for Regional and National management of salmon stocks, their fisheries and the issues facing them. This information will then be reported to Government and to the Public in terms of the National salmon resource, which will contribute to the international management of salmon fisheries through CEFAS, ICES and NASCO.

SAPs are target based, reflecting the objectives for the stocks and fisheries. The setting of targets and the assessment of compliance against them is a rapidly evolving science. Because of this, a common best practice has been established within the Agency for developing SAPs and to provide consistency for the national and international perspectives of the management of salmon. This consistent best practice is detailed within the Agency Salmon Action Plan Guidelines, (Environment Agency, 1996).

Wherever possible, actions proposed from SAPs are primarily based upon best available scientific evidence. However where inadequate evidence is available but the potential damage to the environment is both uncertain and significant then the actions are based upon the precautionary principle. This principle has been adopted by the Agency for the maintenance of the genetic integrity of salmon.

1.1 *THE VISION*

1.1.1 The national vision of the Environment Agency for the management of the salmon fisheries of England and Wales is to:

- ***Optimise recruitment to home water fisheries.***
- ***Maintain and improve the diversity and fitness of stocks.***
- ***Optimise the total economic value of exploited fish whilst allowing for social equity considerations.***
- ***Meet the necessary costs of managing the resource.***

These objectives are to be achieved through catchment specific salmon action plans.

1.1.2 **The Hampshire vision is to establish a self sustaining salmon stock in the River Test to enhance the economic and conservation value of the river. Monitoring information obtained in achieving this vision will provide significant guidance for the best management of other salmon rivers.**

1.2. *THE RIVER TEST SALMON ACTION PLAN*

1.2.1. This Salmon Action Plan is developed from the consultation document The Rivers Test and Itchen Salmon Management Plan (NRA, 1995a), and is written in accordance with the National document A Strategy for the Management of Salmon in England and Wales (NRA, 1996).

1.2.2. The purpose of this plan is to define the management actions required to achieve the vision. The plan will form part of a series of salmon action plans being compiled for all major salmon rivers in England and Wales. The plan will be a living document, being sensitive to new information and knowledge, and with bi-annual updated revisions.

1.2.3. Many of the key limiting factors which affect salmon may also impact on the native brown trout fisheries. A number of the key actions identified within the plan will be of equal benefit to the Test's native brown trout and will provide important information for use in managing other salmon rivers.

1.3. *THE RIVER TEST CATCHMENT*

1.3.1. The River Test is considered by many to be the finest chalk stream in the world. It rises in the village of Ashe, near Overton, and flows southwards through the chalk downlands collecting spring-fed tributaries on its way to the sea at Southampton (Figure 1). The river has a low gradient falling 297m from source to sea. It has been extensively managed and shaped by man for both industrial and agricultural purposes. Recent land use changes have been linked with significant silt input to the river by erosive and surface water processes, combined with discharges from commercial abstractors such as cress beds and fish farms.

1.3.2. The main River Test and lower Dever (a tributary of the Test) are designated Sites of Special Scientific Interest (SSSI) for riverine habitat. This designation seeks to maintain the character, quality, and diversity of the River Test and the associated habitats. Chalk stream habitat is also designated under the EC Bio-diversity Directive and the salmon is listed in Annex 2 of the EC Habitats Directive.

1.3.3. The River Test has been accepted by CEFAS as an indicator river of Southern salmon populations. Indicator rivers are used by CEFAS to assess the marine exploitation of Regional salmon stocks by means of relating tag returns from the marine fisheries to the numbers of tagged fish in the estimated spring smolt run. The use of the River Test as an indicator river owes much to the extensive monitoring of the River Test stock that is undertaken on an annual basis.

1.3.4. General statistics for the River Test Catchment are given in Annex One.

PART 2 : THE FISHERIES OF THE RIVER TEST

2.0.1. The salmonid fisheries.

The River Test is world famous for its brown trout fishing and is the birthplace of dry fly fishing. The majority of the river and tributaries have been designated "Salmonid Fisheries", (Figure 1), under the EC Freshwater Fisheries Directive (78/659/EEC).

For salmon :

- The lower reaches have supported an important rod fishery (Figure 2).
- The rod catch has been declining since the 1960s.
- The present day low numbers of salmon returning to the river mean that the salmon fisheries are no longer commercially viable.
- Two licensed seine nets can be used within the Test Estuary and Southampton Water to catch salmon under a Net Limitation Order.
- The rod season extends from January 17 to October 2 following. The method of fishing is restricted between March 14 and June 16 to artificial fly or lure fishing, (Southern Region Byelaw 8).
- The seine net season extends from February 15 to July 31 following.

For sea trout :

- Historically large numbers of sea trout have entered the lower reaches of the Test. Most migrate up the River Blackwater to spawn (Figure 2).
- Catches of sea trout have declined in recent years.
- The rod season extends from May 1 to October 31 following. The method of fishing is restricted between March 14 and June 16 to artificial fly or lure fishing, (Southern Region Byelaw 8).

For brown and rainbow trout :

- These are the dominant species of fish caught in the River Test, (Figure 3), and for which the fisheries are predominantly managed.
- These species are widely distributed through the catchment undertaking localised migration.
- Natural brown trout production in the Test is not sufficient to support the trout fishery. Considerable numbers of adult trout are stocked into the Test to meet the demand of this very popular fishery.
- The rod season extends from April 3 to October 31. The method of fishing is restricted between March 14 and June 16 to artificial fly or lure fishing, (Southern Region Byelaw 8).

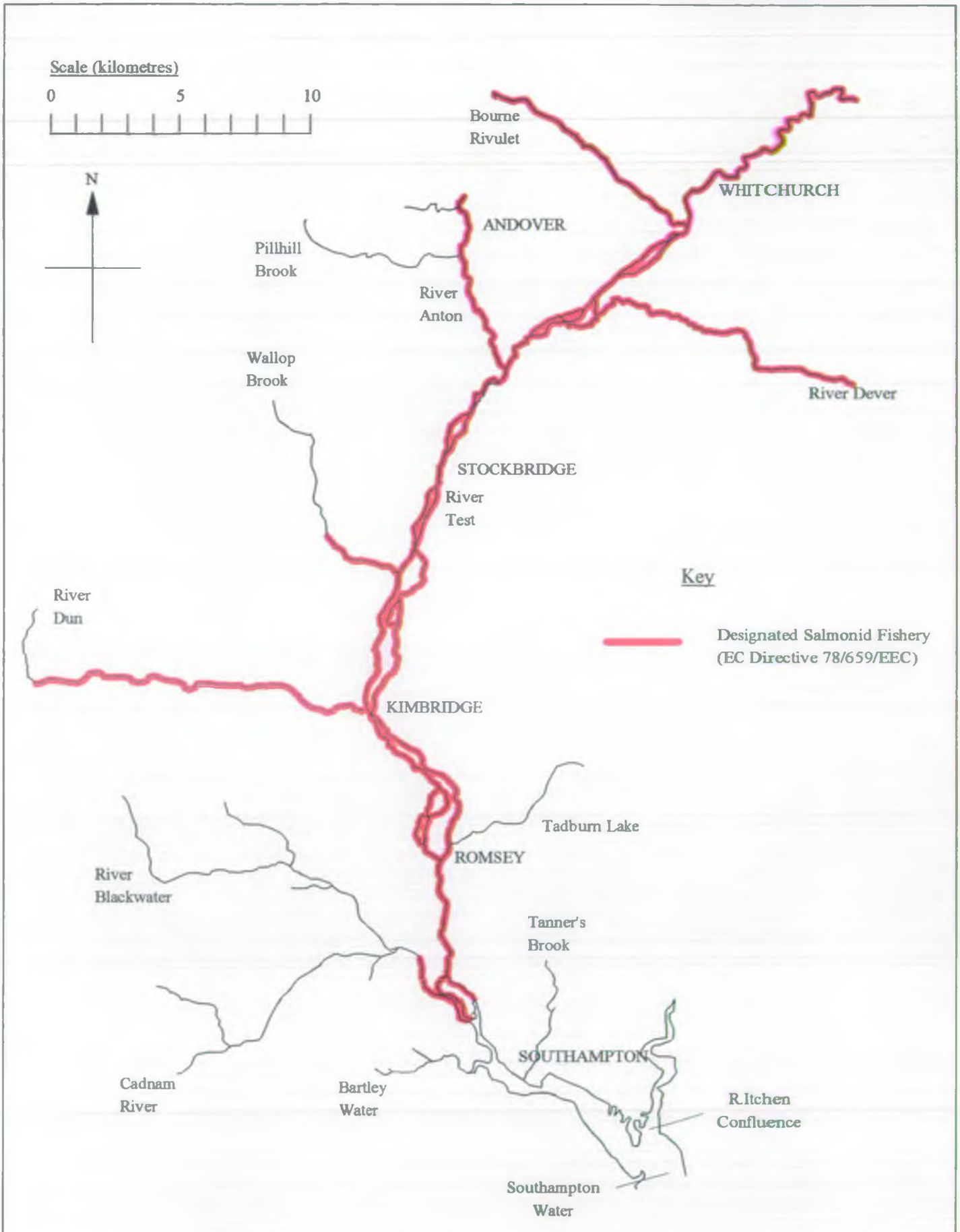


Figure 1 : The River Test Catchment and Designated Salmonid Fishery.

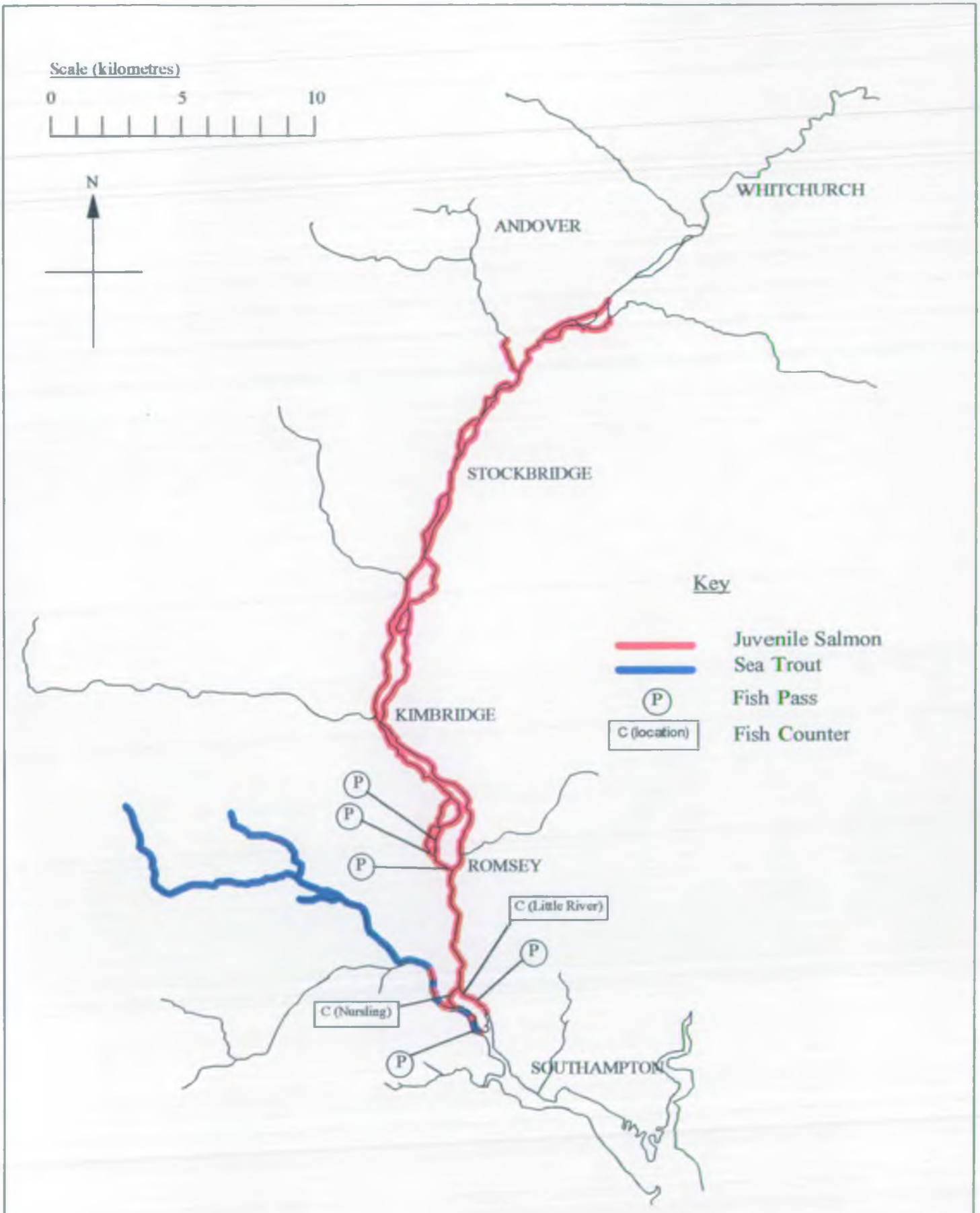


Figure 2 : Distribution of Migratory Salmonids, River Test 1995

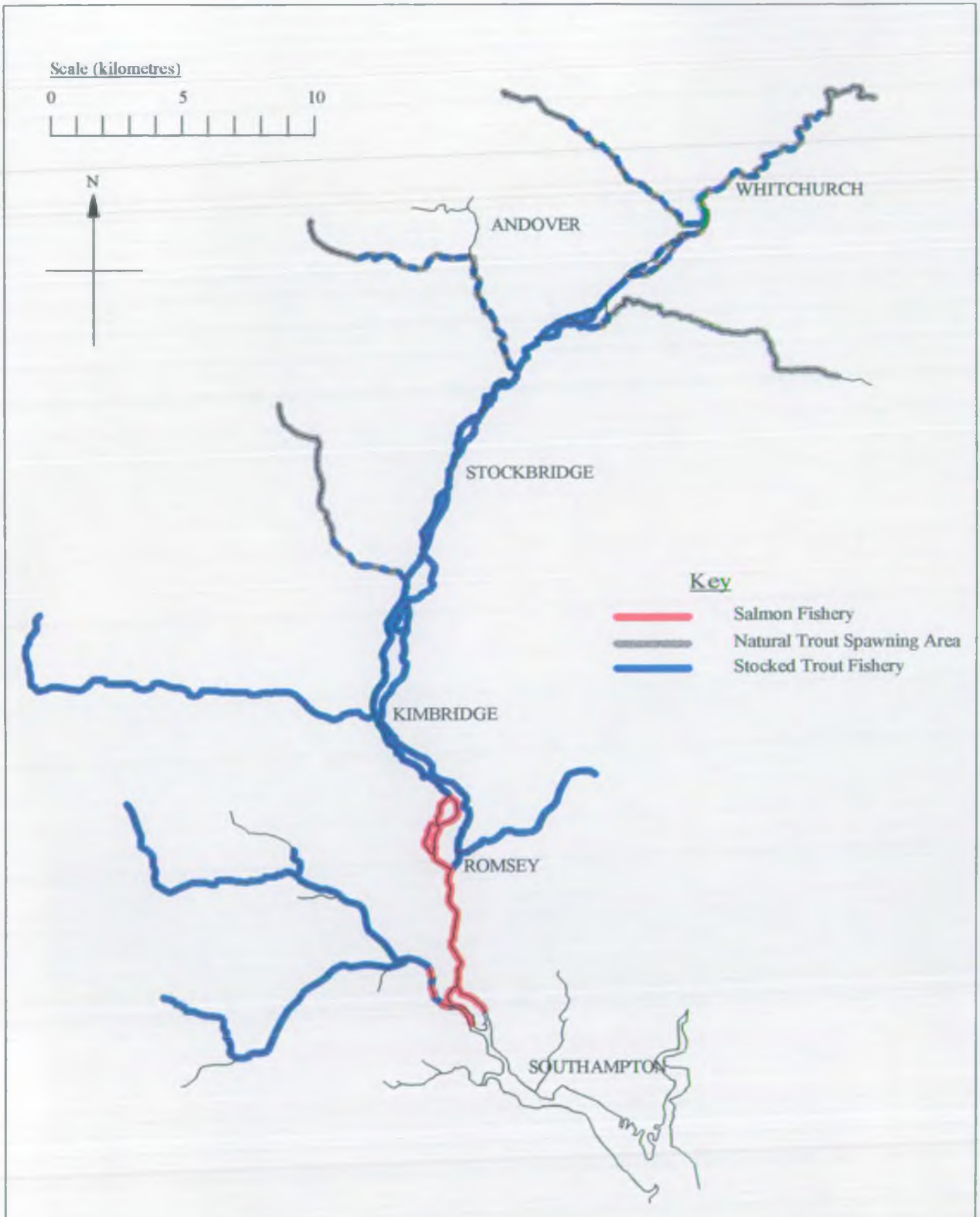


Figure 3 : Distribution of Fisheries, River Test 1995.

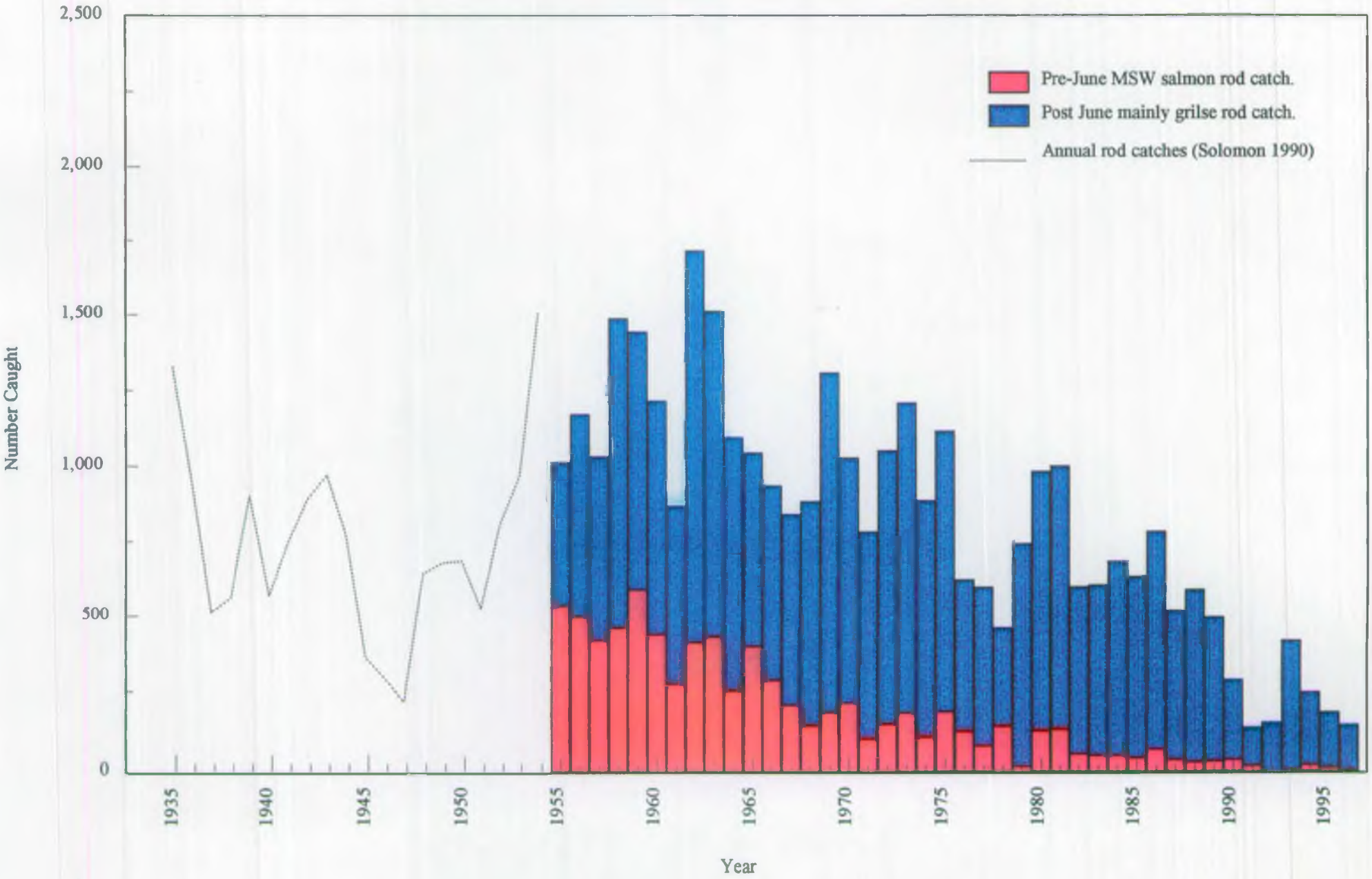


Figure 4 : Historic Salmon Rod Catches, River Test 1932-96

2.0.2. The grayling and coarse fisheries.

- The catchment provides suitable habitat for a variety of coarse fish which include: pike, perch, roach, chub, eel and grayling.
- The eel population is commercially exploited by a number of traps on the river.
- Grayling, perch, pike, roach and chub numbers are controlled by the river's game fishery managers who perceive them as competitors to trout and salmon.
- The season extends from June 16 to March 14 following.

2.1 *CATCHES AND PARTICIPATION*

2.1.1. The recorded long term decline in historic rod catch, (Figure 4), is considered to reflect the perceived decline in the salmon stock. However the variation in rod catch may also be a reflection of changes in fishing effort, catch efficiency and catch reporting.

It is important to note that exploitation by rods is now restricted to the use of artificial fly and lure only between March 14 and June 16, this provides additional protection to multiple sea winter salmon (MSW). These fishing methods are considered less effective and so may have contributed to the reduction in the pre-June (largely MSW) element of the rod catch.

2.1.2. The catch statistics are summarised in Table 1 and illustrate the following:

- Significant fluctuations in historic rod catches.
- Long term decline to current low stock level.
- Long term reduction in the spring running MSW rod catch (also reflected by the decreasing average weight of rod caught salmon).
- Recent reduction in post-June (mainly grilse) element of the rod catch.

Table 1 : Rod Catch Summary

	PRE-1ST JUNE CATCH		POST-1ST JUNE CATCH		ANNUAL CATCH	
	1996	Mean 1991-95	1996	Mean 1991-95	1996	Mean 1991-95
RODS	5	13.4	141	213.6	146	227

NB : Pre- June catch is likely to be MSW.
Post-June catch mainly consists of grilse.

2.1.3. The fates of Test salmon after leaving the river as spring smolts are given in Figure 5:-

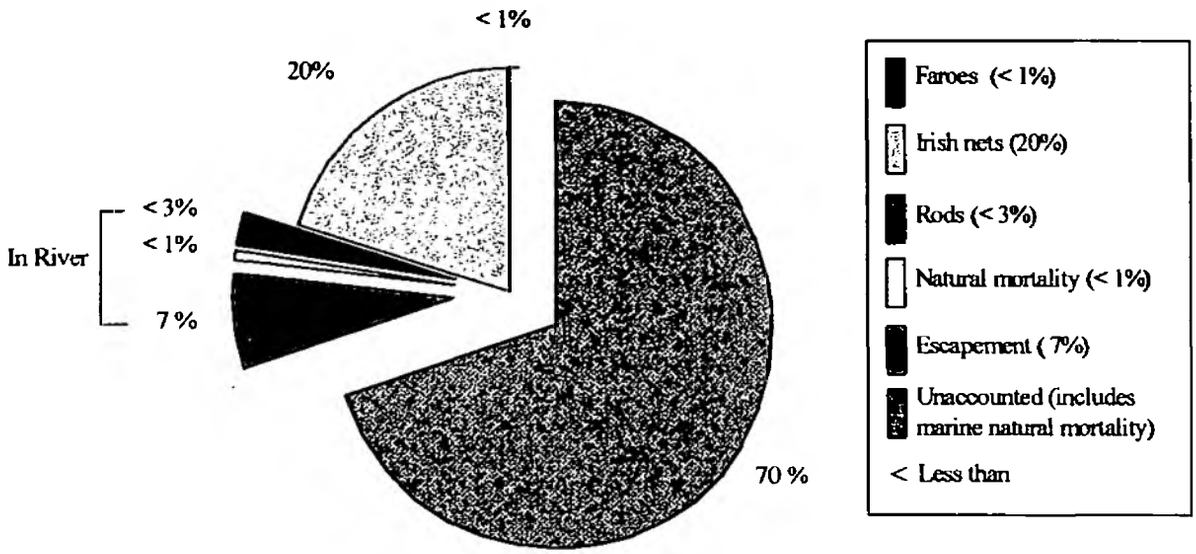


Figure 5 : Fates of 1995 River Test spring salmon smolts.

2.1.4. Key points to note are:

- The percentage figures relate to the estimated numbers of spring smolts that leave the river and their subsequent fates.
- Marine exploitation rates are based upon 1996 data, (CEFAS. I.Russell *pers.comm*).
- Total accountable exploitation is estimated at 23%.
- Spawning escapement is estimated at 7%.
- 70% is unaccounted however, this will include a significant percentage for natural mortalities at sea, in addition to elements for straying, marine predation, other high seas fisheries and poaching pressure.

2.1.5. The quoted exploitation rate for the Irish commercial drift nets is 20% of the migrating spring smolt stock, (detailed in 5.2.5.). This rate was estimated prior to the regulatory measures upon the drift net fishery introduced by the Irish Government in September 1996. These measures include delaying the season until 1 June, restricting fishing to daylight and within 6 miles, but they have also increased the allowable legal catch. It is questionable whether these changes will result in a reduction in exploitation. If not, then this fishery will rank as a major limitation upon the recruitment of River Test adults to home waters.

Plate I : A Cock Salmon caught on the River Test during September 1996.

Plate II : The Fishing on the River Test.

2.1.6. Historically, greater catches of salmon were taken by the fisheries off of Greenland, (net), the Faeroes, (long line), as well as by the interceptory Irish drift net fishery, (Figure 6). A recovery of the salmon stock would be likely to result in increased catches by these fisheries if exploited. It is therefore essential that controls are placed upon exploitation in both high seas and home water fisheries to ensure that any recovery is sustained and that sustainable catch levels are adopted.

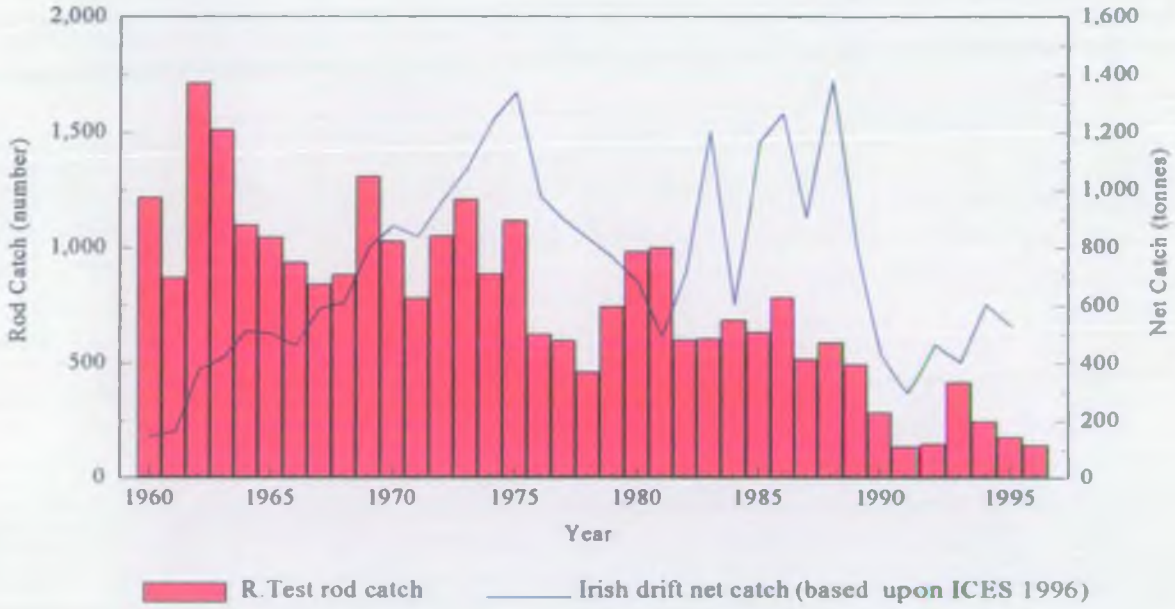


Figure 6 : Historic Test rod and Irish drift net salmon catch.
- 100 tonnes ≈ 27000 fish of 3.5 Kg mean weight.

The illustrated Irish drift net catches are derived by apportionment of historic Irish salmon catches, (ICES 1996), using proportions based upon the report of the Salmon Management Task Force (1996).

Controlling marine exploitation is especially important with regard to the conservation of Multiple Sea Winter salmon, (MSW). These larger salmon have historically constituted a significant proportion of the Greenland and Faeroes catches relative to the other fisheries. ICES has identified a significant reduction in the abundance of MSW salmon relative to one sea winter returning grilse in a number of the North Atlantic salmon stocks. In consequence NASCO has made the protection and conservation of the MSW salmon a priority for all salmon management.

2.2 *FISHERY PARTICIPATION AND VALUE*

The salmon fisheries of the River Test are of national importance as one of only six chalk stream salmon fishery catchments in England. This is of particular significance since the Rivers Test and Itchen are the closest natural salmon rivers to the large population of London and the South East.

Although the river's trout fisheries have been largely responsible for its world acclaim, the salmon fisheries provide an important source of additional sport in the lower river which is less suited to trout.

The salmon fisheries provide an important source of revenue to the estates concerned. A smaller amount of salmon angler revenue is received by the local communities, which provide extensive facilities to cater for both the salmon and trout anglers' needs.

The salmon fisheries have a heritage value, since the sport of salmon angling has been practised on the river for well in excess of two centuries. The landscape of the majority of the lower Test owes much to the river keepers, who have traditionally managed the waters for salmon fishing. If salmon became extinct then this would undoubtedly result in a change in river management practice to either manipulate the lower fisheries to become stocked trout fisheries, or as seems likely the fisheries would fall into dis-repair in the absence of economically viable fisheries to continue the specialised and costly river maintenance.

Concerns have been expressed by the fisheries that the high capital costs of restoring degenerated salmon fisheries would make it a non-viable option, even in the event of a subsequent stock recovery. Furthermore in the absence of the salmon fishery river keepers and the river management practice they currently undertake an increase in illegal exploitation of the residual stock would undoubtedly occur, further impacting on any subsequent natural recovery.

Preserving the salmon on the River Test is a matter of major conservation importance in terms of conserving the Bio-diversity of the river. Furthermore the presence of salmon is accepted as being a biological indicator of the health of a river, as salmon are particularly sensitive to water quality and resource problems. Given the designation of the river as a riverine SSSI, the salmon stock provides an important measure of variation in the condition of the river.

2.2.1. *PARTICIPATION*

Information on rod participation within the fishery is limited. Estimates are therefore based upon mean catch per licence day, (1995/96 Table 12 National statistics), supported by anecdotal rod effort information:

Table 2 : Estimated rod fishery participation

RESIDENT ANGLERS				VISITING ANGLERS				TOTAL			
Number		Days fished		Number		Days fished		Number		Days fished	
1996	Mean 1991-95	1996	Mean 1991-95	1996	Mean 1991-95	1996	Mean 1991-95	1996	Mean 1991-95	1996	Mean 1991-95
12	= 20	N/A	N/A	81	= 133	N/A	N/A	93	= 153	1805	3153

- Total days fished derived from average catch per licence day of 0.072 fish, (national catch statistics Table 12).
- 5 year mean data based upon anecdotal keeper information.

The net fishery is currently limited to two licensed nets by Net Limitation Order (1996).

Table 3 : Net fishery participation

LICENSEES		ENDORSEES		TOTAL NETSMEN		DAYS FISHED	
1996	Mean 1991-95	1996	Mean 1991-95	1996	Mean 1991-95	1996	Mean 1991-95
None	2	None	2	None	4	None	N/A

The historic catches of the net fishery are not known due to poor catch returns.

2.2.2. *ECONOMIC EVALUATION*

The conservation and heritage values of the salmon fishery are recognised as being highly significant, but are difficult to assess. An evaluation of the economic value of the salmon fishery to the country provides therefore a **minimum** value estimate, consisting of the nett value and the impact on the local economy, (including intangible benefits).

NETT ECONOMIC VALUE

The minimum Nett Economic value of the River Test salmon fishery is defined as the sum of the following:

- The value to fishery owners (market value of fishing rights).
- The value to anglers (consumers surplus).
- The value to netsmen (profits from sale of catch).

The estimated values of the fishery to the fishery owners and anglers are given in Table 4:

Table 4 : Estimated economic value to fishery owners and to anglers.

	Rod Catch (A)	Market Value per salmon (B)	Market value to fishery (A x B)	Ratio Anglers' consumers surplus: Market Value	Anglers' consumer surplus
1996	146	£ 8000	£ 1 million	1:1	£ 1 million
Mean 1991-95	227	£ 8000	£ 2 million	1:1	£ 2 million
1988	589	£ 14000	£ 8 million	1:1	£ 8 million

- Values per salmon are the 1988 value, (£14000) and the national mean value per salmon, (£8000), for the salmon fisheries taken from Radford *et al* 1991, and adjusted where necessary for inflation, (multiplied by 1.4). The current value for the Test salmon may be less than the national mean, given the endangered status of stock and low rod catches.
- Anglers consumer surplus is a 10 year capitalised measure of the difference between what anglers are willing to pay for fishing and what they actually pay.

It is recognised that the estimates give only a crude estimate of value. However they have allowed a nationally consistent approach for the economic evaluation of salmon fisheries.

The national default value of a salmon was adopted for the more recent data due to a perceived threat that the fisheries are at risk of closure due to the extinction of the stock. Indeed it is held amongst the fisheries that the current value per salmon is less than the national mean value used. However if the fishery's future were to be more certain, then the higher value would still be appropriate given the importance of the fishery in serving the populous of South East England and its historic reputation, which may allow fishery owners to charge higher prices for permits than elsewhere

The market value of the River Test fisheries are not however solely dependent upon salmon fishing since they also support trout fishing. Estimates of the value of the potential residual fisheries are given in Table 5:

Table 5 : Estimated economic value as trout fisheries, (1995).

Potential bank length	Average Value per m bank length	Market value as a trout fishery	Ratio Anglers' consumers surplus : Market Value	Anglers' consumer surplus
20 km	£ 50	£ 1M	1:1	£ 1M

- Average value per metre bank length is the value estimated by the fisheries for the potential trout fishing in the lower river. By comparison values for the middle river trout fisheries are estimated in excess of £200 per metre.

The minimum nett economic value of the fishery to the country is given in Table 6, which clearly demonstrate the reduction in the economic value of the fishery since 1988:

Table 6 : Estimated Nett Economic Value of River Test Salmon Fishery.

VALUE	1996 (£)	1991-95 (£)	1988 (£)
To fishery owners	£1 million	£2 million	£8 million
To salmon anglers	£1 million	£2 million	£8 million
To netsmen	£0	N/A	N/A
Less total value as a trout fishery	£2 million	£2 million	£2 million
Minimum Nett Economic Value	£0 million	£2 million	£14 million

The restoration of the salmon fishery to 1988 levels would result in an estimated rise in value of £14 million to the fishery owners and the salmon anglers.

IMPACT ON THE LOCAL ECONOMY.

The direct impact of the River Test salmon fisheries upon the local economy is largely restricted to the income and secondary expenditure of the fishery owners, (Table 7). Due to the rivers' close proximity and easy access from the South East, visiting anglers tend not to require overnight accommodation unless they are spending a number of days angling. In addition a number of the fishing permits for the River Test offer all inclusive benefits to the angler, including items such as meals, drinks, tackle and overnight accomodation. As a result the direct recipient of angler expenditure tends to be restricted to the fishery owners with revenue entering the local economy through the expenditure of the fisheries on local services.

Table 7: Anglers' expenditure.

	Total days fished	**Permit price per day**	**Other expenditure per day**	**Total expenditure**
1996	1805	£130	£30	£289 K per year

PART 3 : CURRENT STOCK STATUS AND RELEVANT TRENDS

3.0.1. The status of the stock is monitored by a number of means:

- Fish counters, (sited at Nursling and the Little River).
- Spring smolt run estimation by trapping at Nursling and Romsey.
- Micro-tagging of stocked parr and a proportion of the wild smolt run.
- Salmon redd location.
- Juvenile population surveys.
- Rod catch data analysis.

3.0.2. Potential factors impacting upon the stock have been investigated by a number of means:

- Acoustic tracking of adults and smolts.
- PIT tagging and marking of stocked parr.
- Adult and smolt radio tracking data.
- In gravel egg survival experiments.
- Avian predator faecal pellet and ecological investigations.
- Sequential microtagging of parr and smolts.
- Disease monitoring of the wild population (in collaboration with CEFAS).

Plate III : A Salmon migrating upstream through a fish counter.

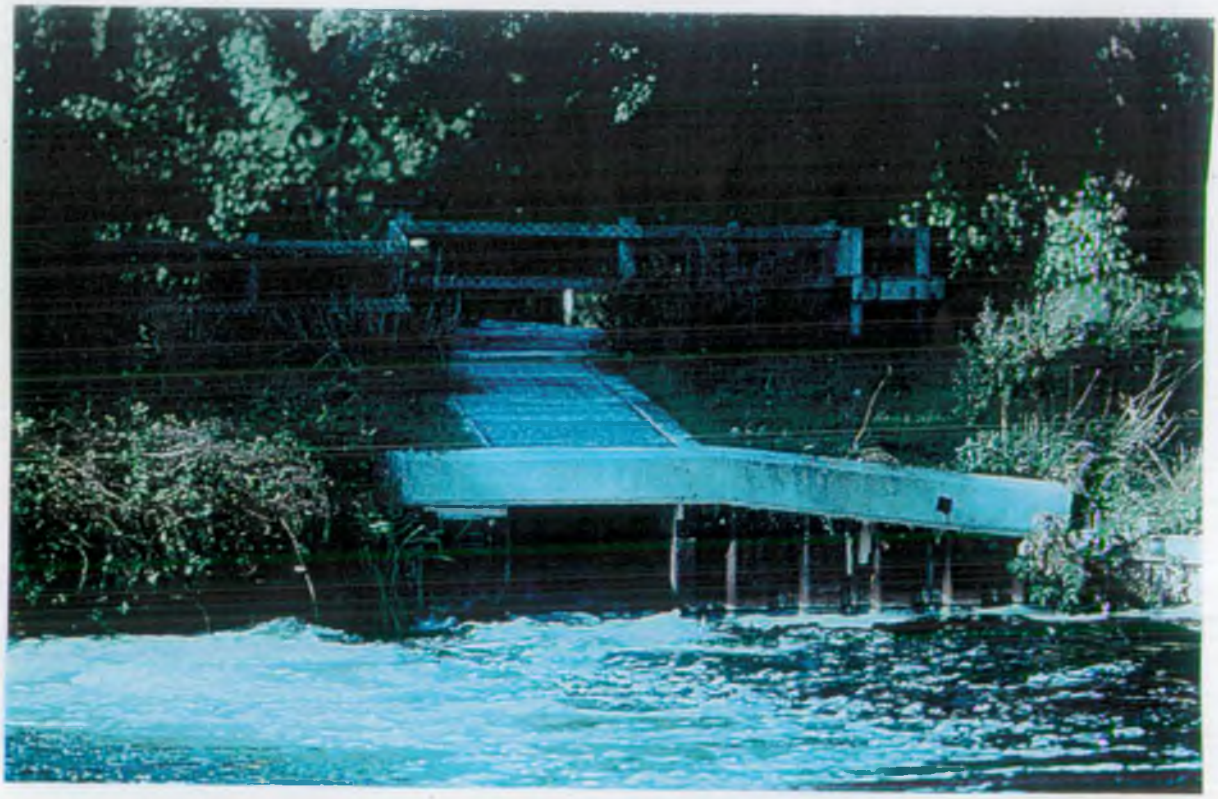


Plate IV : The Fish pass at Nursling.

Plate V : The braided channels of the River Test.

Plate VI : A hen salmon being stripped for the propagation scheme.

3.0.3. The current stock is considered as endangered. A number of features of the current stock are considered significant enough to threaten its continued existence:

- The lower adaptive potential of a small population to overcome new problems.
- Natural variation between year classes of chalk stream salmon populations.
- The effective loss of the spring and multiple sea winter salmon in the River Test, with a resultant increase in the proportion of grilse such that the stock is now considered to be a grilse stock. The decreasing MSW trend has been observed in other North Atlantic salmon stocks, (ICES).
- Variations in river flow due to climate change, abstraction and associated variation in the dilution factors of commercial discharges.

3.0.4. A salmon stocking programme has been carried out on the River Test since the mid 1980s. The purpose of the programme was to conserve the then perceived endangered stock level and to alleviate the impact of the rod catch upon production through mitigative stocking. The effects of the stocking programme, which developed into the current propagation scheme, are suggested to have been extremely variable (Section 3.6.). Much of this may be explained by wide variations that have occurred in the timing, methods and distribution of fish being stocked to the river and in their quality. Best practices are evolving to maximise the benefits of the propagation scheme and to support the research needs of chalk stream salmon.

3.1. *ADULT SALMON RUN*

3.1.1. Knowledge of the size of the adult run and its composition are critical to the management of the salmon fisheries since:

- The salmon fisheries' commercial viability is dependant on the size of the run.
- The level of catch directly affects the spawning escapement.
- The size and composition of the spawning escapement directly effects the numbers of eggs that may be deposited and thus future production.
- The maintenance and enhancement of the salmon stock is directly influenced by the level of production. This can be improved through effective catch and release to the river or to the broodstock programme.

3.1.2. The timing of the adult run has been assessed for seven years by interpretation of salmon fish counter data trends. Recent adult runs and their timings are summarised in Table 8 :

Table 8 : Run size & timing.

METHOD	PRE-1st JUNE		POST-1st JUNE		ANNUAL	
	1996	1991-95	1996	1991-95	1996	1991-95
COUNTERS	14	20	609	745	623	765

It is important to note that the division of the adult run into pre and post June elements is based upon fish counter data that has been validated in a number of ways:

- 1992 - Raw fish counter results, (not validated)
- 1993-1995 - Counts validated by resistivity trace.
- 1996 - Counts validated by video and resistivity trace probability.

3.1.3. The reduction in the recent pre-June element of the adult run provides further confirmation of the observed long term decline in pre-June catches of MSW salmon. This reduction may prove critical to the survival of the stock since the MSW element being larger in individual size have a greater fecundity or reproductive potential per individual than smaller grilse.

Furthermore a significant proportion of the historic MSW adult run consisted of returning repeat spawners, (historic catch data from the fisheries has suggested this may be as much as 20% of the MSW run). Kelts successfully returning to the sea and recovering to return for at least a further spawning contribute significantly to the stock. Multiple spawning by salmon further increases the fecundity per individual fish, thus increasing both the stocks production and its' ability to overcome significant fluctuations in annual production. Therefore the preservation of any MSW and kelt derived run must be given a very high priority if the stock is to survive and recover.

Concern is expressed at the apparent lack of spawned kelts during the past 10 years. The phenomena requires further investigation.

3.1.4. The long term historic adult run, (1955-1975), is estimated at approximately 4000 salmon per year based upon rod exploitation data.

3.2. *SPAWNING ESCAPEMENT*

3.2.1. Nett exploitation by rods is currently estimated at 3% of the adult run, compared to historic exploitation of on average 30 % of the adult salmon run. This has allowed a 5-year average escapement of about 72% , (see Figure 7). The recent reductions in exploitation have resulted from increasingly larger proportions of the salmon caught being donated and used in the propagation scheme, (mean 30%, 1996≈83% of the rod catch), although as in the wild there have been some small losses of these donated salmon whilst in the scheme. A smaller proportion are also reported to have been returned to the river in 1996 (approx 2% rod released; 11% released from broodstock donations).

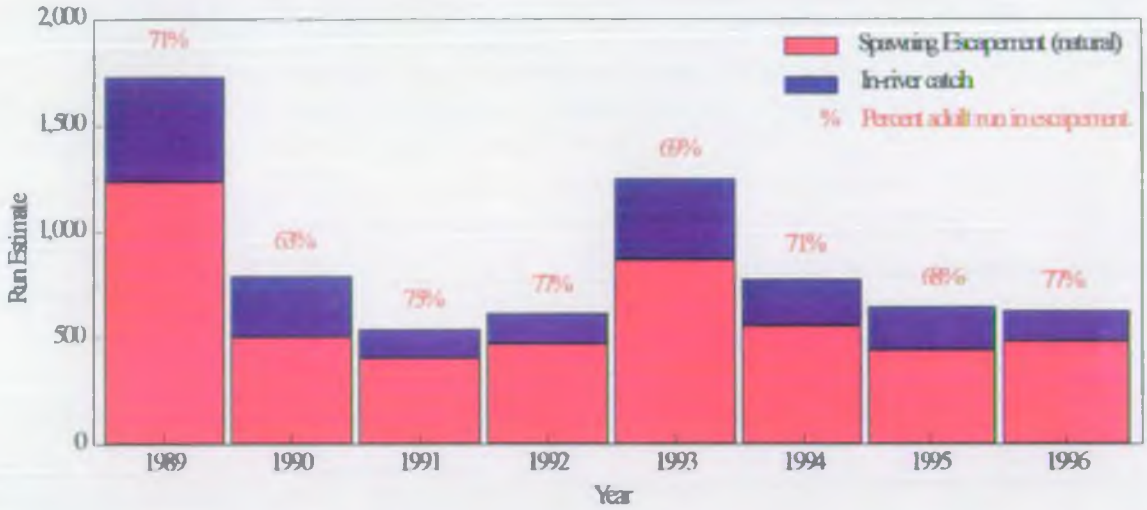


Figure 7 : Historic Salmon Natural Spawning Escapements.

Preventing fish being killed by the rods is of obvious importance in conserving the stock by increasing spawning escapement. Catch and release/donation are favourable methods of doing this, since they allow fishing to continue and the fisheries therefore to survive. However it is vitally important that the stress and damage suffered by the fish are minimised, to enable them to survive to spawn, (either naturally in river or through the scheme). A number of fishing methods have been observed to be more damaging to salmonids than others. For example salmon have been found to be hooked deeper with a baited worm, resulting in potential critical damage during hook retrieval. Damage during hook retrieval would also be further reduced by use of barbless hooks. Studies on rainbow trout, (Schisler *et al.* 1996), have identified a significant reduction in post release mortalities associated with fishing artificial flies as opposed to actively and passively fished artificial baits, (4% fly, 22% active, 32% passive). To minimise post release/donation mortalities may require that voluntary or mandatory controls be made restricting the use of such fishing methods.

3.3. *SPAWNING DISTRIBUTION AND CATCHMENT UTILISATION*

3.3.1. Historic and recent distributions of salmon spawning redds, (Environment Agency 1997b), are given in Figure 8. The distributions are largely restricted to the main river downstream of the confluence with the river Dever. Additional observations of river keepers have noted spawning in many of the tributaries including the Anton, Pilhill Brook, Dun and Dever. Migration into the Dun is now reduced due to a partial obstruction near to its confluence with the Test. It is important to note that the surveys of redd locations undertaken have not provided complete information on the numbers of salmon spawning. This has been due to variable in-river visibility, caused by rainfall and silt input, cutting more than one redd by pairs of salmon, and problems in distinguishing between trout and salmon redds.

3.3.2 Where salmon spawn is influenced by a number of factors which may include: the time of migration into the catchment, river flow, proximity of cover, gravel quality, obstructions, sluice control, angler effort, the presence of springs, and their origin within a catchment.

3.3.3. The available area of suitable and accessible salmon spawning habitat was estimated by qualitative visual assessment in 1996, (Environment Agency, 1997a). The habitat was assessed on the basis of depth, flow, weed cover, gravel presence and quality. The survey results are summarised in Table 9:

Table 9 : Salmon Spawning Habitat Assessment (estimated by field assessment).

	Accessible River		Potential Habitat Suitability Assessment (Hect)		
River Stretch	Length (km)	Area (Hectares)	Unsuitable for salmon	Moderate suitability	Good suitability for salmon
U/S Romsey	118	122	49 (40%)	31 (25%)	42 (35%)
D/S Romsey	11	16	9 (55%)	4 (28%)	3 (17%)
Total	129	138	58 (42%)	35 (26%)	45 (32%)

Bracketed figures refer to percentage of accessible area.

3.3.4. 80 hectares, (58%), of the total accessible habitat, (138 hectares), was estimated to be of either good or moderate suitability for salmon spawning. It was observed that this suitable habitat was all impacted by siltation and/or concretion of gravel substrates such that it can only be considered as potential spawning habitat. However, the visual estimation of habitat suitability cannot take account of water quality factors which although perceived as good may still contain factors which effect salmon. The available habitat estimate must therefore be treated with caution and as a best case scenario.

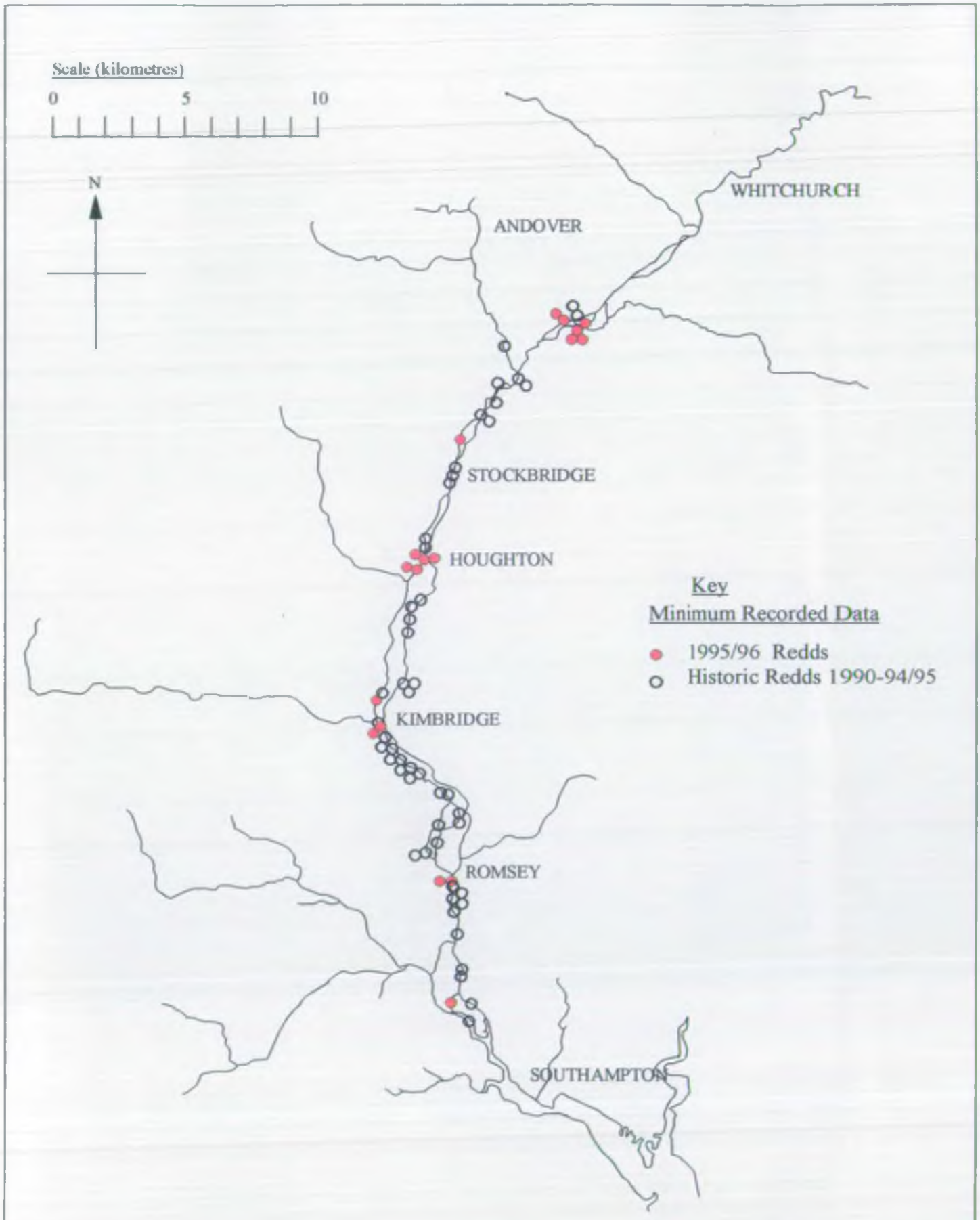


Figure 8 : Distribution of River Test Salmon Redd Sightings 1990-95/96

3.4. *EGG DEPOSITION*

3.4.1. Historic egg deposition rates have been estimated using estimates of spawning escapement, fecundity and sex ratio data and these are illustrated below in Figure 9:

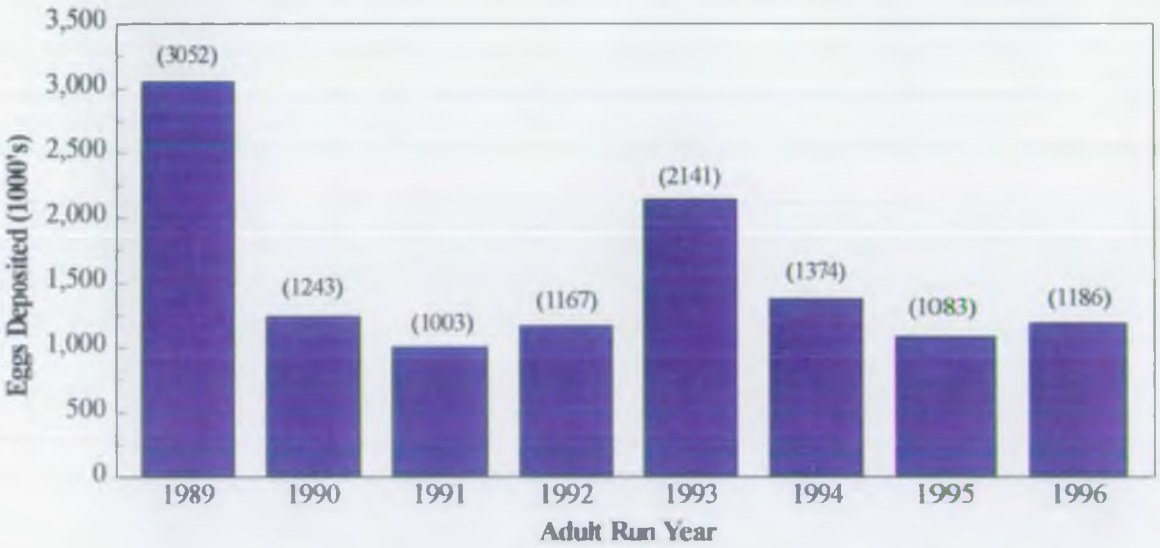


Figure 9 : Estimated Historic Egg Deposition. (Environment Agency 1997a)

- Percent females = 58%
- Fecundity eggs per female = 4673

3.5. *JUVENILE ABUNDANCE*

3.5.1. Information on juvenile abundance is relatively limited:

- A survey of 100 River Test riffle habitats, (NRA 1995b), described a significant overlap in the spatial distributions of juvenile salmon and trout, (Figures 2 & 3).
- Surveys of other stretches of the river have observed salmon parr living in pool habitats, which were not assessed during the 1995 survey.

3.5.2. Current knowledge about the habitat used by salmon parr in the River Test is limited and requires further investigation. The best evidence suggests that competition between fish probably does not limit production. However there are indications that predation or other losses may be limiting the stock. Juvenile salmon in the Test use a wide range of habitats and this in turn exposes them to increased predation pressures (discussed in Annex 1).

3.5.3. The spring smolt run is assessed annually through the operation of smolt traps at Nursling and Romsey, (Russell *et.al.* 1995). A second smaller smolt run has historically been noted to occur during the autumn months, but this has not been evaluated. Smolt trapping is performed for the following reasons:

- To determine the spring smolt run including the wild component.
- To assess the success of the broodstock programme.
- To estimate marine exploitation of Test salmon by release of micro-tagged smolts.

Mark and recapture studies are used to produce estimates of the total spring smolt run, (Table 10). Estimates of marine survival from smolt to adult are derived by relating these smolt run estimates to subsequent fish counter assessed adult run estimates, (based upon adults returning as grilse). The smolt survival estimates are suggested to be too high when compared to other rivers, (ICES data). This may be due to the under-estimation of the smolt runs owing to the Autumnal run of smolts and estimation errors combined with a possible historic over-estimation of the adult runs. As a result of this a conservation survival rate, from smolt to adult, of 5% may be more appropriate.

Table 10 : Historic Spring Smolt Run Estimates.

YEAR CLASS	EST. SMOLT RUN (MAFF DATA)	RESULTANT ADULT RUN	SMOLT TO ADULT SURVIVAL (%)**
1991	11976 (1.5)	1249	10%
1992	7131 (0.9)	775	11%
1993	3381 (0.4) *	647	19%
1994	7040 (0.9)	623	9%
1995	4517 (0.6)	DUE 1997	------

Bracketed figures are number of smolts per $100m^2$ of potential salmon habitat.

* Poor estimate due to excessive weed problems.

** Estimates based upon 100 % grilse return, given in significant MSW element.

3.5.4. The size of the wild and hatchery elements of the spring smolt run are assessed during smolt trapping by the detection of micro-tagged hatchery origin smolts. From this and the ratio of the hatchery fish tagged an estimate of the hatchery origin component of the smolt run is made, (Table 11).

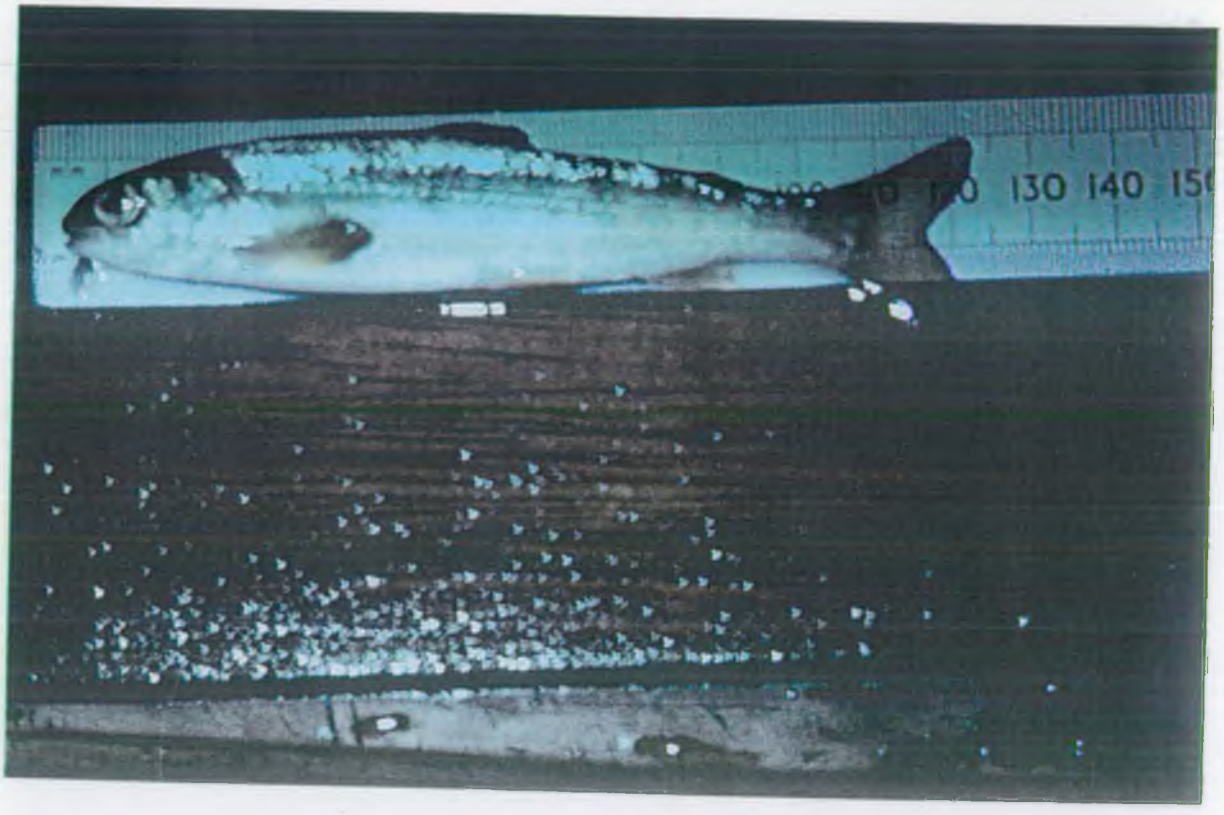


Plate VII : A Salmon smolt trapped on the River Test in late April 1996.

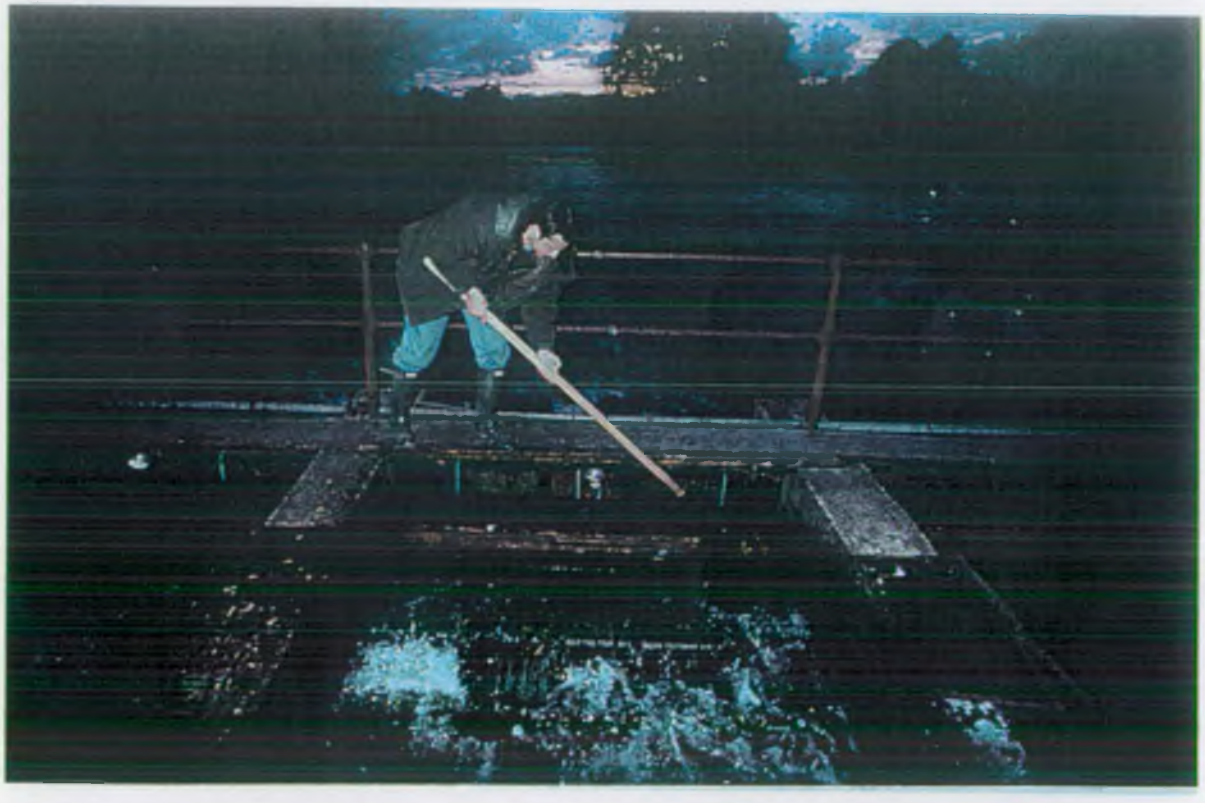


Plate VIII : Smolt trapping on the River Test.

Table 11 : Estimated broodstock programme contribution to smolt runs since 1991.

YEAR CLASS	NUMBER OF PARR STOCKED (0+)	TOTAL SMOLT RUN	STOCKED CONTRIB. %	STOCKED SMOLT RUN ELEMENT	STOCKED SURVIVAL TO SMOLT (%)*
1991	710817	11976 (1.5)	50***	5988 (0.7)***	0.8%
1992	661928	7131 (0.9)	50***	3566 (0.4)***	0.5%
1993	207628	3381 (0.4)****	50***	1691 (0.2)***	0.8%
1994	38806**	7040 (0.9)	44	3104 (0.4)	8%
1995	128000	4517 (0.6)	22	1024 (0.1)	0.8%

Bracketed figures are number of smolts per $100m^2$ of potential salmon habitat.

* Estimates based upon 100 % grilse return, given in-significant MSW element.

** Later autumnal stocking of 100% tagged parr.

*** Estimated contributions to smolt run.

**** Poor estimate due to excessive weed problems.

3.5.5. Notably the survival of the 1994 stocked juveniles to smolt was significantly higher than in the other years. This is attributed to the later autumnal stocking of parr performed in this year.

3.5.6. The initial results of a salmon parr survival study using PIT tagged stocked parr have suggested that the survival of parr stocked into the lower river may be greater than in the higher river. However this requires further investigation to confirm these differences.

3.6. *THE PROPAGATION SCHEME*

3.6.1. In the mid-1980s the fisheries and the predecessors of the Environment Agency established a collaborative stocking programme which has since developed into a joint salmon propagation scheme for the River Test. The initial stocking programme released a small number of salmon parr that were of non-Test origin, in addition to a large number of Test origin parr derived from relatively few hen fish. A broodline of Test salmon was also established in Scotland, with the progeny being transported to the Test hatchery where they were reared prior to release, (approx. 0.5M in 1991) .

3.6.2. The propagation scheme is now restricted to the use of Test origin eggs which are stripped from principally angler donated salmon, that may otherwise have been killed. These are then reared through the constrained stages in the hatchery on the River Test and progressively stocked as parr to the river from July through to the autumn.

3.6.3. Representative numbers of reared parr are routinely tagged with micro-tags and/or PIT tags providing the following essential research information for chalk stream salmon:

- To gain information on the survival of parr to the smolt stage.
- To estimate high seas fishery exploitation.
- Quantifying losses to predation in chalk streams.
- The schemes contribution to the smolt and adult runs.
- To evaluate best stocking practice.

The 1996 stocking used sequentially coded micro-tags. In previous years, batch coded tags were used for micro-tagging. The advantage of the sequential tags used in 1996 is that it enables data on the performance of individual stocking releases to be gathered. This will allow more sensitive interpretation of both the hatchery programme and stocking strategy, and thus add significant value towards the development of best practice for the River Test and other rivers. The use of sequentially coded tags will therefore be continued for future tagging operations.

3.6.4. The contribution of the scheme to the spring smolt run has been extremely variable, as described in 3.5.4. Information on the contribution of the scheme to the adult run is more limited due to the small data set of micro-tag returns from adult fish.

3.6.5. The emphasis of the scheme has changed since its implementation and is now to conserve the endangered salmon stock whilst the environmental constraints upon natural production are identified and addressed. However the use of propagation does introduce potential risks, (detailed later in Annex 2). Furthermore these risks are considered to increase with the time over which propagation continues.

3.6.6. The risks of propagation have been recognised by the Environment Agency, with the performance of hatchery schemes and the best practise for their use currently being assessed by the Agency, its collaborative partners and contractors through the Research and Development Project, "The propagation of chalk stream salmon ". The Test propagation scheme is amongst those being assessed by this project.

The initial findings of the R&D project recommend that the propagation scheme can be further enhanced and suggests preferential autumnal release of quality parr as a priority. However hatchery space is limiting leading to a batch approach to stocking-out, as the facility continually nears capacity. This overcomes the very significant egg to swim-up fry losses caused by siltation of redds and potentially reduces exposure to later in river pressures. Furthermore the costs associated with the hatchery are independent of the number of parr reared and thus no economic benefit is obtained through reduced numbers being held.

3.6.7. Continuous evaluation of the research data enables consideration of the improvement of the population numbers as the constraining factors are addressed. **The scale of the propagation scheme will be reduced as natural production improves to the point when the fisheries are self-sustainiug.**

3.6.8. Additional methods of production are also being investigated by the Environment Agency in collaboration with the fisheries, including the use of in-stream gravel incubators and protected rearing carriers. These methods may be advantageous since they overcome the constrained in-gravel stage, but may allow the action of natural selection upon parr.

PART 4 : ASSESSMENT OF STOCK AND FISHERY PERFORMANCE

4.1 *SPAWNING TARGETS*

4.1.1. The over-riding aim of the use of targets in salmon management is to provide an objective standard against which to assess the status of a river's salmon stock. There are three processes in the use of spawning targets : setting targets, estimating actual egg deposition and assessing compliance against the target. The procedures used in their calculation are described elsewhere, (Environment Agency 1997), but some general points are outlined in Annex 3.

4.1.2. Variation in egg survival in chalk stream salmon populations require such transferred targets to be used with care. However, compliance with spawning targets is a useful guide for the management of future cohort exploitation. The current levels of work and monitoring undertaken by the Agency on the Test salmon stock are considered critical to assess the use of the targets on chalk streams. The information obtained will also have significant bearing for the SAPs of other rivers, such as the Itchen, Avon and Frome.

4.1.3. The self sustaining target egg deposition for the Test catchment is 246 eggs per $100m^2$, derived from a specifically modified National standard stock recruitment curve for a low land river, based upon spring smolt survival and the egg deposition parameters given in Table 12 below.

4.1.4. Apportionment of the spawning target to the area of potential salmon habitat provides an estimate of the egg deposition necessary to sustain the stock whilst maximising potential catch levels (Table 12). It is important to note that the spawning target is specific to the life cycle factors currently acting upon the stock. Variation in these factors will result in variation in the spawning target. In consequence the current stock dominance of lower fecundity grilse results in a reduced target, by comparison to what could have historically been sustained by the then greater dominance of MSW salmon.

Table 12: Target egg deposition for spawning target compliance.

	TARGET
Spawning target egg deposition	425/100m^2 (3.4 M eggs)
Spawners required	1257
Spawning escapement	1382
Exploitable stock (rod catch)	592
Minimum Required Adult Run	1974
Parameters used to calculate above:	Potential habitat area = 80 hectares (river data) Marine Survival (to high seas fisheries) = 30% (spring smolts) Fecundity eggs per female = 4673 (mean river data) Percent Females = 58% (mean river data) In river natural mortality = 9% (national figures) Rod Exploitation = 30% (mean river data)

4.1.5. Whilst the spawning targets refer to the MBAL stock level of abundance, this is not necessarily equivalent to the stock level required for economically viable salmon fisheries. To ensure their viability, the fisheries have expressed a requirement for an exploitable rod catch of 1000 salmon, the historic catch, (with an equivalent adult run of 4000 salmon). This requirement is recognised by the Agency, however the historic runs from which the catches were taken contained significantly greater numbers of MSW salmon, (indeed there were few grilse caught on the river prior to the 1950's). The higher individual fecundity of these MSW salmon would increase the spawning target for MBAL and thus allow for the required rod catch. Therefore whilst the preliminary target for the plan is to return the current grilse stock to the estimated MBAL, the overall target is to restore the MSW element to allow for the higher catches without detriment to the stock. It is important to note that if exploitation at MBAL is greater than the exploitable stock, then this will over a period of years result in a stock decline and an eventual collapse.

4.2. *EGG TARGET - COMPLIANCE ASSESSMENT AND INTERPRETATION*

4.2.1. Estimated historic egg deposition and compliance to current egg target are given in Figure 10:

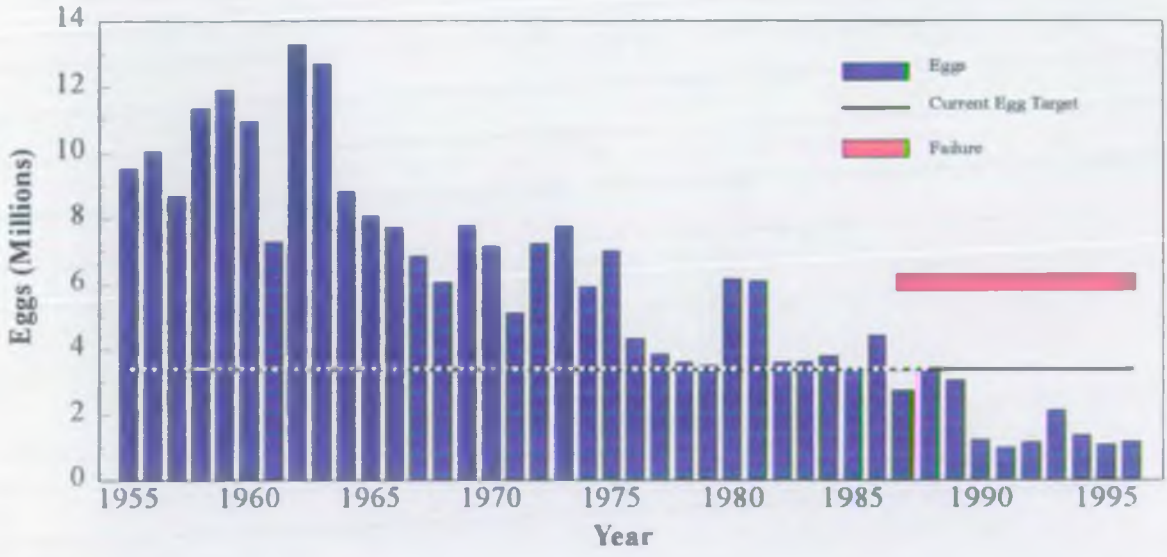


Figure 10 : Estimated salmon egg deposition and target compliance 1955-1996

4.2.2. These historic estimates should be interpreted with extreme caution due to the following assumptions made during their estimation:

- Pre-1989 runs are based upon an estimated constant exploitation rate of 30%.
- Target egg deposition parameters applied for entire period.
- The greater fecundity of the MSW element is not accounted for, egg deposition may have been higher when the population included a larger MSW component.

4.2.3. Salmon egg deposition has not complied with the MBAL target level for ten years.

4.2.4. Current egg deposition compliance is summarised in Table 13:

Table 13 : Summary of Target Egg Deposition Compliance.

Current (Total N of eggs)	Target (number of eggs)	Compliance failure within last three years
0.9 million eggs	3.4 million eggs	Yes

4.2.5. The observed shortfalls are considered highly significant in terms of the critical status of the stock. Currently there is an estimated shortfall of 2.5 million eggs being deposited in the Test. However this shortfall assumes that the available habitat is all of good quality which clearly is not the case for the Test given the observations of the habitat survey, (3.3.4., Page 16). As a result the current shortfall in egg deposition is likely to be much higher.

4.3. *RIVER TEST SMOLT RUN TARGETS*

4.3.1. To establish a self-sustaining salmon fishery on the Test requires a run of 1974 salmon. This in turn requires a run of 19740 spring smolts at 10% smolt to adult survival. It should be noted that the required smolt run would double if the conservation smolt to adult survival rate (5%) applied (3.5.3. page 18).

4.3.2. Spring smolt runs since 1992 are illustrated in Table 10, page 18, a summary of this information is given below:

Table 14 : Historic performance of spring smolt run against target.

Run Component	Smolt Run Estimates		Target	1996
	1996 Run	Mean 1991-95	Smolt run	Shortfall
Wild Component	3927	3795	19740	15813
Hatchery Component	1024	3587	N/A	N/A
Total	4951 (25%)	7382 (37%)	19740	14789

Bracketed figures are percentage of required target run.

4.3.4. Table 14 illustrates that to establish an optimal self sustaining salmon fishery, the smolt run needs to increase by 4 fold (400%) , given current spring smolt survival rates.

4.3.5. To achieve this target a key area to concentrate on is improving natural egg to smolt survival. To aid in this a number of interim smolt run targets have been set, by modelling smolt production based upon current knowledge, (Table 15). These run targets are derived from the target 0.9% egg to smolt survival necessary to produce a recovery within ten years, given current spring smolt survival, fecundity, sex ratio and exploitation estimates. Compliance with the run targets will require the enhanced restoration of further habitat to maintain the necessary overall egg to smolt survival for the increasing numbers of eggs deposited as the adult run increases with each cohort.

Table 15 : Interim egg to spring smolt survival targets.

Grilse Year Class	Eggs Deposited	Target Egg - Smolt survival %	Potential Smolt Run	Adult Return
0	1.2 M	0.9 %	11K	1064
3	1.8 M	0.9 %	16K	1648
6	2.8 M	0.9 %	26K	2561 (recovery achieved)
9	4.4 M	0.9 %	40K	3974 (1960's stock level)

The target egg deposition parameters used are given in Table 12. It must be noted that it is the adult return of each cohort year which deposits the eggs for the next, (ie. the returning grilse from cohort year 0 deposit the eggs for cohort year 3).

4.3.6. Based upon the best available information, natural egg to smolt survival is currently estimated at less than 0.3%. To achieve the target survival of 0.9% requires a 3 fold (586%) increase in egg to smolt survival as an absolute minimum. This will be used as an interim target and will be subject to further refinement.

4.3.7. Survival estimates from studies on the river Bush in Ireland put egg to smolt survival for the Bush at between 0.4 and 2.13%, (mean 1.17%, Harris 1994). On the River Itchen, MAFF and the Environment Agency has shown egg survival to be as low as 0.04%, mean egg survival is put at 2.6%. These suggest that egg to smolt survival in the River Test is poor. Poor egg survival is thought to be the major factor explaining the poor egg to smolt survival, however this requires further evaluation

4.3.8. Preliminary results from the evaluation of improvement work carried out at spawning sites on the River Itchen suggest that it may be possible to improve egg to smolt survival by at least a factor of ten, (28% survival estimated in two redds). If such an improvement was achieved for all of the spawning on the Test it could bring the smolt production close to the target level. The wider validity of this requires further investigation.

Table 16 : Potential of 28% egg to fry survival for Test salmon.

Eggs deposited	Fry produced	Spring smolt run	Improved Egg-Smolt Survival Estimate
1.2 million	336000	23520 *	2.0% (from <0.3%)

* Estimated 7% fry-smolt survival estimated based upon best evidence.

4.3.9. To initially achieve the target egg to smolt survival rate, (0.9%), requires the enhancement to the best quality yet achieved of a minimum of 11600m² of the potential spawning area and 200 spawning salmon, (116 females). This equates to about 1 km bank length of main River Test shallows, (mean width 11m). These estimates are based upon a female salmon requiring 100m² of suitable spawning habitat, allowing for spawning site selection.

To achieve the self-sustaining smolt run target of 19,740 smolts would require that 21600m² of habitat be enhanced to the best standard yet achieved and 372 spawning salmon, (216 females). This equates to about 2 km bank length of main River Test shallows and represents less than 5% of the potentially good spawning habitat available.

It is important to note that these models assume that no other factors limit the survival of fry to smolt. This seems unlikely and so as a precautionary measure it may be justified to double the area required to be improved to allow for this. The modelling also does not account for changes in rod exploitation, production from the propagation scheme, or non-spring running smolts. The scheme contribution represents production from rod caught salmon that may otherwise have been killed or have spawned naturally in the constrained habitat if released. This contribution and any beneficial changes to exploitation should increase the stock recovery rate, whilst sufficient habitat is improved for increased natural spawning.

4.4 *FISHERY PERFORMANCE AT TARGET SPAWNING LEVELS*

4.4.1. Estimates of the expected exploitation, (at current rates), are given in Table 17.

Table 17 : Expected Catch at Target Spawning Level

	Catch		Difference	Difference Values (£)
	Expected	1996	1996	1996
Irish nets	3948	1139	2809	£118K
Rod catch	592	146	446	£4M to fishery + £4M to angler
Spawners	1257	437	820	N/A

- Expected exploitation is based upon 1995 stock catch rates.
- Nets shortfall values are based upon a 60% nett profit on 2.5 kg salmon at £4 per kilogramme which is capitalised for a 10 year period, (multiplied by a factor of 7).
- Rod catch shortfall values are based upon the fishery nett economic value, (Table 4).
- The shortfall values are based upon current economic values for salmon which may vary with increasing stock levels, but this variation cannot currently be estimated.

4.4.2. Compliance with the spawning target should ensure a sustainable 3½ rise in current rod catches, representing rises of £4M to the market value of the fishery to the owners and £4M to the angler consumers' surplus over the 10 year period.

4.5. *DIVERSITY AND FITNESS*

4.5.1. Chalk stream salmon will have evolved specific genetic characteristics appropriate to their particular freshwater environment. This is likely to provide fitness for time of spawning, predator avoidance, food acquisition, migrating ability, disease resistance and as yet unknown requirements.

4.5.2. It is recognised that the propagation scheme introduces a number of risks, (detailed in Annex 2), although scientific opinion is divided over the extent of any genetic impact.

However, an evaluation by Campton (1995), suggests that "many of the problems attributed to hatcheries and hatchery fish may be solvable (or circumvented) by implementing fishery and hatchery management practices that follow established guidelines for conserving genetic resources". Best practices have been and continue to be identified and implemented within the propagation scheme. Yet the significance of these risks to the stock still require evaluation by further investigation and may require action if any of the risks were realised.

Analysis of the genetic make up of the Test salmon stock indicates that it may have been modified by historic introductions of non Test parr. Theoretically any alteration of the Test salmon genetics may compromise the stock's fitness for the characteristics of a southern chalk stream environment. However this cannot be determined absolutely, due to the difficulty in distinguishing between whether biological anomalies, (eg. natural selection), or stocking are the causal genetic effects, and how such alterations are expressed in terms of fitness.

4.5.3. Recent salmon genetic analyses have suggested that the potential for MSW salmon may be inherent within all Atlantic salmon stocks. However, the active preservation of MSW salmon is considered important as NASCO have made their preservation an international priority for salmon management. Furthermore in terms of promoting a stock recovery MSW fish are predominantly female and being larger in size deposit larger and significantly more eggs. The higher the MSW component of the spawning escapement the greater the potential for sustaining the stock.

4.5.4. Measures are proposed to preserve the MSW element of the stock, using the most efficient methods available at the time in terms of exploitation controls and maximised production:

- The stocking of MSW progeny to the best habitat locations with regard to environment, competition and predation pressures.
- Protection of the MSW element by controls upon exploitation. Exploitation by rods is already restricted to the use of artificial fly and lure only between March 14 and June 16, as a provision to protect MSW fish.

PART 5 : LIMITING FACTORS

The factors which limit salmon production can be broadly categorised into those occurring during the freshwater and marine phases of the salmon life cycle. It is essential that the limiting factors are managed to either limit or rectify their effects to enable the salmon stock to recover.

5.1. *FRESHWATER PHASE*

5.1.1. The freshwater phase of the life cycle of a salmon is much more within the control of the Environment Agency and the riparian owners. Whilst marine factors may exert significant effects, the greatest potential for positive management of the stock is in the freshwater phase.

5.1.2. The key factors considered to limit the freshwater phase of Test salmon are given in Table 18:

Table 18 : Risk factors which may limit salmon during the freshwater phase.

Factor	Priority to address	Life stage effected
Siltation/Compaction/ Concretion of gravels.	1.	Adult - Spawning gravel selection. Eggs - In-gravel survival.
Low Flow/Velocity (Physical Habitat)	2.	Eggs - In-gravel survival. Parr - Constrained habitat use leading to competition and predation. Adult - Obstruction to migration, possible mortalities, enhanced exploitation.
Exploitation - Illegal estuarine net catch, (Rods - reduced)	3.	Eggs - Loss of eggs for deposition.
Predation - Avian and Piscivorous (recent increased pressure)	4.	Parr - River clarity enables avian predation. Pool habitat usage exposes parr to large piscivorous predators.
Entrapment - during migrations.	5.	Smolt - Mortalities during migration. Adult - Obstruction to migration, possible mortalities, enhanced exploitation.
Competition - Between salmon and with trout.	6.	Parr - Out competed into less suitable pool habitats where survival is lowered.
Stock fitness (inc. genetics)	7.	All - Low fitness may lower survival through any stage and in restricted stocks can lead to stock extinction by adaptive failure.

5.1.3. Any actions derived to address these factors will feed into the international arena to promote control of the marine phase.

5.2. *MARINE PHASE*

5.2.1 Natural mortality: Advice to NASCO suggests that natural mortality during the marine phase, although variable, has increased 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 strongly related to the availability of ocean at temperatures preferred by salmon (6-8 deg. C). The amount of such suitable thermal habitat has been lower in the 1980s and 1990s than during the 1970s (Reddin and Friedland 1996).

5.2.2 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 Greenland vessels fish it and the catch has been 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 and have been declining. About 15% of the catch is thought to be derived from rivers in England and Wales. In 1993 and 1994, the fishery did not operate, netsmen being paid not to fish. As a result about 5000 additional multi-sea-winter salmon are estimated to have returned to England and Wales in each subsequent year (Potter 1996). In 1995 and 1996, catches in the fishery were 81 and 70 tonnes respectively.

5.2.3 Faroes fishery: Also developed in the 1960s, this fishery uses 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 only about 5 tonnes a year. Potter (1996) estimated that for England and Wales an additional extra 1200 salmon (including 750 grilse) would annually return to home waters due to the reduction in the fishery.

5.2.4 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.

5.2.5 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, (Figure 6). This coincided with the expansion of a coastal drift net fishery. About three-quarters of the Irish salmon catch, some 700 tonnes in 1995, is currently taken by the drift nets, (Salmon Management Task Force, (1996). 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) about 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, as previously described in 2.1.6. These measures may reduce exploitation on English and Welsh stocks. However, there is no intention, as yet, to phase out this mixed stock fishery.

Plate IX : An Agency Inspector on an Anti-poaching Patrol.

Plate X : In-stream egg incubators.

PART 6 : ISSUES AND ACTIONS

6.1. The proposed options for action to address the salmon decline and promote the required recovery are given in Table 19.

6.2. It is identified that for a recovery to occur requires extensive spawning and parr habitat improvements to be undertaken. It is proposed that these improvements be made collaboratively within a seven year period to enable enough habitat to be made available for a potential ten year stock recovery. However it must be noted that the required recovery is likely to take longer than this period, due to the variable effects of both exploitation and natural factors upon the recovering population.

6.3. The Environment Agency will continue the following projects and activities whilst monitoring data justifies their continuation :

- Habitat Enhancement & their assessment (in collaboration with riparian owners)
- Fish Counters
- Smolt Trapping (in collaboration with CEFAS)
- Propagation Scheme (in partnership with fishery owners & anglers)
- Micro-tagging (in partnership with CEFAS)
- Radio-tracking (in partnership with Agency Water Resources)
- Spawning Assessment (in collaboration with CEFAS)
- Fish Pass Maintenance
- Juvenile Surveys
- Enforcement Operations (in collaboration with other Regulators)
- Migration entrapment studies, (smolt & spawning migrations)

These projects and activities will be annually reviewed.

6.4. The following Research and Development projects are proposed:

- Effective sediment management for chalk streams.
- Weed growth and management best practice for sustainable fisheries.
- The effects of nutrient enrichment on chalk streams.
- Automation of gravel cleaning.
- Cost effective large scale river enhancement for salmon populations.
- Efficiency of egg incubators and their application.
- Predation and its impact upon native and stocked populations.
- Efficiency of semi-protected spawning/nursery carriers and their application.
- Investigation of natural trout production.

Table 19 (a) - Issues and proposed actions (for consultation purposes) .

ISSUE	LIMITING FACTORS	OPTIONS	RESPONSIBILITY	COST £K	PRIORITY
Egg deposition currently 84 % below target level.	Inadequate spawning escapement	1. Promotion of catch and release to river & broodtank.	Fishery Owners, Anglers, (Agency Fisheries)	5 per annum *0 per annum*	H
		2. Increase proportion of catch released to river.	Fishery Owners, Anglers, (Agency Fisheries)	5 per annum *0 per annum*	H
		3. Intelligence driven Anti-poaching patrols	Agency, Fishery Owners, Anglers, Public.	15 per annum *5 per annum*	H
	Rod exploitation rate too high (nett exploitation in 1996 was 3%).	1. Promote voluntary measures to control rod catch.	Fishery Owners, Anglers, (Agency Fisheries)	5 per annum *0 per annum*	H
		2. Seek to ensure that rod caught fish are returned alive or contributed to broodstock.	Fishery Owners, Anglers, (Agency Fisheries)	5 per annum *0 per annum*	H
		3. Introduce byelaws banning the use of barbed hooks and worm as a bait.	Agency Fisheries (Fishery Owners, Anglers)	5 per annum *0 per annum*	M
		4. Introduce byelaw restricting fishing method to artificial fly only.	Agency Fisheries (Fishery Owners, Anglers)	5 per annum *0 per annum*	L
		5. Introduce byelaw reducing season length, introducing bag and/or weekly limits.	Agency Fisheries (Fishery Owners, Anglers)	5 per annum *0 per annum*	L

NB - Costs are estimated option cost, *Italicized text is fisheries current expenditure for this activity.*

Table 19 (b) - Issues and proposed actions (for consultation purposes)

ISSUE	LIMITING FACTORS	OPTIONS	RESPONSIBILITY	COST £K	PRIORITY
Egg deposition currently 84 % below target level.	Low kelt derived Multiple Spawning Salmon contribution.	1. Investigation of the factors effecting kelt survival.	Agency Fisheries,	15 K (project)	M
	Entrapment at obstructions.	1. Flow management to divert adults through un-obstructed channels.	Agency Flood Defence & Water Resources, Fishery Owners, (Agency Fisheries).	10 per annum *0 per annum*	M
		2. Fish pass construction	Sponsorship, (Agency)	10 - 100 + (projects)	L
	Disease	1. Wild fish disease investigation.	CEFAS (Weymouth)	N/A	H
In-gravel egg survival currently 64% below target level.	Low habitat availability due to silt load, continued ingress, and gravel concretion.	1. Clean 8500m^2 of gravel habitat per annum.	Fishery Owners, Anglers, Agency Fisheries.	23 per annum *7 per annum*	H
		2. Land use management schemes.	EN, Land Owners, CLA, NFU, ADAS, MAFF.	N/A	H
		3. Promote the use of buffer strips.	Fishery Owners, MAFF, ADAS, NFU, EN, CLA, Agency	10 per annum *0 per annum*	M
	Continued silt ingress into the system due to land use changes.	1. Actions from results of Geomorpholgiocal survey.	Agency Water Quality, MAFF, ADAS, NFU, Riparian owners, CLA. (Agency Fisheries)	15 per annum *0 per annum*	H

NB - Costs are estimated option cost, *Italicized text is fisheries current expenditure for this activity.*

Table 19 (c) - Issues and proposed actions (for consultation purposes)

ISSUE	LIMITING FACTORS	OPTIONS	RESPONSIBILITY	COST £K	PRIORITY
In-gravel egg survival currently 64% below target level.	Continued silt ingress into the system due to land use changes.	2. Reduce soil run off by promotion of soil conservation.	AgencyWater Quality, MAFF, ADAS, NFU, Riparian owners, CLA. (Agency Fisheries)	15 per annum *0 per annum*	H
		3. Land use management schemes.	EN, Land Owners, CLA, NFU, ADAS, MAFF.	N/A	H
	Insufficient flow to maintain self-cleaning gravel.	1. Survey of catchment Geomorphology to produce action plan.	Agency Water Resources & Fisheries	N/A Project (25K est.)	H
		2. Enhance the flow of 8500m^2 of habitat per annum.	Fishery owners,Anglers, Agency Water Resources & Fisheries	119 per annum *28 per annum*	H
		3. Maintain adequate flow distribution by promotion of channel management.	Agency Flood Defence, Fishery owners,(Agency Fisheries)	5 per annum *0 per annum*	H
		4. Assess nutrient loading by commercial discharges and subsequent effects on weed growth.	Agency Water Quality & Fisheries	15 (project)	M
Uncertainty about longevity of enhancement benefit.	Subsequent silt ingress progressively reducing benefit	1. Undertake temporal validation of enhancement.	Agency & CEFAS	3 per annum *0 per annum*	M

NB - Costs are estimated option cost, *Italicized text is fisheries current expenditure for this activity.*

Table 19 (d) - Issues and proposed actions (for consultation purposes)

ISSUE	LIMITING FACTORS	OPTIONS	RESPONSIBILITY	COST £K	PRIORITY
Lower fitness of Test stock.	Naivety to wild conditions upon release.	I. Exposure of hatchery fish to "natural" conditions within the hatchery or protected carrier/raceway	Fishery Owners, Agency.	15 (project)	M
	Genetic modification of stock.	1. Reduce hatchery production as stock recovers.	Fishery Owners, Agency.	0 per annum	H
		2. Investigation of in-stream egg incubators.	Agency R&D Project, CEFAS	10 per annum *0 per annum*	H
		3. Identify potential genetic donor stock.	CEFAS, Agency	5 (project)	M
Smolt output currently 85% below target	Nursery habitat abundance.	I. Maximise associated benefits of spawning enhancements.	Agency, Fishery Owners.	5 per annum *0 per annum*	H
Smolt output currently 85% below target	Nursery habitat abundance.	2. Rear parr in suitably managed proteeted carrier.	Fishery Owners, Agency	To be assessed.	H
		3. Assess available habitat by Habscore.	Agency Water Resources & Fisheries	10 (project)	M
		4. Undertake nursery habitat enhancement	Fishery Owners, Agency	Subject to Habscore (3.)	M

NB - Costs are estimated option cost, *Italicized text is fisheries current expenditure for this activity.*

Table 19 (e) - Issues and proposed actions (for consultation purposes)

ISSUE	LIMITING FACTORS	OPTIONS	RESPONSIBILITY	COST £K	PRIORITY
Smolt output currently 85% below target	Intra- and Inter-species resource competition.	1. Assess impacts of : • Predation. • Stocked salmon.	Fishery Owners, Agency R&D Project	15 (project)	L
		2. Review trout stocking practices.	Fishery Owners, Agency	5 (project)	L
		3. Restrict salmon access from areas of high competition.	Agency, Fishery Owners	Subject to impact assessment.	L
	Smolt entrapment.	1. Screening of artificial abstraction channels or conduits feeding water, canal, mill or fish farm businesses (Sch. 15 Environment Act).	Specific abstractors before 1999, Fishery Owners (Agency Water Resources & Flood Defence).	N/A	H
Marine return currently 83% below target.	Excessive marine exploitation.	1. Seek limitations upon appropriate marine fisheries.	Agency, CEFAS, Fishery Owners, Public	5 per annum *0 per annum*	H
	Coastal Poaching	1. Intelligence driven Anti-poaching patrols.	Agency,Netsmen,Public, Sea Fisheries Comm.	15 per annum *5 per annum*	M

NB - Costs are estimated option cost, *Italicized text is fisheries current expenditure for this activity.*

6.5. The Environment Agency is committed to continuing its work in collaboration with the Hampshire Salmon Sub- group and recognises the collaborative benefits derived from this partnership.

PART 7 : FUNDING THE PLAN

At present, the income to fund Agency work in migratory salmonid fisheries is obtained from rod and net licence duties, Grant-in-Aid and, to a very limited extent, rechargeable services. Of these Grant-in-Aid is to fund 82% of the planned national expenditure on salmon and sea trout fisheries in 1997/8. However, the level of this public funding has been halved in recent years, and continues to decline with a 5% reduction having been announced for 1997/8. On the Test, income from fishing licences is estimated to amount to only £3000. Therefore to ensure the success of the plan, other funding sources need to be identified and utilised, with a further need to identify how these sources can contribute either in partnership or independently.

7.1 *CURRENT EXPENDITURE*

7.1.1. A breakdown of current Agency expenditure on the salmon fisheries is given in Table 20:

Table 20 : Hampshire Fisheries Expenditure on the River Test Salmon Fisheries.

Process	Cost	Source
Enforcement	£15K	Licence Revenue G.I.A.
Monitoring	£25K (+£25K W.R.)	Licence Revenue G.I.A. Water Resources
Research	£19K (+£5K W.R.)	G.I.A. Water Resources
Enhancement	£35K	G.I.A.
Propagation	£26K	G.I.A.

Total £160K

7.1.2. The water resource investigations are providing important additional collaborative contributions to the salmon work on the River Test, (£30K).

7.2. *COST BENEFIT ANALYSIS OF ACTIONS.*

7.2.1. The costs and benefits to the stock recovery of addressing the limiting factors for the Test salmon stock over a ten year period are estimated in Table 21:

Table 21 : Cost/Benefit assessment of resolving limiting factors

Factor	Cost (£)	Recovery Benefit	Economic Benefit	Economic Beneficiaries
Historic Siltation, Concretion & Low Habitat Availability (Spawning & Parr)	£838K (enhance flows) £162K (gravel cleaning)	V. High (70%)	£3M market value. £3M A.C. surplus.	Fishery owners Salmon anglers
Future Siltation	£250K	High (50%)	£2M market value. £2M A.C. surplus.	Fishery owners Salmon anglers
Excessive Exploitation	£400K	High (30%)	£1M market value. £1M A.C. surplus.	Fishery owners Salmon anglers
Predation & Competition	£45K	Medium (15%)	<£1M market value. <£1M A.C. surplus.	Fishery owners Salmon anglers
Smolt Entrapment	Costs of screens	Medium (15%)	<£1M market value. <£1M A.C. surplus.	Fishery owners Salmon anglers
Adult Entrapment	£40K	Medium (15%)	<£1M market value. <£1M A.C. surplus.	Fishery owners Salmon anglers
Lower Fitness	£70K	Medium (15%)	<£1M market value. <£1M A.C. surplus.	Fishery owners Salmon anglers

Bracketed figures refer to estimated benefit as a percentage of recovery achievable by rectifying a single factor with others remaining constant.

It is recommended that priority is given to addressing the very high and high, benefit factors.

7.2.2. The benefits derived from the plan will be :-

- The value to the Agency of meeting both its statutory duties to maintain, develop and improve the fisheries resources and its obligations to NASCO.
- The conservation value in terms of preserving an Annex 2 listed species and an important element of the bio-diversity of the river, thus meeting both the Agency and the Government duties under the EC Bio-diversity Directive.
- The value of research information obtained for the benefit of the international management of other salmon stocks, (potentially applicable to non-salmon stocks).
- Preservation and enhancement of the heritage value of the salmon fishery management practices on the river.
- The value of the collaboration between the Agency and the riparian owners, enabling better customer service and potential for more amenable future collaboration on necessary projects.
- The international value to the country of preserving the salmon fishery on an internationally famous salmonid river.

In examining the Cost Benefit of the plan it is also clear that in absolute monetary terms, the £3 million cost over 10 years is significantly outweighed by the economic value developed:

- £4 million in market value of fisheries to fishery owners.
- £4 million to the anglers consumer surplus.

7.3. *REQUIRED FUNDING*

7.3.1. The funding required to enable the actions in addition to the work programme are as follows:

Table 22 : Required Funding for River Test Action Plan.

	Annual Funding	Total Cost	Benefit (economic only)
Current Expenditure	£160K	£1.6M	£1.1M (2¼ : 1)
Additional Action Expenditure	£170K	£1.7M	£7.4M (4 : 1)
Total	£330K	£3.3M	£8.5M (3 : 1)
Riparian Exp.- direct in-direct	£70K £130K	£0.7M £1.3M	

Bracketed Figures refer to Benefit : Cost ratio of a 10 year recovery programme.

7.3.2. The current expenditure on the River Test Salmon Fisheries is 44% of the fisheries area budget, although some of this is met by cross function funding from Water Resources (to fund the minimum flow investigation) and additional Grant in Aid bids.

7.3.3. Implementation of the proposed actions would require 92% of the area budget to be spent on the salmon fisheries of the River Test. This is not feasible due to the other duties of the Area but highlights the need for additional funding to be sought.

7.3.4. A strategic investment plan is required to ensure the continued commitment to future expenditure upon the salmon fisheries by the riparian owners of the River Test. The lack of such planned investment results in uncertainty and risks reducing pro-active and collaborative benefits between the Agency and its partners.

7.4. *FUTURE FUNDING SOURCES*

7.4.1. It is proposed that new sources of funding/resource are sought to enable the plan to be implemented. Initial sources to be investigated include:

- Secure priority allocation of MAFF Grant-in-Aid.
- Further cross funding by other Agency functions.
- Partnership/sponsorship funding and joint ventures with fishery owners and industry.
- The National Lottery Millennium funds.
- The European Union on the basis of the Habitat Directive.
- Licensing Revenues.
- Cost recovery.
- Service charges.

7.4.2. The Hampshire Salmon Trust has been formed to enable external funds to be utilised in suitable partnership operations with the Test & Itchen Association. The four trustees of which include the Secretary of the Test & Itchen Association and the Hampshire Area Manager of the Environment Agency.

7.4.3. In addition to direct funding other methods are being investigated to maximise any benefits to the fisheries of other works being carried out in the system. Such methods may include:

- Mitigation works and conditions on any detrimental consent.
- Additional benefits from associated works.
- Changes to working practices to lower potential impacts and maximise benefits to the fisheries.
- Other sources as they become available.

PART 8 : CONSULTATION PLAN

Stage	Timescale
Draft to internal consultation	14th February 1997
Presented to Salmon Sub-Group	17th February 1997
Responses from 1st consultation	28th February 1997
Agreed with Nat.Salmon Group	17th March 1997
Final Consultation Draft produced	28th March 1997
Press launch to Public	17th April 1997
Responses from Public	30th May 1997
Launch of Final Document	7th July 1997 (week commencing)

Consultation List :
- Environment Agency Staff.
- Test Riparian Owners.
- Salmon Fishing Interests
- CEFAS
- Local Government.
- General Public

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Glossary Of Terms

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.These juveniles are stocked into the river to conserve the production of juveniles where identified as a limiting factor in increasing smolt production.

Buffer strips : areas adjacent to the river channel where natural vegetation is allowed to thrive, thereby reducing the chemical and particulate (silt) elements of surface water runoff from surrounding land entering the river.

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.

Cohort : a year class of the population, from egg deposited to returning spawner.

Concretion : calcification of gravel, leading to an effect not unlike concrete in the top layer of the river bed. Concretion severely impairs the digging of redds by spawning salmon.

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.

Egg incubators : in stream egg incubator boxes used to incubate salmon eggs to the stage of swim-up fry (independent). Their use eases the problems of poor natural survival in spawning gravels until mitigation is achieved. Cheap in capital terms, though labour intensive.

Entrapment : the trapping and/or delay of smolts and/or adults by structures or channel features, leading to death or delays in migration.

Escapement : the stock remaining after exploitation.

Extant : when applied to fish stocks (eg. extant stock), refers to the total population of that year class/cohort at any point in time.

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

Fertility : the number/proportion of fertile eggs produced by one mature female.

Fitness : specific genetic adaptation to a particular environment. Propagation, influx of non native genotypes, and changing environmental conditions may lower the natural 'inbuilt' suitability of chalk stream salmon for their environment.

Fry : juvenile lifestage between alevin and parr, where the alevin becomes free-swimming and actively hunts for food.

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

Hampshire Salmon Investigation : a project initiated by the NRA and supported by the Environment Agency, involved with the relationships between river discharge and migration of salmon. Studies use data from both fish counters and radio tracking, funded by the area water resources function.

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

MAFF : the Ministry of Agriculture, Fisheries and Food.

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

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

NASCO : North Atlantic Salmon Conservation Organisation. A convention of signatories including all North Atlantic countries with salmon interests, which advises and formulates policy on the management/exploitation of salmon stocks. As a member of the EU, the UK is represented by their delegation to NASCO.

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

PIT tag : Passive Integrated Transponding tag. A cylindrical glass tag, 11mm long and 2mm diameter, using one of 35,000 million different codes to allow permanent, unambiguous identification of individual fish. Tags are injected into the body cavity or muscle tissue, and subsequently read without harm to the fish.

Precautionary Principle : Set out by the Rio Declaration as :

> *"When there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost effective measures to prevent environmental degradation."*

Redd : A salmon 'nest' in the 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 : lifestage 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.

SSSI : Site of Special Scientific Interest. A designation, administered by English Nature, intended to conserve the biological interest of a given site through legal restrictions on development/management practices.

Straying : the habit of some salmon to return to rivers other than that of their parent stock.

Substrate : the composition of the river bed.

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

Year Class : the population of salmon, of all life stages, resulting from one years spawning.

ANNEX ONE
RIVER TEST CATCHMENT STATISTICS

Catchment Factor	Statistic
Surface Catchment Area	1250.3 sq.km.
Length of River - Test source to sea **Catchment (inc. channels)**	60 km 263 km
Topography	297 m AOD Maximum Level 0 m AOD Minimum Level
Geology	Chalk (upstream of Kimbridge) Tertiaries (downstream of Kimbridge)
Estimated Catchment Population	300,000
Water Resources - Rainfall **- River Flow** **- Public Water Abstraction** **- Industrial Abstraction** **(includes Agricultural)**	823 mm/yr (mean Upper catchment) 1096 Ml/d (mean daily flow) 62 Ml/d (Groundwater) 136 Ml/d (Surface water) 168 Ml/d (Groundwater) 3 Ml/d (Surface Water)
Water Quality Designations (GQA)	A - 34 % B - 49 % C - 15% D - 2%

Figures quoted from Environment Agency (1996b) and NRA (1993)

ANNEX TWO
COMPETITION AND PREDATION

Competition within salmonid communities for food resource and individual territory niches is well documented, (Shaw, 1839; Lindroth, 1955; Saunders & Gee, 1964; Jones, 1975; Wankowski & Thorpe, 1979; Kennedy & Strange, 1986; Hearn, 1987; Huntingford *et al.*, 1988; Bird *et al.*, 1995). Competition between juvenile salmon has been reported, (Wankowski & Thorpe, 1979), to be a function of food acquisition which was related to water velocity and swimming ability. This competition resulted in larger juvenile salmon out-competing smaller individuals for preferred velocity habitats by means of better swimming ability due to their larger size.

Where salmon and trout co-exist, it has been suggested that juvenile trout out-compete salmon, with salmon being displaced to niches with either higher or lower water velocities, (riffles or pools), than preferred. However, it has been identified, (Nilsson, 1967; Kennedy & Strange, 1986; Heggenes, 1990;1991) that in the absence of juvenile trout, juvenile salmon occupied habitats with a wide range of depths and slower water velocities. In the Test juvenile salmon have also been observed occupying similar habitats to these. This suggests that inter-species competition may not be a significant factor. The densities of both juvenile trout and salmon are also considered as low, (trout tending to be stocked as 1+), further supporting this suggestion.

Predation of juvenile salmon is also well documented, (Mills, 1964; Environment Agency, 1995c; Ibbotson, 1996), with both avian and piscivorous predation being observed. Avian predation has received a lot of press in recent years with the focus of attention being placed upon predation by cormorants, which is currently being assessed by a Research and Development Project.

Piscivorous predation is not currently being assessed to the same extent, although local studies have been undertaken, (Ibbotson, 1996), which have found juvenile salmon to be taken by a wide variety of the fish species present including pike, eels and trout. These predators tend to occupy glide and pool habitats which have slower water velocities than riffles, (Kennedy & Strange 1986; Bird *et al.*, 1995).

Notably the absence of displacement pressures from competition with juvenile trout may therefore expose the juvenile salmon to increased pressure from predation by the predators that inhabit their preferred habitats. This suggests that the absence of competition may constrain the population due to the increased pressure of predation. The effects of competition and predation upon the juvenile salmon of the River Test requires further investigation.

Mills, (1964) found that predation by trout on recently stocked salmon fry accounted for a very high proportion of the observed losses. It was suggested that this predation occurred whilst the fry were establishing their niche territories. Such predation may have a significant implications for stocking practice. This has led to the adoption of a scatter stocking approach by the propagation scheme, which Crisp (1995) found to give better post stocking survival rates than a point stocking, (27% as opposed to between 14% and 19%).

ANNEX THREE
THE RISKS OF PROPAGATION

The propagation of salmon provides an opportunity for the immeadiate removal of an in river pressure on the life cycle of salmon. However, a wdie range of international experience and research has shown that it carries its own significant limitations and associated risks.

The risks are considered to be:

- In-breeding which can result in the lowering of the stocks genetic variability, (Ståhl 1983), and hetero zygocity, (Cross 1989). Genetic hetero zygocity can be considered to be a measure of the stocks fitness to adapt to overcome problems. The dangers of potential in-breeding are greatest in small populations, such as the Test salmon and within propagation schemes, where the probability that two salmon are closely related is greatest due to the smaller genetic pool of salmon available for pairing. Ståhl 1983 found that the average hetero zygocity was reduced by 20% within hatchery stocks.

- Reduction in the effective wild parent population, leading to in-breeding and a reduction in the genetic variability of natural production.

- Hatchery management, selection and environment leading to the lowering of stock fitness and the production of fish maladapted for establishing a self-sustaining stock, (Flagg *et al.* 1995). Stock fitness may be altered by the preservation of unfit parr from the action of natural selection and the "domestication" of parr by rearing in un-natural culture conditions resulting in poor survival when released.

- The larger cultured size of stocked parr on release placing wild parr at a competitive disadvantage, (Flagg *et al.* 1995).

- Extensive stockings of parr in numbers that may be greater than the habitat carrying capacity of the river, which is currently unknown.

- The potential for major losses to stock production due to broodstock mortalities with a large proportion of the stock retained in a single broodstock unit.

- Lack of knowledge on the effects of propagation, resulting in risks of as yet unidentified factors.

ANNEX FOUR
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 sine 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, 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 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 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 an 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 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 S-R curves are 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.