Science Directorate

Report of the Workshop on Farmed Fish Welfare

Held on Monday 28th October 2002

Department for Environment, Food and Rural Affairs

SCIENCE DIRECTORATE
FARMED FISH WELFARE WORKSHOP

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1.0 INTRODUCTION

1.1 Defra animal welfare research

The animal welfare research programme contributes to Defra's objective *to ensure high standards of animal health and welfare.* The Department commissions research and development (R&D) to support this objective and to provide a sound scientific base of knowledge to guide policy development and application as well as to support the UK's negotiating positions with the EU, the Council of Europe and other fora. Defra reviews and evaluates areas of its R&D programme on a regular basis (usually every four to five years). The objective of the Fish Welfare Workshop is to provide an opportunity to look at a broad spectrum of welfare issues influencing farmed fish with a view to deriving a ROAME (*R*ationale, *O*bjectives, *A*ppraisal, *M*onitoring, *E*valuation) statement covering the extended responsibilities of the Department.

Fish welfare projects fall into one of six programmes concerned with the welfare of animals. The remaining five programmes are concerned with the welfare of poultry, pigs, ruminants, welfare during transport and at markets and welfare at slaughter. As such the Department is also concerned with the welfare of fish during transport and at slaughter. The proportion of the animal welfare budget currently directed towards the fish welfare research programme is 2.5%. Expenditure on the fish welfare programme since 1999/2000 is presented in **Figure 1** below. Costs of individual projects are listed in **Annex A**.

Defra fish welfare R&D expenditure

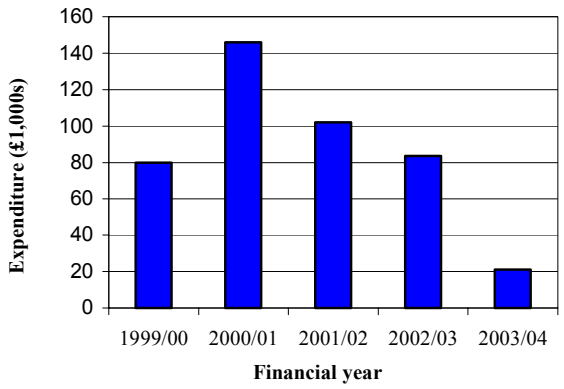


FIGURE 1

Annual expenditure since 1999/2000 on the fish welfare research programme expressed in £ thousands.

1.2 Strategic objectives of animal welfare research

The overall objective of the animal welfare research programme is to provide a scientific evidence base on which policies, strategy and negotiations relating to animal welfare are based. This is achieved by:

- Defining welfare requirements;
- Applying scientific knowledge to the study of uncertainties; and
- Identifying ways in which welfare parameters can be met and monitored within varied farming environments.

The direction and nature of a research programme is based on the ROAME A statement, which provides a formal description of the rationale behind the programme. The statement defines the customer's objectives firstly in policy terms, and secondly in terms of scientific objectives to support the policy need.

1.3 Objectives for the farmed fish workshop

This workshop is intended to review recent Defra funded research on fish welfare and to provide a forum for the exchange of views on present and future issues that fall under the general field of fish welfare. Its aims are:

i. To examine progress to date against Defra's stated policy and scientific objectives (see **section 1.2** above).
ii. To identify through open and wide discussion those issues which relate to fish welfare in aquaculture and associated activities.
iii. To consider emerging issues and to define those which may become relevant to Departmental responsibilities for animal welfare.
iv. To determine the direction and priorities for future research.

Ultimately, the outcome of the review will be to derive a ROAME A to guide the future direction of the fish welfare programme.

1.4 Policy background

Research commissioned by the Government under the animal welfare research programme not only intends to ensure that the UK's negotiating position in the EU, Council of Europe and other fora has a sound scientific base but it is also used for standard setting and to inform both policy development and application.

The general policy drivers behind the farmed fish R&D programme include:

- A desire to improve the welfare of fish in existing production systems;
- The development, where necessary, of alternatives to existing systems; and
- The determination and refinement of methods used to measure animal welfare in order to ensure that change will bring about overall welfare improvement.

The research programme is also guided by:

- Advice and recommendations from the Farm Animal Welfare Council;
- The development of recommendations in the Council of Europe;
- Consideration of external reports; and
- The emergence and development of new production systems.

The results produced from Defra funded research are applied through a variety of ways including:

- Welfare codes and best practice guidelines;
- Publications in scientific and lay media;
- Demonstrations of the application of technology;
- Meetings and seminars to increase awareness and advise industry; and also
- Monitoring and enforcement.

2.0 PRESENTATIONS

Summary reports, for projects AW1202 and AW1203, have been prepared by the researchers carrying out the projects. They were designed to describe the aims, methods, results and conclusions in a clear and easily readable format.

Further details can be obtained from the Science Directorate should they be required.

Abstracts have been prepared by those speakers who were not project leaders of Defra funded projects but kindly agreed to give a presentation at the workshop. The 'Fish Disease and Welfare' abstract has been prepared by the Science Directorate. The aim of the abstracts was to provide a brief overview of the talk presented on the day.

Further details can be obtained directly from the speakers should they be required.

2.1 AW1203: The effects of stocking density on the welfare of farmed rainbow trout

Dr T Ellis
CEFAS Weymouth Laboratory
University of Stirling
British Trout Association

Project running: Jan/April 2002 – June 2003/March 2005

Aims

- To develop non-invasive stress assay for rainbow trout.
- To quantify current stocking density practices on commercial UK trout farms.
- To review existing scientific evidence for effects of density on trout welfare.
- To experimentally examine effects of stocking density on trout.
- To review available methodology for independent stocking density assessment.
- To examine effects of stocking density on commercial trout farms.
- Preliminary examination of trout fin erosion.
- To examine effects of primary water quality parameters on trout welfare.

Relevance to Defra

The general aim of these two complementary projects is to examine the effects of stocking density on rainbow trout welfare. This involves developing novel methodology for assessing stress hormone (cortisol) levels non-invasively, and using a variety of morphological, physiological and histopathological indicators of fish welfare status.

Methods

1. Measurement of the amount of the stress hormone - cortisol - released into the water by rainbow trout. The cortisol is concentrated from the water onto an absorptive matrix, retrieved using a solvent, purified and then measured.

2. Questionnaire survey of BTA member farms.

3. Review of scientific literature on effects on rainbow trout of stocking density, water quality and behavioural interactions.

4. Laboratory experimentation examining potential welfare indicators identified from the literature review.

5. Search of trade publications, Internet and scientific literature.

6. Sampling commercial (BTA) trout farms for welfare indicators.

7. Examination of fine structure of intact and damaged fins using electron and light microscopy techniques.

8. Manipulation of key water quality parameters (unionised ammonia, dissolved oxygen and carbon dioxide) under laboratory conditions.

Results

1. Rainbow trout release stress hormones into the water with the concentration of cortisol (the major stress hormone) exceeding that of cortisone (a breakdown product). The amount of cortisol released is a valid measure of stress level, being correlated with plasma cortisol levels and the severity of the stress. The recovery efficiency of our methodology is good (87%) and the variability is acceptably low (CoV=10%). The technique used to measure the cortisol - radioimmunoassay - meets required standards (intra- & inter-assay variation, specificity and parallelism). Freeze storage of samples does not cause loss of cortisol. Water cortisol levels change as expected with temperature, dilution and fish size. Water cortisol concentration (ng l^{-1}) can be used as a relative measure of stress level - over time or between replicate systems. Cortisol release rate (ng kg^{-1} min^{-1}) can be used as an absolute measure, but requires accurate information on biomass and dilution rates.

2. A questionnaire was distributed to British Trout Association (BTA) member farms in order to establish stocking practices and perceptions of stocking density. The questionnaire was generally well received with a response rate of 65% from BTA member farms, which represent over 80% of total UK trout production. These data are currently being collated and analysed and follow-up work is still under way in the form of farm visits and stock monitoring. The survey highlighted the problems of obtaining accurate water-flow rates and system volume data from farms. The vast majority of farms (80%) use additional aeration / oxygenation, especially in the later stages of production. Several responses highlighted provision of adequate levels of oxygen as the priority for maintaining fish health and condition, rather than avoiding higher stocking densities.

3. Forty-three experimental studies have examined the effects of density on rainbow trout. Increased disease incidence and mortality are not generic effects of increasing density in rainbow trout. There is also little evidence for prolonged “crowding stress” in rainbow trout, although dismissal of crowding stress is hampered by a poor appreciation of cortisol dynamics under chronic stress. It has been suggested that the lack of elevated

cortisol levels in response to increasing density may be due to either acclimation, an increase in cortisol clearance rate, or impairment of the stress response by poor water quality.

Commonly reported effects of increasing density are reductions in food conversion efficiency, nutritional condition and growth, and an increase in fin erosion. Less well-documented effects are gill damage and a decrease in white blood cell numbers (reflecting a reduced immune capacity). Such changes are indicative of a reduced welfare status. The magnitude of density effects is highly dependent upon study-specific conditions. There is dispute as to the cause of density effects, with water quality deterioration and/or an increase in aggressive behaviour being proposed. The weight of evidence indicates that water quality deterioration is the primary cause, although the relative contributions of the two causes may depend upon the specific conditions. Recommendations in the literature for appropriate levels of the key water quality parameters (dissolved oxygen, unionised ammonia) differ, often varying by a factor of two or more.

4. Densities ranging from 10 to 100 kg/m^3 have been studied in laboratory and pilot-scale tanks and a suite of potential welfare indicators measured at regular intervals. Under the same flow regimes, the defined stocking densities did not affect growth, nutritional status or survival. Although density reduced water quality (decreased dissolved oxygen and increased unionised ammonia), critical levels were not exceeded, and there was no effect of density on gill condition. The relatively high water replacement rates and additional aeration/oxygenation may account for the lack of the commonly observed density effects. Although fish were darker (an anecdotal indicator of stress) at higher densities, amounts of cortisol in the blood and released into the water were not elevated at higher densities.

   There was some evidence (a greater variation between individuals in growth and cortisol level) indicating that behavioural interactions may impact on the welfare of subordinates at low (10 kg/m^3) densities.

   Other welfare indicators possibly indicated a reduced welfare status at higher densities. Increasing density increased fin erosion, with all rayed fins being subject to increased damage. The paired (pectoral and pelvic) fins were subject to asymmetric fin erosion and subsequent experiments manipulating the direction of circular swimming have shown that such asymmetric damage is caused by factors other than abrasion with tank surfaces. However, it is not known whether such effects are also seen in the larger tanks, ponds or raceways used in commercial culture.

Increasing density reduced red blood cell volume (haematocrit), and increased a non-specific immune response (lysozyme activity). However it is difficult to interpret these results in terms of effects of density on welfare. The higher haematocrit at low densities may represent a stress response, or alternatively extended chronic stress or blood loss (due to fin erosion) at higher densities. The lysozyme activity may represent either immuno-suppression at low densities (due to aggressive behaviour) or an elevated immune response at high densities (possibly due to greater fin erosion). Also the magnitude of differences between density treatments was minor when compared to changes due to seasonal effects.

5. Various fish counters and size estimators are available to the aquaculture industry. However, no equipment is currently available that would allow regulators to independently assess densities in situ on farms in a non-intrusive manner.

6. Stocking practices and welfare indicators are being monitored on raceway, earth pond and circular tank farms representing a range of intensities of production. There is also potential for a further commercial trial examining the performance of fish of the same origin in different types of production system. Data collection and analysis is still on going.

7. Not yet started.

8. Not yet started.

Conclusions

Water quality appears to be the key factor in relation to density affecting welfare. However, appropriate levels of key parameters are unclear. The role of aggressive behaviour in relation to higher densities and trout welfare has possibly been over-emphasised, although it is likely to be significant at lower densities.

Fin erosion is potentially of considerable significance in relation to density. However, the actual causes and processes are unknown.

Blanket legislation limiting density is likely to be unworkable due to:

- Dependence of effects upon a series of interrelated and dynamic environmental conditions;
- Regulatory difficulties;
- Lack of a generally applicable unit for describing density; and
- Need for minimum (to avoid excessive aggressive behaviour) as well as maximum density limits.

A more practical option might be to prescribe acceptable levels of water quality, health, nutritional condition and behavioural indicators.

The hormonal stress level of fish can be measured non-invasively with the advantages that:

- The inherently stressful/ lethal procedure of blood sampling is avoided;
- Multiple measurements can be made on the same group of fish over time reducing the number of fish needed for time-course experiments;
- The stress level of fish too small to sample for blood can be assessed.

It is currently difficult to interpret physiological and hormonal fish welfare indicators. We need a better understanding of appropriate basal levels over a range of environmental conditions.

Future Research

It is clear that further work will be required on stocking density in a variety of representative commercial farm environments. We need a better understanding of the interactions of density, water quality, behaviour, environmental conditions and trout welfare.

A need remains for further development of objective methods for assessing fish welfare. Fin erosion has potential as a morphological welfare indicator, but more work will be needed to determine causes, consequences and effects of environmental factors. Physiological indicators are currently difficult to interpret, and research is needed to clarify appropriate baseline levels over a range of environmental conditions. Although the cortisol stress response is a well-documented indicator of acute stress, there is a need to improve our understanding of:

- Cortisol dynamics (production & clearance rates rather than simple level in the blood) under chronic stress; and
- The interplay within and between the various components of hormonal and immune systems.

Before specific limits are set for key water quality parameters (as per Council of Europe recommendations), we need an improved understanding of appropriate levels, the practicalities of determination by fish farmers and regulators, and the variability over different time-scales on commercial farms.

Disease transmission and susceptibility on commercial farms may be a convenient proxy for assessing the welfare status of fish. Epidemiological

studies would enable examination of potential risk factors, such as water quality parameters and density.

Publications

Ellis, T., North, B., Scott, A. P., Bromage, N. R. & Porter, M. (In press). Review paper: The relationships between stocking density and welfare in farmed rainbow trout. *J Fish Biology*

Scott, A. P., Pinillos, M. & Ellis, T. (2001). Why measure steroids in fish plasma when you can measure them in water. p 1291-1295 in *Perspectives in Comparative Endocrinology: unity and diversity*, HJT Goos, RK Rastogi, H Vaudry, R Pierantoni (Eds)

Ellis, T., Scott, A. P., Bromage, N., North, B. & Porter, M. (2001). What is stocking density? *Trout News* **32** 35-37

Ellis, T., North, B., Scott, A. P., Bromage, N. R. & Porter, M. (In press). A review of the relationships between stocking density and welfare in farmed rainbow trout. *European Aquaculture Society Special Publication*

Ellis, T., Scott, A. P. & James, J. (In press). A non-invasive stress assay for rainbow trout. *European Aquaculture Society Special Publication*

Workshop Comment

Discussions following the presentation concentrated on the remote measurement of cortisol from the water column. This method would be an extremely useful tool for use on-farm and it was suggested that little additional effort would be required to develop the method for on-farm use.

Questions were asked as to how the current method copes with the fact that there is controversy in other animal species over the application of cortisol measures as a true indicator of stress. It was stated that under experimental conditions this would not be a problem as you can validate the water assay with systemic values and other indices of stress. The problem would arise in an on-farm situation. The difficulties involved with understanding chronic stress may undermine the adverse welfare effects of high stocking densities. This was debated and it was indicated that other factors such as reduced growth rate and food conversion ratios would be used in addition to the level of cortisol to determine whether a fish was experiencing stress.

The results from this project tended to indicate that stocking density per se might not adversely effect welfare. This issue was discussed and the point clarified; if a producer were to stock fish at high densities the water quality would have to be maintained at high standards. This however, does not take into account the behavioural needs of the fish since space at high densities would be reduced.

2.2 Management Practices in Trout Farming, with regard to welfare. Water Quality, Food Provisioning and Stocking Density

Mr M Davies
British Trout Association

The British Trout Association Code of Practice states that: "Trout farmers should recognise that by engaging in the act of fish farming they have a duty of care for the welfare of their stock from egg to harvest". This is encapsulated in the phrase "stewardship", defined as ownership with responsibility.

Three main areas where trout farmers can influence the well-being of their stock are described below.

a) **Water Quality**
This is a complex matrix of inter-related parameters. Farmers must ensure that appropriate flow rates are maintained, providing adequate oxygen supplies and facilitating removal of products of metabolism. Environmental conditions which may influence water quality must be anticipated and necessary action taken. These actions may be further complicated as both the fish and the aquatic medium are profoundly affected by the environment.

b) **Food Provisioning**
The quality of feed, its distribution and the daily feeding rate of trout should optimise nutrition and minimise aggression and the amount of waste products. A variety of systems are employed to deliver feed. It is essential that any method(s) used are capable of delivering the daily ration in a manner that allows all fish access to adequate feed and prevents wastage. Recognition should also be taken of the crepuscular nature of trout and feeding regimes tailored accordingly. Fasting regimes, best expressed in degree days are an essential management technique, but should be kept to a minimum.

c) **Stocking Density**
Trout must be stocked at densities appropriate to their size, water temperature and flow, available oxygen, stage in production cycle and type of fish holding unit in order to minimise the risk of poor water quality, physical damage, stress and disease. Given the number of influential variables, the setting of absolute levels must be treated with caution. Appropriate stocking densities are managed on a farm by farm basis by maintaining water quality parameters at levels which are thought to be necessary for the maintenance of welfare of the fish.

By being aware of all factors likely to influence welfare, the responsibility which rests with the farmer can be satisfactorily discharged. Many of these factors are suitably encapsulated in the BTA Code of Practice, the FEAP Code of Conduct and the QTUK Farm Standards.

Workshop Comment
This talk highlighted the fact that stocking density effects are intrinsically linked with the levels of other parameters such as the concentration of dissolved oxygen, carbon dioxide and ammonia in water and particulate matter.

Queries arose as to whether water quality should be measured on farm and whether these measurements were a predicable indicator of good husbandry. It was felt that there is a need to establish acceptable levels of dissolved oxygen, carbon dioxide and ammonia in the water column and in fact minimum levels of these parameters have been discussed during Council of Europe (CoE) deliberations.

The debate then moved onto the subject of fin erosion and the fin index. This index is a function of both fin growth and erosion. Image analysis is now being used to assess fin erosion and regrowth. The majority of fin size reduction is thought to be primarily physical damage and bacterial damage is thought to be secondary.

When assessing on-farm fish welfare farmers assess the fishes overall state. Veterinary inspectors undertake a similar practice. Should welfare appear to be compromised further investigation is undertaken.

Questions arose about the appropriateness and completeness of EU regulations. It was felt that the CoE document was a pragmatic document that aimed to take account of fish farming practice.

The subject of fasting periods was aired. FAWC have recommended that trout undergo a maximum 48h fasting period; the period being influenced by the temperature. Industry's aim is to expose fish to the shortest period of fasting possible eg it has been found that following a 48h fast at 1 ^{0}C a full gut would not evacuate fully. When producing fish there is a need to consider the stress the fish are exposed to as well as both contamination by gut contents and the quality of the product. This was thought to be an area that required further research.

2.3 Assessment of Pain in Fish

Dr L U Sneddon
Roslin Institute/University of Liverpool

The detection of potentially painful, injurious stimuli is crucial to survival. This important sensory ability to detect and react accordingly to damaging stimuli has been demonstrated in mammals, birds and amphibians but no study has proven fish possess this capability. Therefore an integrated approach was employed to assess nociception and possible pain perception in the rainbow trout (*Oncoryhnchus mykiss*).

Neuroanatomical analysis of the trigeminal nerve of this fish confirmed the presence of A-delta and C fibres that convey pain information from oro-facial areas in higher vertebrates. Electrophysiological recordings from the trigeminal nerve demonstrated that there were a number of receptors on the head, face and lips of the trout that preferentially responded to noxious stimuli and these receptors had similar physiological properties to mammalian nociceptors. These results prove that the fish is capable of nociception, the detection and reflex response to a noxious stimulus, but to prove pain perception, it must be shown that behavioural responses are not reflexive.

Short-term noxious chemicals were injected into the lips of the trout and the resulting behavioural responses were compared with saline injected fish and handled controls. Behavioural responses were prolonged over 3 hours with the performance of pain-coping behaviours. Opercular (gill) beat rate almost doubled in fish injected with noxious substances whereas there was only a 30% increase in the controls. Fish did not feed until the behavioural and physiological responses had subsided.

To assess the effect of pain on attention mechanisms, noxiously stimulated fish were presented with a fear-causing stimulus. Control fish demonstrated a classic neophobia whereas pain dominated attention in the noxious treatment and these fish did not show an appropriate fear response. These behaviours were not merely reflexive and suggest higher processing is involved. This suggests that the rainbow trout is potentially capable of pain perception and this is relevant to commercial practices and to the welfare of fish.

Workshop Comment
Results from these studies indicate that carbon dioxide used for the slaughter of fish may be a noxious stimulus. Under current Scottish Quality Salmon (SQS) Codes of Practice CO_2 slaughter is disallowed. This method of slaughter is included in the CoE recommendations but it is to be used only for large numbers of fish.

Debate followed as to whether fish have cold receptors and whether exposure to low temperatures was a welfare issue. Different opinions were aired in relation to this subject. It was suggested that if fish had cold receptors then exposure to temperatures between 4 ^{0}C to –12 ^{0}C may be a welfare issue but this conclusion would require additional research to support this view. In

contrast data presented at a meeting in Trieste indicated that behavioural changes were not elicited from Bass and Bream on exposure to cold temperatures.

2.4 AW1202: Automated humane slaughter of trout

Dr J A Lines
Silsoe Research Institute

Project running: Sept 1989 - Sept 2001

Aims

- To review current fish slaughter methods in order to identify and evaluate the welfare and quality implications of fish slaughter methods.

- To develop a device able to humanely stun trout beyond the point of recovery. The design should be capable of being developed into a commercial machine, which would be affordable and practical for use on the larger trout farms. It should be tolerant of poorly presented fish; maintain or enhance the general carcass quality, be capable of delivering fish to a cooling medium at a rate approaching 3 fish per second and be safe and reliable in operation.

- To transfer the information and technology resulting from this research to the industry.

Relevance to Defra
The FAWC report on fish farming included recommendations that:

- trout must be killed in a humane way and that widely used method of leaving the animals to suffocate in air is not acceptable,

- a satisfactory method of slaughtering trout en masse which renders them insensible instantaneously until death supervenes is urgently required, and

- the cooling of live trout on ice after they have been removed from water should be prohibited.

These recommendations were identified by Defra as those with the highest priority. This research has provided a way forward in this area.

Methods
All work in this project was done in close collaboration with scientists from the University of Bristol and with staff from the Humane Slaughter Association.

A review of fish slaughter methods was written. In some areas where welfare or quality issues were poorly established, the review was supported by trials. This process identified electric stunning in water as the method most suitable

for development. It also showed that research was needed to overcome the carcass quality issues normally associated with electric stunning.

Farmed trout were placed in a water tank and stunned using an electric field. The parameters of the electric field (strength, frequency and duration) were varied. The fish were then held in water to monitor the duration of insensibility using behavioural indices. Any fish that recovered were humanely killed by mechanical percussion. Fish carcasses were examined for haemorrhages. Electric field parameters that resulted in permanent insensibility, produced few haemorrhages, and were consistent with the commercial operational requirements were identified.

Practical techniques for applying the stun in various farm operating conditions were explored. A demonstration machine was built and tested.

Results

The duration of insensibility of the trout was found to increase with electric field strength and stun duration and to decrease with increasing frequency. Haemorrhages were found to decrease with increasing electrical frequency and to be independent of stun duration. During all experiments, the onset of insensibility was virtually instantaneous (substantially less than one second). Recovery, where this occurred took between 10 seconds and several minutes.

A 60 second exposure to a 1000Hz sinusoidal electric field of strength 2.5 v /cm rms permanently stuns portion sized rainbow trout in most areas of England. In areas of very low conductivity a small increase in field strength may be required.

A demonstration trout harvester capable of working at around 2 tonnes per hour has been built. It has been tested, and demonstrated on farms in England and Scotland. It has also spent several months on trial at a major trout farm. Its use results in a high standard of fish welfare at slaughter. It also provides a relatively safe working environment and fits into current harvest practises. In back to back comparisons with traditional harvest techniques it has been found to produce the same low level of haemorrhaging as the traditional slaughter method, a longer pre-rigor period during which the fish can be processed and lower levels of slime and surface damage on the fish.

The machine is capable of working at about two tonnes of trout per hour. This is 30% slower than was originally requested by the industry however this is simply related to the size of the machine which was limited by a practical need to transport it from site to site.

Reports about results of this research have been published. Trout producers and retailers are currently examining ways to implement humane slaughter on trout farms on a regular basis.

Conclusions

Humane slaughter of trout using electric stunning is possible and practical.

A 60 second exposure to a 1000Hz sinusoidal electric field of 2.5 v/cm rms results stuns portion size rainbow trout beyond recovery without causing carcass damage. A small increase in the field strength may be required in areas of very low conductivity water.
A demonstration humane trout harvester has been built and shown to work effectively, producing high quality carcasses, a safe working environment and to fit into current harvest practice. It has been tested on farms during commercial harvests and in back to back comparisons with traditional techniques. It produces the same low level of haemorrhaging as the traditional slaughter method, a longer pre-rigor period during which the fish can be processed and lower levels of slime and surface damage on the fish.
Production humane slaughter units can be designed and built based on the findings of this development project and on the design of the demonstration machine. Although implementing humane slaughter will never be as cheap as traditional techniques, improvements in the quality of the carcasses may offset some of the implementation costs. The British Trout Industry is working towards the wide spread adoption this technology. The technology transfer is being actively supported by the HSA.

Future Research
A major and important challenge is to identify and develop techniques to reduce the electric power required to produce permanent insensibility in fish.

This research would enable sea fish to be slaughtered humanely. For some farmed sea fish there is currently no recognised humane slaughter method. Electric stunning of fish in seawater is not currently possible. This is because of the huge electric currents that would be required caused by the very high conductivity of sea water. Currents are typically 100 times greater than that required for fresh water fish.

The results of this proposed research would also benefit fresh water fish such as trout, since it would lead to significant reductions in the cost of equipment and greater freedom in equipment design. This might be expected to result in wider and faster uptake of humane slaughter methods.

A third benefit would be that developments in this area would lay a foundation of knowledge that could eventually make possible the humane slaughter of wild catch fish. The welfare of wild catch fish at slaughter is likely to become increasingly important to the public.

References & Publications
Robb, D.H.F., O'Callaghan, M.O., Lines, J.A., Kestin, S.C. 2002. Electrical stunning of rainbow trout (oncorhynchus mykiss):factors that affect stun duration. *Aquaculture* **205** 359 – 371

Robb, D.H.F., Kestin, S.C. 2002. Methods used to kill fish: field observations and literature reviewed. *Animal Welfare* **11**(3) 269 – 282

Lines, J.A., Robb, D.H., Kestin, S.C., Crook, S.C., Benson T. A System for the Humane Slaughter of Trout. Submitted to *Aquacultural Engineering*

During the course of the project posters were regularly presented at Aquaculture exhibitions, two invited papers have been presented to the BTA annual conference at Sparsholt, regular contributions were made to industry magazines and copies of the final report have been made available to a large number of interested farmers.

Workshop Comment

Discussion started with reference to the application of the electrical stunning method to wild and also marine fish. It was estimated that the slaughter of marine species using this method would require additional power in the region of half a mega watt. The hardness of the water supply might effect the systems efficacy since conductivity can be related to water hardness. During the project however little differences in effectiveness of the system had been encountered in areas with different water conductivity levels.

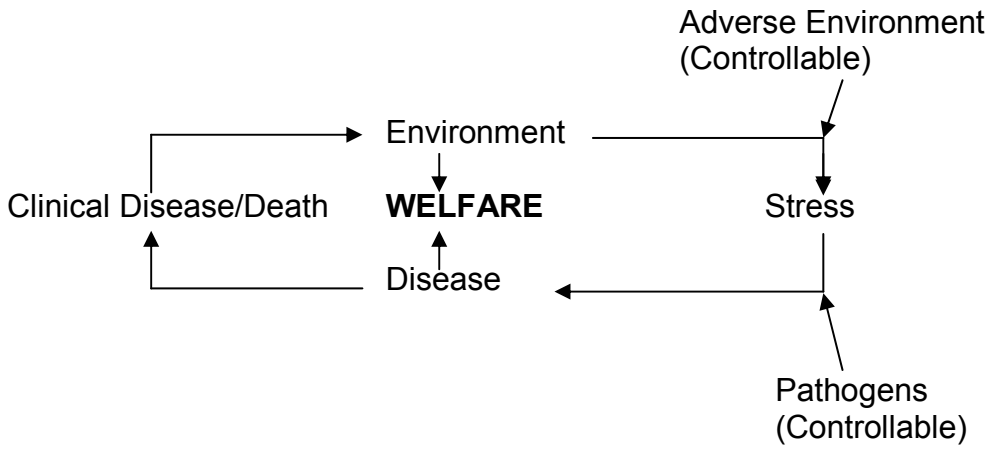
A question arose as to whether the body of the fish would be damaged as a result of the rotating drum design? Originally this had proved problematic but due to additional design input brushes at the entrances to the drum had alleviated the problem.

The commercial application of the system was debated and it was felt that for casualty slaughter of fish multiple units would be more efficient than having a single large unit. When considering this a number of things would need to be taken account of the welfare of the fish, operator safety and carcass quality. The project's aim was to establish the electrical parameters required to slaughter fish. This had been accomplished. The future of the system was dependent on the uptake by industry. They may be more inclined to use the basic information on the parameters required for electrical slaughter rather than using the developed prototype.

The influence of stun time on carcass quality was deliberated on. The current project examined the effect of a maximum 60 sec stun time on carcass quality. Generally as you increase the stunning time you get an increase in lactic acid in the muscles that can reduce the time to rigour. It was debated as to whether this was a negative response especially as those carcass' that go into rigour quickly would also come out of rigour quickly.

2.5 Fish Disease and Welfare

Mr Eric Hudson
CEFAS Weymouth



Fish disease is intrinsically linked to the control of the environment and also the control of pathogens.

Welfare problems associated with fish diseases tend to be species specific. A number of examples of fish diseases were presented:

Carp disease SVC: This is a notifiable viral disease that tends to occur mainly in the spring. It results in septicaemia;

Trout BKD: This is a notifiable salmonid bacterial disease that occurs in temperatures less than 15 ^{0}C; and

Salmon Disease: This is a notifiable parasitic disease that originates from the Baltic.

To date there are no easy treatments for any of these diseases.

Growth of Aquaculture
In the 1970's and 80's there was increased growth in the aquaculture industry and this came hand-in-hand with an increase in the level of intensification. This saw a rise in the incidence of disease eg Whirling Disease which is caused by a protozoan parasite that effects the development of cartilage in young fish. A simple management change from using mud-based ponds, the habitat of the intermediate host, to concrete ponds was sufficient to control the disease.

Mitigation of Disease
Disease occurrence may be alleviated in a number of ways including the control of movement of fish introductions, the control of fish into inland waters, the routine inspection of fish kills and diseased fish and habitat management and conservation.

Further Work
Further research is required on the potential welfare consequences of those systems that re-circulate their water supply especially as their use is on the increase. It was also suggested that the costs associated with receiving veterinary medicine approval and licensing needs to be assessed.

Workshop Comment
Much discussion centred on the fact that there are limited numbers of licensed products currently available for the treatment of fish. Presently amoxicillin is being used but this requires a lengthy withdrawal period before the fish can go to market. BKD and Sleeping sickness were used as examples of diseases where there are no effective treatments currently available. It was suggested that the problem lay with the cost of the licensing procedure and the fact that each product needs a separate licence for each EU State.

It was stated that under the current cascade the fish industry could use licensed products that are presently being used for other animals.

2.6 Reef to Retail

Mr P West
Managing Director Tropical Marine Centre Ltd

Paul West previously has spent 17 years in marine aquaculture developing and operating fin fish hatcheries in the UK, Spain, Chile and Canada. He is a director of OATA (Ornamental Aquatic Trade Association) and sits on the Handling, Husbandry and Transport Standards advisory group for the Marine Aquarium Council. The Marine Aquarium Council (MAC) is an international, not-for-profit organisation that brings marine aquarium animal collectors, exporters, importers and retailers together with aquarium keepers, public aquariums, conservation organisations and government agencies.

Tropical Marine Centre Ltd (TMC) is UK's largest ornamental marine livestock importer and operates the largest aquarium-based wholesale facilities in Europe. Based outside London and Manchester its fish holding facilities operate completely closed recirculating systems holding over 200,000 litres of artificial seawater.

TMC works closely with 39 livestock suppliers in 26 countries to ensure the most rigorous welfare and environmental standards are met. Everything is done to ensure that livestock is net caught and held near to the catching area in well designed and carefully managed holding facilities. This local attention to detail combined with careful packing and transportation procedures ensure livestock arrive in the best possible condition. TMC imports more than 500,000 animals represented by over 1200 species of fish and invertebrates annually. Typically there are upto 18 shipments arriving at TMC's facilities every week. Upon arrival the fish are unpacked in a separate facility equipped with red lights. The fish are carefully acclimatised over many hours and are then placed in individual aquariums or compartments to rest and be introduced to a variety of enriched frozen foods. When selected for sale, all livestock are individually screened by experienced staff and packed in double wall polythene bags, enriched with oxygen, and then sealed placed in polystyrene boxes for dispatch to the customer.

In 1994 TMC established Europe’s only commercial reef fish hatchery. This facility is recognised internationally as a leading centre of excellence in marine fish propagation offering TMC customers a tank bred and raised, disease free alternative to a number of popular wild caught reef species. Over 40 species of reef animals have been successfully bred and reared in this facility including a number of world firsts.

In partnership with a wide range of research organisations, conservation groups and other NGO's including the World Conservation Monitoring Centre and the Marine Aquarium TMC actively promotes the aim of a sustainable and environmentally responsible trade from a well managed, fairly funded and properly understood natural resource. TMC hopes to be one of the first importers in the world to be certified by the Marine Aquarium Council whose Certification system will set standards for all stages of the marine ornamental

trade from collection to retailing to the hobbyist. TMC's import data including and mortality is made available to WCMC who maintain the Global Marine Animal Database which was established through charitable funding through the Marine Aquarium Council as a database for the all stakeholders including governments in the Marine ornamental trade.

Workshop Comment

The session opened with a question on how Tropical Marine Centre Ltd (TMC) ensure the welfare of fish once they have arrived at the retailers? This is addressed by the fact that TMC specify standards for their retailers that must be met before TMC will supply them with fish but they can only guarantee the fish's welfare to point of sale.

The debate moved on to whether the current IATA livestock regulations were adequate to ensure the welfare of fish arriving in the UK and if TMC received any feedback from carriers regarding this matter. Fish importers are responsible for the fish's welfare but the arrivals departments at the airport also share some of this responsibility and Border Inspection Posts (BIP) are in place to ensure that welfare standards are met.

A query arose about whether there were regulations regarding the number of species that can be collected off reefs. The Marine Aquarium Council (MAC) set standards for, and monitors, fish collectors. In addition, TMC monitor collector standards and require fish collection to be undertaken in a sustainable manner with collectors keeping records of the numbers of fish caught. The Global Marine Aquarium Database is potentially a way to check the number of fish being taken and some organisations actually use the database for this purpose. Since the database is in the public domain the general public can access this type of information.

The debate progressed to the topic of what additional legislation is required in relation to fish imports and also with regard to fish movements within the UK. Currently there are a number of pieces of legislation that relate to the importation of tropical fish but a real issue is the length of time it takes to pass fish through the BIP. This can add upto 6 hours onto the overall transportation time and during this time TMC cannot gain access to fish to monitor them. Additionally there is no current legislation that covers disease control of tropical fish imports and this needs to be addressed.

Finally it was asked what percentage of fish is bred in the UK rather than being caught and imported? TMC have the only hatchery for tropical fish in the UK. They breed 5 species of fish one of which accounts for the majority of tropical fish sales in the UK – the Clown Fish. At present there is no commerical pressure to breed reef fish for the UK market.

2.7 Fish Breeding & Welfare

Professor J A Beardmore
Fishgen Ltd/University of Wales Swansea

The systematic utilisation of genetics in the farming of farmed aquatic species lags well behind that applied, with great success, to terrestrial plant and animal species. Nevertheless, significant, if patchy, growth in such applications is evident and there is now available a large portfolio of techniques which, either singly or combined, can be used for genetic improvement of stocks.

The primary goals of breeding programmes tend to focus on performance characteristics like growth rate and disease resistance though in some species end-user driven characteristics like taste and texture are beginning to enter breeding programmes.

It does not appear that welfare considerations are prominent in commercial aquaculture. This may be because it is more difficult to assess well-being in aquatic species than in terrestrial (frequently mammalian) species. However, it may also be because of a complex mix of psychological, cultural and even political considerations which bear on the matter.

The production of genetically improved stocks is not, in principle, inconsistent with high standards of welfare though, as with terrestrial animals, the best production performance in genetically improved fish is in environments which are adapted to that end.

There is a complex web of factors and of interactions influencing welfare in fish farming. The primary relevant factor is usually seen as stocking density in the production (grow-out) process but it is not the only factor and the stages of fry production, transport and slaughter need also to be considered.

There are sound reasons for arguing that appropriate application of genetic technology can be expected to contribute to increasing the well-being of farmed fish in some, but not all, respects and the ways in which this might be done will be considered. However, it is also clear that regulation and ethical considerations, together with recognition by fish farmers that a state of well being in the stock is conducive to high performance and hence profit levels in their products will be the dominant forces driving improvements in the welfare of farmed fish.

Workshop Comment
The discussion opened with a comment on how geneticists generally justify breeding programmes and genetic manipulation by the production advantages that these give the farmer. The example of the dairy cow, which has been selected for increased milk yield, was used. In this example the cow does produce greater volumes of milk but a consequence of this has been reduced longevity for the cow. Thus, although there are short-term gains for the farmer overall there is a minimal benefit.

The general consensus was to agree with this sentiment. It was stated that there are benefits to be had from breeding programmes etc but that each species and market must be looked at individually. In contrast concern was raised about this type of technology eg breeding fish for disease resistance. It was argued that this would not be necessary if it weren't for the fact that animals were farmed intensively.

The debate then moved on towards 'fitting the fish to its environment'. Most EU countries have examined the natural behavioural repertoire of farmed animals. Subsequently they have looked at the environment and husbandry system in an attempt to allow animals to perform the full range of behaviours they express. It now appears that genetics may be able to change behavioural expression so 'fitting' the fish to its environment. It was felt that in order to maintain an animal's welfare it should be able to 'fit' its environment.

Views were expressed that it is good to be cautious about genetic modification and transgenics. There must however, be some level of genetic management in aquaculture as there is a need to maintain genetic diversity within the farmed fish population.

3.0 GENERAL DISCUSSION

The general consensus of the group was that the day had been extremely interesting. Three areas of discussion dominated the closing session: ways to record welfare; methods of slaughter; and stocking density.

Methods of Welfare Assessment
The areas discussed throughout the day highlighted the fact that indices of welfare are difficult to measure and interpret. Consequently, there is a need for a number of industry-wide agreed indicators to measure fish welfare.

The Fishing Society for the British Isles has drafted a briefing document that includes a list of possible indicators of welfare. The difficulty with these potential indices is the lack of sufficient information available on the sample sizes of fish required to validate the measures. It was stated that any indices derived on an experimental level required scaling up to on-farm trials and it was good to see that the Defra stocking density project intended to do this.

It was suggested that if growth, food conversion ratios and mortality levels were all acceptable then you might infer that the animal's welfare is not being compromised. This was debated until the consensus of opinion was that it would be beneficial to try to marry production and welfare assessments giving a practical method to assess welfare.

Slaughter
The slaughter paper presented at the workshop was welcomed particularly as current European legislation only deals with emergency slaughter. Counter to this it was stated that in the current WASK regulations fish are covered under the general provision, regulation 4 so that, "No person engaged in the movement, lairaging, restraint, stunning, slaughter or killing of animals shall – (a) cause any avoidable excitement, pain or suffering to any animal; or (b) permit any animal to sustain any avoidable excitement, pain or suffering."

Stocking Density
Discussion progressed to the issue of legislating for a maximum stocking density particularly to aid the control and emergence of disease. The general feeling was that if water quality was maintained farmers could stock at higher densities. This point was discussed at length and concern was raised about the repercussions of not setting a maximum figure.

After much deliberation it was suggested that perhaps establishing an upper biomass limit rather stocking density would be more beneficial. This would be advantageous for schooling species as direct observations of these fish would suggest that these animals are at a higher stocking density than non-schooling species stocked at the same level. In addition, it may be beneficial to determine, and establish, the limits for other water quality measures eg particulate matter, dissolved oxygen etc. These levels would need to be both species and system specific. Previous studies have indicated that below a certain threshold stocking density the welfare of the fish was not effected so perhaps measures could be taken to allow farms that maintain water quality to

stock at higher stocking densities; this is comparable to the broiler stocking density system used in Sweden.

R&D Funding

A query was raised about how funding is partitioned between Scotland, England and Wales post devolution. It was stated that Defra represents the UK in Council of Europe deliberations. The State Veterinary Service operates GB-wide and so covers Scotland, England and Wales. Allocation of R&D funding is based purely on the quality of the proposal received and the outputs that will be obtained from the project. Thus, research is placed on an UK basis.

ANNEX A

ANNEX A ATTENDEES AT THE WORKSHOP FOR ON-FARM FISH WELFARE 28TH OCTOBER 2002

Attendee			Company
Dr	Charles	Allan	Fisheries Research Services
Dr	Peter	Barrowman	Defra
Professor	John	Beardmore	University of Wales
Ms	Tess	Benson	Humane Slaughter Association
Mr	Edward	Branson	Fish Veterinary Society
Professor	Niall	Bromage	University of Stirling
Dr	Colette	Clarke	Defra
Dr	Nick	Coulson	Defra
Ms	Moira	Cregan	SEERAD
Mr	William	Crowe	Federation of European Aquaculture Producers
Mr	Mark	Davies	British Trout Association
Miss	Hannah	Dear	Defra
Dr	Tim	Ellis	CEFAS (Weymouth)
Dr	Hugh	Ferguson	University of Stirling
Dr	Amanda	Fox	Defra
Dr	Abigail	Hall	RSPCA
Mr	Tim	Harris	Animal Air Transportation Association
Mr	Simon	Howson	Defra
Mr	Eric	Hudson	Fish Inspectorate
Professor	Felicity	Huntingford	University of Glasgow
Dr	Mark	James	FRM Ltd/LINK
Dr	Sunil	Kadri	University of Glasgow
Dr	Simon	Kerley	BBSRC
Dr	Steve	Kestin	University of Bristol
Dr	Rupert	Lewis	Defra
Dr	Jeff	Lines	Silsoe Research Institute
Ms	Alison	Maydom	Defra
Mr	George	Noble	Defra
Mr	Ben	North	University of Stirling
Dr	Martin	Potter	FAWC
Mr	David	Pritchard	Defra
Mr	Nick	Read	British Trout Association
Dr	Nick	Renn	Defra
Mr	Robin	Scott	British Trout Association
Dr	Sandy	Scott	CEFAS (Weymouth)
Mr	Richard	Slaski	British Marine Fin-fish Association
Dr	Lynne	Sneddon	University of Liverpool
Mr	Pete	Southgate	Fish Veterinary Group
Dr	Ron	Stagg	Fisheries Research Council
Mr	Peter	Stevenson	CIWF
Miss	Yen	Truong	Defra
Dr	Jimmy	Turnbull	University of Stirling
Mr	Andrew	Voas	SEERAD
Mr	Tony	Wall	Fish Veterinary Group
Dr	John	Webster	Scottish Quality Salmon
Mr	Paul	West	Tropical Marine Centre
Mr	Dave	Wyman	SEERAD

ANNEX B

ANNEX B DEFRA FUNDED RESEARCH

This annex contains a summary of projects funded by Defra under the animal welfare research budget and also those funded via the fish health & aquaculture; conservation of sea fish stocks; and the salmon, whaling, and inland fisheries research budgets that have implications for fish welfare.

Defra funded- Veterinary Science Unit

TITLE	CONTRACTOR	START DATE	END DATE	TOTAL COST
The effects of stocking density on the welfare of farmed rainbow trout	CEFAS	01/01/00	30/06/03	£282,550
Automated humane slaughter of trout	Silsoe Research Institute	01/09/98	31/08/01	£149,706

Defra funded – Fisheries and Aquatic Science Unit

TITLE	CONTRACTOR	START DATE	END DATE	TOTAL COST
Endocrinolgical & behavioural measures of the welfare of farmed fish in relation to stocking densities	CEFAS	01/04/00	31/03/05	£402,296
Evaluation of the risks involved using gene therapy techniques for stock improvement in aquaculture	CEFAS	01/04/02	31/05/03	£630,000
Non destructive methods for sex determination	CEFAS	01/04/02	31/03/05	£125,089
Development of improved assessment models and evaluation of management procedures for multi-species systems	CEFAS	01/04/99	31/03/03	£961,317
Factors affecting the disease susceptibility of farmed fish	CEFAS	01/04/98	31/05/03	£928,897

Improving understanding of the epidemiology of serious fish diseases	CEFAS	02/01/01	31/03/06	£406,893
Studies on pathogenicity, tissue tropism and transmission of VHS	CEFAS	01/04/01	31/03/06	£686,684
The use of prebiotics to improve fish health	CEFAS	01/07/00	30/06/03	£255,881
Identification & impact of emerging and notifiable virus diseases in farmed and wild fish	CEFAS	01/04/00	31/03/05	£1,252,493
Characterisation & pathogenesis of parasites and diseases in fish & shellfish stocks	CEFAS	01/04/00	30/03/05	£343,341
Life cycle and transmission requirements of the PKD organism and other myosporean pathogens of freshwater fish	CEFAS	01/04/00	31/03/05	£492,974
Improving the health of fish by promoting natural disease resistance – a molecular biological approach	CEFAS	01/04/00	31/03/05	£439,908
Development of vaccines & strategy for their use to control ulcer disease in cold water ornamental fish	Heriot Watt University	15/01/01	14/01/04	£106,545
Development of database models for effective treatment & the environmentally safe use of veterinary methods in the control of sea lice infestations of farmed salmon	Strathclyde University	01/10/99	30/09/02	£135,422
Immune gene expression during PKD infection	University of Aberdeen	01/10/01	30/09/04	£202,273

Immunology of PKD in fish-identification of protective antigens and host immunity	University of Stirling	01/10/01	30/09/04	£199,060
Semi-automated recognition of fish pathogens using statistical classification	University of Stirling	01/11/00	31/10/02	£107,723
Are essential fish habitats important considerations for fisheries management	University of Wales	01/10/00	30/09/03	£303,208
Impacts of agricultural and aquaculture contaminants on wild salmonoids	CEFAS	01/04/99	31/03/04	£418,359
Development of humane and more efficient methods of tag attachment and implantation	CEFAS	01/04/99	31/03/03	£136,261
Assessing the abundance, distribution and vulnerability of rare and declining species impacted by fisheries	CEFAS	01/04/02	31/10/07	£611,723
Development of improved assessment models & evaluation of management procedures for multi-species systems	CEFAS	01/04/99	31/03/03	£961,317
Non destructive methods for sex determination	CEFAS	01/04/02	31/03/05	£125,089

ANNEX C

ANNEX C WORK SUPPORTED BY OTHER FUNDERS

This annex contains a summary of fish research underway and funded by the Scottish Executive, NERC,BBSRC and Crown Estates. Further details can be obtained directly from the funding bodies should they be required.

Scottish Executive – funded research				
Title	**Institute**	**Start date**	**End date**	**Total cost**
Carrying capacity of coastal waters for aquaculture	Marine Laboratory	04/ 02	03/04	£79,890
Novel oral/immersion vaccine delivery systems for novel DNA vaccine formulations	Marine Laboratory	04/98	03/03	£606,095
Disease susceptibility and immunology of cultured marine fish	Marine Laboratory	04/00	03/03	£454,833
Pathogenic IPN	Marine Laboratory	04/00	03/03	£435,850
Diagnosis of emerging fish diseases	Marine Laboratory	04/00	03/03	£380,823
Solutions for legislative control of VHS in the marine environment	Marine Laboratory	04/01	03/03	£358,189
Limiting the disease impact from new species	Marine Laboratory	04/02	03/05	£493079
Scientific basis for control zones	Marine Laboratory	04/02	03/05	£851,192
IPN Epidemiology	Marine Laboratory	04/02	03/05	£601,284
Impacts of salmon farming on wild fish populations	Marine Laboratory	04/00	03/04	£604,733
Ecosystem effects of fisheries productivity	Marine Laboratory	04/02	03/06	£749,230
Molecular markers for ecto-parasite resistance in Atlantic salmon	Marine Laboratory	04/01	03/05	£244,502
Population dynamics of Atlantic salmon and other species of freshwater fish in relation to predation and other impacts	Freshwater Laboratory	04/00	03/04	£650,658

NERC – funded research				
Title	**Institute**	**Start date**	**End date**	**Total Cost**
Ecology of fish-pathogenic rickettsia	University of Glasgow	01/02/01	31/01/03	£45,901
A demand-based system for automated logging of feeding activity in fish	University of Glasgow	01/01/98	31/07/02	£27,173
Genomically-integrated responses in environmental stress adaptation in teleost fish	University of Liverpool	21/05/00	20/05/05	£892,020

BBSRC – funded research				
Title	**Institute**	**Start date**	**End date**	**Total cost**
Nociception and pain in the trout	Roslin Institute	16/08/99	16/08/02	£122,528
Control and monitoring of fish	Silsoe Research Institute	01/04/00	31/03/03	Not Available
Development of alpha virus vectors for use in fish	Queen's University Belfast	01/08/99	01/08/02	£161,856
Molecular phylogenetics and evolution of actinopterygian fishes as inferred from mitochondrial protein coding sequences	University College of London	05/04/00	05/04/03	£190,604
Molecular mechanisms controlling fin muscle formation	University of Edinburgh	01/11/00	01/11/02	£115,416
Triggering of moulting and metamorphosis in copepodid larvae of the salmon louse lepeophtheirus salmonis	University of Stirling	01/04/00	01/04/03	£190,604
The genetic basis of sex determination in fish: a molecular cytogenetic analysis	University of Stirling	17/04/00	17/04/03	£203,732

Muscle microstructure/growth rate and its relation to product quality and processing characteristics in Atlantic salmon	University of St. Andrews	01/04/02	01/04/05	£149,448
Studentships				
An investigation of stress in cultural Atlantic halibut, H. hippoglossus and how this impacts upon fish performance	University of St. Andrews	01/10/99	03/09/02	Not available
Optimising feeds and feeding to provide year – round consistency in the quality of farmed Atlantic salmon	University of Glasgow	01/10/01	30/09/04	Not available
Automatic interpretation of ultrasonic images for fish farm management	University of Oxford	01/10/01	30/09/04	Not available
Generation of non-specific humoral factors in rainbow trout following vaccination	University of Wales	01/10/99	03/09/02	Not available

Crown Estate – funded research				
Title	**Institute**	**Start date**	**End date**	**Total cost**
Halibut broodstock nutrition	British Marine Finfish Association	01/04/01	31/03/04	Not available
Scoping study for research into the aquaculture (fish and shellfish) carrying capacity of sea lochs, voes and, if possible GB coastal waters more generally	FRS Marine Laboratory	01/04/02	31/12/02	Not available
Development of IPN vaccine	FRS Marine Laboratory	01/04/02	31/03/04	Not available
Disease resistant genes and markers in Atlantic Salmon	North Atlantic Fisheries College	3 Year Programme		Not available
Cod farming in the marine environment	Sea Fish Industry Authority	01/04/02	31/03/05	Not available

Host odour trap for the capture of sea lice	University of Aberdeen	01/04/02	31/03/03	Not available