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National Rivers Authority
Welsh Region

RESIDENT BROWN TROUT

A Management Strategy
Implementation And Progress Report

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RESIDENT BROWN TROUT: A MANAGEMENT STRATEGY

IMPLEMENTATION AND PROGRESS REPORT

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EXECUTIVE SUMMARY

In January 1991 a management strategy for resident brown trout was produced and agreed with the Regional Fisheries Advisory Committee. This strategy made a total of 25 recommendations ranging from the establishment of a database on trout fisheries to measures for environmental and fisheries protection.

This report sets out how the Region proposes to implement the recommendations contained in the strategy. It is clear that full implementation of the recommendations is not possible immediately with present resources. Therefore for each recommendation the present position is discussed, followed by short term proposals which cover a two year time period and which can be implemented within present resources. Longer term proposals, ie greater than two years, will require additional resources for their implementation.

In formulating this implementation plan a number of common themes are apparent. Firstly, data on the brown trout resource in terms of its status, diversity and exploitation are inadequate for effective management. Secondly, the conservation and improvement of habitat, particularly upper catchment areas which are the principal spawning and nursery areas, must be a priority. The Region's programme of catchment management plans is likely to be the vehicle through which this can be achieved. Finally, the impact of inappropriate restocking and exploitation patterns can be significant and needs to be remedied by regulation and education.

The proposals will be actioned by allocating tasks to appropriate Departments within the Region. Progress on these tasks will be monitored and reviewed and reported to local fisheries groups and the Regional Fisheries Advisory Committee at appropriate regular intervals.

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1. INTRODUCTION

Following consultations between Fisheries Managers and the Regional Fisheries Advisory Committee (RFAC), a strategy for the management of resident brown trout was agreed in January 1991.

This strategy makes 25 recommendations relating to the establishment of a database on trout fisheries, as well as environmental and fisheries protection.

This implementation and progress report addresses each recommendation under the following headings:

Present Position : states the existing situation and practice and defines issues which need addressing.

Short Term Proposals : (< 2 years) : actions considered to be achievable and to be implemented within the existing Regional Plan and available resources.

Long Term Proposals : (> 2 years) : targets to be achieved as and when resources become available.

The phasing and timescales for the short term proposals are shown in Table 1.

2. HISTORICAL PERSPECTIVE

The British Isles were ice-covered during the last glaciation between 10,000 and 70,000 years ago. At the maximum extent of ice cover only the southern part of Britain remained ice free, although even here permafrost conditions would have existed. It is therefore most unlikely that any purely freshwater fish population could have survived in Britain. However during the ice age migratory trout could have lived to the south and south west of Britain in conditions similar to those found in the Artic and northern Atlantic Oceans to-day. By 13,000 years ago most of Britain was ice free and as the ice retreated northwards the migratory salmonids probably moved with it and entered freshwater systems as they became available. Thus present day resident brown trout populations must have arisen from migratory ancestors which entered in post-glacial times. As water temperatures increased many populations became freshwater resident. Also brown trout populations in high mountain lakes or in upstream areas of rivers isolated from sea trout stocks by impassable waterfalls must have been accessible to migratory trout at some time since the last glaciation.

In more recent times considerable restocking of brown trout has occurred to satisfy increased angling demand. Pressures on stocks have also arisen through habitat destruction, pollution and over-exploitation. These factors have combined to necessitate the production of a management strategy whose implementation will lead to the conservation and improvement of this valuable fishery resource.

Table 1 **Schedule of Short Term Proposals**

	RECOMMENDATION	No.	1993 Q1	1993 Q2	1993 Q3	1993 Q4	1994 Q1	1994 Q2	1994 Q3	1994 Q4
1	Database	(1)		◄--►	►					
		(2)			◄	---	---	---	---	►
		(3)					◄--►			
4	Monitoring			◄	---	---	---	---	---	►
5	Historical Catch Records					◄--►		◄--►		
6	Future Catch Records	(1)				◄--►				
		(2)				◄--►				
7	Economic Value	(1&2)			◄--►					
8	Pollution control	(1)	◄	---	---	---	---	---	---	►
		(2)					◄	---	---	►
9	Acidification	(1)	◄	---	---	---	---	---	---	►
		(2)	◄	---	---	---	---	---	---	►
		(3)				◄--►				
10	Flows	(1&2)	◄	---	---	---	---	---	---	►
11	Upland drainage	(1&2)			◄	---	---	---	---	►
12	Upland Use	(1)	◄	---	---	---	---	---	---	►
		(2)							◄--►	
13	River Engineering	(1,2&3)	◄	---	---	---	---	---	---	►
14	Restoration		◄	---	---	---	---	---	---	►
15	Non-Main River	(1,3&4)	◄	---	---	---	---	---	---	►
		(2)	◄--►							
3	SSSI/CCW						◄--►			
16	Predation	(1,2,3)	◄	---	---	---	---	---	---	►
24	Brown/Sea Trout		◄	---	---	---	---	---	---	►
17	Size limits		◄	---	---	---	►			
18	Byelaw Review		◄	---	---	---	►			
21	Bag Limits		◄	---	---	---	---	---	---	►
2	Stocking Control	(1)			◄	---	►			
		(2)	◄	---	---	---	---	---	---	►
19	Genetics Research		◄--►							
20	Role of Stocking	(1&2)	◄	---	---	---	---	---	---	►
22	Stocking Strategies	(1&2)	◄	---	---	---	---	---	---	►
23	Wild Trout Rearing	(1)	◄	---	---	---	---	---	---	►
		(2)			◄--►					
25	Biological Factors									

3. THE RESOURCE

The trout (Salmo trutta L.) resource within the Welsh Region of the National Rivers Authority is extensive, diverse and valuable. More than 50 river catchments comprising 7000 km of river plus numerous tributaries are important for both resident and migratory trout. There are 36 significant estuaries and around 300 km of coastline through which the migratory fish pass.

The Region also contains 1647 lakes and 134 reservoirs representing 15% of the total for England and Wales. These waters, the majority of which contain trout, range from small upland lakes through to vast more low lying man-made reservoirs. They are well distributed throughout the Region with a large proportion located in more upland areas. Although 45% are larger than 1 hectare, many are comparatively small with 50% of reservoirs and 98% of lakes being less than 19.7 hectares in area.

The brown trout stocks exhibit great diversity (Figures 1A,1B,1C), supporting a variety of fisheries ranging from natural, unstocked to artificially maintained put and take. This is a highly desirable feature of Welsh trout fisheries which needs to be actively maintained. Many brown trout fisheries co-exist with migratory trout fisheries, the boundaries of which are often blurred, presenting real challenges for their management.

Figure 1A Diversity of Brown Trout Populations

Figure 1B

Figure 1C

3.1 Recommendation 1. That a data base of all brown trout fisheries is established, specifically identifying natural brown trout fisheries.

Present Position

A database for lake fisheries has been set up (figure 2), incorporating information on ownership, physical features and fishery characteristics of more than 300 waters in Welsh region. The database has already been used in assessing the impact of acidification, designing sampling programmes for the Chernobyl radioactivity monitoring programme, for initial resource assessment as part of the brown trout strategy and in identifying fishery ownership for the Section 142 charging scheme database.

Further work is required to make it more "user friendly", to validate and update the database Regionally (it is proposed that this task should come within the Section 142 Fishery Assessment data collation). A database for river and stream fisheries has not yet been developed. Options for this will be reviewed when Section 142 data have been fully collated, some of which will be useful for the fishery database.

Short Term Proposals

1) Software for Lake archive will be refined to improve accessibility by Area staff (by July 1993).
2) A Regional rolling programme will be set up to update and validate the database (by September 1993).
3) Proposals for the development of the flowing water fisheries archive will be made following review of the Section 142 data (by April 1994).

Long Term Proposals

1) A database will be completed and maintained on a permanent basis, combining all trout fisheries in the Region.

3.2 Recommendation 4. That the juvenile salmonid monitoring programme be modified to include more sites representative of resident brown trout populations.

Present Position

The juvenile salmonid monitoring programme commenced in 1985 (Figure 3) with the objectives of establishing a baseline information on the status of juvenile salmonid stocks and to monitor changes in response to natural and management-based factors. Annual sampling at key sites is targeted at a number of major catchments, with other catchments being sampled less frequently under a rolling programme.

In 1990 a total of 20 river catchments and 493 sites were sampled. Since it is not possible to distinguish between juvenile resident brown trout and juvenile migratory trout the current assessment of resident trout stocks is largely confined to areas upstream of impassable barriers. Even on those rivers which do not have a significant migratory trout component e.g. Wye, Usk, the present sampling strategy is unlikely to adequately describe their status. In 1990 42 sites above impassable barriers were sampled of which 21 were situated on the Wye catchment, primarily on the Monnow.

Results from the monitoring programme show that in general the highest juvenile trout densities occur on rivers which have significant migratory whilst lowest abundance levels are recorded on the Wye,

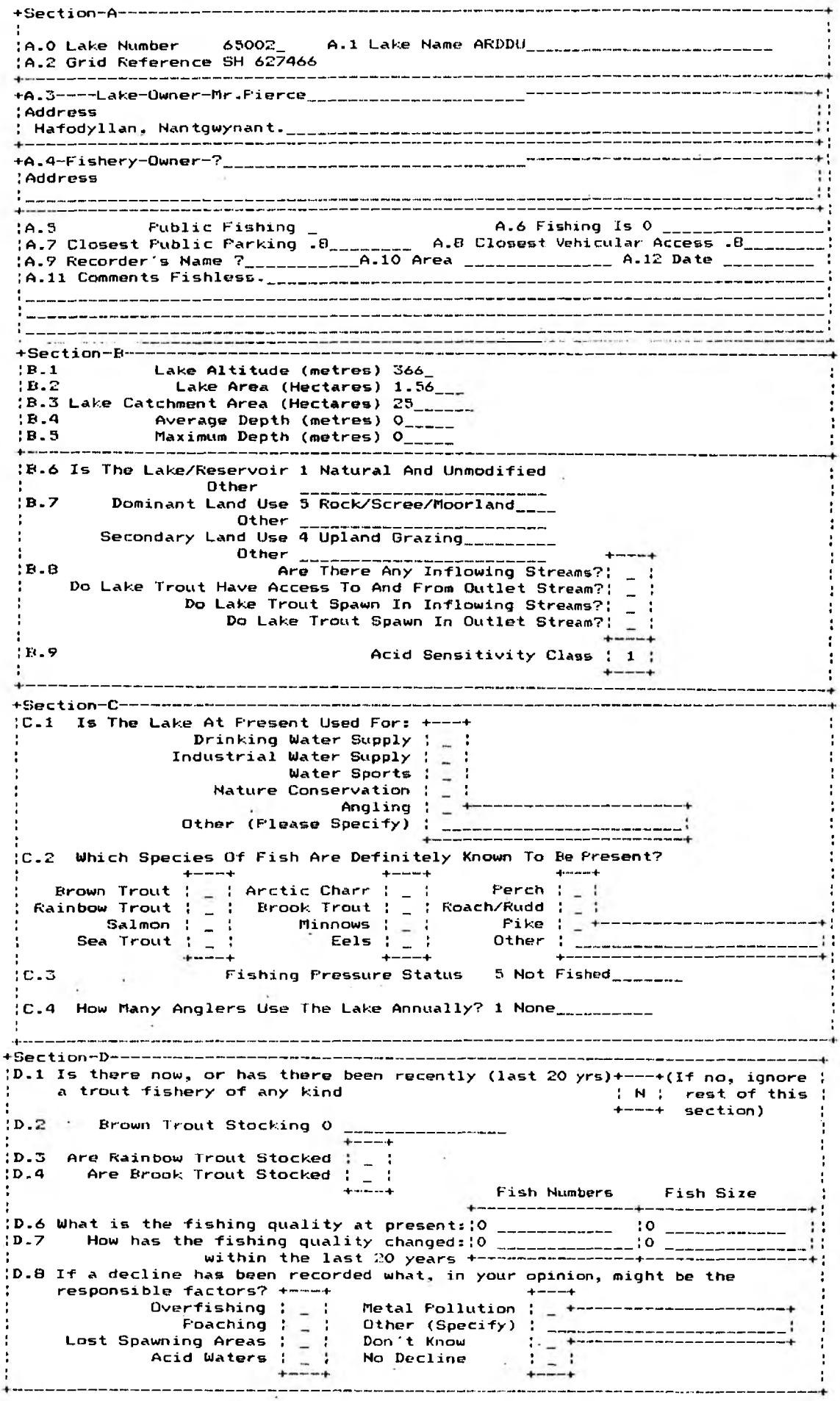


Figure 2 Lake Fishery Archive

Usk and Dee which do not have a significant migratory trout component. Additional surveys undertaken on the Wye and Usk catchments have demonstrated a clear distinction in the distribution of salmon and trout. Trout fry and one year old parr were more numerous in small streams generally less than 3m wide, whilst older trout and salmon fry and parr were more numerous in the larger streams.

Short Term Proposals

1) Within present resources, where possible sampling effort will be increased above impassable barriers and on smaller sub-tributaries. A revised programme will be produced by June 1993.

Long Term Proposals

1) Brown trout populations in both rivers and stillwaters will be adequately monitored and the results used to guide management. Where appropriate specific studies into brown trout populations to address management problems will be undertaken.

Figure 3 Electric Fishing Survey Work

3.3 Recommendation 5. That all angling clubs, syndicates and individual anglers be asked to make available to the NRA, any historical catch records relating to brown trout fisheries.

Present Position

Catch returns for brown trout are not mandatory and are not routinely collected by the Region. Catches can provide data on a sample of the total fish stock, even though this sample is biased in terms of gear selectivity, sampling period, effort and location. Catch statistics can provide useful data for monitoring trends in the numbers and composition of the exploited portion of the population and can be used as a measure of the pattern of utilisation of the fishery resource.

When catch data have been available, they have proved valuable for investigative and management purposes e.g. Llyn Conwy (Figure 4), Llyn Gregennen, River Alyn. Around 50,000 non-migratory trout licences were sold annually in Welsh Region and the collection of catch returns from licencees, a proportion of which fished solely for rainbow trout in stillwaters was not a viable option. With the introduction of the national, all-species licence, there are major logistical constraints on the collection of catch statistics for brown trout.

Short Term Proposals

1) A questionnaire will be sent out in winter 1993 to angling clubs and fishery owners held on the Authority's database requesting details of any catch records held. This will also include details of the fishery, number of anglers and any stocking history.

2) A recommended standard format for catch recording will be publicised in the winter 1993 edition of Glasydorlan and advice given on how to maximise the quality of returns.

Long Term Proposals

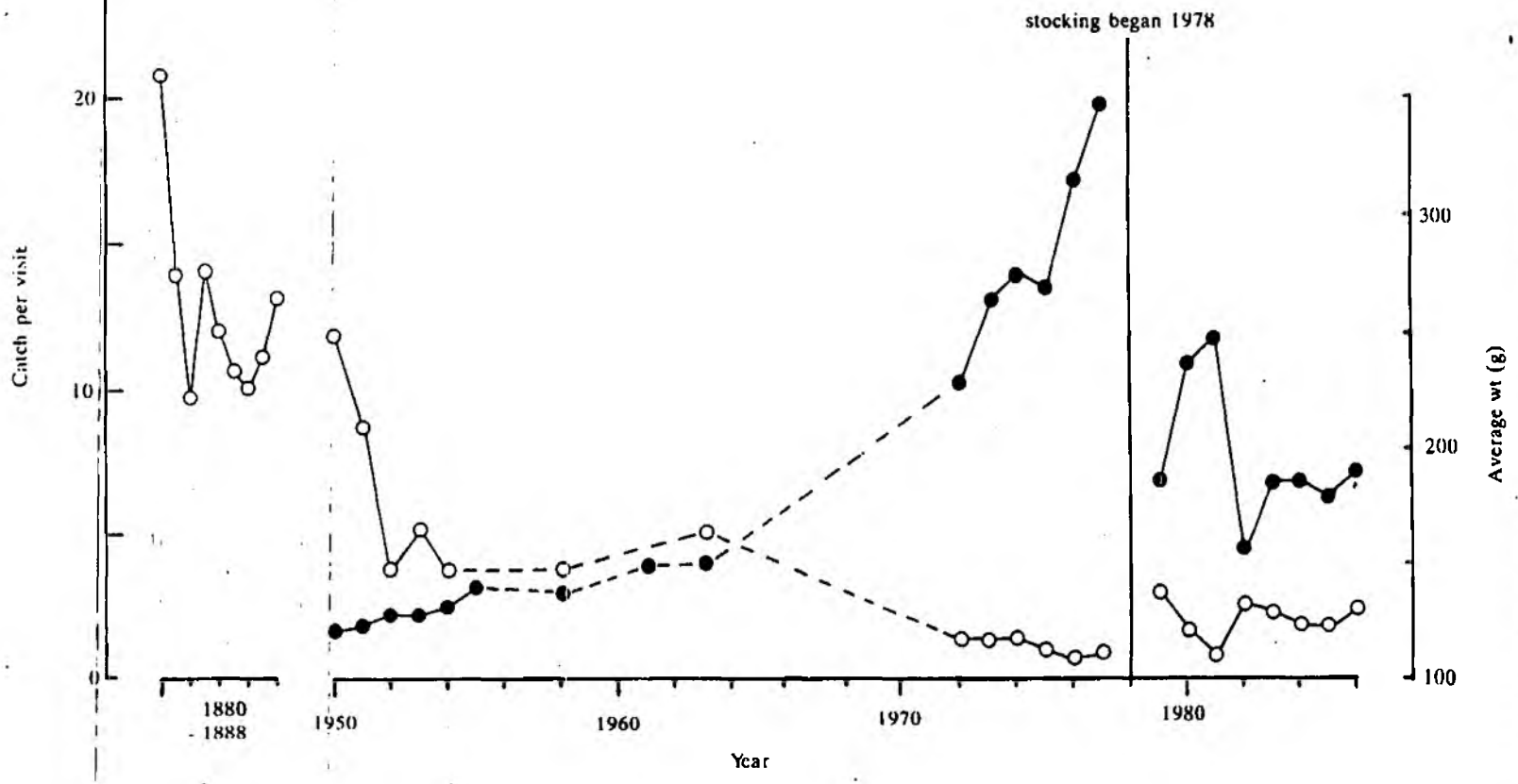
1) Any identified datasets will be collated as appropriate and linked with the brown trout fishery archive.

2) Further options for standardising catch data collection by targeted fisheries will be examined.

3.6 Recommendation 6. That all angling clubs, syndicates are encouraged to maintain catch records for brown trout fisheries in Wales. On specific waters log book schemes will be established.

Present Position

The extent to which catch records for brown trout are maintained is not known, although some angling clubs and fishery owners insist on anglers submitting a return for the previous season prior to issuing a new permit. The value and importance of collecting catch data for a variety of fishery management purposes is widely recognised and has been addressed in recommendation 5.



Historical changes in brown trout catch per visit (open symbols) and average weight (closed symbols) between 1880 and 1986 in Llyn Conwy, Gwynedd, North Wales.

Figure 4 (Source: Acid-Waters-in-Wales – Edwards, Gee and Stoner 1990).

Log books (Figure 5) are being increasingly used to monitor salmon and sea trout fisheries and poentially could also be employed on brown trout fisheries.

Short Term Proposals

1) An article will be produced for the winter 1993 edition of Glas-y-Dorlan setting out the main criteria and advantages of routinely collecting brown trout catch data.

Long Term Proposals

1) Log books will be issued to selected fisheries and Angling Associations and a system for the collation and reporting of data will be developed.

REMEMBER: ONLY ONE TRIP TO BE RECORDED ON EACH PAGE

RIVER		LOCATION	

DATE	PLEASE CIRCLE APPROPRIATE BOXES										
DATE	1	2	3	4	5	6	7	8	9	10	11
	12	13	14	15	16	17	18	19	20	30	31
	21	22	23	24	25	26	27	28	29		
MONTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	

FISHING EFFORT	HOURS
HOURS FISHING FOR SALMON ONLY	
HOURS FISHING FOR SEA TROUT (SEWIN) ONLY	
HOURS FISHING FOR BOTH SPECIES AT THE SAME TIME	
HOURS FISHING AT NIGHT	

CATCH			IF NIL TICK BOX ——————>							
FISH No.	SPECIES (TICK BOX)		WEIGHT		CAPTURE TIME (TICK)		METHOD			TAG No.
	SALMON	SEWIN	LBS	OZ	DAY	NIGHT	FLY	SPNR	BT	
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

COMMENTS.....

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Figure 5 Example of a Log Book Catch Return

3.5 **Recommendation 7. That the economic value of the resource and consumer (angler) demand for the resource are assessed periodically so that financial resources for the conservation, improvement and development of trout fisheries can be appropriately allocated.**

Present Position

There is currently very little information available on the economic value of brown trout fisheries. The best available estimate of the value of river trout fisheries in Welsh Region is £7m. This figure is likely to be underestimated since it is based on a value of £2000 per Km; in 1982 three fisheries on the River Usk, noted primarily for their brown trout, were sold for £20,000 - £30,000 per km. With a further £5m added for stillwater trout fisheries, the total estimated value of brown trout fisheries in Wales equals that attributed to salmon and sea trout fisheries (excluding the River Wye). These are values attributable to the owners only, and the overall value would be greater if the values accruing to the anglers (Figure 6) and to the general public (conservation value etc.) were to be included.

The economic value of a fishery can be conveniently divided into four parts:

i) Capital value - value to the fishery owner.
ii) Consumer surplus - amount anglers are willing to pay in addition to present costs to continue fishing i.e. net benefit to anglers.
iii) Benefits to the local economy - this may be significant for some fisheries e.g. on the River Usk a survey showed that 1 in 11 anglers originated from outside the catchment.
iv) Benefit of having a recreational fishery

There is clearly a need to identify the economic value of brown trout fisheries in Wales so that appropriate resources can be devoted to conserving and developing their full potential. This is a very specialised area of investigation and the expertise and resources are not available within the NRA to undertake such a study.

Short Term Proposal

1) A study of the economic value of brown trout fisheries will be proposed for consideration in the NRA's R & D programme, possibly initially on a pilot scale for selected areas and fisheries.

2) The proposed study should include a survey of angler origin from licence sales data. This would enable the identification of areas with inadequate brown trout fisheries so that resources can be targeted to developing and improving fisheries in these areas.

Long Term Proposals

1) This economic survey should be repeated at least once every 10 years to update the data on a regular basis.

Figure 6 Trout Fishing on the River Usk

4. ENVIRONMENTAL PROTECTION

4.1 WATER QUALITY

4.1.1 Recommendation 8. That the NRA continue to give a high priority to pollution prevention and the setting of water quality objectives for all standing waters and small streams.

Present Position

Pollution control continues to be a high priority for the Authority, with a planned expenditure in excess of £9m in 1992/93. In Welsh Region priority is being given to identifying and resolving farm pollution, the impact of STWs and storm water overflows (Figure 7). Much of this work is directly relevant to protection of brown trout fisheries, and in some cases fisheries survey forms part of the impact assessment.

In addition to the effects of point source pollution, trout stocks in the uplands particularly are vulnerable to diffuse pollution such as that derived from agricultural and forestry practise and acidification (see Recs. 9,10,11,12). A further issue is the effectiveness of environmental protection to first order streams and to standing waters. Environmental degradation (water quality, habitat or flows) in such waters could be the cause of long term stock decline if they represent significant habitat for trout. Recent research to look specifically at this suggests that they may be important for maintaining brown trout stocks. In the Conwy, first order streams contribute between 18% and 20% of total stream wetted area and 61% of total stream length. This work and other studies on the Usk will assist the Authority in assessing the relative importance of such waters and, if appropriate, presenting a case for their better protection.

As well as monitoring effluents to demonstrate compliance with consents, there is a general duty on the Authority to monitor water quality in controlled waters, particularly to assess compliance with any Statutory Water Quality Objective (SWQO) which will be set by the Secretary of State. Discussions are in hand between the NRA and DoE regarding the appropriate SWQOs. The DoE recently published proposals, based on an earlier NRA consultation paper (WQ Series,No 5,1991), for comment which sets out a scheme for classifying rivers, setting use-related standards and objectives. The Government plans to begin the process of introducing WQO's for rivers gradually from 1993 and two pilot schemes on the Conwy and Cleddau have been selected in Welsh Region. This will be limited to the fisheries ecosystem and potable abstraction uses applied to water quality classified stretches.

The development of Catchment management plans has been progressing. These cover the full range of the NRA's statutory roles in an integrated approach to identifying problems, proposing and implementing solutions for each catchment. As part of this process, trout fisheries are specifically included in the overall assessment of resources under the NRA's responsibility.

Short Term Proposals

1) The initiative to develop SWQOs is being piloted in the Region.

2) Information will be reviewed on the relative importance of small streams to trout stock maintenance, with recommendations on management needs by September 1994.

Long Term Proposals

1) To complement WQOs, flow and habitat objectives that will form the basis of protective management strategies for small streams will be developed.

Figure 7 Pollution Input to a River

4.1.2 Recommendation 9. That the NRA continue research into the effects and amelioration of acidification.

Present Position

Following a provisional assessment of the present day impact of acidification on Regional fisheries (Figure 8), research and operational investigations in this area have centred mainly on the means to ameliorate acidification effects. The following studies are in progress.

1) Monitoring of catchment management experiments (techniques processes and ecological changes), Llyn Brianne. The DoE funded element of this project ceased during 1991 and was reported in 1992. Further low level monitoring is continuing until 1994, funded by Welsh Office and the NRA.
2) Liming of Llyn Brianne and monitoring of chemical and ecological changes in the Afon Tywi.
3) Catchment liming of Llyn Gamallt, and monitoring of chemical and ecological changes (CCW involvement). This is specifically aimed at restoring a brown trout fishery.
4) Classification of acid vulnerable catchments in Wales(R&D).
5) Assessment of Regional liming needs, costs and strategy development.
6) Contribution to UK Acid Water Monitoring Programme (fisheries and water quality).

7) Assessment of acidification in upper Dee tributaries.

8) Long term monitoring network of stream chemistry draining from forested catchments. A total of 12 sites are located in Wales and this study is to continue for 10 years from 1991. Part-funded by Forestry Commission.

9) Regional review of acidification status of rivers and lakes, to compare with the survey carried out in 1984.

Short Term Proposals

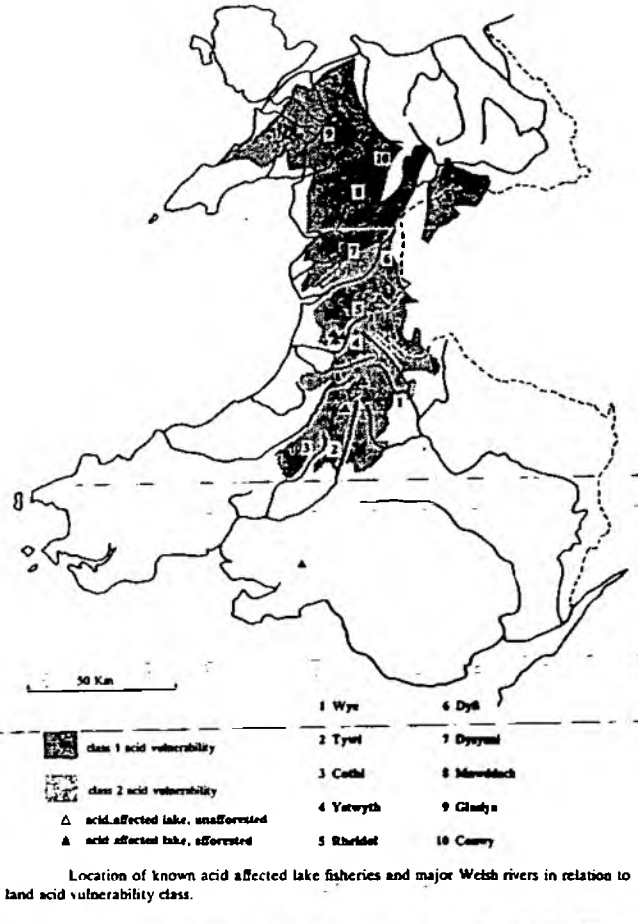
1) Programmes above will continue.

2) Proposals for liming will be treated on a catchment-specific basis, having due regard for conservation interests.

3) A Glas-y-dorlan article on managing trout fisheries in acidified catchments will be produced in winter 1993 for use by angling clubs.

Long Term Proposals

1) There are presently no long term proposals for Regional research, future emphasis should be on implementing recommendations from earlier work.



Location of known acid affected lake fisheries and major Welsh rivers in relation to land acid vulnerability class.

Figure 8 (Source: Acid Waters in Wales – Edwards, Gee and Stoner 1990)

4.2 WATER QUANTITY

4.2.1 Recommendation 10. That high priority be given to the implementation and enforcement of minimum environmental flows.

Present position

Since the Water Resources Act 1963, and more recently under the 1991 Water Resources Act the opportunity has been available to make recommendations on the setting of Minimum Acceptable Flows (MAF) to the Secretary of State. This has not been pursued because of shortcomings in the methodology for deriving such flows to protect aquatic resources. An R&D project on Ecologically Acceptable flows is currently underway and a method for assessing the severity of low flow problems has been formulated which is based on the use of four indicators and two adjustment factors. The ecological indicator generates scores which reflect the extent to which low flows are jeopardising the channel and riparian communities which depend on groundwater or a surface watercourse. As far as possible the ecological parameters have been framed to make use of existing data, generally collected for other purposes. Nevertheless, the assessment needs to be carried out by experienced biologists with local knowledge, both to interpret available data and to assign scores on the basis of informed judgement. The current research to develop a means of assessing Minimum Ecologically Acceptable flow may eliminate the need for a methodology to assess the extent of habitat and community derogation by low flows.

Ecologically Acceptable flows are a much narrower issue than Minimum Acceptable flows. The latter includes the requirements of abstractors and lawful users, and of navigation, fisheries and land drainage. Each use will have a different flow requirement and so MAF may actually mean a suite of flows.

Low flow problems (Figure 9) arise in several ways, such as spray irrigation, abstraction for domestic and industrial supply, land use changes eg. forestry, and also from long term changes in climate. The NRA has recently produced a discussion document to review the problem from the water resources viewpoint. The hydrological characteristics of most catchments in Welsh Region mean that low flows can arise within a very short timescale as a result of relatively brief periods of low rainfall. Improved land drainage is a significant factor in increasing speed of run-off and reducing base flow. In particular, large bodies of peat are important contributors during low flow periods, and the effect of drainage can be severe. Although most of the acute problems are outside Welsh Region there are many local problems which will be identified through the catchment planning process.

Short term proposals

1) To continue existing research into ways of identifying flow requirements and ensure low flow problems are taken into account in catchment planning.
2) To continue and improve monitoring and enforcement of existing licence agreements to comply with National policy.

Long term proposals

1) Depending on the outcome of R&D programme, recommendations to the Secretary of State may be made regarding environmentally protective flows.

Figure 9 Stream Under Low Flow Conditions

4.2.2 Recommendation 11. That the NRA continue research into the effects and amelioration of upland drainage and afforestation, particularly in relation to the effect on discharge patterns.

Present Position

Work by the NRA Welsh Region has demonstrated major impacts of forestry on stream ecology affecting trout abundance. These effects include changes to flow and temperature regimes, habitat structure and stability and availability of food organisms. Acidification is probably the best known environmental impact of afforestation and is largely restricted to acid sensitive areas. However it is important to note that any plantation of conifers is potentially very damaging to stream ecology for the reasons noted above.

Guidelines have recently been produced by the Forestry Commission (Forest and Water Guidelines HMSO 1991), agreed with the Water Industry regarding the minimising of ecological effects, but the value of these in combating acidification has yet to be demonstrated (Figure 10). However, the problems of water yield and flow regime are satisfactorily addressed by the guidelines.

Short Term Proposals

1) These Guidelines should be widely publicised and further discussions should be held with the Forestry Commission concerning clearfelling and planting of second rotation forests.
2) The implementation of these Guidelines in planting schemes should be monitored.

Long Term Proposals

1) Areas for further investigation should be identified and progressed through the National R&D programme.

Figure 10 Streamside Clearfelling

4.3 PHYSICAL FACTORS

4.3.1 Recommendation 12. That the NRA seek the development of procedures for the control of upland use.

Present Position

As a result of Government policy there is a general move away from intensive agriculture-use of the uplands towards diversification. Welsh Region has in place an agreed policy and procedure for Forestry and Surface Water Acidification. This is based on a preliminary assessment of the vulnerability of a catchment to acidification using acid-sensitive area maps. Further consideration and decisions on the acceptability of individual planting schemes will depend upon mean water hardness and local factors (Figure 11).

Also of concern, particularly in small streams which are important brown trout spawning and nursery areas, is habitat destruction through small-scale drainage schemes. The Salmon Advisory Committee's recent report on factors affecting natural smolt production recommended the creation of riparian buffer zones adjacent to spawning and nursery areas. The potential benefits would include allowing bankside cover to develop, preventing bank erosion and stream damage by grazing animals and reduce the risk of input of agricultural chemicals and pollutants.

CCW are piloting a 'Tir Cymen' scheme in the Districts of Merionnydd, Dinefwr, and Swansea(Gower) aimed at improving the conservation and management of landscape and habitat types by a system of grant-aiding 'whole farm plans'. Tir Cymen has positive management guidelines for different types of land and water features and offers annual payments for following these guidelines. In addition Tir Cymen also offers a range of standard capital grants for one-off environmental improvement work.

Short Term Proposals

1) Catchment management plans should consider the need to control upland use.
2) The benefits of the Tir Cymen scheme for conserving small upland streams will be discussed with CCW, by September 1994.

Long Term Proposals

1) The development and creation of riparian buffer zones will be further progressed, possibly using income derived from the Section 142 charging scheme.

Figure 11 Forestry in the Uplands

4.3.2 Recommendation 13. That effective liaison over river engineering schemes is continued to protect and improve habitat quality.

Present Position

In recent years there has been a change in emphasis from agricultural land drainage to urban flood protection. As a result the number of capital land drainage schemes (Figure 12) has greatly decreased. Changes in agricultural policy has reduced pressure on the farming community to improve drainage and hence increase productivity. The present liaison arrangements are well established and are generally working well.

Short Term Proposals

1) Maintain procedures and liaison as above to ensure protection of stream habitat.
2) Ensure that scope for habitat improvement is included in the early stages of scheme promotion.
3) Carry out post-scheme audits.

Long Term Proposals

1) The river corridor survey programme and catchment management plan programme will identify areas where habitat improvements are necessary.

Figure 12 River Engineering

4.3.3 Recommendation 14. That where funds are available, areas of catchment previously affected by land drainage schemes should be restored and improved as a matter of priority.

Present Position

There is a need to take a catchment-wide perspective in identifying where previous schemes were either poorly mitigated or where the mitigation measures have failed. Catchment management plans will prioritise within a catchment where restoration is required (Figure 13). However, the catchment management planning programme is mainly driven by water quality considerations which may not coincide with priorities based upon physical features and the impact of previous land drainage schemes. Catchment management plans will provide the means of targeting resources to carry out habitat restoration and improvement work. In addition several projects in the National R&D programme are addressing the methodologies of habitat restoration, improvement and appraisal in different river types including gravel bed rivers.

Short Term Proposals

1) A programme of auditing of schemes will be carried out to determine if mitigation work has been carried out as requested and whether it has been successful.

Long Term Proposals

1) River corridor surveys and catchment management plans will identify areas in need of restoration. The financing of restoration will then need to be considered.
2) Implement findings and recommendations of R&D projects as appropriate.

Figure 13 A Canalised River

4.3.4 Recommendation 15. That the NRA achieve greater control over engineering schemes on non-main river either by more effective liaison with outside agencies or by an extension of it's main river powers.

Present Position

The extension of main river powers is unlikely to be a viable option due to the possible cost implications in maintaining them, unless there is a flood defence need to do so.

The Authority's policy in respect of consenting schemes promoted by outside agencies is that conservation and fisheries implications must be taken into account prior to consent being granted. Consent may be refused if environmental damage cannot be avoided (Figure 14). Regional guidance notes indicating how conservation matters should be taken into account have been prepared.

The NRA policy regarding erosion of rivers and the role of land owners has been recently explained by an article in Glas-y-Dorlan. In addition a developers guide to environmentally sensitive river works is in preparation.

Short Term Proposals

1) More rigorous control of schemes promoted by outside agencies will be achieved through consenting procedures.
2) A developers guide to environmentally sensitive river works will be published by April 1993.
3) Further articles on relevant aspects of engineering schemes and their promotion will be published in Glas-y-Dorlan as appropriate.

Long Term Proposals

1) Monitoring compliance with NRA policy on promotion and consenting of schemes will be undertaken.

Figure 14 A Canalised First Order Stream

5. FISHERIES PROTECTION

5.1 CONSERVATION

5.1.1 Recommendation 3. That the NRA should liaise with the Nature Conservancy Council (NCC) to ensure that fisheries of particular note are given official protection.

Present Position

The NCC, now called the Countryside Council for Wales (CCW), are able to legally designate land or water containing plants, animals, geological features or landforms of special nature conservation interest as a Site of Special Scientific Interest (SSSI). There are 38 SSSI's designated within Welsh Region which have a direct rivers' interest and a further 210 which have other aquatic interests including lakes, ponds and wetlands. In general SSSI status is not designated for a single species unless it constitutes a significant proportion of a population e.g. breeding bird colonies. More commonly specific important habitat types are designated which may contain wild brown trout stocks e.g. upland streams or lakes.

The Institute of Freshwater Ecology (IFE) is currently completing a survey of freshwater fish in National Nature Reserves in Great Britain, of which there are 45 in Wales, with the aim of identifying practical conservation action for selected species. The results will assist CCW to make decisions regarding any action they may consider necessary on fish conservation. Designation of a brown trout fishery as an SSSI would enable certain activities e.g. habitat alterations, which may harm the fishery to be notifiable and therefore controllable (Figure 15).

Short Term Proposals

1) Discussions will be held with CCW regarding designation of priority brown trout fisheries by April 1994.
2) Priority brown trout fisheries should be identified as in recommendations 2 and 19.

Long Term Proposals

1) All priority fisheries to be designated.
2) Other fisheries to be designated as appropriate.

Figure 15 Llyn Eiddew Fawr – A Potential SSSI ?

5.1.2 Recommendation 16. That the NRA review the effect of predators on brown trout stocks following receipt of the Salmon Advisory Committee's report on predation and the results of recent research in Scotland by Dr. Marquiss.

Present Position

The report by Dr Marquiss has recently been published. The principal findings of this work which were based on studies on the North Esk and Scottish Dee and targeted principally on the effects of sawbill ducks (Figure 16) on salmon were:

- Large population shifts of goosander were observed across the watershed and between seasons, suggesting that full grown birds easily switch between habitats and regions in response to seasonal prey availability.
- Goosander diet varied with season and location. On the Dee, salmon parr formed 70% by weight of their diet in winter and 93% in summer. On the Esk the spring diet was 45% salmon, 43% trout.
- The average size of salmon consumed (7.7cm) was significantly less than that of trout (13.4cm).

The report concludes that on it's own such information is insufficient to assess the effect that sawbill duck predation has on fish harvest. This is because the effect that the loss of the fish consumed has on the remaining fish is currently unknown and it has not been established whether the predation is additive to other causes of mortality, or is compensated by a reduction in these other losses.

The Salmon Advisory Committee report on predation has not yet been published.

Short Term Proposals

1) The Region will not support licences to control populations of goosander or other avian predators until firm evidence becomes available that they are necessary to prevent serious damage to fisheries.
2) Monitoring of predator population trends will continue.
3) Monitoring of juvenile and resident trout stocks will continue.

Long Term Proposals

1) The Salmon Advisory Committee report will be reviewed when published.
2) National R&D initiatives in relation to studies on fish predators will be actively supported.

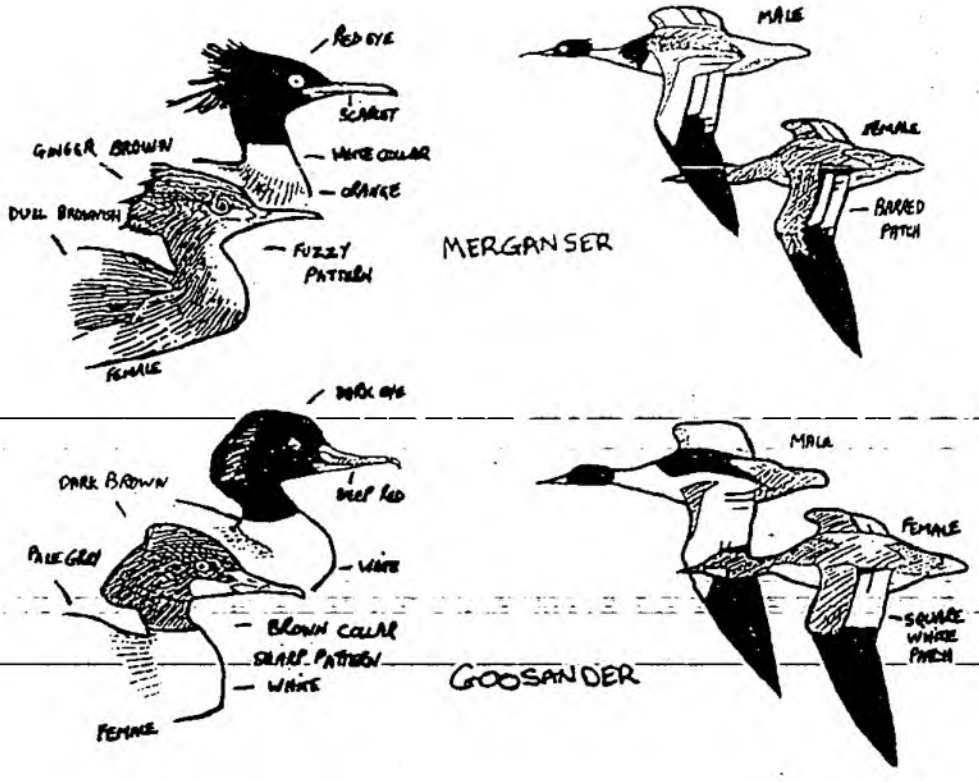


Figure 16 Fish Eating Birds

5.1.3 Recommendation 24. That investigations into the interaction between sea trout and brown trout continue, particularly in relation to genetic, biological and environmental factors.

Present Position

This topic is being specifically studied on an experimental catchment in the upper Conwy catchment (Figure 17). Sea trout fry are stocked at different densities each year, and the subsequent performance of stocked and resident trout monitored by electric fishing surveys and a smolt trap at the mouth of the stream.

Due to natural variation, particularly the confounding influence of annual weather patterns, this type of study is necessarily long term. The project began in 1987 and is now producing valuable results on growth and survival of the two types of trout. The latest results indicate that although resident trout fry survival decreased after stocking began, this also occurred in control sites. Therefore, no influence of the stocked fish on the resident trout has yet been demonstrated.

The genetic consequences of such stocking also remain unclear. Genetic studies have shown that sea trout introductions on the upper Conwy have altered the genetic composition of resident trout stocks. Although the biological consequences of this are unknown, the precautionary approach to stocking non-indigenous trout taken by Welsh Region is reinforced by this result.

A Regional study by U.C. Swansea genetics department on trout (resident and migratory) is in progress (funded as National R&D), to be completed by 1993.

Sea trout stocking is also being monitored on the Rivers Mawddach and Ogmore as part of the Regional microtagging programme. The National R&D project on Sea Trout Investigations is being established in which sea/brown trout interactions will be studied.

Short Term Proposals

1) Continue the existing Regional projects to schedule, and contribute to national programmes as required.

Long Term Proposals

1) Results from the above projects will be reported as they become available and incorporated into policy or management practice as appropriate.

Figure 17 Iwrch Smolt Trap – Upper Conwy

5.2 REGULATIONS

5.2.1 Recommendation 17. That, in order to increase spawning escapement, consideration is given to revised bye-laws increasing the size limit for trout.

Present position

There is some evidence to suggest that the present 19cm minimum size limit for trout is too small, allowing 2+ fish to be taken before they have reached maturity (Figure 18). In heavily exploited fisheries close to population centres, this effect may be offset by regular stocking activity. Increasing the minimum size limit should enhance natural recruitment and reduce the NRA's stocking burden. As an additional benefit, the larger sea trout smolts would be protected during their spring migration.

A regional project was undertaken to provide accurate estimates of the mean size and age at maturity of resident brown trout. Samples have been taken from rivers and streams across the Welsh region from the most productive southern lowlands to the acidified northern uplands. The final report, produced in March 1992, illustrates the variability in the maturation of Welsh trout and makes recommendations on suitable Regional size limits. The results indicate that trout from poor stocks mature early but grow slowly and rarely achieve even the size at which the better stocks mature. Ideally different size limits should be defined for individual stocks reflecting the variations in the size of trout at maturity both between and within catchments. For practical reasons the size limit should be as consistent as possible within the Region. The new byelaw proposes a size limit of 23 cm except in the Gwynedd Fisheries District where a 21 cm limit will apply.

Short term proposals

1) The new size limits have recently been advertised and, subject to confirmation by the Secretary of State, will be introduced in time for the 1994 angling season.

Long term proposals

1) Consideration will be given to potential options for maximising yield, biomass and eggs per recruit, including further modifications to legal size limits and restrictions on exploitation levels.

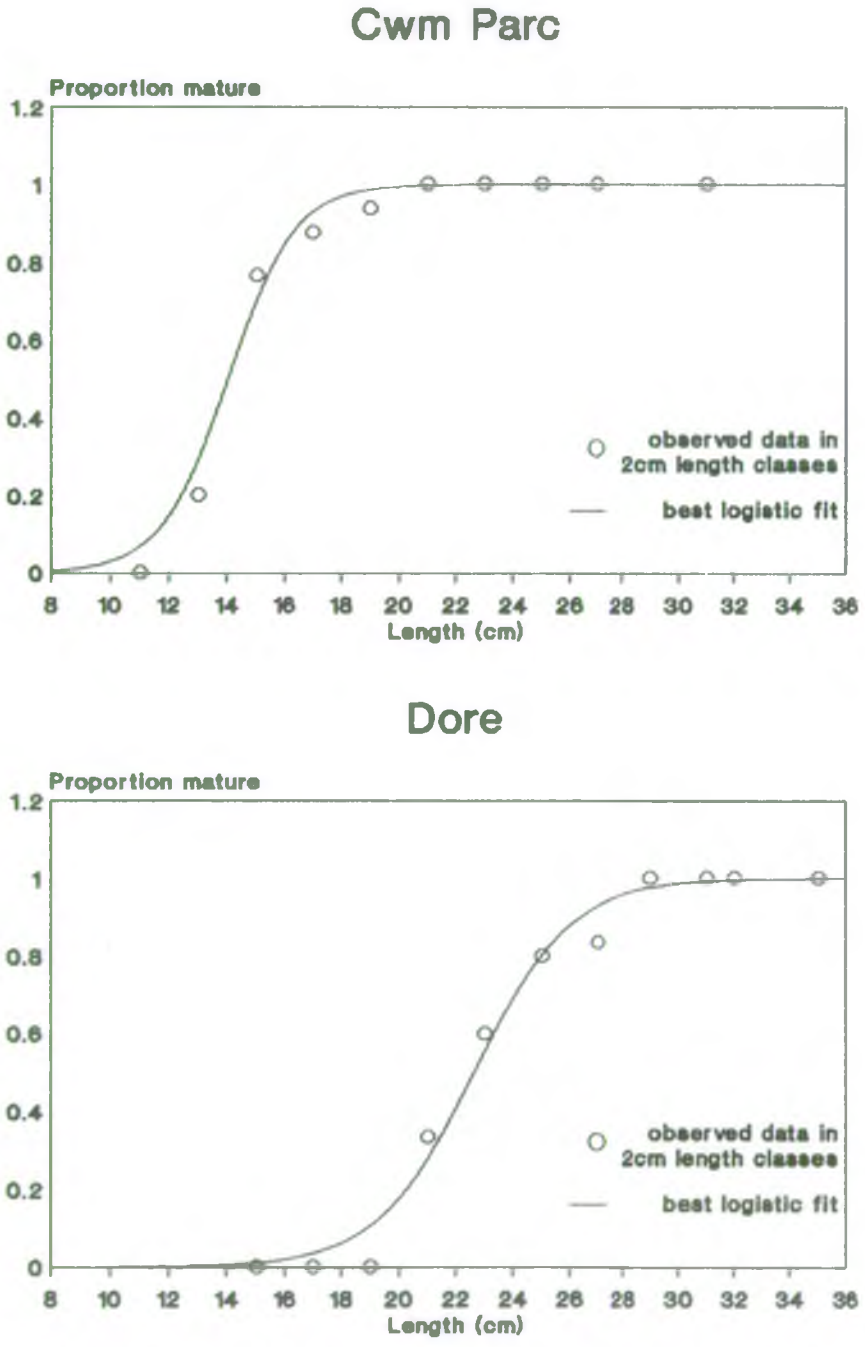


Figure 18

5.2.2 Recommendation 18. That there is a complete review of byelaws affecting trout stocks to ascertain what other measures may be required to protect the resource.

Present Position

The current rod fishing byelaws underwent a major review in the 1970's which resulted in considerable rationalisation of previously wide-ranging regulations in different parts of the Region. These byelaws specify the fishing season, minimum size of takeable fish (see recommendation 17), use of lures and baits, use of hooks and hooking of fish, and restrictions on fishing near obstructions.

A review of these byelaws has recently been carried out including consultation with Local Fisheries Groups and RFAC. Recommended amendments which directly affect brown trout include:

- altering the opening date of the season from 20th March to 3rd March on Llynnau Cwmorthin, Dorwynion, Du Bach y Bont, Barlwyd, Ffridd, Manod and Conwy.
- Updating of restrictions on fishing near obstructions.

In addition to legislative changes there is considerable scope for individual Angling Associations and fishery owners to implement changes in fishing rules which could conserve and improve trout fisheries under their control (Figure 19). These aspects are further discussed in Recommendation 21.

Short Term Proposals

1) The present proposed amendments to the byelaws will be finalised and progressed in 1993 with the objective of obtaining approval from the Secretary of State in time for the 1994 angling season.

Long Term Proposals

1) The byelaws will be reviewed and amendments progressed in response to management needs.

5.2.3 Recommendation 21. That the NRA provides and promotes advice on methods of reducing anglers take of fish whilst maintaining sporting values (eg. bag limits, size limits, hook and release schemes, including the use of barbless hooks).

Present Position

'Catch and release' has been practised in North America for many years. Although considerable resistance by anglers was initially encountered it is now widely accepted. There is a large volume of evidence from studies in both North America and Europe that when correctly carried out, in general, survival of released fish can be very good with typical survival rates of up to 95-100% quoted. The vulnerability of fish to poor handling is well known and this survival rate can be affected by the way the fish is played and handled prior to release (Figure 20). Damage may be immediately obvious such as by bad hooking, but delayed mortality due to the combined effects of capture, exhaustion and handling can also occur.

The deployment of catch and release in the UK has been limited and generally restricted to local, voluntary measures primarily targeted at female fish close to spawning condition. However it is an important and viable option for effecting increased survival and spawning escapement whilst still maintaining anglers' sport and enjoyment.

Figure 19 A Fine Catch of Trout

Short Term Proposals

1) Angling Associations and fishery owners will be encouraged by appropriate publicity campaigns to introduce voluntary catch and release schemes for vulnerable stocks.

Long Term Proposals

1) Studies will be undertaken to establish the factors affecting survival of released, rod caught fish.
2) Where necessary byelaws will be introduced to reduce anglers catches to protect threatened stocks.

5.3 STOCKING AND GENETICS

5.3.1 Recommendation 2. That natural brown trout populations are protected by control or prohibition of stocking with sea trout or non-indigenous strains of brown trout.

Present Position

The Authority has absolute control over stocking of sea and brown trout through Section 30 of the Salmon and Freshwater Fisheries Act 1975. The Authority's policy on issuing Section 30 consents allows ecological and genetic factors to be taken into account. Although there are currently no policy restrictions on the origin of brown trout for stocking, sea trout stocking must be carried out with progeny from the same catchment, to preserve genetic integrity.

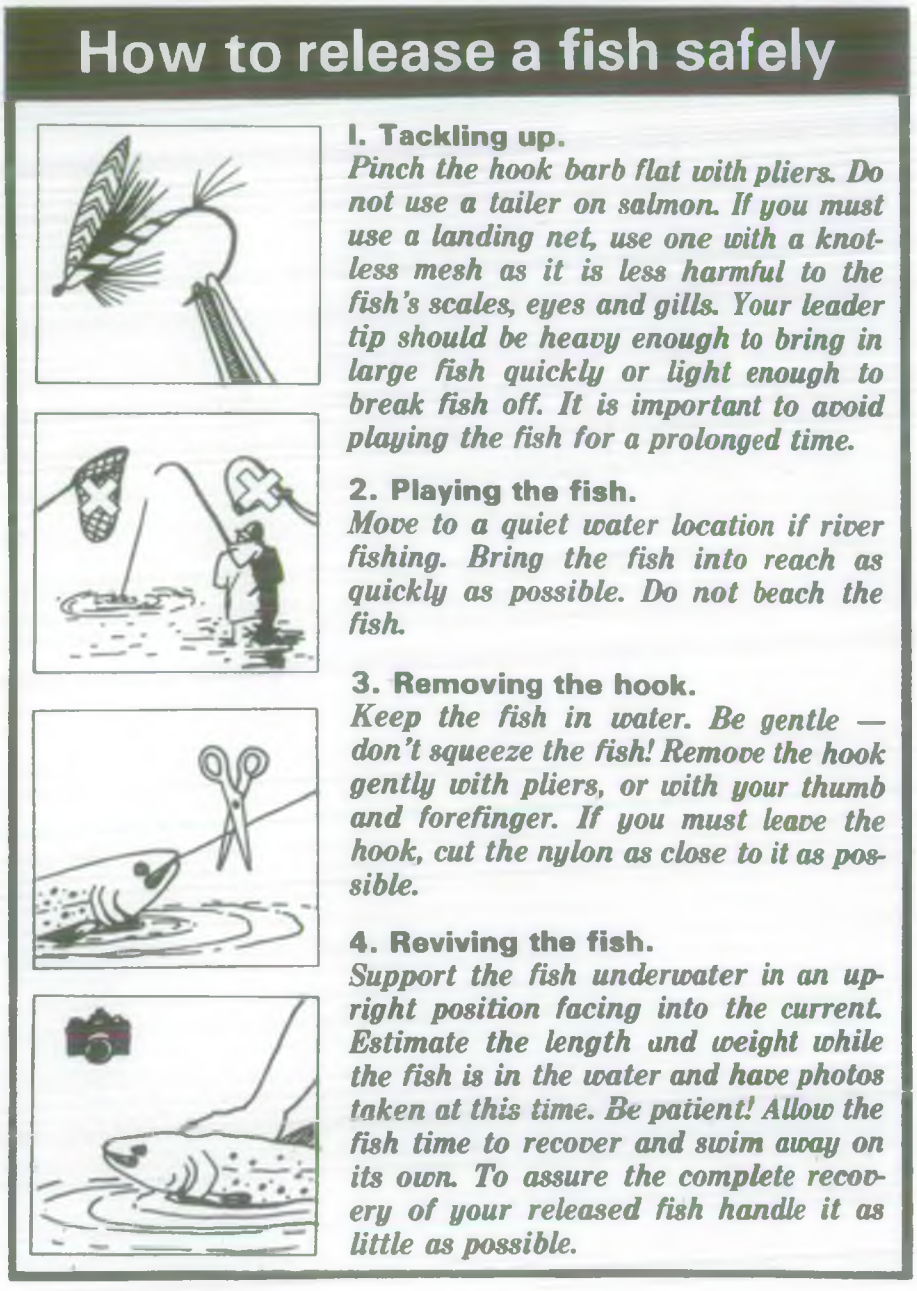


Figure 20 Catch and Release Guidelines

Several issues are raised in relation to the NRA's role in conservation of genetic resources, some of which are referred to in the context of other Recommendations (3,19,20,22,23,24). Two important management issues here are the implications of: (a) stocking (of brown or sea trout) above natural impassable falls and, (b) the related activity of opening up barriers to allow passage by migratory trout into former isolated areas.

Recent evidence (see recommendations 19 and 24) has demonstrated that introduced sea trout can rapidly alter the genetic composition of a river's trout stocks, by interbreeding with resident trout. Scientific opinion is generally of the view that this is to be avoided because it compromises the long term survival of stocks. Further research is in progress, but two further proposals to policy can be made on the basis of existing evidence.

The impact of stocked sea trout on resident brown trout populations has been studied in an experimental stream in the Conwy catchment where trapping facilities enable migrants from the stream to be counted.

Stocking with non-indigenous, farm-reared trout may also pose a threat and where 'pristine' brown trout fisheries are identified, these should be protected from stocking with non-indigenous strains (Figure 21).

Short Term Proposals

1) Regional stocking policy should prohibit the stocking of sea trout progeny and non-indigenous strains of farm-reared trout into the following areas:
   (a) Upstream of impassable barriers.
   (b) 'Pristine' brown trout fisheries (streams and lakes). An inventory of all such identified waters should be prepared for each Area, to establish their extent by December 1993.

2) Any fishpass proposal, on barriers in freshwater, should include a specific statement regarding the genetic consequences of the scheme, and this should be a factor in it's overall cost-benefit appraisal.

Long Term Proposals

1) Review current policy and 'sanctuary' areas in the light of experimental studies and knowledge of fishery status.

Figure 21 Stocking Llyn Gamallt with Wild Brown Trout

5.3.2 **Recommendation 19. That further research be carried out into the genetic differentiation between stocks, and the extent of introgression of fish farm stocks. The research should be aimed at providing information upon which scientifically-based stocking policies can be formulated.**

Present position

Research has been carried out by MSc students from UCNW and previously reported to RFAC. This has demonstrated the interbreeding of stocked sea trout with resident brown trout in the Conwy catchment and subsequent change in genetic composition of stocks above Conwy Falls (Figure 22). Research into sea and brown trout genetics in Welsh rivers on a wider scale has been undertaken at UC Swansea; completion date was October 1992, and a final summary report will be produced by February 1993. In addition a NRA post-doctoral fellowship has recently been awarded which will undertake a genetic study of sea trout populations in England and Wales.
Note that specific research into introgression by fish farm stocks is not being undertaken in Wales, but recommendations for this may arise depending on the outcome of current work.

Short term proposals

1) Continue the current research.
2) Continue existing stocking policy, taking precautionary approach to introductions.

Long term proposals

1) Review policy and need for additional research depending on the outcome of work in progress.

5.20 **Recommendation 20. That the NRA encourage a policy of rectifying the causes of stock deficiencies whenever possible rather than artificially maintaining populations by stocking inappropriate strains of trout.**

Present Position

Stocking with hatchery-reared fish is just one of a number of management techniques which can be used to maintain and improve trout stocks and catches. In recent years several Angling Associations have developed small-scale hatcheries, mainly for rearing non-native trout. These hatcheries have recently been reviewed and recommendations made for their future operation and any new developments. In particular the report concludes that there are a number of alternative strategies, including catch controls eg. bag-and-size limits, method and time restrictions and catch and release, and habitat improvements (Figure 23) for improving trout populations. These techniques should be fully considered as alternatives to, or an integral part of any hatchery rearing and restocking programme. In addition it was recommended that there should be a general move towards rearing local strains of trout in appropriate situations where wild broodstock are available.

Many of the causes of stock deficiencies are likely to be identified through the NRA's catchment management planning process.

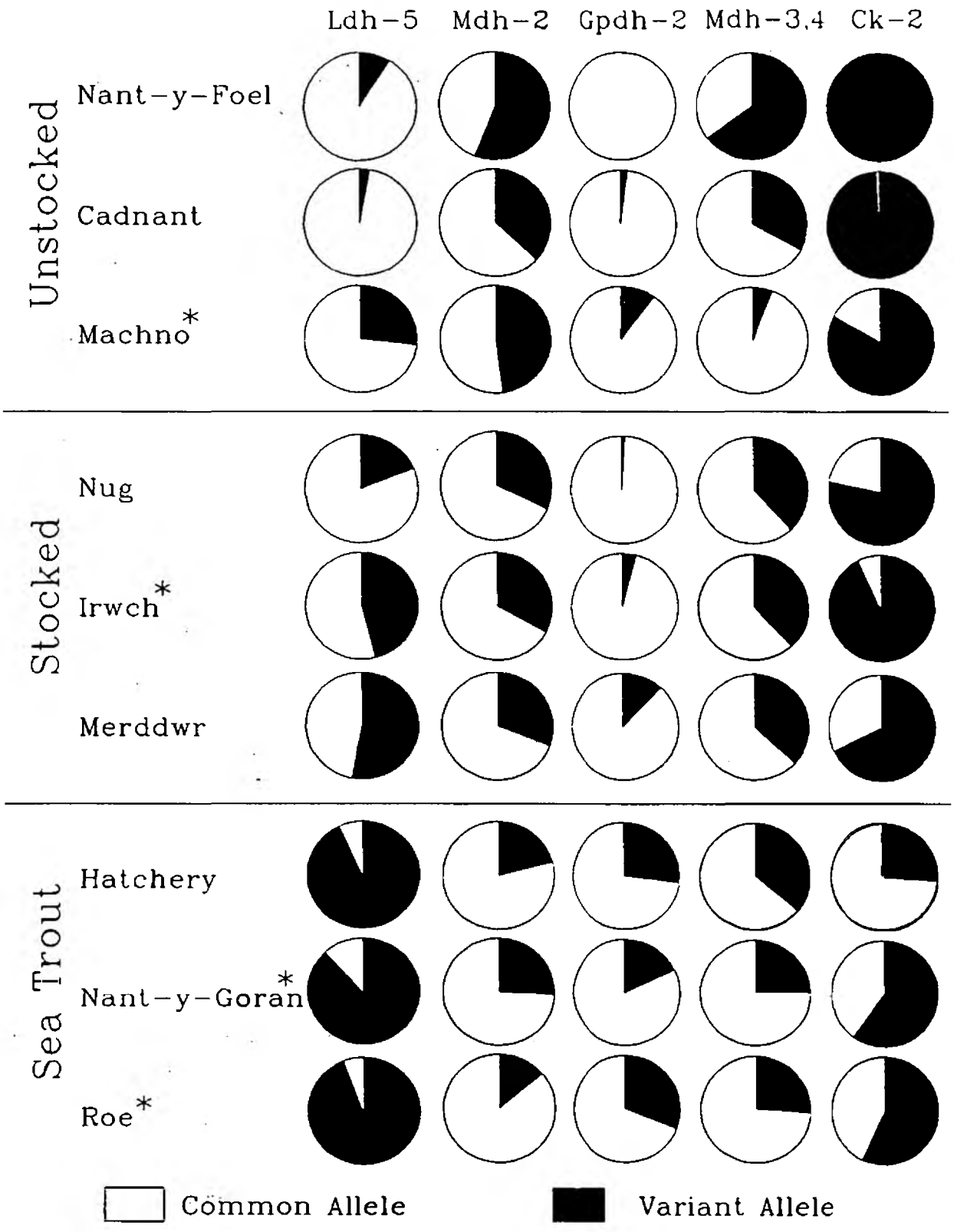


Figure 22 (Source: Hauser L. (1990) Effects of Stocking on the Population Genetics of Brown Trout in the Conwy River System, North Wales. MSc Thesis UC of North Wales, Bangor).

Short Term Proposals

1) Appropriate articles will be produced in future editions of Glas-y-Dorlan explaining the various possible causes of stock deficiencies and the ways they can be remedied.
2) The catchment management plan programme will identify specific causes of stock deficiencies and recommend remedial actions.

Long Term Proposals

1) An advisory booklet on the management of trout fisheries will be produced.

Figure 23 Habitat Improvement by Groyne Construction

5.3.4 Recommendation 22. That the NRA promote guidelines emphasising alternatives to stocking but providing advice on scientifically based stocking strategies where appropriate (this should include the stocking of rainbow trout and triploid brown trout).

Present Position

Restocking may be considered when the natural production of takeable-sized fish does not satisfy angling demand. This situation may occur if:

- Angling demand is very high eg. on fisheries close to areas of high population.
- Natural production is low due to poor spawning facilities, low growth rate or low carrying capacity.
- The native population is reduced by a fish kill.

With the exception of the latter case, restocking is unlikely to have any long term benefits. Studies have shown that in rivers few stocked fish of takeable size survive to contribute to the catch in the season after stocking and where spawning facilities are poor, their contribution to natural recruitment would be insignificant. Thus, in these cases the main objective of restocking must be to provide maximum benefit in the season of stocking by stocking fish of takeable size, especially in waters where growth rates are low (Figure 24). Also appropriate stocking strategies should be employed to maximise the return in the season of stocking. In lakes, stocking with undersize trout in June to provide takeable-size fish in the following season has been shown to be a viable management option.

The use of rainbow trout and triploid brown trout in appropriate cases may also minimise any adverse impact on native populations since they will not breed, although care must be taken to limit competition with native fish.

Short Term Proposals

1) Management advice will be provided to Angling Associations and fishery owners on scientifically based stocking strategies.
2) Where restocking proposals are considered to be inappropriate or pose a threat to native populations Section 30 stocking consent will be refused and advice on alternatives given.

Long Term Proposals

1) An advisory booklet and articles in Glas-y-Dorlan will be published giving guidelines on scientifically-based stocking strategies.

5.3.5 Recommendation 23. That consideration be given to the production of trout reared from native broodstock for restocking purposes. Guidelines should be produced and pilot production programmes set up by either the NRA or by collaboration with private farms. Specific attention should be paid to selective breeding (eg. for acid resistance), and the identification of suitable areas for restocking.

Present Position

The Region's fish culture capacity is fully utilised for the production of migratory salmonids for priority mitigation and rehabilitation purposes. Only limited rearing of wild brown trout has taken place, (Figure 25) with some purchase of trout from commercial sources for mitigation purposes.

Although the Region is currently progressing the enlargement of it's fish rearing capacity which would provide facilities for rearing brown trout stocks, this is dependent on planning and financial constraints and the results of the on-going national review of fish culture by the NRA.

Previous collaborative exercises in fish rearing with private commercial farms have been unsuccessful due to a variety of husbandry and disease problems. Commercial farms are generally operated to rear large quantities of trout which have been line-reared to provide fast growing, stress and disease-resistant strains. The rearing of wild strains of trout may not be compatible with these conditions.

The selective breeding of trout is a highly specialised and long-term programme which the Region does not have the expertise or resources to carry out. In view of it's national and international significance it may be more appropriate to carry out a desk study of current research in this area under the national R&D programme. Thereafter it may be appropriate to commission a selective breeding programme by a competent establishment.

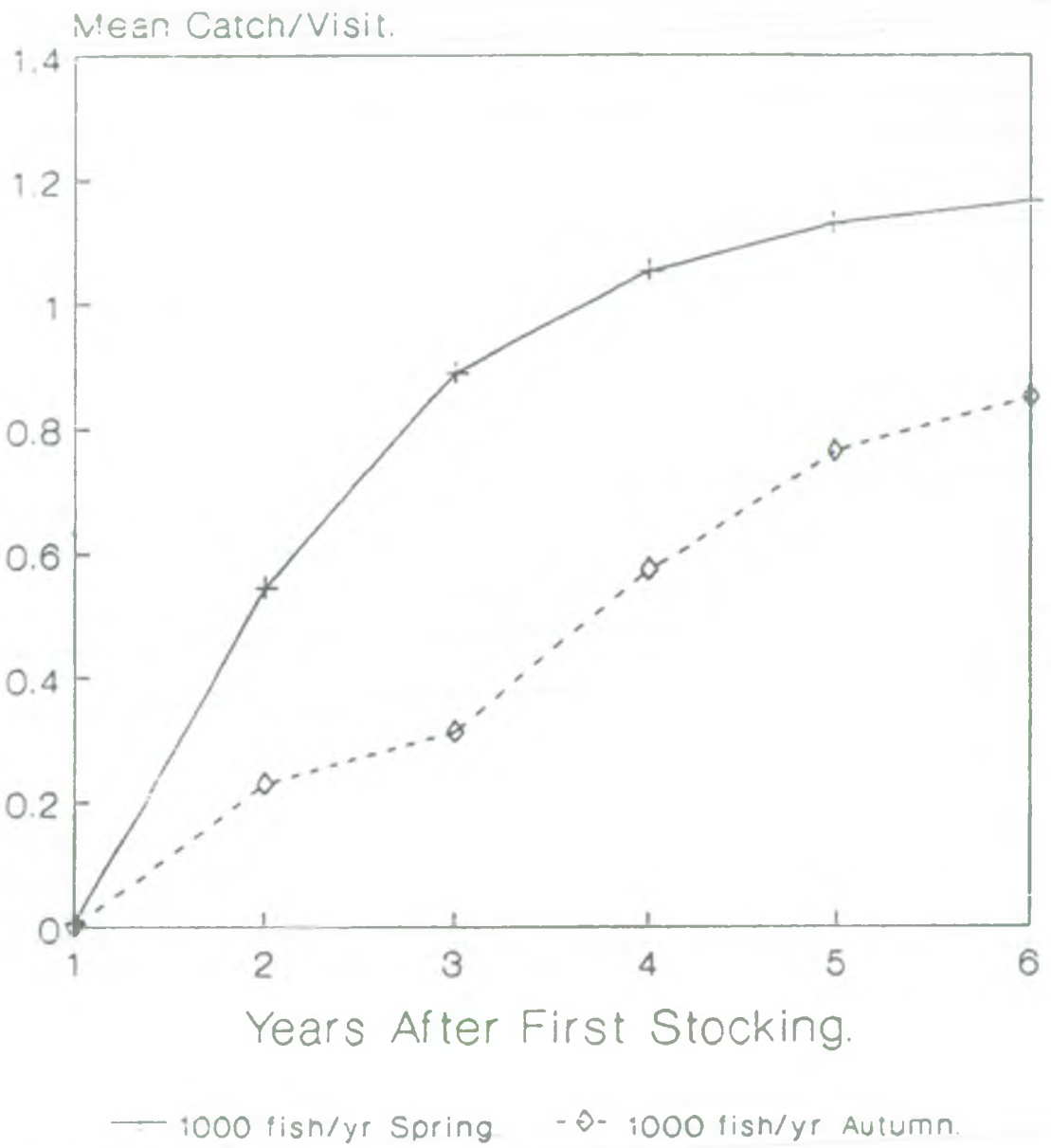


Figure 24 (Source: Henderson A.J. (1989) A Spreadsheet Simulation Model of Lake-stocked Brown Trout (Salmo Trutta) in Llyn Conwy, North Wales. MSc Thesis UC North Wales, Bangor).

Short Term Proposals

1) Wild, native brown trout will be reared by the Region subject to the availability of rearing capacity and other priority rearing requirements.
2) A proposal for a desk study review of selective breeding of trout will be formulated for the national R&D programme by September 1993.

Long Term Proposals

1) Rearing capacity for wild brown trout will be increased subject to planning and financial constraints and the results of the NRA review.

Figure 25 Stripping Eggs from Wild Brown Trout

5.3.6 Recommendation 25. That there should be further investigation into the biology of natural recruitment, including limiting factors in trout production and the responses of fisheries to exploitation. This should lead to the development of cost-effective stocking strategies coupled with better understanding of factors affecting potential yields.

Present Position

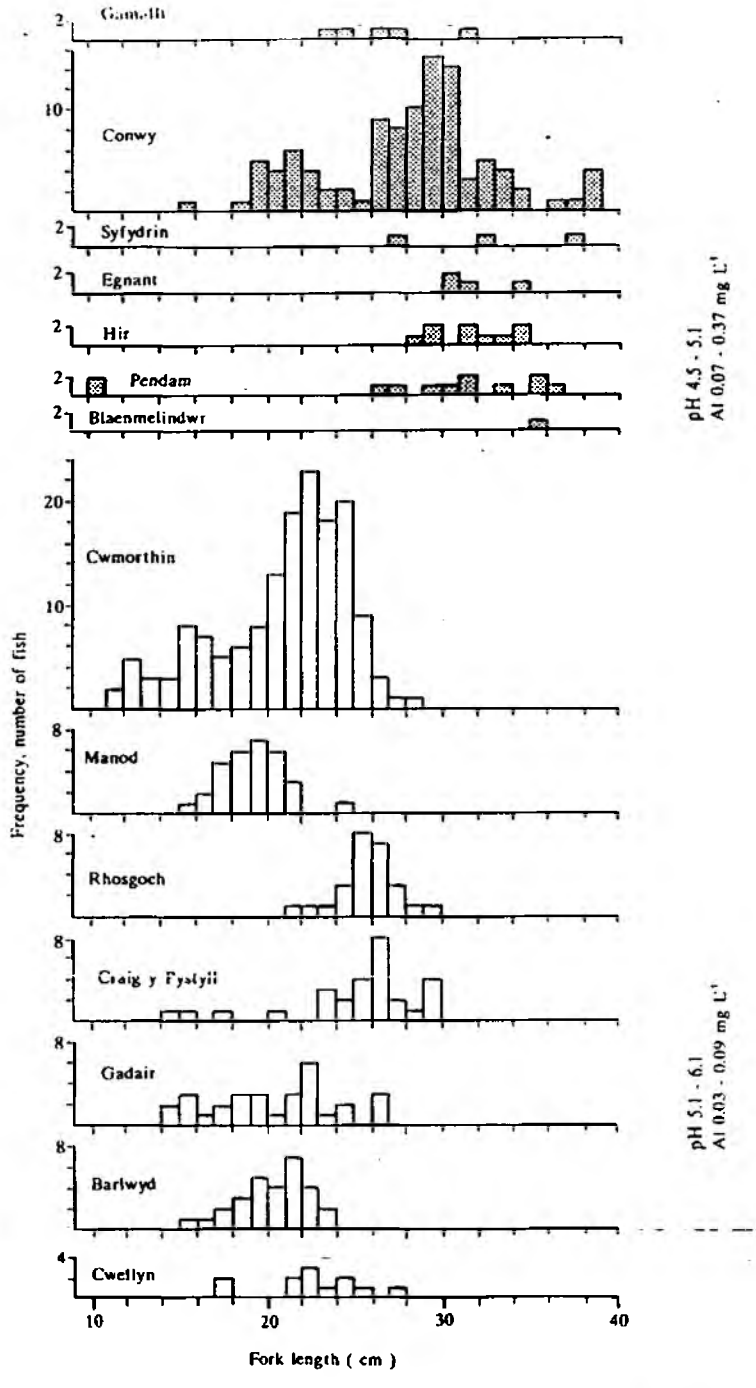
This recommendation arose principally in the context of lake fisheries in which yield is determined by a variety of natural physical and biological factors (Figure 26). Without a clear understanding of these it is difficult to distinguish low productivity due to natural factors from that due to artificial factors requiring remedial management. Moreover, best stocking practice cannot be adopted because the carrying capacity of lakes cannot be reliably predicted. This is not a high priority and, with existing resource limitations, special project work in this field will not be undertaken. Specific information requirements such as data on growth rates and maturation will be collected in the context of more important topics eg. Derivation of size limits (see recommendation 17).

Short Term Proposals

1) This recommendation should be shelved until clear questions relating to significant management problems can be formulated.

Long Term Proposals

None



Length-frequency distributions for Welsh lake brown trout populations (fyke net samples, October 1983). Shaded and unshaded histograms represent acid-impacted and non-impacted lakes respectively.

Figure 26 (Source: Acid Waters in Wales – Edwards, Gee and Stoner 1990)

APPENDIX 1

RESIDENT BROWN TROUT : A MANAGEMENT STRATEGY

Report Presented to RFAC – January 1991

RESIDENT BROWN TROUT: A MANAGEMENT STRATEGY

1. INTRODUCTION

1.1 Trout (Salmo trutta) populations exhibit a 'continuum' of migratory habit, with the resident brown trout at one extreme and the migratory sea trout at the other. The degree of manifestation of migratory habit is determined by a combination of genetic background, biological (population) and environmental factors. Whilst the juvenile populations of resident and migratory trout are indistinguishable, the adults are regarded as distinct, being subject to differences in season, licences and the requirement to make catch returns. This paper addresses the status and management of the resident brown trout resource in particular.

2. THE RESOURCE AND ITS STATUS

2.1 The resident brown trout resource is extensive, exhibits great diversity and forms an important part of the overall fisheries resource in Wales. Populations occur in most rivers and stillwaters and vary from completely natural fisheries, with or without the presence of sea trout, to semi-natural fisheries where stocking supplements natural production and 'put and take' fisheries dependent entirely on stocking. The diversity of the trout resource is an intrinsic part of its value and improvements in one type of fishery should not be at the expense of another.

It is recommended that a database of all brown trout fisheries is established specifically indentifying natural brown trout populations (R1).

It is recommended that natural brown trout populations are protected by control of prohibition of stocking with sea trout or non-indigenous strains of brown trout (R2).

It is recommended that the NRA should liaise with the Nature Conservancy Council to ensure that fisheries of particular note are given official protection (R3).

2.2 Levels of angling catch are popularly cited as proof of changes in fishery status. This practise can be misleading, since it focuses attention on adult populations, ignoring the underlying recruitment patterns, and also assumes a relationship between catch and stock. Although direct and more reliable data on trout populations are now being obtained from monitoring programmes, such information is still limited. The current juvenile salmonid monitoring programme is primarily directed towards migratory stocks of salmon and sea trout. Only about 30 of the 270 sites are located above impassable barriers, where distinct non-migratory populations exist. The majority of remaining sites are on migratory salmonid nursery areas, and exclude the deeper water where older brown trout would be more prevalant.

It is recommended that the juvenile salmonid monitoring programme be modified to include more sites representative of resident brown trout populations (R4).

2.3 Until a greater time series of scientific information is available, historical catch records will remain important. Unlike migratory trout, catch returns for brown trout are not mandatory. Although some angling clubs keep records, complete and reliable sets of data are rare. As a result the resource is generally poorly described and information is derived primarily from subjective assessments.

It is recommended that all angling clubs, syndicates and individual anglers be asked to make available, to the NRA, any historical catch records relating to brown trout fisheries in Wales. This information will be collated and reviewed (R5).

It is recommended that all angling clubs, syndicates and individual anglers be encouraged to maintain catch records for brown trout. On specific waters log book schemes will be established (R6).

2.4 Of the 3,091km of river of fisherable-size reported to contain brown trout, 42% is regarded as good wild brown trout fishing, whilst 17% is supported by stocking. Stocking occurs predominatly in the more industrial areas -Usk/Taff, Gower, Dee and Clwyd, and more usually in rivers without notable migratory stocks. Approximately 1,300km of river exists above impassable barriers where, in the absence of stocking, trout populations may be regarded as genetically distinct.

2.5 Of the 1647 lakes and 134 reservoirs in the area, 98% and 50% respectively are <9.7 ha.. A questionnarire survey, covering 42% of the 810 waters >1ha., showed that 58% contained brown trout only, 4% rainbow trout only, 31% mixture of both and that 6% were fishless. The majority of lakes in West and North West Wales contain brown trout only and many are unsupported by stocking; stocked fisheries are more prevalent in South East Wales.

2.6 A decline in fishing quality is reported for many rivrs and stillwaters, a perception supported in specific cases by some of the limited number of objective assessments available (eg Afon Alyn, see Milner and Jones, 1983; Afon Tawe, see Wightman, 1987).

3. VALUE OF RESOURCE

3.1 The value (attributable to the owners only) of riverine and stillwater trout fisheries are estimated at £7 million and £5 million respectively; the total value equals that attributied to migratory fisheries (excluding Wye). The importance of brown trout fishing is further exemplified by angling demand, a minimum estimate of which is provided by licence sales. The number of licences sold for non-migratory trout is 3 times that for migratory salmonids, generating incomes (1987) of £213,780 and £319,204 respectively.

3.2 The availabilty of information on the value of the trout fishery resource and the consumer demand for trout fishing is essential for economic appreciation of the costs and benefits of maintaining and improving this resource.

It is recommended that the economic value of the resource and consumer (angler) demand for the resource are assessed periodically so that financial resources for the conservation, improvement and development of trout fisheries can be appropriately allocated (R7).

4. FACTORS AFFECTING STATUS OF THE RESOURCE

4.1 Environmental, biological and human factors influence fishery status, but often act in combination making it difficult to isolate individual factors. The damage caused by any single incident may be insignificant in fishery terms, but the cumulative effects can be severe. This gradual insidious loss of resources may be responsible for the picture of general decline in trout fisheries.

4.2 Resident brown trout populations in rivers are particularly vulnerable to intermittent periods of poor water quality and/or reductions in flow. Above impassable barriers, populations may take years to re-establish naturally. Other streams may be re-colonized more readily by adult sea trout returning to spawn, with possible consequences for the balance of resident and migratory components within the population.

Water Quality

4.3 Water quality throughout the Welsh Region is generally good with 70% of river and canal lengths (total 4802km) achieving or exceeding long-term objectives in 1986/87 (WWA,1987). The extent to which problems exist varies throughout the region as does the relative importance of different pollutants, eg storm water overflows in urban areas, agricultural problems in South West Wales and acidifcation and heavy metal pollution in Mid and North Wales. The consequences of pollution may be intermittent fish kills or persistent poor water quality which prevents fish from inhabiting or spawning in an area. Implementaion of normal water quality controls should contain this problem, but the setting of Water Quality Objectives for many standing waters and small streams has as yet not been completed.

It is recommended that the NRA continue to give a high priority to pollution prevention and the setting of Water Quality Objectives for all standing waters and small streams (R8).

4.5 Natural populations which occur pedominately in upland lakes and upper reaches of rivers are particularly affected by acidification which is a significant problem in Mid and North Wales; 20% of Wales, containing 28% of stream length and 54% of the 810 lakes >1 ha., lie within recognised acid sensitive areas. Fisheries in these areas have suffered a severe fisheries decline that may be acid related.

It is recommended that the NRA continue research into the effects and amelioration of acidification (R9).

Water Quantity

4.5 Abstraction from and regulation of rivers must be effectively controlled both to protect fish populations and the quality of fishing. Upland drainage is also of concern, causing accelerated run-off and hence higher spate flows which if they occur at spawning time can wash out redds. The drainage of upland marsh/bog areas eliminates the slow-release (sponge effect), resulting in premature drying-up of tributaries, hence reducing effective spawning and nursery areas.

Afforestation, often associated with drainage schemes, further reduces flows in the river. The resultant reduction in dry weather flows can reduce carrying capacity in lower reaches.

It is recommended that a high priority is given to the implementation and enforcement of minimum environmental flows (R10).

It is recommended that the NRA continue research into the effects and amelioration of upland drainage and afforestation, particularly in relation to the effect on drainage patterns (R11).

It is recommended that the NRA seek the development of procedures for the control of upland use (R12).

Habitat

4.6 In the past, in-house river engineering schemes have destroyed areas of riverine habitat affecting all stages of salmonid development; spawning beds, nursery areas, and holding pools. Microhabitat changes caused by drainage schemes may have other undetermined consequences and are already known to exacerbate acidification problems. However, liaison between fisheries staff and drainage engineers has improved in recent years resulting in a more sympathetic treatment of sensitive areas. Upland drainage carried out by non-river authority agencies remains a problem, although efforts are made whenever possible to provide advice which will minimise damage.

It is recommended that effective liaison over river engineering schemes is continued to protect and improve habitat quality (R13).

It is recommended that where funds are available areas of catchment previously affected by land drainage schemes should be restored and improved as a matter of priority (R14).

It is recommended that the NRA achieve greater control over engineering schemes on non-main river either by more effective liaison with outside agencies or by an extension of its main river powers(R15).

Predation

4.7 There is increasing concern amongst anglers that avian predators such as cormorants and goosanders and fish predators such as pike are having a significant affect on fish stocks particularly in localised areas.

It is recommended that the NRA review the effect of predators on brown trout stocks following receipt of the Salmon Advisory Committee report on predation and the results of recent research in Scotland by Dr Marquiss (R16).

Overexploitation

4.8 Brown trout fisheries close to centres of population are those most likely to be subjected to higher angling pressure which can lead to over-exploitation of the spawning stock. The effects of this may be masked by stocking.

4.9 There is some evidence to suggest that the 19cm minimum size limit for brown trout is too small, allowing to 2+ fish to be taken before they have reached maturity (Wightman, 1987).

It is recommended that in order to increase spawning escapement consideration be given to revised byelaws increasing the size limit for trout. This would also protect the larger sea trout pre-smolts in spring (R17).

It is recommended that there is a complete review of byelaws affecting trout stocks to ascertan what other new measures may be required to protect the resource (R18).

Stocking

4.10. The increase in put and take fisheries has enhanced the public's expectation for catch rates in natural and semi-natural fisheries. As a result there is an increasing pressure on fishery managers to re-stock. However, supplemental stocking of hatchery-reared brown or rainbow trout may in itself detrimentally affect success of native brown trout populations.

(i) The introduction of hathery-reared trout of takeable size increases or artifically maintains level of angling pressure upon a native population, hence accelerating its decline by over exploitation;

(ii) If hatchery-reared brown trout derived from farm broodstock, whether introduced as fry, fingerling or takeable sized fish, survive to spawn, they may alter locally-adapted gene pools within the native population (Taggart & Ferguson, 1986) with possible consequences for breeding behaviour and tolerance to specific environmental factors (eg acidification).

(iii) Hatchery-reared fish may introduce diseases and new parasites to a natural population.

(iv) Although rainbow trout rarely establish self sustaining populations in Britain they do compete for food and space with native brown trout, and should be stocked with caution in natural fisheries.

It is recommended that further research be carried out into the genetic differentiation between stocks, and the extent of introgression of fish farm stocks. The research should be aimed at providing information upon which scientifically-based stocking policies can be formulated (R19).

4.11 Stocking with hatchery-reared trout of takeable size has little long term benefit in many rivers and its use is limited to the provision of short-term sport at a recurring cost. Less that 1% of stocked fish contribute to the catch in the season after stocking, and the main benefits are limited to 4 to 5 weeks following the introduction. On average, only 50% of stocked fish are taken by anglers, effectively doubling the price of each fish caught (Cresswell, Harris & Williams, 1982).

4.12 In view of the short term benefits and possible longer term detriment to wild trout populations, introductions of hatchery-reared brown trout of takeable size to rivers should be made with caution. Fishery managers should be encouraged to rectify the cause of a shortfall in wild fish (eg environmental improvement), rather than treating the symptom (restocking).

It is recommended that the NRA encourage a policy of rectifying the causes of stock deficiencies whenever possible rather than artificially maintaining populations by stocking inappropriate strains of trout (R20).

4.13 A shortfall in takeable-size fish need not necessarily be due to environmental factors. Fisheries which rely entirely or partically on natural recruitment often attract more angling pressure than can be supported. To avoid restocking, catch controls can be employed to reduce the take of fish by anglers. Such measures can protect the fishery whilst permitting the continuation of sport fishing.

It is recommended that the NRA provides and promotes advice on methods of reducing anglers take of fish whilst maintaining sporting values (eg bag limits, size limits, hook and release schemes, including the use of barbless hooks) (R21).

It is recommended that the NRA promote guidelines emphasising alternatives to stocking but providing advice on scientifically based stocking strategies where appropriate (this should include the stocking of rainbow trout and triploid brown trout) (R22).

It is recommeded that consideration be given to the production of trout reared from native broodstock for restocking purposes. Guidelines should be produced and pilot production programmes set up by either the NRA or by collaboration with private farms. Specific attention should be paid to selective breeding (eg. for acid resistance), and the identification of suitable areas for restocking (R23).

4.14 Stocking of juvenile sea trout may have a detrimental effect on resident trout stocks by introducing or increasing the migratory component within the population. This would be particularly damaging above impassable barriers where a migratory tendency is undesirable for resident stocks.

It is recommended that investigations into the interaction between sea trout and brown trout continue, particularly in relation to genetic, biological and environmental factors (R24).

4.15 In lakes, scientifically based (eg age, season, strain) supplementary stocking can provide acceptable fisheries, thus maintaining a significant level of natural recruitment. The effects of stocking on spawning of indigenous fish needs to be resolved. An assessment of the contribution of natural recruitment and a better understanding of the carrying capacity of these waters is required.

It is recommended that there should be further investigaton into the biology of natural recruitment, including limiting factors in trout production and the responses of fisheries to exploitation. This should lead to the development of cost effective stocking strategies, coupled with better understanding of factors affecting potential yields. (R25).

5. Summary of recommendations

5.1 Database

For effective strategic planning and to enable the establishment of efficient systems of maintenance, improvement and development of the trout fisheries resource, a comprehensive set of baseline data is essential.

It is therefore recommended that:-

- a database of all brown trout fisheries is established specifically identifying natural brown trout populations (R1).
- the juvenile salmonid monitoring programme be modified to include more sites representative of resident brown trout populations (R4).
- all angling clubs, syndicates and individual anglers be asked to make available, to the NRA, any historical catch records relating to brown trout fisheries in Wales. This information will be collated and reviewed (R5).
- all angling clubs, syndicates and individual anglers be encouraged to maintain catch records for brown trout. On specific waters log book schemes will be established (R6).
- the economic value of resource and consumer (angler) demand for the resource are assessed periodically so that financial resources for the conservation, improvement and development of trout fisheries can be appropriately allocated (R7).

5.2 Environmental protection

Few trout fisheries appear to be unaffected by some form of habitat degradation. Water quality and habitat suitabilty have all been shown to act as limiting factors in the distribution and well-being of the trout resource. Environmental protection and improvement is therefore an important part of any strategy to maintain and develop fishery resources.

It is therefore recommended:-

- that the NRA continue to give a high priority to pollution prevention and the setting of Water Quality Objectives for all standing waters and small streams (R8).
- the NRA continue research into the effects and amelioration of acidification (R9).
- a high priority is given to the implementation and enforcement of minimum environmental flows (R10).
- the NRA continue research into the effects and amelioration of upland drainage and afforestation, particularly in relation to the effect on discharge patterns (R11).

- the NRA seek the development of procedures for the control of upland use (R12).

- effective liaison over river engineering schemes is continued to protect and improve habitat quality (R13).

- where funds are available areas of catchment previously affected by land drainage schemes should be restored and improved as a matter of priority (R14).

- the NRA achieve greater control over engineering schemes on non-main river either by more effective liaison with outside agencies or by an extension of its main river powers (R15).

5.3 Fisheries Protection

To protect fisheries from excessive predation, ill-conceived management and over exploitation.,

It is recommended that

- natural brown trout populations are protected by control or prohibition of stocking with sea trout or non-indigenous strains of brown trout (R2).

- the NRA should liaise with the Nature Conservancy Council to ensure that fisheries of particular note are given official protection (R3).

- the NRA review the effect of predators on brown trout stocks following reciept of the Salmon Advisory Committee report on predation and the results of recent research in Scotland by Dr Marquis (R16).

- in order to increase spawning escapement, consideration be given to revised byelaws increasing the size limit for trout. This would also protect the larger sea trout pre-smolts in spring (R17).

- there is a complete review of byelaws affecting trout stocks to ascertain what other new measures may be required to protect the resource (R18).

- further research be carried out into the genetic differentiation between stocks, and the extent of introgression of fish farm stocks. The research should be aimed at providing information upon which scientifically-based stocking policies can be formulated (R19).

- the NRA encourage a policy of rectifying the causes of stock deficiencies whenever possible rather than artificially maintaining populations by stocking inappropriate strains of trout (R20).

- the NRA provides and promotes advice on methods of reducing anglers' take of fish whilst maintaining sporting values (eg bag limits, size limits, hook and release schemes, including use of barbless hooks) (R21).

- the NRA promote guidlines emphasising alternatives to stocking but providing advice on scientifically based stocking strategies where appropriate (this should include the stocking of rainbow trout and triploid brown trout) (R22).

- consideration be given to the production of trout reared from native broodstock for restocking purposes. Guidelines should be produced and pilot production programmes set up by either the NRA or by collaboration with private farms. Specific attention should be paid to selective breeding (eg for acid-resistance), and the identification of suitable areas for restocking (R23).

- investigations into the interaction between sea trout and brown trout continue, particularly in relation to genetic, biological and environmental factors (R24).

- there should be further investigations into the biology of natural recruitment, including limiting factors in trout production and the responses of fisheries to exploitation. This should lead to the development of cost effective stocking strategies, coupled with better understanding of factors affecting potential yields (R25).