

A STRATEGY FOR THE MANAGEMENT OF
SALMON
IN ENGLAND & WALES

F E B R U A R Y 1 9 9 6



NRA

National Rivers Authority

Guardians of
the Water Environment

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SUMMARY

- The purpose of this document is to provide for the first time a national Strategy for the management of salmon fisheries in England and Wales.
- Although this Strategy has been developed by the NRA, responsibility for its implementation will pass to the Environment Agency from April 1st 1996. This new body will inherit from the NRA the existing duties and powers relating to salmon but will also be subject to a cost benefit duty and Government's guidance on sustainable development. This new legislation, contained within the Environment Act 1995, will undoubtedly influence future salmon management.
- It sets out four clear objectives for the future management of this resource and outlines how these could be achieved in practice. These are 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.**
- The Strategy provides a new approach to salmon management driven by the setting of targets, monitoring of stocks and performance of fisheries.
- Such an approach cannot, on its own, guarantee the number of salmon returning to individual rivers in a particular year. There is increasing evidence that numbers of salmon vary considerably from year to year as a result of natural factors, both in freshwater and the sea.
- What the NRA and others can do is to monitor and manage effectively salmon stocks and fisheries in home waters in an attempt to optimise the potential of individual river catchments and hence the national resource. This requires a rational framework of policies, objectives and procedures which this Strategy attempts to provide.
- In addition to enabling better management of salmon within the NRA's area of jurisdiction, it is hoped that the Strategy will also help to improve the contribution that the United Kingdom makes to international salmon management.
- The successful implementation of the Strategy will require the full participation of all those involved in the management and exploitation of salmon and their willingness to contribute the necessary resources. Government should continue to fund law enforcement activities and the repair of historic and unattributable damage relating to salmon fisheries, as well as to pay for the direct and indirect benefits the public receives from salmon. In addition, EC funding for salmon management activities might become available given the special protection afforded to salmon by the EC Habitats Directive.
- The Strategy will need to be reviewed regularly and altered if there is a requirement to do so.

S A L M O N M A N A G E M E N T S T R A T E G Y

ENVIRONMENT AGENCY



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INTRODUCTION

The primary aim of this NRA document is to propose clear objectives and recommend a strategy for the future management of salmon in England and Wales. However, it is hoped that it could also contribute to future strategies which might be developed for the British Isles or even the North East Atlantic.

The NRA has a duty, under the Water Resources Act 1991, to maintain, improve and develop the salmon, trout, freshwater and eel fisheries under its jurisdiction. It also has a duty to regulate these fisheries and prevent their illegal exploitation. The majority of the NRA's powers to regulate and protect fisheries are defined in the Salmon and Freshwater Fisheries Act 1975, supplemented by the Salmon Act 1986. The NRA also has powers to: help ensure the unobstructed migration of salmon and sea trout from the sea to their spawning grounds; 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 (Section 142 Orders).

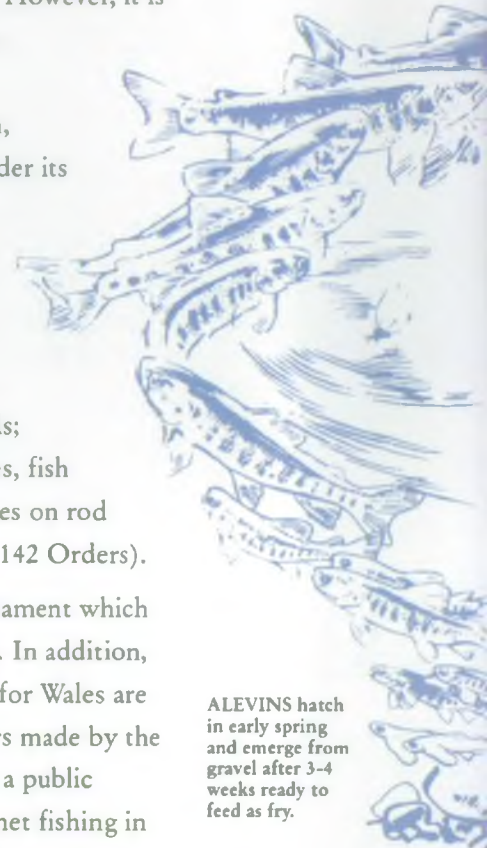
Although the NRA provides the operational fisheries service, it is Parliament which sets the statutory framework within which these fisheries are managed. In addition, the Minister of Agriculture, Fisheries and Food and Secretary of State for Wales are required to consider all new fishery byelaws and Net Limitation Orders made by the NRA. They have the power to approve or reject them with or without a public inquiry. They must also approve changes to licence duties for rod and net fishing in cases where proposed duties have attracted formal objections.

However, it is not just the NRA and Government which protect and manage the salmon resource. Many other bodies and organisations play a vital role. These include individual anglers and netmen, fishery owners, fishery associations and clubs, the NRA's Fisheries Advisory Committees, the Salmon and Trout Association, the Atlantic Salmon Trust, other enforcement agencies such as the Police, the Water Companies, the media and not least the public. The ultimate success of this Salmon Management Strategy will depend on effective liaison with these groups and the support of all concerned.

The Atlantic salmon has a complex life history, spawning and spending its early life in freshwater, making long migrations to its sea feeding grounds and returning again to spawn in its natal river. Salmon are at the mercy of the oceanic, estuarine and river environments, over which man has limited control. Stocks of salmon are thus subject to year-to-year fluctuations (and perhaps longer-term cycles) in abundance caused by oceanic, climatic and other factors.

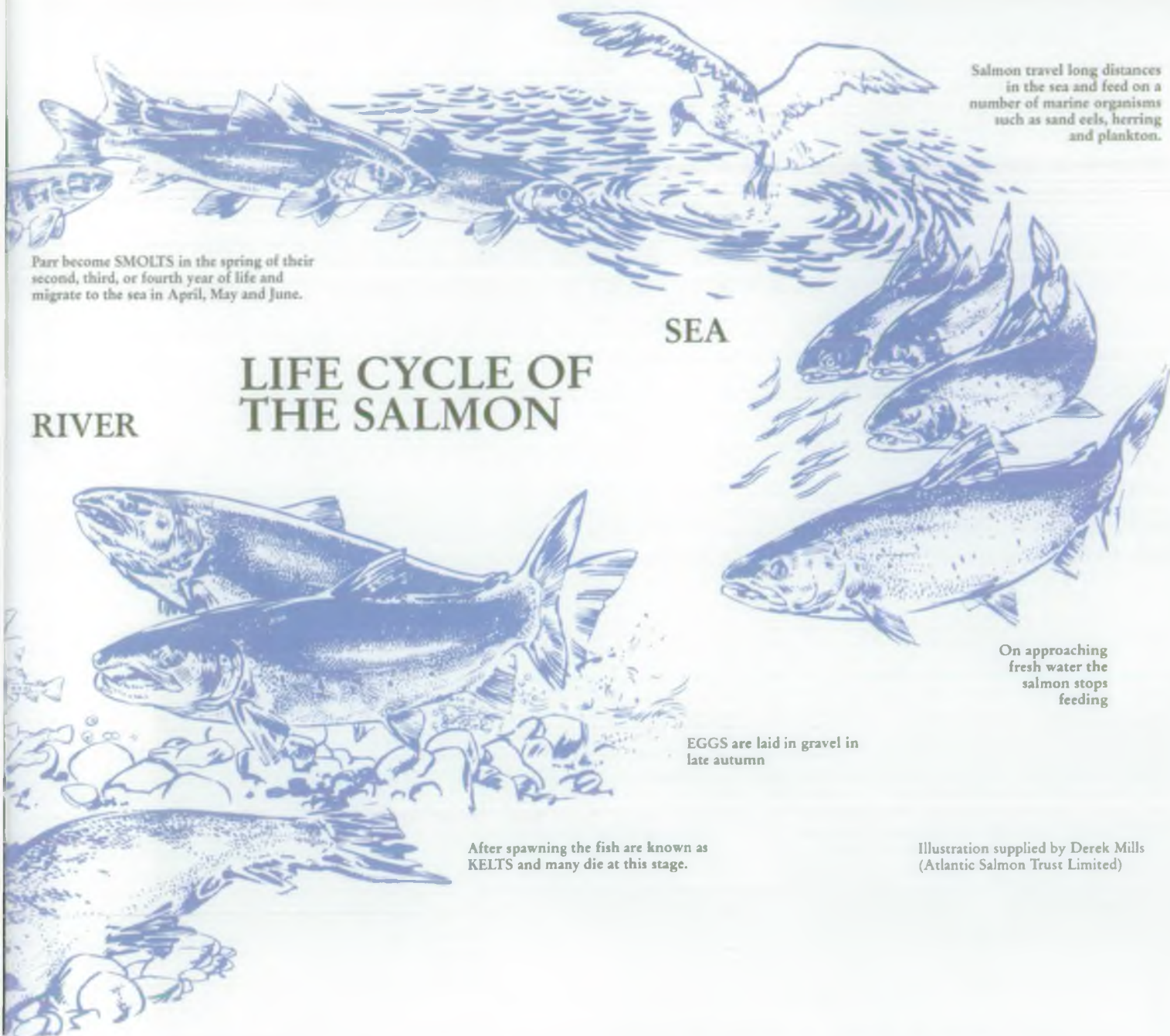
Management can take some account of these fluctuations but cannot eliminate them. Further management challenges are presented by the fact that English and Welsh salmon stocks are exploited not just in home waters but in distant water and coastal fisheries over which the NRA has no direct control.

PARR remain in fresh water for two to three years, feeding on aquatic insects.



ALEVINS hatch in early spring and emerge from gravel after 3-4 weeks ready to feed as fry.





Parr become SMOLTS in the spring of their second, third, or fourth year of life and migrate to the sea in April, May and June.

Salmon travel long distances in the sea and feed on a number of marine organisms such as sand eels, herring and plankton.

SEA

LIFE CYCLE OF THE SALMON

RIVER

On approaching fresh water the salmon stops feeding

EGGS are laid in gravel in late autumn

After spawning the fish are known as KELTS and many die at this stage.

Illustration supplied by Derek Mills (Atlantic Salmon Trust Limited)

For matters affecting salmon fisheries in the UK, the NRA along with MAFF and the Welsh Office liaise with the Scottish Office and the Department of Agriculture for Northern Ireland. Liaison also takes place with the Irish Department of the Marine with respect to UK salmon exploited in fisheries operated off the coasts of the Republic of Ireland.

For the regulation of distant water salmon fisheries, the UK is represented by the European Union (EU). The NRA helps advise MAFF, who are part of the EU delegation, and who contribute to the development of appropriate international measures for the regulation of these fisheries through the North Atlantic Salmon Conservation Organisation (NASCO). Close links are also maintained by both the NRA and MAFF with the International Council for the Exploration of the Sea (ICES) and the European Inland Fisheries Advisory Commission (EIFAC).

S A L M O N M A N A G E M E N T S T R A T E G Y

Within the NRA's jurisdiction, the salmon is regarded by many as being pre-eminent amongst freshwater fish in terms of its economic, social and aesthetic value and is often the focus of concern when managing water resources in rivers. However, the NRA, whilst recognising the salmon's importance, has a duty to manage not just salmon but other freshwater fish and river uses as well as to conserve aquatic wildlife. The contents of this document will therefore need to be interpreted and implemented in the context of management plans for other fish species together with those for river catchments. In particular, the fishery management requirements of sea trout in many cases overlap with those of salmon yet differ in crucial respects. Separate management strategies for sea trout and other fish species will be produced in due course.

NEED FOR AND BENEFITS OF THE STRATEGY

Salmon are a valuable resource requiring national and international management. The development of this strategy, the first drafted for the management of salmon in England and Wales, became feasible with the creation of the NRA. However, the implementation of the Strategy will become the responsibility of its successor body, the Environment Agency, which has the same duties and powers to carry out this work as the NRA, but which will also be subject to a cost benefit duty and Government's guidance on sustainable development.

In the context of the Strategy, it is envisaged that the sustainable utilisation of the salmon resource will require consideration of biological, economic efficiency and social equity factors. The NRA will seek to ensure that salmon stocks are sustained at target levels and that the exploitation of surplus stocks strikes a reasonable balance between economic and social objectives.

This document provides consistent policies and a framework for the management of English and Welsh salmon stocks. However, it is recognised that in many cases decisions relating to the management of salmon stocks in rivers and coastal waters need to be made locally. There also needs to be recognition of the constraints (environmental, biological, political, legal, economic and social) which apply and which may need to be overcome for the Strategy to be implemented by the NRA and others.

The overall status of salmon stocks in the North East Atlantic gives cause for concern. In particular, the multi-sea-winter components of many stocks are at very low levels and may still be declining. Failure to manage properly salmon stocks could result in long term or even permanent damage to our fisheries, with associated economic and social consequences.

The primary deficiencies in the present management of English and Welsh salmon fisheries are:

- The lack of clear biological, economic, social and political objectives.
- Inadequate information to manage the resource (e.g. to set accurate targets for the numbers of spawning fish required for each river system).

- A lack of co-ordination and co-operation between many of those involved in the management of these fisheries.
- Reducing funds to manage the resource.

Within this document, the NRA identifies clear objectives allowing resources to be focused on priority activities. It is from management objectives that information shortfalls can be most clearly identified and these can then be addressed through the NRA, MAFF and ICES monitoring and R & D programmes. Furthermore, the very existence of the Strategy will contribute towards co-ordinating the activities of those who have an interest in the salmon resource as well as highlighting deficiencies in existing administrative arrangements and legal powers for salmon management in England and Wales.

The absence of an effective management strategy could result in the failure to maintain, improve and develop salmon fisheries, thereby not maximising the economic and social benefits these could provide.

A new approach to salmon management is proposed that will set targets and monitor their achievement. It should not only benefit the resource and its exploitation but be more efficient and accountable.

At present, there is considerable debate as to how and by whom fisheries services in England and Wales should be funded. Clearly there are considerable benefits to be gained from the exploitation of salmon but at what cost and who should pay? The NRA must identify the range and cost of the services it provides and assess the extent to which different groups benefit from these services. All services should be necessary and offer value for money so that ultimately the management of salmon in England and Wales will result in a net economic gain to the country as a whole as well as providing social and conservation benefits.

This document has a vital role in informing others how the NRA proposes salmon should be managed. It is envisaged that other government organisations, the NRA's own Advisory Committees, fishery owners, netsmen, anglers, statutory and voluntary conservation bodies as well as the public will all be interested in the Strategy and the issues arising from it.

The NRA anticipates that a vigorous public debate will ensue and this is regarded as being a major benefit. However, the Strategy needs to be disseminated to the widest possible audience and should contribute to the international management of salmon.

OUTLINE OF THE OBJECTIVES

The NRA proposes four major objectives for the future management and exploitation of English and Welsh salmon.

The first and second of these are biological objectives relating to the management of stocks. Objectives 3 and 4 relate to the exploitation and cost of managing the resource and are determined by political, economic and social rather than biological factors.

OBJECTIVE 1 Individual salmon stocks and the environment in which they live should be managed to optimise recruitment to home water fisheries.

This objective seeks to ensure that, within principal salmon rivers, there will be sufficient spawners from different components of the run to utilise all the naturally available spawning and nursery areas; that this freshwater habitat is protected and where appropriate restored and/or enhanced to allow optimal smolt outputs; and that any subsequent exploitation of adult stocks is controlled to ensure that the optimal numbers of spawners are maintained. However, most commercial exploitation of English and Welsh salmon stocks takes place prior to fish re-entering freshwater and these home water fisheries are regulated by effort restrictions rather than catch quotas.

It is therefore impossible to control catches precisely enough to guarantee the optimal escapement of fish into freshwater. To do so on an annual basis would require estimates of pre-fishery abundance and the setting of appropriate catch quotas. At present, neither the estimates nor the ability to set quotas are available. Consequently, exploitation in net and rod fisheries will need to be regulated mainly using effort restrictions in relation to actual and target levels of spawning escapement. Any decision to terminate or reduce exploitation would have to be taken after the spawning escapement had fallen significantly below the target level.

OBJECTIVE 2 The diversity and fitness of salmon stocks should be maintained and where appropriate improved throughout English and Welsh rivers.

The achievement of this objective will maintain and improve the genetic integrity and fitness of both individual salmon stocks and components of those stocks such as multi-sea-winter salmon. The precise homing behaviour of adult salmon back to their natal river results in reproductively isolated populations which continue to adapt to local conditions. This process can be interfered with by stocking genetically different fish from other river systems and/or allowing escapees from fish farms to breed in the wild. Failure to ensure the survival of individual stocks and their components by over-exploitation or degradation of the freshwater habitat could also result in reduced fitness or even the complete loss of stocks.

SALMON TAGGING CAN
PROVIDE INFORMATION
ON EXPLOITATION RATES
AND THE DISTRIBUTION
OF FISH IN THE RIVER



OBJECTIVE 3 Once an optimal spawning escapement has been allowed for, the exploitation of surplus fish should optimise their total economic value whilst allowing for social equity considerations.

This objective recognises that in principle, exploitation should take place only if the number of returning adult fish exceeds that required to provide the optimal spawning escapement. It also identifies the need for resource allocation based upon social as well as economic benefits although it is fully recognised that these are difficult to determine. However at present, the NRA does not have powers to regulate fisheries other than to conserve the resource and/or to improve the management of individual stocks. Consequently, the NRA's current role in resource apportionment is necessarily restricted to facilitating negotiations between rods and netmen where rods wish to pay netmen not to exercise their fishing rights.

OBJECTIVE 4 The necessary costs of managing migratory salmonid fisheries should be met by the beneficiaries (nets, rods, riparian owners and the general public) and where schemes adversely affect these fisheries, any mitigation or restoration costs should be met by the promoter or polluter.

Grant-in-Aid effectively funds over 80% of expenditure on salmon and sea trout fisheries and this highlights important issues with respect to their future funding, in particular the relative contribution made by the direct participants in these fisheries i.e. rods, nets and owners as compared to that made by Government. Where proposed schemes, such as estuarine barrages or reservoir construction, may have a detrimental effect on salmon fisheries, it is considered that the promoter should also pay for all pre- and post-impact studies including those carried out by the NRA. However, much damage to salmon fisheries, not exclusively historic, is unattributable. In these cases, it seems reasonable to expect that such work should be funded, at least partly, by public money.

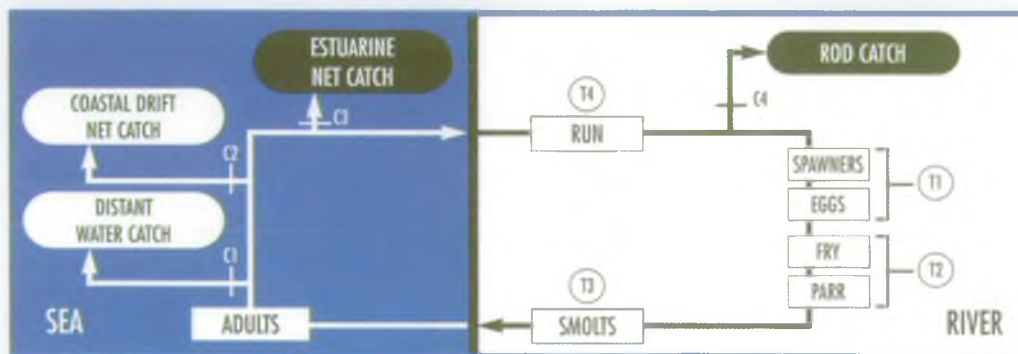
In the following sections, it is described how the NRA proposes to achieve these four objectives, a far from easy task. To quote Dr Kevin Friedland (1993), a fisheries scientist with the North East Fisheries Science Centre in the USA: "When managers move from theoretic concerns of spawning escapements and the expected impacts of effort reduction or quota regimes to the actual implementations of management it is quickly evident that neither fish nor fishermen are theoretical".

OBJECTIVE 1

A PRACTICAL BASIS FOR MANAGING INDIVIDUAL SALMON STOCKS AND THE ENVIRONMENT IN WHICH THEY LIVE IN ORDER TO OPTIMISE RECRUITMENT TO HOME WATER FISHERIES.

If optimal recruitment to salmon fisheries is to be achieved, management actions will be required throughout the salmon's life cycle. Figure 1 is a schematic representation of this life cycle which highlights a number of possible stock targets (T1 to T4). The principal control points to regulate catches, both within and outside the NRA's jurisdiction are also shown (C1 to C4) and catch levels in these fisheries need to be closely monitored.

Fig. 1. Targets and Controls in the Salmon Life Cycle.



- T1 Target spawning escapement and egg deposition
- T2 Target juvenile abundance
- T3 Target smolt output
- T4 Target adult run size
- C1 Distant water fishery quotas
- C2 Irish drift net fishery effort controls
- C3 NRA effort controls on coastal and estuarine net fisheries
- C4 NRA effort/catch controls on rod fisheries

Figure 1 does not include losses due to natural mortality, illegal fishing or the effects of environmental management. These are all important to salmon management but are hard to measure. However, in setting and assessing targets due allowance must be made for natural mortality which occurs throughout the life cycle. If quantifiable, illegal fishing may also need to be taken into account.

Ideally, the achievement of Objective 1 requires setting and achieving all of these targets and controls for every salmon stock. In practice, however, this would not be cost effective. It will therefore be necessary to select those which are achievable and affordable and which provide sufficient information to meet the overall objective of optimising recruitment to homewater fisheries. Furthermore, as the NRA's jurisdiction is limited to freshwater, estuaries and coastal waters up to 6 miles off-shore, it is necessary to consider separately those management measures under direct NRA control and those that lie outside its area of jurisdiction.

1.1 Salmon Stock Management within the NRA's Area of Jurisdiction

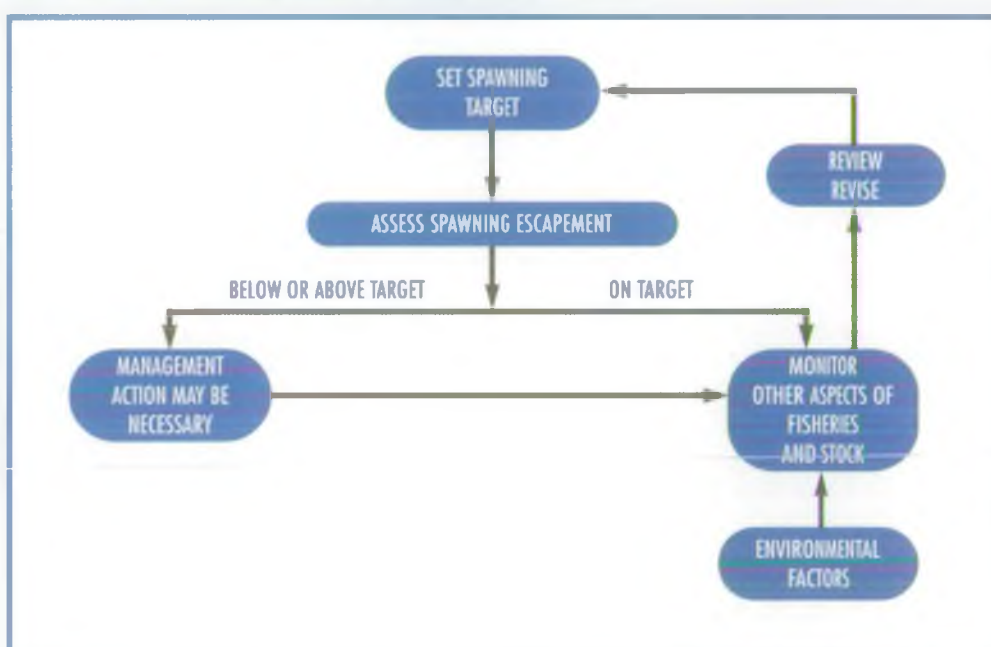
1.1.1 Achieving Salmon Spawning Targets

Four main processes are involved in target-based management:

- Target setting.
- Assessment of performance in relation to targets.
- Management actions to compensate for target shortfalls.
- Monitoring of effects of management actions and/or other factors.

The most fundamental target to meet is the optimal spawning escapement (T1). If this is achieved, it should ensure that both stock and catches are maintained at optimum levels. Figure 2 shows how this could be achieved in practice.

Fig. 2. Model for Achieving Salmon Spawning Targets



1.1.2 Setting Spawning Targets

Defining the optimum spawning level is critical in this target based approach.

Spawning targets and escapement estimates have already been developed for many North American salmon stocks and these form the basis upon which catch advice for the mixed stock fisheries of West Greenland are based (Friedland, 1993). In contrast, in the North East Atlantic, targets have only been set for the River Bush in Northern Ireland (Kennedy and Crozier, 1993) and the Girnock Burn in Scotland (Buck and Hay, 1984). The Working Group on North Atlantic Salmon (Anon, 1993) has recommended that the development of mechanisms for setting spawning targets should be a principal objective in coming years. The UK and Canadian data are adequate to begin the development of this process for rivers in England and Wales.

The principle is straight forward, for example Chadwick (1985) calculated empirically the number of Atlantic salmon spawners required to give the optimal yield in Canadian streams from the following simple equation.

$$S = A.E/F$$

Where	S	=	Number of spawners required.
	A	=	Surface area of the juvenile habitat.
	E	=	Target egg deposition rate (Nos eggs/m ²).
	F	=	Average number of eggs per spawner.

The mechanisms for defining E (the egg deposition rate) and A (the effective area utilised for rearing) are complex. Provisional spawning escapement targets have already been estimated for some Welsh rivers to assist in NLO reviews and further research to develop robust methods is being carried out within the NRA's R & D programme. Guidelines on setting targets and their assessment by monitoring will be prepared to support the implementation of this Strategy. Once these guidelines are available, spawning escapement targets need to be set for the principal salmon rivers in England and Wales.

The NRA will ensure that these targets:

- Identify, where possible, the optimal number of spawners for each component of the stock e.g. grilse and multi-sea-winter salmon, in order to conserve the full range of stock characteristics.
- Relate to existing conditions in the short term but these may be revised upwards if constraints are removed.
- Be adjusted up or down if better information upon which to base the estimates becomes available.

1.1.3 Assessing Spawning Escapements

The first step is to measure or estimate the current numbers of spawners and to relate this to egg deposition. Numbers of fish may be obtained directly by traps or counters, or indirectly from catches. Next steps include estimating the spawning and rearing areas available in catchments and establishing the actual distribution of spawners from redd counts and/or electric fishing surveys of juvenile salmon.

Spawning escapements may be below, at or above required levels. If on target, it may only be necessary to continue current management practices and monitor the fisheries' and other aspects of the stock's performance. If below or above required levels, management actions may be required.



1.1.4 Management Actions in Response to Different Levels of Spawning Escapement

i) Number of Spawners Above the Required Level

The logical management action in response to being above the expected spawning escapement would be to allow increased exploitation. However in practice, such a decision is very unlikely to be made during the same fishing season. Any decision to increase exploitation in the next or subsequent years would have to be balanced against the risk that both juvenile recruitment, particularly at high adult stock levels, and post-smolt survival rates at sea can be highly variable. Therefore it would be more sensible to take such a decision only after the spawning target had been significantly exceeded over several years.

ii) Number of Spawners Below the Target Level

Selecting and implementing the appropriate management action(s) to redress a shortage of spawners will be dependent on the:

- Identification of limiting factors.
- Definition of possible solutions, which may require modelling in advance.
- Identification of priorities for practical action.
- Identification of resources available.
- Implementation of management actions.
- Monitoring of management actions/success.

Failure to reach the spawning target or subsequently the optimum smolt production could be due to one or more of many causes. However these fall into three main types: environmental, biological and fishery based (Table 1).

A wide range of factors can limit the survival and production of salmon

SAPROLEGNIA
(A FRESHWATER FUNGUS)
IS A COMMON AND OFTEN
LETHAL SECONDARY
INFECTION OF SALMON

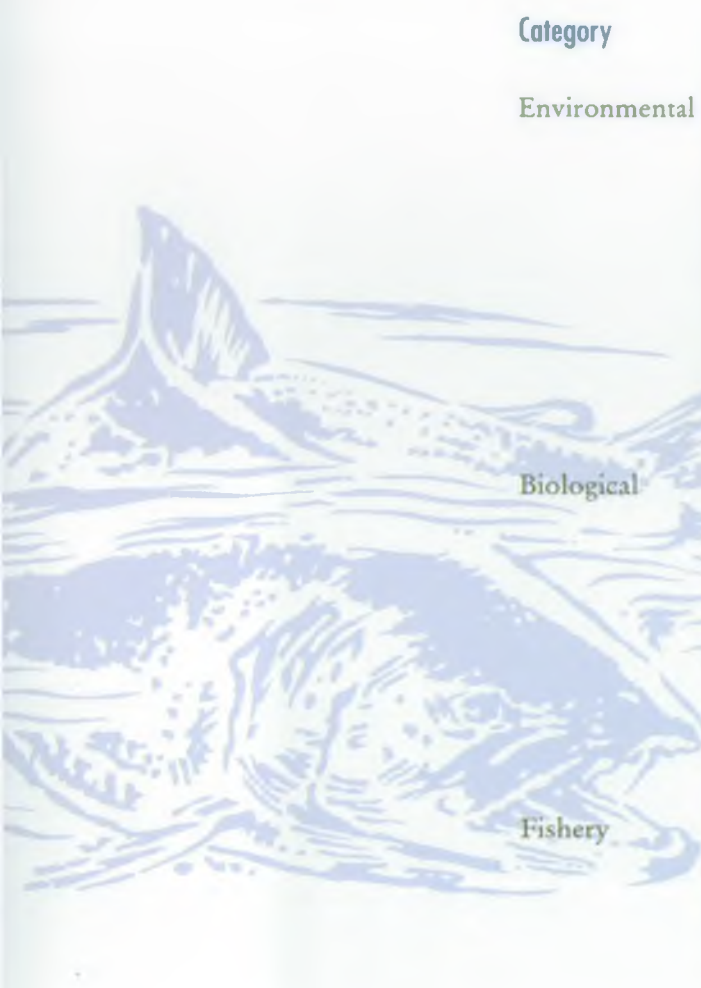


LIMING CAN BE USED TO
REDUCE ACIDIFICATION IN
UPLAND STREAMS



POACHING IS STILL A
PROBLEM AND THE NRA
WORKS CLOSELY WITH THE
POLICE TO COMBAT IT

Table 1. Possible Factors Limiting Salmon Survival and Production in Freshwater



Category	Limiting Factor	Possible Management Actions
Environmental	Water Quality, Water Quantity, Area and quality of habitat, Obstructions, Climate.	Improve water quality, prevent pollution, develop or revise Environmental Quality Standards, control abstraction, change or improve water/land management, improve/restore habitat, remove or provide access past obstructions.
Biological	Competition (for space and food), Predation, Disease, Parasites, Adverse genetic change.	Biomanipulation, remove or control predation, control fish introductions.
Fishery	Lack of returning adults, Illegal, over or selective exploitation, Economics.	Reduce exploitation, enhancement of stocks, enforcement.

In many cases, there will be clearly identifiable limiting factors which prevent the achievement of optimal spawning escapements. In others, the reason will be unknown and it will be necessary to examine critically all the available evidence. For example, if the spawning target has not been reached, is it the same for all stock components and in all tributaries? Have spawning escapements in neighbouring river systems also fallen? The size, timing and make-up of the adult run, the degree to which it has been legally or illegally exploited and the influence of environmental variables such as flow on the final distribution of spawners may all need to be considered.

In all cases, the solution will require some form of environmental, biological or fisheries management (Table 1). To be effective, such management requires the identification and removal of limiting factors in order to optimise juvenile production, adult survival, spawning success and hence fisheries yields. In addition, it may be necessary to increase juvenile production by stocking and/or habitat enhancement (Section 1.1.6 ii) or even to re-introduce juveniles if the stock has been lost.

However, the effects of any such actions will be carefully evaluated before being taken. Even simple models may allow the outcome of management actions to be predicted. For example, if an artificial obstruction which restricts access to adult spawners is removed, modelling could be used to estimate the increase in juvenile production and adult catch that might result as well as the cost benefit ratio. Any effects on other fish and wildlife species must also be considered.

The outcome of management actions will be monitored by means of stock and fisheries performance measures and results may be used to review and revise the existing target.

1.1.5 Other Fisheries Targets and Performance Measures

The same basic model (Fig. 2) used to set and achieve spawning targets can be applied to other fisheries targets (Fig. 1: T2 to T4). It should be possible to set juvenile abundance targets (T2) for most salmon rivers although the resources required to do so would be very high. However, smolt and adult run size targets (T3 & T4) could only be set where facilities exist to count down and upstream migrants. **Measurement of juvenile abundance, smolt output and run size in relation to these targets can provide objective performance measures. These along with the performance of rod and net fisheries can be used to assess and direct a wide range of management actions.** In the following sections, the uses and limitations of these targets and performance measures are discussed briefly.

i) Juvenile Abundance and Smolt Numbers

Strategic electric fishing surveys, many in juvenile migratory salmonid streams, are being carried out in all NRA regions. The results will provide a measure of the extent to which spawning and nursery habitat is being utilised, as well as helping to identify adverse environmental impacts and, in extreme cases, recruitment failure. The precision with which targets can be assessed will depend on the nature of the spatial and temporal variability in juvenile abundance. However, as this variability is often high, extensive surveys would be required to assess compliance with targets set to measure juvenile recruitment. This would not be cost effective and juvenile abundance is most likely to be compared with standards, derived from a fisheries classification scheme and/or the existing HABSCORE methodology, to assess environmental impacts. Smolt output is a critical target in theoretical terms representing the outcome of freshwater production. At present however, no full trapping facility exists on any English or Welsh river and estimates of smolt output can only be made by mark and recapture techniques and by back calculation using run reconstruction modelling. In the future it may be possible to estimate smolt output using hydro-acoustic techniques and this is the subject of an R & D project.

ii) Run Size

Run size can be measured directly in those river systems which possess counting facilities, either by a trap (full river) or by some form of counter (resistivity, optical, video or hydro-acoustic). Estimates of run size can also be obtained using mark recapture methods and from catch data. A very limited number of rivers have upstream trapping facilities e.g. the Rivers Coquet, Dee, Lune, Ribble, Taff, Tamar, Tawe and Thames and some of these will be developed as "monitored rivers", highly studied rivers supporting intensive research programmes. However in recent years, an increasing number of electronic fish counters have been installed on English and Welsh rivers and the accuracy of the counts obtained is improving steadily. Data on run size are important to calculate spawning escapements, exploitation rates for use in run-reconstruction models and to investigate the relationship between stock and catch.

THE INCREASED ELECTRICAL RESISTANCE OF A SALMON PASSING OVER THE ELECTRODES TRIGGERS A COUNT



iii) Rod and Net Catches

Rod and net catch statistics are collected from all salmon rivers in England and Wales and considerable historical data exist. Declared catches provide an index of yield from a fishery and for most rivers are the only indicator of possible stock size. **Consequently the NRA is committed to improving the quality of these data.** The NRA has commissioned a national R & D project to evaluate the use of migratory salmonid catch statistics and to determine how they can be best used to estimate stock size. Although national catch data are available from statutory rod and net catch returns, the NRA has also introduced log book systems to a number of salmon rivers in order to obtain high quality catch per unit effort data from rod fishermen.

However, it is proposed not to set precise catch targets. Quotas, as used in distant water salmon fisheries, cannot be set for home water fisheries as pre-fishery abundance measures are not available for specific rivers and because it is not possible to open and close fisheries within the fishing season. Nor can minimum catch targets be set, below which catches must not fall, as this may be incompatible with maintaining and protecting the spawning stock. However in practice, spawning targets will be defined in such a way so as to safeguard catches. **Furthermore, the NRA will monitor and review catch levels on a regular basis, and should these consistently fall below identified levels, management actions may be necessary.**

Just as for spawning escapements, if the abundance of juvenile fish, smolt output, run size or fishery yields are below or above targeted levels then management actions may be required. In all cases the natural variability in the performance of stocks and fisheries will need to be taken into account. The same method can be used to identify and implement the required management measures (as outlined in Section 1.1.4 ii) and these fall into the same three broad categories: environmental, biological and fishery based (Table 1).

In the following Section (1.1.6) fishery based management actions will be considered in more detail. In particular, NRA policies and objectives in relation to the control of legal and illegal exploitation and stock enhancement are outlined.

1.1.6 Fishery Based Management Actions

i) The Control of Legal and Illegal Exploitation in English and Welsh Salmon Fisheries

Under the Salmon and Freshwater Fisheries Act 1975 and the Salmon Act 1986, the NRA is responsible for regulating a wide range of commercial and recreational fisheries and is empowered to control the illegal exploitation of salmon within its area of jurisdiction.

a) Net Fisheries

For the most part, English and Welsh salmon fishing rights in estuaries and the sea are not privately owned. However, this public right to fish is regulated in practice by the need for all fishermen to be licensed. Furthermore, most public fisheries are limited by Net Limitation Orders (NLOs) which fix the number of licences issued. In cases where it is considered that stocks are not sufficiently large to support a fishery, the NLO can be reduced to a low number or a byelaw introduced in order to close down the fishery altogether.

The current administrative procedures to promote Orders or change byelaws are cumbersome and time consuming. **The NRA will discuss with MAFF the possibility of simplifying and streamlining these procedures.** Current legislation is by necessity conservative in nature and allows little, if any, flexibility to react to changing circumstances. For example, at present the NRA has no ability to introduce or relax, speedily, fishery control measures where a rapid response may be required or desirable. **The NRA will explore the feasibility of promoting the necessary legislation to acquire such powers.**

At present there is a diversity of byelaws governing net fisheries, as inherited from the Regional Water Authorities. **The NRA will review these byelaws as well as those for rods with a view to promoting a national, uniform set for those issues common to all regions but retaining certain byelaws to deal with local issues or problems.**

Net fishing for salmon in England and Wales is regulated by effort controls (close season, times of fishing and in many cases by licence numbers), area limits and gear controls but not catch quotas. Control by quota, an alternative approach to regulating catch, would require reliable measures and/or predictors of pre-fishery stock abundance.

These are not yet available, so for the time being, the NRA will continue to regulate net fisheries either by control of fishing effort or by fishery closure where stocks are threatened.

Most of these net fisheries operate within estuaries and although they undoubtedly exploit salmon from other river systems, it is considered likely that the majority of the fish caught are derived from and destined for that particular river. In large estuaries such as the Severn or Solway, certain net fisheries may exploit mixed stocks to a greater extent. However, coastal salmon and sea trout net fisheries such as those operating off the North East and East coasts of England are known to exploit a mixture of stocks originating from different river systems in unknown proportions.

DRIFT NETTING OFF
THE NORTH EAST
COAST OF ENGLAND



The NRA policy is that exploitation of salmon should take place, as far as is possible, where the stock of salmon is from a single river. In fisheries which can be shown to exploit predominantly mixed stocks, fishing will be phased out over an appropriate timescale.

Such a policy is already being implemented in relation to the North East coast drift net fishery. This fishery was subject to a Government review under Section 39 of the Salmon Act 1986 and a report entitled "Salmon Net Fisheries" was presented to Parliament in 1991. In this report, the Government concluded that "This review has not produced evidence of an immediate threat to stocks and thus any justification for depriving existing licensees of their licences at a stroke. It would however, aid and improve the management of individual East coast salmon and sea trout stocks if the drift net fishery were to come to an end". The NRA after carrying out its own analysis of the data, agreed with the Government that these stocks are not immediately threatened.

The Government also considered that the phase out of the North East drift net fishery should be "gradually so as not to cause unnecessary hardship" and invited the NRA to reduce the number of drift net licences as current licence holders leave the fishery. In response, the NRA concluded that there was no legal constraint in phasing out the drift net fishery. However, without a clear conservation case for stopping the fishery immediately, the NRA proposed the introduction of a new Net Limitation Order under which the re-allocation of surrendered drift net licences would be prohibited. This approach is wholly consistent with the mechanism set out by the Ministers in their report and the NRA estimates that if no new licences are issued, the number of drift nets will halve in ten years and the fishery will be completely phased out in under forty years. Unless there is clear evidence that stocks need to be conserved, any speedier phasing out or closure of this fishery would require action by Government.

b) Rod Fisheries

Throughout England and Wales, all salmon fisheries in fresh water are private. Thus, in addition to an NRA national rod licence, all anglers must have authorisation to fish and fishing effort is restricted mainly by limiting access.

Unlike nets, no statutory controls exist to limit the number of rods used on any particular river. However, byelaws and fishery rules may be used to restrict fishing methods, set catch limits and institute close seasons which can all help to reduce exploitation rates. However, these are generally less restrictive than for net fisheries presumably in recognition of the perceived lower exploitation rates of rod fisheries. However, rod exploitation rates can be high, particularly of early running multi-sea-winter salmon. The NRA may need to reduce the exploitation of salmon by rod and line by shortening the fishing season, prohibiting certain fishing methods or applying catch limits. For example, on the Rivers Wye, Usk and Dee the NRA has recently introduced byelaws to delay the start of spinning and bait fishing in order to protect spring fish stocks. Whilst to allow recovery of depleted stocks in the River Torridge in Devon, the NRA introduced a byelaw in 1991 limiting each angler's catch to two salmon per day, three per week and five per season.



Where such conservation measures need to be introduced, it has been suggested that the introduction of carcass tagging would enable rod limits to be enforced. Furthermore, carcass tagging could be used to introduce an equitable method of catch apportionment amongst rod fishermen. In many rivers, a large proportion of the total catch is taken by relatively few anglers. The setting of an appropriate catch quota and the allocation of the matching number of tags to each angler would make it necessary for anyone who reached their quota either to stop fishing, return any further fish they caught or purchase additional tags. However, in addition to any mandatory conservation measures that might be required, the NRA will continue to encourage anglers to catch and release fish on a voluntary basis, where this is appropriate and undertaken correctly, in order to conserve spawning stocks.

c) Illegal Fishing

Overall, salmon poaching is perceived to be declining. Notwithstanding this, illegal catches of salmon both at sea and in fresh water remain of utmost concern to the NRA and a future resurgence of illegal fishing is quite possible given improved runs and/or reduced enforcement activity.

The NRA expends considerable resources on enforcement activities to prevent illegal fishing. In 1994/95, the cost of these activities was over four million pounds which represents 42% of all NRA expenditure on migratory salmonid fisheries. The NRA will continue to review enforcement methods and results in order to ensure the most effective, efficient and economic deployment of limited resources.

Additional powers provided by the Salmon Act 1986 have proved to be beneficial in controlling illegal fishing, particularly in some coastal fisheries. However, any additional means of preventing illegal exploitation must be pursued and the NRA recommends that:

- **Carcass tagging as a means of preventing the sale of illegally caught salmon and for validating catch returns should be reconsidered.**

This technique used in Canada and France was previously rejected for use in England and Wales mainly because of the need to tag all farmed salmon. However, the salmon farming industry is now moving towards carcass tagging as a way of brand marketing which means that a reconsideration of this approach for controlling illegal fishing would be timely.

- **The introduction of dealer licensing should be re-examined.**

Originally rejected as unworkable by MAFF because of the perceived difficulties in identifying farmed from wild salmon. This is no longer believed to be an obstacle.

- **The sale of rod caught salmon is prohibited.**

Poachers are known to use the possession of a rod licence to legitimise the fish they sell. Furthermore, such legislation should aid stock conservation by encouraging anglers to practice catch and release once their own immediate requirements have been satisfied.

- **Courts should be encouraged to withdraw the right to hold a rod or net licence from convicted poachers.**
- **The life of search warrants issued under Section 33 of the Salmon and Freshwater Fisheries Act 1975 should be extended from one week to one month.**
- **Courts should be encouraged to increase penalties for convicted poachers and dealers, particularly in relation to the forfeiture of boats and vehicles.**
- **Section 34 of the Salmon and Freshwater Fisheries Act 1975 is amended to give powers of arrest during the day for fishing offences (other than angling) and handling offences.**



INCREASINGLY SOPHISTICATED
SURVEILLANCE AND
COMMUNICATION EQUIPMENT
IS USED TO COMBAT
ILLEGAL FISHING

d) Sea Fisheries

Prior to the introduction of the Salmon Act 1986, sea fishermen could incidentally catch salmon and sea trout whilst legitimately fishing for sea fish. This was because of the dichotomous legislation relating to the regulation of sea fish and migratory salmonids in coastal and estuarial waters. However, Sections 33 and 37 of the Salmon Act have helped to prevent illegal netting of salmon at sea. Section 33 clarifies the position over the uses of fixed engines for sea fish and in most districts authorising byelaws have now been implemented. Under Section 37, Sea Fisheries Committees were given the power to make byelaws for the purpose of protecting salmon or preventing any interference with their migration. Such byelaws can only be made by joint agreement between the NRA and the relevant Sea Fisheries Committee.

In the NRA's South West and Welsh regions, these new measures are considered to have provided considerable benefits. The Tamar, Camel and Fowey estuaries effectively are closed to sea fishing, other than by angling. There are similar restrictions on many estuaries in NRA, Welsh region, most notably the Dee and Severn estuaries where the NRA is the *de facto* Sea Fisheries Committee.

However, there may be some problems over the enforcement of Sea Fisheries Committee byelaws. Whilst NRA Bailiffs can deal with Section 6 offences under the Salmon and Freshwater Fisheries Act 1975, a Sea Fisheries Officer's powers are required to enforce Sea Fisheries Committee Byelaws. This problem can be overcome through NRA Bailiffs being cross-warranted. However, the NRA recommends that their Bailiffs should be directly empowered to police byelaws which regulate sea fishing for the protection of salmon.

ii) Stock Enhancement

Although in many cases optimal recruitment to a fishery may be achieved by environmental management or controlling exploitation, stocking of juvenile fish has in the past been the most favoured option.

The eggs and young of salmon have been stocked into rivers for at least 150 years. Stocking has been widely employed throughout the British Isles in the belief that it would improve the quantity and quality of catches and have long term beneficial effects on stocks. However, it is now recognised that there are potential risks associated with stocking which include:

- Reducing the genetic fitness of the native salmon stock (see Section 2.1).
- Causing competition and/or predation between stocked and wild fish.
- Introducing disease or parasites.
- The fact that stocking may not be successful, particularly if adverse environmental conditions exist.

In carrying out its own stocking programmes, the NRA makes every attempt to prevent causing any deleterious effects. Any private stocking is subject to the NRA granting a Section 30 Consent under the Salmon and Freshwater Fisheries Act 1975.

Despite many studies, the effectiveness of salmonid stocking is still not reliably established. There has been an urgent need to review the effectiveness of salmon stocking strategies (to include their cost/benefit ratio in terms of adult returns) and this is currently being carried out in an NRA national R & D project. The results from this review, and if necessary further research, will be used to formulate guidelines for future NRA stocking programmes and consenting stocking proposals by others. These guidelines will be based upon sound scientific principles and a proper understanding of the factors affecting the survival, production and yields of salmon stocks. Monitoring and evaluation will be an integral part of such stocking programmes which should also be linked to stock assessment, environmental and water quality surveys. The conclusions from this review could also result in changes to the number and type of NRA migratory salmonid fish rearing facilities.

NRA resources for stocking juvenile salmonids are limited and a policy already exists whereby outputs from NRA fish culture units are allocated on the following priority basis:

- **Mitigation**

To compensate for lost production e.g. due to loss of spawning and nursery area as a result of a reservoir being built.

- **Restoration**

To rehabilitate a salmon river that has lost part or all of its stock or to replace fish lost due to a pollution incident.

- **Enhancement**

To supplement existing stocks where fish production is less than the carrying capacity of the environment.

However, even if stock enhancement is required, increasingly it is recognised that often habitat restoration and improvement can be more efficient, self-sustaining and cost effective means of increasing fish production than stocking. The most commonly used methods include the building of fish passes, the creation of holding and spawning areas for adults and rearing areas for juveniles. The NRA has already reviewed past work on the restoration of riverine habitats and is commissioning further research to develop and produce an illustrated manual providing guidelines and recommendations for the reinstatement and management of spawning gravels and juvenile habitats for salmon. Within the context of river management plans, considerable scope exists for the NRA and riparian owners to carry out such habitat works in partnership and the NRA will pursue these wherever possible.

N.B. Further important issues in relation to stocking which include genetic considerations, restoration of salmon populations and maintaining spring run salmon are discussed in Sections 2.1 and 2.2.

1.1.7 Salmon and Catchment Management Plans

The need for new or changed management practices to remove limiting factors, achieve fisheries targets or enhance juvenile production can only be determined on a river by river basis. It is therefore recommended that five year action plans are drawn up for the principal salmon rivers in England and Wales by the year 2000.

These Salmon Management Plans will:

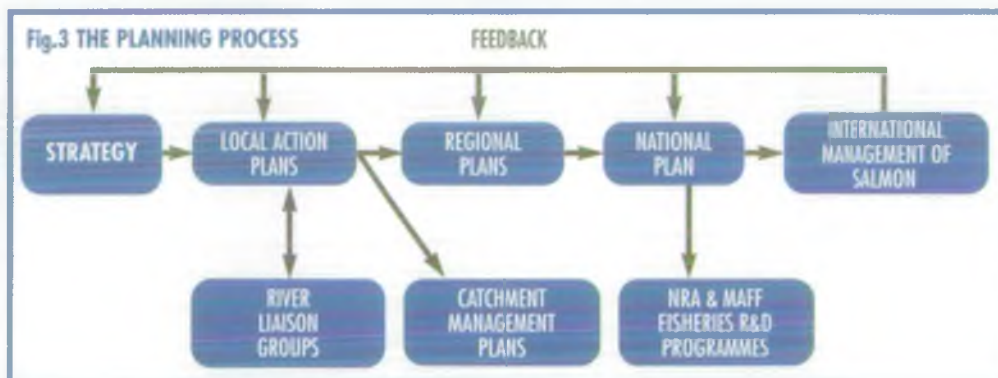
- Set selected initial spawning targets and fishing effort controls for both salmon stocks and fisheries (Fig. 1).
- Identify, rank and establish the feasibility of removing specified limiting factors.
- Outline a programme of works to carry out necessary remedial, improvement and development measures.

As these action plans are implemented and the performance of both stocks and fisheries are measured, both targets and management actions may need to be modified. Thus, the Plans will encourage the removal of factors limiting juvenile production and adult survival and the continued monitoring of annual fluctuations in key fisheries and stock performance measures.

It will be essential to consult all interested parties when drawing up these Plans.

The NRA recognises that public consultation will enhance the initial reception of the Plans and increase the chance of their successful implementation. It is essential that information about the progress of Plans can be regularly communicated to user groups and to achieve this, the NRA may set up River Liaison Groups. On a number of rivers, riparian owners, anglers and netmen are already actively working with the NRA to maintain, improve and develop salmon stocks. These partnerships are encouraged by the NRA and can contribute much to salmon management.

The implementation of these local Salmon Management Plans will not be carried out in isolation. The NRA believes in taking an integrated approach to river management. Thus, the major objectives contained within individual Salmon Management Plans will need to be incorporated into NRA Catchment Management Plans to ensure that as far as possible all use-related environmental objectives (abstraction and discharge needs, fisheries, recreation and navigation uses, areas of special conservation interest or in need of flood protection) are met and any conflicts between these objectives resolved (see Fig. 3).



The development of Salmon and Catchment Management Plans will enable a high proportion of salmon management to take place at the local level. However, certain activities need to be planned at regional and national levels, e.g. the collation of migratory salmonid catch statistics, the development of targets for the international management of salmon and the co-ordination of research and development. It is therefore recommended that NRA regions should consider producing Salmon Management Plans and that a National Salmon Management Plan should be drawn up as soon as possible. Whether local, regional or national, all such plans should use this Strategy to provide a framework and should set specified targets together with the resource requirements and timescales to meet them.

1.2 Salmon Stock Management outside the NRA's Area of Jurisdiction

1.2.1 Distant Water Fisheries

The main "distant water" marine fisheries for European salmon are those operating at the Faroes and West Greenland. In the period 1967-1984, there was a third distant water fishery involving vessels from Denmark, Faroe Islands, Finland, Germany, Norway and Sweden which took place North of 67°N. This fishery, which at its peak amounted to 911 tonnes, ceased when the NASCO Convention entered into force. However in recent years, a small number of vessels which have been reflagged so as to avoid the provisions of the NASCO Convention, have commenced fishing in the area of international waters bordered by the Exclusive Economic Zones of Faroes, Norway, Jan Mayen, Iceland, Greenland and Spitzbergen.

At the Faroes, almost all of the salmon caught are of European origin, some of which are English and Welsh fish. In contrast, the West Greenland fishery takes both North American and European salmon and most of the latter are believed to come from the United Kingdom and Ireland.

Catch quotas for both the Faroes and West Greenland fisheries are set by the North Atlantic Salmon Conservation Organisation (NASCO) and regulatory measures have been in place in most years since 1984 for both these fisheries. Since 1991, compensation agreements have been negotiated between the Faroese ship owners and private interests by which an annual payment is made to the fishermen for not fishing the NASCO quota. Under these agreements small scale research fishing is still permitted. Since 1993, compensation agreements have also been reached for the Greenland fishery and under these no commercial fishing is conducted but a subsistence fishery, restricted to 12 tonnes, is permitted. In 1995, however, fishing resumed at Greenland with a catch quota of 77 tonnes set by NASCO.

Thus for the time being, a major part of the exploitation of English and Welsh salmon stocks in distant water fisheries has ceased. However, these buy-outs are for limited periods and there is no guarantee that fishing will not resume in the future, as was the case at Greenland in 1995. Prior to these moratoria, there were serious deficiencies in

the way in which English and Welsh stocks were managed in these fisheries and in our ability to influence their management.

These included:

- A lack of clear objectives for the management of European stocks in these distant water fisheries.
- The setting of catch quotas which may not have prevented over-fishing of particular stocks or cohorts.
- Lack of knowledge about the factors affecting post-smolt survival at sea.
- Unregulated fishing for salmon in other international waters.

In addition, the NRA advocates that any fishery predominantly exploiting mixed stocks, whether home or distant water, should be phased out. However, until this is achieved, to rectify the deficiencies listed above it is proposed that clear objectives for the future management of European stocks in these distant water fisheries should be drawn up as soon as possible. NASCO have considered this matter but as yet no objectives have been adopted (Potter, 1993). It is proposed in this Strategy that the fundamental objective must be to protect stocks from over-exploitation and to ensure that sufficient numbers of adult fish return to provide home water fisheries and to provide target spawning escapements. Furthermore, in order to meet this objective, the NRA must develop the ability to set the appropriate catch quotas for these fisheries (see C1 in Fig. 1).

In order to achieve this, the NRA must:

- Set spawning targets for the principal English and Welsh salmon rivers (Section 1.1.2).
- Work in partnership with MAFF to develop methods of estimating the pre-fishery abundance and exploitation rates of English and Welsh salmon in these distant water fisheries. This will require continuing and possibly expanding the NRA's microtagging programme and the development of "indicator rivers" whose stocks may be representative of those in a larger geographic area. Data can then be gathered from these rivers to develop "run-reconstruction" and also "predictive" models in order to estimate pre-fishery abundance. A number of potential indicator rivers have already been identified and these include the Welsh Dee, the Wear, the Test and the Lune. Traditionally, monitoring the stocks in such rivers required trapping systems. However, the NRA in conjunction with MAFF's Directorate of Fisheries Research are developing an alternative semi-automated approach on the rivers Test and Lune using electronic fish counters and video cameras to estimate the number of tagged fish of each sea-age group entering the river. If successful, it is hoped that this more cost-effective means of monitoring will be adopted on other rivers. The data will then be extrapolated to estimate catch quotas on a national or regional basis and the more stocks which can be assessed using the run-reconstruction model, the more accurate the estimates should be. However, it should be stressed that if assessments have to be based on limited

sampling then some stocks will be poorly represented and appropriate additional safeguards need to be built in to any management advice on setting quotas.

- Find out more about the natural factors regulating salmon numbers in the sea.

The survival of juvenile salmon in freshwater appears to be far less variable than it is during the marine phase (Reddin, 1988) and despite trends that suggest generally stable or increased smolt populations, the number of adults in both North American and European salmon populations as indicated by catches has decreased over the past two decades. **It is therefore of crucial importance to know more about the factors that determine the marine survival of post-smolts and the NRA recognises that there is an urgent need for further research in this area, probably as part of an international programme.**

- Prevent illegal fishing in international waters. The NASCO convention prohibits member countries from salmon fishing in international waters but fishing takes place by vessels which have been re-flagged in countries which are not party to the convention. Recently, NASCO has agreed on the need for further diplomatic efforts to eliminate fishing for salmon in international waters and improved surveillance in the relevant area. **The NRA fully supports these measures.**

1.2.2 The Irish Drift Net Fishery

This drift net fishery which operates around the Southern, Western and North Western coasts of Ireland has existed for over one hundred years. However, it rapidly expanded in the 1970s and 1980s with the advent of monofilament nets and a high proportion of illegal, unlicensed fishermen. As well as accounting for 70-80% of the homewater catch (Anon, 1987; Twomey, 1990) concern has been raised that this fishery may be intercepting significant numbers of salmon destined for rivers in the United Kingdom (Mills, 1983). More recently, this has been confirmed by the number of microtagged fish, mainly grilse, which were originally tagged in Welsh and English South and West coast rivers and which were subsequently caught in this fishery. Preliminary estimates of the exploitation of river Test and Itchen salmon in this fishery are as high as 24% (Russell and Potter, 1993).

The Irish Salmon Review Group (Anon, 1987) made a number of recommendations to limit the fishery, but to date none of these have been put into effect. In September, 1993, Irish press reports suggested that the Irish Government was actively considering the complete banning of drift net fishing around the Irish coast. Any reduction or closure of the fishery would have important benefits for English and Welsh one-sea-winter salmon stocks. In the meantime, it is essential that the NRA and MAFF continue to participate in the monitoring of the exploitation of English and Welsh salmon stocks in this fishery.

The NRA recommends that the UK Government presses for the phasing out of this mixed stock fishery for the reasons outlined in Sections 1.1.6 and 1.2.1 concerning both home water and distant water fisheries for English, Welsh and Scottish Salmon.

OBJECTIVE 2

MAINTAINING AND IMPROVING THE DIVERSITY AND FITNESS OF ENGLISH & WELSH SALMON STOCKS.

2.1 Maintaining and Improving Local Salmon Stocks

Numerous studies have shown that local salmon populations are typically genetically distinct. These differences can occur both between river catchments and between different tributaries within a river catchment. Furthermore, some of these genetic differences between local populations are adaptive (Maclean and Evans, 1981). The extent to which genetic differences have been caused by natural selection and may be adaptive is unknown, as is the risk of damage from mixing separate genetic stocks. However, until more is known, the NRA has a general precautionary policy of not allowing the further transfer of salmon stocks between different river catchments. An obvious exception would be to restore salmon to a river which had lost its stock.

Investigations to establish the genetic differences between salmon populations are essential if salmon stocks are to be managed properly and both the NRA and MAFF are currently carrying out such studies. The NRA has funded a project examining the genetic variation of salmon in Welsh rivers and these data will contribute to a wider MAFF funded review of salmon genetics in the British Isles. These efforts to type as many English and Welsh salmon populations as possible in their present state can be used as a baseline against which further genetic changes are assessed. Such changes can and probably have occurred because of over-exploitation or damage to the freshwater habitat reducing population sizes and their genetic variability. However, probably a more common cause has been incorrect stocking practices.

Most NRA salmon enhancement programmes use native wild spawners as broodstock. Their offspring are artificially hatched and reared and released into the wild as fry, parr and smolts. This strategy ensures that no exogenous genes are introduced into the wild fish population and the taking of new broodstock from the wild each year tends to limit the loss of genetic diversity. However, genetic variability in the recipient population may be reduced if a small number of adults used in a hatchery contribute to a large proportion of the total number of offspring in the wild. Thus establishing and maintaining broodstocks for intentional release to the wild demands a compromise between production and the conservation of genetic diversity.

The necessary measures for achieving this have been identified by NASCO and the NRA endorses the NASCO guidelines and where possible complies with them in running its own hatcheries.

However, if too few fish remain in the river to take as broodstock, then a donor population will be required. In this case the recommended practice is to choose a donor stock from a river which is not only near to the recipient river but also as similar as possible in terms of geography, geology, water chemistry and physics, ecology and run characteristics. The same method may be adopted to stock a river where salmon have become extinct, however a number of other possible strategies have been suggested.

These include:

- Experiments with more than one donor strain.
- In severely depleted but not totally extinct stocks, using the milt from one local male to fertilise the eggs of up to fifty imported females, to produce a large "hybrid stock" in one generation.
- Obtaining stocks from locations that are readily and cheaply available thus providing a wide range of genetic material and allowing natural selection to create a new and well adapted genetic stock.
- Creating or maintaining a run from hatchery stock though it should be noted that Cross (1989) specifically recommends against using this strategy.
- Setting up a living gene bank in the wild from a stock that is threatened elsewhere.
- In situations where salmon populations have been lost and are being restored, there is scope for careful experimentation. However, in all cases thorough monitoring will be essential.

2.2 Maintaining and Improving Spring Run Salmon Stocks

It is equally important that the full range of components of the salmon stock is maintained.

Populations of early running, multi-sea-winter salmon have declined over the past thirty years throughout the North Atlantic range of the species. The decline of spring run salmon in English and Welsh rivers has been comprehensively reviewed by Gough, Winstone and Hilder (1992). The rivers most affected are the Hampshire Avon, Exe, Eden, Lune, Frome, Severn, Wye, Usk and the Welsh Dee. Possible reasons for this decline include over-exploitation by rods in certain rivers as well as changes in marine and freshwater environmental variables.

There are two separate facets of the multi-sea-winter spring run trait:

- The timing of the upstream migration.
- The sea age at maturation.

Spring running fish are almost invariably multi-sea-winter and these traits for late maturation and early running are both genetically and environmentally controlled.

The NRA recently commissioned a study (Rogan, O'Flynn, FitzGerald and Cross, 1993) to review what is known about the genetic characteristics of salmon of different sea ages and run timing and to assess the feasibility for specific enhancement of the spring salmon component of English and Welsh stocks.

The major conclusions from this study were that:

- Exploitation in estuarial and riverine fisheries should be viewed as a strong selective force against the early running MSW habit and must be decreased.
- If freshwater habitat is being degraded in major spring run salmon producing rivers in England and Wales, it must be identified and redressed. This is particularly important in the upper reaches where a higher proportion of spring salmon may spawn.

- Further research is required to:
 - Find out more about where salmon with different life histories spawn.
 - Gain a better understanding of the effects of marine environmental fluctuations on salmon maturation.
 - Develop effective stock enhancement practices for the spring run component of English and Welsh salmon stocks where appropriate.

The cessation of fishing at West Greenland may help spring fish stocks to recover but only if adequate protection is also given to this stock component in home waters. Consequently, the NRA has already introduced byelaws to protect these stocks in the Hampshire Avon, Wye, Usk and Dee. **The NRA will continue to protect and, where necessary, attempt to enhance spring run salmon stocks.**

"THE GOOD OLD DAYS"? SIX SPRINGERS WEIGHING A TOTAL OF 126½ lbs CAUGHT IN THE RIVER WYE ON APRIL 4th, 1916.



OBJECTIVE 3

TOWARDS THE SUSTAINABLE EXPLOITATION OF SURPLUS STOCKS SO AS TO OPTIMISE THEIR TOTAL ECONOMIC VALUE WHILST ALLOWING FOR SOCIAL EQUITY CONSIDERATIONS.

3.1 Apportioning the Resource

This objective seeks to ensure that surplus stocks are exploited in such a way so as to optimise their total economic value, though it must be recognised that no form of exploitation should jeopardise achieving the optimal spawning escapement or ignore social equity considerations. However, if the spawning target is being achieved, then it can be decided how, and by whom, surplus stocks should be exploited. The question as to who has the most right to harvest the salmon resource, the nets or the rods, is a long standing issue. In order to try and resolve it, a number of studies have been carried out to assess the relative economic value of rod and net fisheries.

A LEGAL DRIFT NET
LICENSED TO OPERATE IN
THE LUNE ESTUARY



Mills (1989), who comprehensively reviewed these studies, reported that it would seem “that a salmon caught with rod and line is of more value than a salmon taken commercially although in some cases (e.g. Ireland) only marginally more”. In a more recent study, entitled “Economic evaluation of salmon fisheries in Great Britain”, Radford, Hatcher and Whitmarsh (1991) pointed out that many of these earlier studies were based upon anglers’ expenditure and its impacts and that these estimates of gross expenditure are not a recognised measure of economic value. In their own study, which was based on economic value, they concluded: “While it appears that for Great Britain as a whole the recreational fishery is significantly more valuable than the commercial fishery, this does not constitute the case for a change in the current balance... In order to make a judgement about the most valuable balance between the two sectors in the exploitation of a particular salmon stock, the effects of a change in the catches of one sector on the catches in the other sector would need to be confidently predicted. Our appreciation of the biological literature suggests that this would be difficult.”

Indeed, if a net fishery was closed down, it cannot be assumed that the total net catch would become available to the rod fishery in that river. The benefit to a rod fishery and spawning stocks resulting from a reduction in netting can be estimated by proportional calculations. Such calculations clearly show that a reduction in net fishing would lead to a relatively small direct increase in the rod catch; the extra fish making a larger contribution to the spawning stock. However, these estimates are an oversimplification. The effects of eliminating a net fishery depends on its size relative to that of the rod fishery, its location and the time of its operation.

The location of the net fishery is important because, due to straying, the catch in net fisheries operated in outer estuaries or the adjacent coastal zone will generally have a lower proportion of native fish when compared to nets fished in the upper reaches of estuaries. Thus, Shearer (1992) estimated that the removal of a net fishery from a hypothetical East coast Scottish river (many of which operate well outside river estuaries) might result in only just over half of the putative net catch becoming available to the rod fishery. In marked contrast, on the River Dee in North Wales, the net fishery is mainly located well within the estuary and straying, as estimated by radio tracking, is only a few per cent. Calculations have shown that the closure of the Dee net fishery (NB not currently an option) would result in about a 25% increase in rod catch and 10% increase in spawning escapement (NRA unpublished).

The time of operation of the net fishery is also important. Shearer pointed out that the closure of net fisheries which operate during the summer months will lead to more grilse entering the river and these will be exploited predominantly in the lowermost beats of rivers. However, it is unlikely that in all cases a discernible improvement in the rod fishery will accrue from a cessation of the net fishery. For example, there was no significant difference in the rod catch of salmon on the River Wye following the closure of the net fishery in 1984. The average annual rod catch in the period 1976-1984 was 3367 compared with 2989 for the nine year period following its closure (1985-1993).

Furthermore, even when the closure of a net fishery results in increased numbers of fish entering the river, and the total catch increases it is highly unlikely that the rod fishery would adequately exploit all of the stock available. Indeed, on the Rivers Frome and Coquet, exploitation rates of salmon by rod and line have been found to decrease with increasing stock size (Solomon and Potter, 1992). Increased adult runs would result in increased numbers of spawners, probably predominantly one-sea-winter male fish. Any additional hen fish would be beneficial only if the overall egg deposition had been limiting the juvenile production prior to the removal of the net fishery. However, if the cessation of netting merely allowed an increase in the number of spawners in a plentiful and/or unwanted component of the stock, these fish could depress still further the scarcer and/or preferred components of the stock. Thus an increased number of grilse could increase the possibility of multi-sea-winter salmon and grilse mating together with the result that fewer of their progeny might possess the gene complex required to develop the late maturing, early running habit.

Thus, it is clear that predicting the results of changes in the exploitation of salmon is complex. However, the NRA could advise on the likely biological and economic changes that might arise from any change in resource attribution on a particular river system. The modelling of such changes could in turn be used to identify how the salmon stock in question could be exploited so as to maximise its economic value. At present, the implementation of such changes can only be brought about by voluntary agreement between the nets and rods.

3.2 Buy Back

There are particular local situations where fishery owners and/or anglers might be prepared to pay netsmen compensation to stop netting in order to maintain or increase the availability of “in-season stocks” for exploitation by rod and line.

Such arrangements can only be reached by mutual agreement between the rods and nets and in these situations the NRA would be happy to help both parties to reach such an agreement.

It should be stressed that most licensed salmon and sea trout nets in England and Wales operate under a public right of fishing and the netsmen do not own the right to fish and cannot therefore sell that right. Except, therefore, in those cases where the fishing rights are privately owned, it would only be possible to pay netsmen not to exercise their fishing rights rather than buy them out.

3.3 Social Values and Legislative Change

Radford, Hatcher and Whitmarsh also pointed out that:

“Almost any change in resource allocations, however it may appear to increase net economic value, will have distributional consequences. Inevitably, some individuals will be made worse off by the change. Distributional consequences should not be ignored because an objective economic evaluation has shown a proposed change to be beneficial.”

The NRA would not wish to and cannot ignore these “distributional consequences”. Under the provisions of the Salmon and Freshwater Fisheries Act 1975, the NRA does not have any powers to seek a reduction in netting effort in order to increase the share of the catch taken by anglers. The Authority’s present powers to regulate licensed fishing are limited to the conservation of the resource and/or to improve the management of individual stocks. Any decision to change compulsorily resource allocation in order to optimise economic or social values can only be made by Government and would require legislative change.

OBJECTIVE 4

MEETING THE NECESSARY COSTS OF MANAGING MIGRATORY SALMONID FISHERIES.

The successful implementation of this Strategy will require the full participation of everybody involved in the management and exploitation of salmon and the willingness of the direct participants and Government to provide the necessary resources.

In order to achieve Objective 4 in an equitable way it is necessary to:

- Identify the beneficiaries of the NRA’s fisheries work.
- Determine the necessary costs of managing migratory salmonid fisheries* now and in the foreseeable future.
- Obtain the necessary income to meet these costs.

* It should be noted that in the case of salmon and sea trout it is rarely possible to separate the costs and income attributable to each species.

In addition, this must be carried out in accordance with the Department of the Environment's Financial Memorandum to the NRA which clearly charges its Fisheries Function to:

- Balance cash income (including Grant-in-Aid) and expenditure in each financial year.
- Seek to establish fair charging policies which will maximise income from licence duties, contributions under Section 142 of the Water Resources Act 1991 and fees from rechargeable services.

Furthermore, when the Environment Agency takes over responsibility for the management of salmon fisheries in England and Wales on April 1st, 1996, its actions will be subject to the cost benefit duty provided by Clause 39 of the Environment Act 1995. This "general duty of the new Agency to have regard to costs and benefits in exercising its powers" will influence the use of this Strategy to manage salmon.

The benefits from certain management actions relating to the exploitation of the salmon resource may be relatively easy to measure in monetary terms. Priority should be given to those management actions and/or improvement schemes which provide the highest return for any given investment. More marginal schemes, in terms of cost benefit, will be given lesser priority or may not be selected at all.

However, the benefits of conserving stocks may be more difficult to quantify. Nevertheless, this must not preclude the funding of projects to conserve or restore salmon or mean that priority should necessarily be given solely to increasing the economic value of existing stocks.

The new cost benefit duty will also apply to all other activities of the Environment Agency e.g. improving water quality. Such activities may, directly or indirectly, affect the salmon resource. Consequently, the consideration of the likely costs and benefits in these areas will have to take into account fisheries implications.

4.1 The Beneficiaries

The beneficiaries of the NRA's fisheries services are those groups and individuals on whose behalf such work is undertaken, or because of whom such work is necessary or both.

They comprise:

- Anglers
- Netsmen (including those in distant water fisheries)
- Fishery owners
- The General Public
- Other NRA Functions
- Others outside the NRA

4.2 The Necessary Costs of Managing Migratory Salmonid Fisheries

The NRA will carry out its activities and provide services in a cost-effective manner and will continue to target expenditure at providing fisheries services and activities.

This document identifies priority activities, which if adopted, will need to be costed. The proposed local Salmon Action Plans will be used to identify the cost of implementing the Strategy, to the required level, on individual river catchments but there will also be additional costs which will need to be identified in Regional and National Salmon Management Plans (Section 1.1.7).

4.3 Funding the NRA's Management of Migratory Salmonid Fisheries

At present, the income to fund 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 has funded over 80% of planned expenditure on salmon and sea trout fisheries in 1995/96. However, public funding of the NRA's Fisheries Function has already been reduced and this highlights important issues regarding the future funding of migratory salmonid fisheries.

These include:

i) The need for rods, nets and fishery owners to pay for a greater proportion of the total expenditure on migratory salmonid fisheries.

Income from rod and net licences funds around 10% of expenditure. All licence duties are regularly reviewed but clearly these sources of income alone would never fund established levels of fisheries services. So far the NRA and fishery owners have failed to agree upon a direct charging scheme, however, the NRA believes that it will be necessary for fishery owners to meet some of the NRA's costs. Fishery Associations, clubs and owners may wish to form partnerships with the NRA by voluntarily contributing money or other resources to carry out specified works or activities. Such partnerships already exist and the NRA strongly supports these initiatives which enable more resources to be put into a particular river catchment than would be otherwise possible.

ii) The need for the NRA to maximise its funding by efficient cost recovery and extra income generation.

a) Expenditure on fisheries by other NRA Functions

Other NRA Functions e.g. Water Quality already spend money which contributes towards fisheries improvements. Such contributions are appropriate where:

- work which coincidentally benefits fisheries is carried out by another NRA Function in order to fulfil that Function's statutory duties e.g. improvements to water quality.
- remedial or mitigation works to fisheries are required as a result of the activities of the NRA's Flood Defence or Water Resources Functions. These Functions have specific duties for fisheries under Sections 105(3) and (4) and Sections 21(5)(b) and 40(2) of the Water Resources Act 1991.

Other NRA Functions will continue to fund fisheries work both directly and indirectly, however an increase in such funding is unlikely.

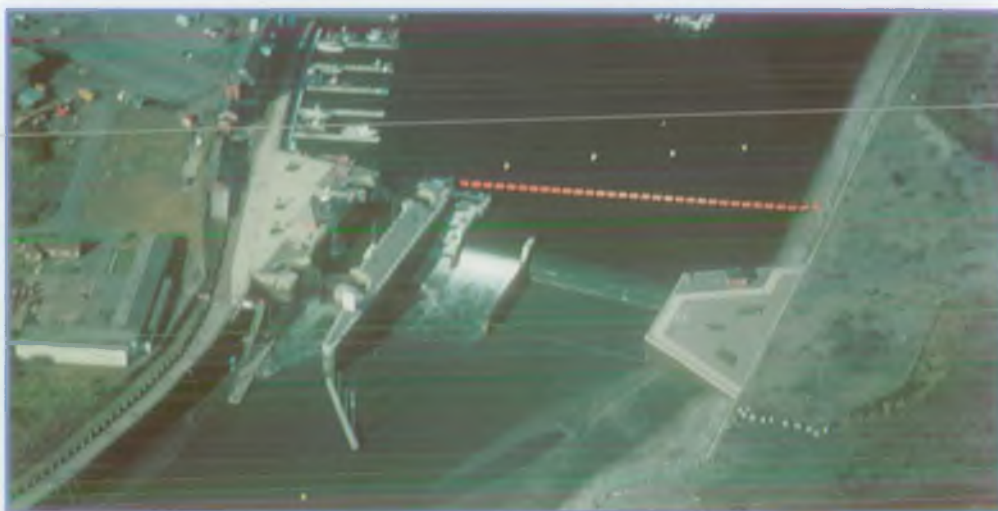
b) Direct charges

There is more scope for charging for certain fisheries services outside of the NRA and this could be used to generate increased income as well as recover costs. Such direct charges could only be justified, however, if an individual or group specifically requests such services or can be clearly identified as being the primary beneficiary. Services which are provided for the wider public good should not be charged for directly. Funding from direct charges could become increasingly important but is unlikely to be of major significance in the overall funding of fisheries.

c) Cost recovery for damage to migratory salmonid fisheries

Many construction schemes and human activities can adversely affect migratory salmonid fisheries. These include estuarine barrages, reservoirs, river engineering works and crossings, abstractions, water transfer schemes, pollutions and many forms of land use e.g. forestry. As described in Section 4.3.1 (iii) some of these are historic and/or cannot be attributed to any particular body or person. However in many cases, the promoters of such schemes are readily identifiable. In these cases, the NRA considers that the promoter should pay for all pre- and post-impact studies as well as full restoration and/or mitigation costs if the resource is in any way damaged or reduced. Such costs must reflect the true value of the damaged or lost resource.

THE PROMOTER SHOULD
PAY FOR EXTENSIVE
IMPACT STUDIES AND
EFFECTIVE FISH PASSES IF
BARRAGES ARE BUILT



d) Sponsorship

The Thames Salmon Rehabilitation Scheme is the best known example of sponsorship to fund a major salmon project in England. Donations totalling nearly half a million pounds have through the Thames Salmon Trust, a registered charity, been spent on providing fish passes which enable adult salmon to migrate upstream to reach their spawning grounds. Sponsors have ranged from large multi-national companies to individuals, all sharing the common vision of restoring salmon to the Thames. Other rivers may benefit from similar initiatives and these will be encouraged by the NRA.

iii) The need for public funding of the salmon resource.

All of the present Fisheries Grant-in-Aid is spent on migratory salmonid fisheries. This, together with other sources of income, enables the NRA to undertake a wide range of activities to fulfil its duty to maintain, improve and develop these fisheries in England and Wales. The NRA will not increase trout and coarse licence duties to pay for a shortfall in salmon and sea trout fisheries expenditure. As a result, the services provided for salmon fisheries could be reduced if Grant-in-Aid continues to fall.

A major part of this expenditure is spent on anti-poaching enforcement, activities that involve the NRA in crime detection, deterrence and prosecution. Although there is a degree of flexibility as to the extent to which this work is undertaken, nevertheless poaching must be controlled and, in order to do so, the NRA believes that public funding should be made available.

In addition, public funding of the NRA Fisheries Function's activities by Grant-in-Aid is needed:

a) To repair historic damage to salmon fisheries

A number of salmon rivers have a legacy of problems in many cases stemming from the last century and the Industrial Revolution. Examples of such problems include old dams obstructing fish migration, long term water quality problems, over abstraction for water supply or other purposes as well as habitat degradation due to long established flood prevention and/or flood drainage works.

b) To protect or restore salmon populations affected by current environmental pressures

Unattributable damage to salmon fisheries is not restricted to historic cases. Pollution from land and air as well as water, agricultural practices and forestry can all impact upon the salmon resource. However, as with historic damage, in cases where no particular body or person can be held liable the NRA still has to monitor, protect and, if necessary, restore the fisheries resource. Thus it seems reasonable to expect that such work should be funded, at least partly, by public money and in the case of restocking costs which cannot be attributed to an identified polluter, the NRA has a policy of charging the Water Quality Function's account rather than that of Fisheries.

c) To pay for the direct and indirect benefits that the general public receives from the salmon resource. These include:

- Economic activity from sales of fish and rod and net fishermen's expenditure.
- The social benefits of angling as a means of recreation.
- The conservation and heritage value of fish and fisheries.
- The rates paid by fishery owners to Local Authorities.



HAAF NETTING - A TRADITIONAL
FORM OF SALMON FISHING

d) As a national contribution to the preservation of a species and genetically distinct sub-specific stocks which are internationally recognised as having a high conservation value and which adds to the biodiversity of England and Wales. The salmon is afforded special protection by the EC Habitats Directive and this Strategy could form the basis of a "Species Action Plan" for it.

4.4 Fair Charging Policies

The NRA will continue to seek to establish fair charging policies in compliance with the Department of the Environment's Financial Memorandum. The NRA has and will continue to consult with Regional Fisheries Advisory Committees and the general public with respect to any changes in rod and net licence structures and duties. Furthermore, any changes made to licence duties for both rod and net fisheries are subject to approval by MAFF and the Welsh Office.

SALMON HAVE A HIGH
CONSERVATION VALUE
AND ARE A SPECIES
WHICH MUST BE
PRESERVED FOR
FUTURE GENERATIONS



Authorship and Acknowledgements

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A Strategy for the Management of Salmon in England and Wales

Timetable for Production of Action Plans for Principal Rivers

Region	River	1996/97	1997/98	1998/99	1999/2000	2000/01
North West	Eden	*				
	Leven	*				
	Lune	*				
	Derwent		*			
	Ehen		*			
	Ribble		*			
	Wyre		*			
	Border Esk			*		
	Kent			*		
	Cumbrian Esk				*	
	Duddon				*	
North East	Coquet	*				
	Wear		*			
	Esk		*			
	Tees			*		
	Tyne			*		
Southern	Test }	*				
	Itchen }					
Midlands	Severn	*				
	Severn Estuary		*			
South West	Torridge	*				
	Avon(Hants)	*				
	Tamar	*				
	Lynher	*				
	Taw		*			
	Frome		*			
	Tavy		*			
	Camel			*		
	Piddle			*		
	Teign			*		
	Dart			*		
	Exe				*	
	Fowey				*	
	Lyn				*	
	Stour				*	
	Axe					*
	Plym					*
	Erme					*
	Avon(Devon)					*
Thames	Thames		*			
Welsh	Dee	*				
	Mawddach	*				
	Teifi	*				
	Wye	*				
	Dwyfawr		*			
	Ogwen		*			
	Seiont/Gwyrfai		*			
	Tywi		*			
	Usk		*			
	Cleddau			*		
	Clwyd			*		
	Conwy			*		
	Dysynni			*		
	Taff			*		
	Tawe			*		
	Dyfi				*	
	Glaslyn/Dwyrdd				*	
	Ogmore				*	
	Taf				*	
	Nevern					*
	Rheidol					*



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