Finfish News

(incorporating Trout News)

Number 1, Winter 2006

Cefas

CENTRE FOR ENVIRONMENT, FISHERIES AND
AQUACULTURE SCIENCE

FINFISH NEWS

Incorporating Trout News

Number 1
Winter 2006

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Many thanks to Stuart Minnikin for the picture of the brown trout on the front cover.
www.yorkshire-dales-flyfishing.com

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- Articles, letters and news relating to farming of trout and other food fish and the production of coarse and coldwater ornamental fish are welcome and should be sent to the editor. The deadline for the next issue is Friday 30th June.

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CONTENTS Page

EDITORIAL

Welcome to the first edition of *Finfish News*, which is replacing *Trout News*.

Trout News was first published in February 1987, its raison d'être being to

- "provide a service to the industry and to improve the level of communication between the industry and those conducting Government funded R&D", and
- to provide information on "policy regarding fish disease and government legislation on matters relating to the trout farming sector".

These aims have remained the motivation for *Trout News* over the last 19 years. However, some fish farms in England and Wales are diversifying into production of finfish species other than salmonids, i.e. coarse and ornamental cold-water species and food fish in recirculation systems. To reflect this change, the remit of the publication has expanded to encompass all sectors of the land-based fish production industry in the UK, and the title of the publication has now been modified accordingly, to *Finfish News*.

We have also taken the opportunity to revise the layout of the publication. We hope that you find the new cover and layout more pleasant. As *Finfish News* is provided as a service to the industry, we need to ensure that we are providing what is desired. We would therefore welcome constructive ideas for improving the format and content. Please feedback any comments to the editors (contact details on inside front cover). We also hope that *Finfish News* will reach a wider audience in Scotland and Northern Ireland than *Trout News* previously did. If you know of any farmers who are not on the mailing list, again please advise the editors.

We would also like to remind readers that back issues of *Trout News* are available for viewing on the Cefas website. (www.cefas.co.uk/publications/trout-news.htm)

Finally we would like to emphasise that the editors would welcome contributions from all parts of the fish farming industry, especially the new sectors, in addition to the usual R&D articles.

FOCUS ON WATER TREATMENT PROCESSES FOR LAND-BASED FISH FARMS AT NEW CENTRE FOR SUSTAINABLE AQUACULTURE RESEARCH

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Introduction

The management of aquaculture effluents is a pressing issue for fish farmers in the UK and internationally, due to concerns about potential negative effects on receiving waters of nutrification with nitrogen and phosphorous and contamination with heavy metals or other by-products of the rearing process. While regulations on water use vary according to region, there is a consistent trend for increasingly restrictive measures on water abstraction and water quality protection, governed at the EU level by the Water Framework Directive (Directive 2000/60/EC). This places pressure on land-based fish farms both to reduce the quantity of water used per unit fish produced and to improve the efficiency of effluent treatment processes. These aspects challenge the economic viability of current farming practices and require innovation to ensure that appropriate fish health and welfare standards are maintained.

Against this background, a programme of research on aquaculture effluent characteristics and water treatment technologies has been established at the recently commissioned Centre for Sustainable Aquaculture Research (CSAR) located at Swansea University, in collaboration with the University's Centre for Complex Fluids Processing and Microbial Genetics research group. The CSAR comprises a series of controlled environment laboratories incorporating pilot scale recirculating aquaculture systems with effluent processing capabilities, designed for rearing freshwater and marine organisms from temperate to tropical latitudes (Figure 1). This facility has been established as part of the EU and Welsh Assembly Government (WAG) funded Aquaculture Wales project, with financial assistance from Swansea University, to assist

Figure 1. Centre for Sustainable Aquaculture Research (CSAR), Swansea University. Exterior view (top), controlled laboratory environment (centre), and water purification equipment (bottom).

the WAG in its goal of economic development through sustainable aquaculture.

Current Research Projects

Improvement and innovation of aquaculture effluent treatment technology, "AquaETreat"

AquaETreat (www.aquaetreat.org) is a 3 year EU Collective Research Project (2004 – 2007) examining the feasibility of developing and implementing cost effective treatment systems for aquaculture farm effluent and for valorising and reusing the products and by-products. Swansea University's principal role in this project is to characterise the physical and chemical properties of sludge obtained from participating fish farms and to design-install-evaluate solids separation devices. This involves the use of simple low cost sedimentation systems, followed by further thickening in sludge ponds. The waters from the sludges are treated using biofilters to remove organics and fine particles, allowing the water to be reused or released with minimal environmental impact.

To date, sludges obtained from biofilter washings and microsieve backwash at a rainbow trout recirculation farm have been found to be rich in iron (6-8% w/w), reflecting a high iron content in the farm's incoming water supply. The iron effectively binds phosphorous in the sludge (4-5% phosphorous w/w), such that phosphorous levels in the discharge water are lower than in the incoming water supply. Bound phosphorous levels in the highly buffered sludge are sufficiently high to be problematic for use as a plant fertilizer, therefore methods are currently being investigated to solubilise and recover the phosphorous, including acidification and fermentation. Under acid conditions there may also be improvements in sludge dewatering and sludge stability, so improving handling and storage properties.

Research partners in the AquaETreat project include the UK Institute of Grassland Research (IGER), which is responsible for evaluating fish farm sludges as plant fertilizers, soil amenders, etc. British Trout Association members are represented via the Federation of European Aquaculture Producers (FEAP), the project's European Industrial Association.

Microbial community structure and nitrification processes in a constructed wetland receiving effluents from a marine fish farm

With the help of a NERC CASE PhD studentship award, we are evaluating the performance of a modular saline wetland system treating wastewater from a marine fish farm on Anglesey. Constructed wetlands are used to treat wastewater from a wide range of sources, for example sewage, agriculture and hyper-eutrophic lakes. Subject to correct configuration and operation, they are efficient at reducing the chemical oxygen demand (COD), biological oxygen demand (BOD), suspended solids and bacterial pollution, but require careful optimisation for nitrogen and phosphorous removal. Many factors such as the presence / absence of wetland plants, nutrient loading rate, bed composition and operating parameters affect their performance, however the microbial processes involved are not well understood.

Constructed wetlands offer a promising means of improving the discharge water quality from land-based fish farms, however they are relatively unproven in this application, despite aquaculture wastewater typically being much more dilute than municipal wastewater sources. One of the principal constraints to this application of constructed wetlands is the large surface area traditionally required for construction; more compact designs would permit wider installation at both existing and new fish farms, although design and operating criteria would be expected to be more critical under these circumstances.

The modular wetland system under investigation in this project comprises a series of gravel-based wetland cells, each of which can be operated in vertical flow or horizontal flow mode, with or without water recirculation. A combination of molecular biological techniques and water chemistry analyses is being used to investigate the microbial conversion of nitrogenous wastes to elemental nitrogen under different wetland configurations and loading rates, incorporating the use of model wetland units at Swansea University. The PCR-based methods, automated ribosomal intergenic spacer analysis (ARISA) and terminal restriction fragment analysis (T-RFLP), are being used to profile microbial community composition within the wetland system.

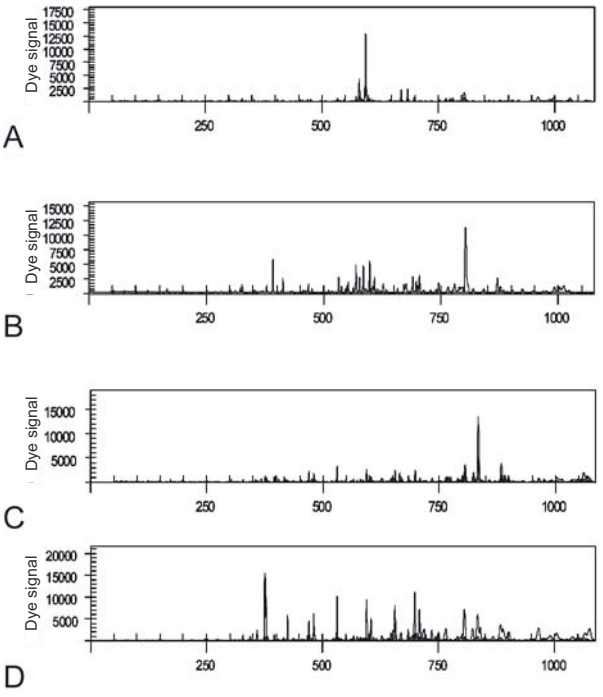

Figure 2. ARISA profiles of 16S rRNA PCR products amplified from biofilm sampled from a model saline wetland unit at 1 (A), 4 (B), 8 (C) and 12 (D) weeks. Vertical scale-relative fluorescent units

Figure 2 illustrates ARISA profiles of 16S rRNA PCR products amplified from the biofilm on a wetland model at different intervals following start up, indicating an increase in microbial community complexity with time. The response of the model wetland units to varying ammonia loads is currently being investigated and protocols are being tested to quantify nitrification by measuring the activity of the AmoA gene, which encodes the active-site subunit of the ammonia monooxygenase present in all ammonia oxidising bacteria.

Influence of feed formulation on properties of marine fish farm effluents

In order to lower the concentrations of faecal solids, dietary nitrogen and phosphorous in fish farm effluents, it is necessary to minimise the amount of uneaten feed, increase the retention of dietary phosphorus and nitrogen and limit the proportion of indigestible carbohydrate in the diet. Major advances have been made in producing high nutrient density diets containing a low proportion of indigestible dietary phosphorus, highly digestible protein sources and optimal dietary protein to energy ratios. In parallel, improved feed delivery methods have been developed that reduce the quantity of uneaten feed released to the environment. However, there is a growing need to reduce fishmeal inclusion levels in formulated diets for carnivorous fish by substituting with alternative protein sources, which may have a negative effect on diet digestibility and effluent release characteristics.

For land-based fish farms, the quantity and properties of particulate wastes have an important effect on the operating efficiency of solids removal devices. This is especially significant for water recirculation systems, where solids must be rapidly and efficiently

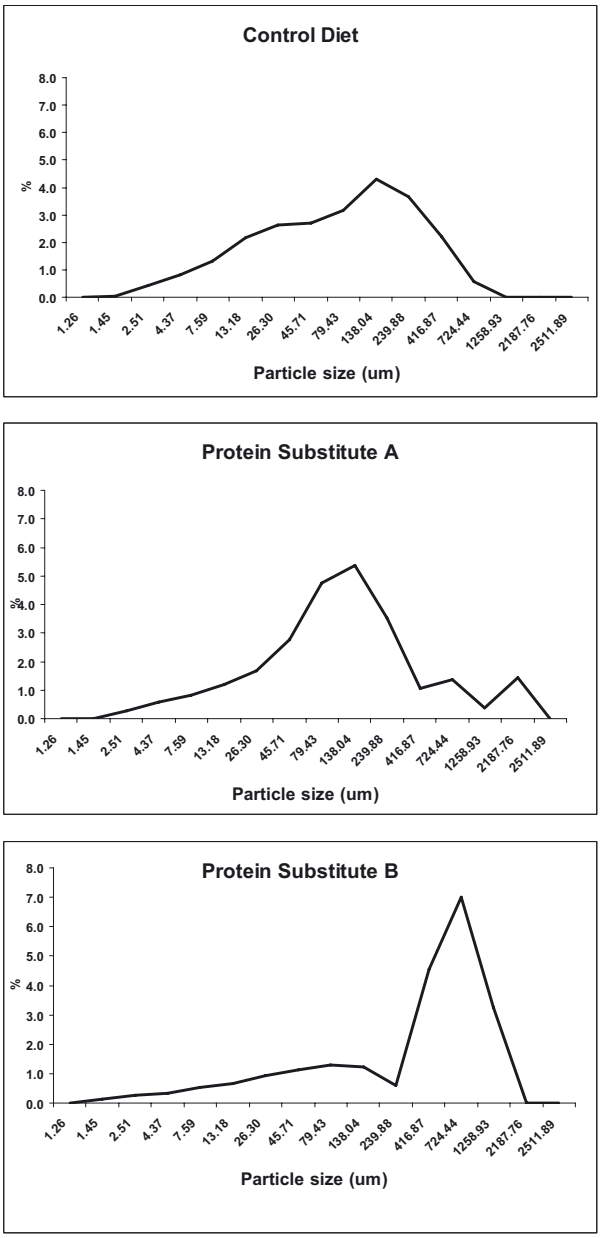

Figure 3. Particle size frequency distributions for 4 mm extruded marine fish pellets following 24 hr immersion in 15°C seawater. I) control diet (no fishmeal substitution); II) protein substitute A; III) protein substitute B.

removed from the water circuit to avoid particle breakdown and increased BOD. This industry sponsored PhD studentship is examining the physical properties of marine fish diets formulated using different protein sources, together with the faecal characteristics of Atlantic cod and European sea bass receiving these diets. In addition to conventional measures of growth, feed digestibility and feed conversion efficiency, the rheological properties (viscosity, shear strength) and sedimentation characteristics (density, size, shape, buoyancy) of fish faeces and feed are being examined and the consequences on fish waste handling processes assessed. Figure 3 illustrates the effect of substituting a proportion of dietary fishmeal with two vegetable protein sources on particle size characteristics for 4 mm extruded marine fish pellets following 24 hr immersion in seawater at 15°C.

Summary

Land-based fish farms in the UK and elsewhere face increasingly strict regulations on water abstraction and on discharge water quality criteria. In response to this, a multidisciplinary research programme has been established at the recently commissioned Centre for Sustainable Aquaculture Research to assist in developing improved water utilisation and waste management practices. Current research to develop methods for separating solids from aquaculture effluents, remove dissolved inorganic nitrogen from effluents by means of constructed wetlands, and to assess the effects of feed formulation on suspended solids characteristics in marine fish farms will continue through 2006. It is planned to expand this area of research, for example by identifying compounds responsible for growth retardation in finfish recirculating aquaculture systems (RAS) and developing removal methods.

FIN EROSION TROUT WELFARE PROJECT (DEFRA PROJECT AW1204)

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Fin erosion, i.e. damage to and/or loss of fin tissue, is a common morphological abnormality found in salmonids farmed in the UK and worldwide. As an evident external feature, fin erosion affects the quality of fish reared for stocking fisheries, and has been highlighted as a welfare issue in table fish. However, despite being perceived as commonplace, there is a lack of quantitative data on the incidence and degree of fin damage in farmed stocks. There is also a poor understanding of the process of fin erosion – existing research suggests that it is a complex multifactorial process, and not attributable to a single cause.

In April 2005 a collaborative study funded by Defra, between Cefas Weymouth, Bristol University, Stirling University and the British Trout Association commenced. The aims of the study are to quantify the extent of fin damage on UK rainbow trout farms and identify risk factors that play a role in fin damage. Many farms throughout the UK have taken part, and continue to take part in this study, and we thank you for all of your support.

Before farm sampling could be started we needed a method for assessing fin damage. Previous studies had shown that all the rayed fins of rainbow trout sustain damage, but that the adipose fin does not. We therefore decided to examine all the rayed fins (dorsal, caudal, anal, left and right pectoral and ventral fins). Fin damage has previously been assessed by measuring fin length, and we used callipers to measure the length of the longest fin ray of each fin, two measurements being taken for the caudal fin, i.e. top and bottom lobe. Because such length measurements are time consuming, we also developed a photographic chart to categorise the amount of fin tissue lost. The photographic chart has 6 classes (0 to 5) covering progressive erosion of all rayed fins (0 = as good as wild fish, 5 = > 90% fin missing). We also developed a method for describing visible aspects of fin damage, i.e. the number and depth of splits present, and the presence or absence of haemorrhage, inflammation, scaring and regeneration.

In the first part of the project 40 commercial farms producing rainbow trout for the table and restocking markets were visited, as well as some hatcheries. The 40 farms were selected randomly from an original list of 109 farms which had agreed to participate in the survey. The farms were distributed throughout England, Wales and Scotland. Sampling was carried out from June to August 2005. The aim of this part of the study was to gain a representative perspective of the type and amount of fin damage experienced by farmed rainbow trout in the UK.

The on site sampling of farms was stratified to ensure that data was collected from both recently introduced fish (fish targeted <30g) and fish which had been on the farm for several months (fish targeted 150-300g). On each farm both size classes were aimed for; however, if one size class was not present (i.e. at a hatchery site) then two samples of the same size class were collected from two different units. A 60 fish sample was collected from each unit with a hand net and humanely killed. The length and weight of all fish were measured, and the fins assessed as described above. A total of 4200 individual fish were sampled from 40 different farms.

As well as farm details, such as type of pond/ enclosure, we also recorded batch specific data on stocking density, diet brand, feeding method, feeding ration, hatchery of origin, date of hatch, disease history and sex. Water quality parameters (DO, pH, temperature and clarity) were measured in samples of outflow water from each unit sampled. The results from this study are currently being analysed and should provide information on the extent of fin damage in UK farmed trout, and a preliminary indication of risk factors for fin damage.

We have recently commenced the second part of this study, which will take over 12 months to complete, and aims to identify the risk factors involved in causing fin damage, and therefore hopefully provide some answers to reduce the problem. It involves using similar recording techniques as previously described, and following several batches of fish in selected farms, from arrival onto the farm until harvest, and recording any events which the batches experience. The results from this particular study will be collated and analysed once it has been completed and will hopefully be published in 2007.

Once again, many thanks to all the farms participating in this project. You are providing us with not only invaluable data, but also through your experience and willingness to talk to us about it, we are gaining a valuable insight. We hope to have some answers to some of the questions surrounding fin erosion soon. If you have any queries relating to the study please contact Imogen Hoyle or Birgit Oidtmann at Cefas Weymouth (Tel: 01305 206600; Email: i.c.a.hoyle@cefas.co.uk or b.oidtmann@cefas.co.uk).

INTERACTIONS BETWEEN WATER QUALITY AND TROUT WELFARE (DEFRA PROJECT AW1205)

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Project background

As the topic of fish welfare gains prominence, there is increasing pressure on regulatory bodies to legislate on fish welfare. The Council of Europe have drafted recommendations on farmed fish which in time may be adopted as a Directive by the EU. The European Parliament, Defra and the fish farming industry recognise the need for any legislation to be based on sound, scientific data.

Poor water quality is recognised as one of the major threats to fish welfare (FAWC, 1996; Ellis *et al*. 2002). Fish are in constant, intimate contact with their environment, and therefore the quality of the water is of paramount importance to the health and welfare of the animal. Limits on water quality are a key factor in the Council of Europe recommendations.

In April 2004 a collaborative study between the University of Stirling, Cefas Weymouth, and Bristol University commenced. The project is

funded by Defra with support from the British Trout Association (BTA), which awarded the first Niall Bromage studentship to fund a PhD student to work alongside this project.

There are two main aims to this project:

1. To define acceptable limits of water quality for farmed rainbow trout, and
2. To form a consensus with stakeholders on practical measures for assessing fish welfare in commercial systems.

These aims are being addressed through various approaches as detailed below.

What does the literature tell us?

As part of this project, a detailed literature review was conducted into the effects of water quality on rainbow trout. The purpose was to identify the current recommendations for water quality limits and to establish contradictions and gaps in the literature.

The review concentrated on the aspects of water quality that the farmer can control to some extent, specifically dissolved oxygen, ammonia, carbon dioxide, nitrite, suspended solids and gas supersaturation. Aside from suspended solids, the literature on these subjects is extensive, but often contradictory and confusing. As an example, recommended maximum levels of un-ionised ammonia range from 0.0002 mg/L to 0.3 mg/L (Haywood, 1983; Hampson, 1976). This review also questioned the relevance of many studies into the effects of adverse water quality on fish. Many studies have only measured the fish's response to one water parameter without taking into account interactions between parameters. This can make it difficult to apply the findings to real farming situations. Furthermore, most studies have used starved fish, a situation that bears limited relevance to the welfare of farmed fish, and considered toxicity, rather than the welfare of the fish *per se*.

The literature review highlighted the need for data to be collected from commercial trout farming systems, rather than laboratory studies, to gain insight into conditions that fish experience on farms.

What do the stakeholders think?

A series of focus groups were conducted with stakeholders in the UK trout farming industry; these included fish farmers, fish veterinarians, animal welfare organisations, retailers, academics and consumers. The aim of this exercise was to explore criteria that could be used to evaluate fish welfare and to identify stakeholders' concerns regarding the welfare of farmed trout, thus highlighting the subject area and enhancing their participation and ownership of the project.

The format of each focus group was tailored to suit the stakeholders present. The meetings that involved trout farmers, veterinarians, and academics studying aspects of fish welfare concentrated specifically on identifying and prioritising a list of acceptable and measurable welfare indicators. The focus groups involving retailers, consumers and representatives from governmental and non-governmental organisations discussed perceptions of fish welfare, and the practicalities and potential benefits of implementing schemes to assess fish welfare.

All stakeholder groups recognised that the selection of appropriate indicators is largely dependent on the context and purpose of the assessment. Possible reasons for welfare assessment could include: auditory/regulatory purposes, a framework for Hazard Analysis and Critical Control Points (HACCP) and/or Hazard Analysis and Risk Assessment (HARA) systems, quality assurance/accreditation schemes and daily monitoring for farm management. Potential benefits of implementing systems to monitor and safeguard fish welfare would be improved traceability and transparency through the farming system, and provision of the means of demonstrating a farmer's duty of care to their stock.

There was generally a high level of agreement between the various stakeholders regarding the most important factors for assessing welfare. These factors have been broadly categorised under the following headings:

1. Operational Welfare Indicators

Behaviour was considered to be a very important operational welfare indicator (OWI) by

all groups, although it was recognised that it is difficult to quantify behaviour in the commercial aquaculture environment. Nonetheless, even if behavioural observations were limited to 'changes from the norm', this was still considered to be the best early indicator of potential welfare problems. Feeding behaviour (appetite) and feed conversion ratio (FCR) were considered to be useful OWIs on the premise that good appetite and FCR would be indicative of good welfare. They were also suggested as factors to which every farmer pays a great deal of attention and would also be readily obtainable from most farms. Other useful OWIs included mortality rates, condition factor and fin condition.

2. Environmental quality

This encompasses factors that can be measured and reflects the quality of the environment in which the fish lives. Poor environmental quality could be associated with an increased risk of poor welfare. Water quality was considered to be the most important aspect of the fish's environment and dissolved oxygen (DO) was considered to be the single most important water quality parameter. Other important parameters included levels of suspended solids, ammonia and carbon dioxide. The complexity of interactions between different parameters, temperature and the chemical characteristics of a water source were also recognised as important considerations. There was, however, some debate regarding the feasibility of measuring water quality on-farm. Other issues related to environmental quality included availability of water, pollutants, structural fouling of nets, quality of on-site equipment and toxic algae blooms.

3. Farm records

The maintenance of accurate and up-to-date farm records that allow distinct batches of fish to be tracked through the production system was deemed to be reflective of good husbandry practice. Accurate and up-to-date farm records would also provide the transparency and traceability required to facilitate external audits. Factors that were suggested to reflect the welfare status of a batch of fish included: mortalities (including the cause of death), water quality (especially DO, flow rates, pH and water temperature), production data (e.g. biomass, stocking density, growth and appetite), and disease treatments. It was suggested that while most farmers already recorded some of this information, farm records were limited to providing a historical perspective of fish welfare, rather than a picture of current status.

4. Targeted sampling of fish

The following were considered to be useful indicators of welfare that could be used in post-mortem based assessment of fish: gills (consensus that gills were most important), condition factor, fin measurements, and inspection of the liver, spleen, gut and kidney. There were reservations over the relative costs and benefits of such methods if used routinely, but in a targeted manner these could be useful.

5. Demonstration of good stockmanship

Discussion points listed here encompass a variety of ways by which farmers could demonstrate good stockmanship and satisfy their duty of care to their fish. It was suggested that it would be useful to have a recognised General National Vocational Qualification (GNVQ), or award, as evidence of competence based on records of training and experience. The general condition of a farm was also considered to have potential implications for the welfare of fish with factors such as the provision of adequate protection from predators, the presence and quality of equipment (pumps, graders, water quality monitoring equipment), and condition of nets being suggested to be important factors. Standardised protocols for husbandry procedures (e.g. disinfection, disease treatments), minimising the amount of handling/ disturbance of fish, and well maintained farm records were other ways to demonstrate good stockmanship. Many of these indicators of good stockmanship were considered to already be in place on most well-managed trout farms.

6. Harvest measures

Feedback from fish processors was suggested as an objective, quantifiable and, at present, an 'untapped resource'. Deformities, fin damage, condition factor and scale loss were highlighted as important factors. Other post-harvest indicators included cataracts, vaccination scars, physical injury, and parasites. Parallels were drawn between post-slaughter assessment of fin damage and existing schemes in the poultry industry for inspections of leg/feet deformities.

Survey of current water quality monitoring and control on UK trout farms

Prior to any field sampling, contact was established with as many UK trout farmers as possible, primarily to inform them about this project and ask for their participation and cooperation. A list of over 300 trout farms was compiled from BTA members, trade directories and Intrafish (a media house for the international fisheries and aquaculture industry). Initial contact was established by telephone,

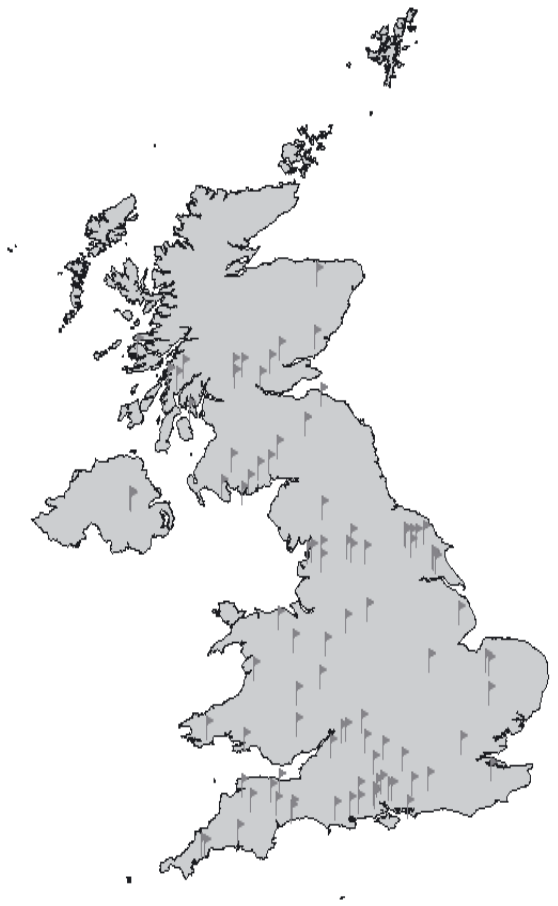

Figure 1. Distribution of trout farms included in the study

resulting in a register of over 100 farms that were identified as being suitable and willing to participate in this project (Figure 1).

The telephone calls were informal but included a brief questionnaire to allow us to categorise farms depending on size (tonnes per annum) and type of production (e.g. table, hatchery, restocking). Other questions established which water quality parameters were commonly measured and recorded, and the frequency of visits by the various UK environmental agencies. To supplement the information obtained during the telephone interviews, a total of 61 farms were visited throughout the UK. These visits provided us with a better understanding of the extent of water quality monitoring and allowed us to compare farm equipment against laboratory calibrated equipment. From the information gathered we were able to establish the current status of water quality monitoring on UK trout farms. This information will be taken into account when considering what is realistically achievable on-farm.

Experimental trials

Although this project is predominantly field-based, several tank-based experimental trials have been conducted at the Niall Bromage Freshwater Research Station of the Institute of Aquaculture, Stirling. These trials are attempting to reproduce the complex deterioration in water quality that occurs under farming conditions but in a controlled system, free from the constraints of commercial production. These trials will identify those welfare indicators that are sensitive to deteriorating water quality.

One of the trials stocked twenty 0.3 m^3 tanks with identical numbers of fish. The tanks were aligned in four banks of five tanks, the first tank in each bank supplied with first-use water at an inflow rate of 40 L/ min. Submersible pumps were used to pump water from one tank to the next, creating a cascade effect with water quality deteriorating progressively down each series of five tanks. The last tank in each cascade was fitted with an oxygen monitoring and alarm system, which recorded DO at 5 minute intervals. If DO in the last tank in the cascade dropped below 5 mg/L additional aeration was administered to the first tank in the cascade, thus maintaining the gradient effect through the cascade. In addition to the DO monitoring, water quality was monitored using YSI 6920 multi parameter sondes that measure pH, temperature, DO, ammonia, and conductivity. Four sondes were moved sequentially between tanks, remaining for approximately 24 h in a tank before moving along to the next. Parallel 24 h water sampling was carried out to validate the sonde's results and to measure water quality parameters outwith their capacity (suspended solids, CO_2, NO_2, NO_3).

Thirty fish from each tank were PIT tagged (Passive Implant Transponders) to enable analysis of growth and fin condition data for individual fish, improving the power of the study. Sampling took place at monthly intervals. In addition to the data collected from the PIT tagged fish, a further 10 fish from each tank were sacrificed and the following parameters measured from each fish: length, weight, condition factor, relative length of all rayed fins, liver, gut, and spleen weights, feed intake (using X-ray radiography of the gut allowing measurement of food containing radio-opaque beads) and gill samples were taken for histopathological examination. Blood samples were also taken to allow analysis of cortisol, lysozyme activity, glucose and haematocrit. The experiment ran from October 2004 through until August 2005 and analysis is on-going.

Other trials have focused more specifically on the development of methodology for assessing gill condition. Gills are delicate structures that are in intimate contact with the water, making them particularly vulnerable to poor water quality. Assessing pathological changes within gill tissue therefore presents an obvious tool for assessing the effects of water quality deterioration on fish welfare. However, existing methods of assessing gill damage are time consuming and too subjective to be a practical on-farm indicator. The main output of these experiments has been the development of a simplified gill scoring scheme that can be incorporated into a system for welfare assessment in the field-sampling.

Field study

To investigate the interaction between water quality and the welfare of farmed fish, an extensive field study is underway. We are sampling from around 60 farms during summer and again during winter, to take account of seasonal variability. The 60 farms have been randomly selected from the list compiled during the telephone interviews. Such a large number of farms will enable us to take into account the variety of farming systems found in the UK trout industry, and draw robust conclusions that are relevant to the industry.

Welfare indicators are being recorded from 48 fish per visit from each farm. The multi-parameter sondes that were used in the tank studies are also being deployed for 24 h to monitor water quality in the outflow of each sampled system, allowing us to gain an insight into the conditions under which the fish live and variation over a daily cycle.

Sampling for the farm based study began in July 2005 and is scheduled to end by November 2006.

What next?

After completion of the field sampling, and all data has been processed and analysed, we intend to hold a workshop with stakeholders to discuss the findings from this project. We want to provide the industry, Defra and other stakeholders with the information necessary to agree key auditable welfare measures. It is envisaged that this workshop will take place in the early part of 2007.

Acknowledgements

Our thanks go to all the farmers participating in this study without whose co-operation we would be unable to undertake the project. We would also like to state that any information obtained from farmers is treated as confidential and all results are anonymous.

We also gratefully acknowledge Defra and the British Trout Association for funding this work.

If you have any queries relating to the study please contact Craig MacIntyre or Ben North at the University of Stirling (Tel: 01786 467878. E-mail cm39@stir.ac.uk and bpn2@stir.ac.uk).

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GOLDFISH HERPESVIRUS

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Over the last few years, many people within the aquatics and aquaculture industry have become aware of Koi Herpesvirus KHV and its potentially devastating effects on carp *Cyprinus carpio* in all its varieties (i.e. koi, common, mirror, leather carp etc). However, fewer people are aware of another serious pathogen that can affect another cyprinid goldfish *Carassius auratus* and its varieties (i.e. shubunkins, fantails etc). This article aims to provide more information on this disease.

Causative Agent

Cyprinid herpesvirus 2 (CyHV-2) is a contagious disease of goldfish. The virus is a member of the *Herpesviridae* family. KHV and carp pox are also members of this same group of viruses.

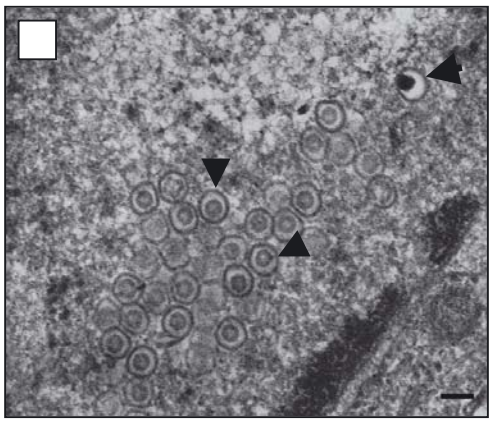

Figure 1. High power electron microscope image of the virus (indicated by ▲). The virus appears hexagonal in shape, is approximately 100 nm in size with a 50 nm off-centre core.

Geographical Distribution

The virus was first isolated and described in Japan[(1)] following disease outbreaks in goldfish in two prefectures in the springs of 1992 & 1993. At this stage it was known as herpesviral haematopoietic necrosis virus (HVHN). More recently it has become known as cyprinid herpesvirus 2 (CyHV-2) and has been diagnosed and reported in the USA, Taiwan and Australia [(2-4)]. In 2004 and 2005, Cefas diagnosed several goldfish herpes disease outbreaks within the UK. These have been within aquatic centres, fish dealerships and hobbyist collections. Recent findings from the USA indicate that CyHV-2 is widespread within the U.S. and likely to be an important, but rarely detected, pathogen of goldfish worldwide [(5)].

Susceptible Species

It is currently thought that only varieties of goldfish are susceptible. However, Cefas is currently carrying out research into the susceptibility of the native crucian carp *Carassius carassius*.

Epidemiology

Laboratory studies have supported field observations that CyHV-2 causes mortalities in goldfish. Cohabitation studies have shown that disease transmission occurs from fish to fish. It is likely that the disease can also be spread through contaminated water, nets, tanks and other equipment. The disease occurs at temperatures between 15°C and 25°C with problems often reported after a rise in temperature to the 20-22°C range. The severity of the disease seems to range from almost total stock loss to low-level chronic losses. As a group, herpesviruses have a number of unusual characteristics including the ability to remain latent in the host for long periods of time, with the virus only becoming active under particular circumstances, such as changing environmental conditions or stress.

Disease signs

Externally signs for goldfish infected with CyHV-2 commonly include lethargy, anorexia and pale gills. The gills can change from healthy red to white and patchy within a short period. Small white blister like pustules on the skin are also reported.

At post mortem the most common internal signs are spleens and kidneys that are pale and swollen. The spleen can contain pale granular lumps or nodules.

Figure 2. Severe Gill Necrosis

Figure 3. Enlarged Spleen with nodules

The symptoms of the disease, however, may be complicated by secondary infection by opportunistic organisms such as bacteria, fungi and parasites.

Diagnosis

Diagnosis relies on a number of techniques. The standard method of isolating viruses by tissue culture is most frequently employed but has been problematic for the diagnosis of goldfish herpesvirus. More reliable methods for this virus are the use of PCR (Polymerase chain reaction), histology and electron microscopy. Cefas are currently researching, monitoring and testing for this disease. However, there is currently no commercial diagnostic service available.

Treatment and Control

CyHV-2 is not a notifiable disease so there are no movement controls on infected sites. As with all fish viral diseases there is no known treatment for the infection. It should be noted that fish which recover from the disease may continue to carry the virus, and act as a reservoir of infection. Work is underway to try and establish if the virus is vertically transmittable (i.e. contained within the egg).

Cleaning and disinfection of holding facilities, and restocking with disease free stock remains the best option for eradicating the disease.

Acknowledgements

The laboratory studies have been funded by Defra under project FC1166 Characterisation and pathogenesis of fish and shellfish emerging diseases.

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ENGLISH CARP HERITAGE ORGANISATION (ECHO) FUNDED RESEARCH ON KOI HERPESVIRUS (KHV) AT THE CEFAS WEYMOUTH LABORATORY

Nick Beevers and Kevin Denham, Cefas Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset, DT4 8UB.

The English Carp Heritage Organisation (ECHO) was established in 2001 by a small group of anglers concerned about the threat to native stocks of common carp from the illegal importation of carp and other coarse fish species into the UK. The organisation has subsequently grown to over 1000 individual and corporate members, and has launched branches in Belgium and Holland.

ECHO's aims include the preservation of the UK's angling heritage and promoting this to younger generations, educating the public about the threat to native carp from illegal imports and illegal introductions, promoting the use of home grown fish for stocking UK waters, cooperating with the authorities to prevent illegal imports, and improving the welfare of carp and coarse fish stocks.

ECHO's aims also include a commitment to work with authorities and institutions to advance knowledge on diseases that threaten native common carp stocks. To advance this aim ECHO have sponsored research at Cefas including the work below on Koi Herpesvirus (KHV).

KHV

Koi Herpesvirus is a highly virulent viral disease that causes severe mortalities in common carp *Cyprinus carpio* and its varieties such as mirror, leather, koi and ghost carp. The disease is of global significance because of the extensive international trade in highly prized and expensive ornamental koi and the economic importance of common carp as a food fish in areas such as south-east Asia, and eastern Europe. Common carp also represent a significant resource in the UK as a major target species for freshwater anglers. Following the initial identification of KHV in the late 1990's in koi carp in the USA, the virus has been reported in many countries across the world. There are now major concerns over the potential spread of KHV into UK wild stocks of common carp which sustain a multi-million pound angling sport.

Experiments undertaken at Cefas Weymouth with funding from the English Carp Heritage Organisation (ECHO) in support of Defra research contracts on koi herpesvirus (FC1150 and FC1136), were conducted with a view to increasing the protection of English wild carp stocks. Our studies addressed the issues of:

1). How common carp exposed to KHV may become carriers of the virus and thus conceal a covert infection whilst appearing healthy.
2). Assess the threat that carrier fish pose to unexposed common carp.
3). Develop methods to identify carrier fish

It is known that temperature is the predetermining factor controlling whether KHV develops into a lethal infection, and that suitable temperatures permit the clinical development of the disease in the UK during late spring and summer. This is when large-scale mortalities of common carp associated with KHV are most likely to occur in UK fisheries.

Our experiments have revealed the presence of KHV in fish that have been previously exposed to the virus but show no evidence of infection. Common carp exposed to KHV and then held at 21°C, a suitable temperature for the growth of the virus, experienced 98% mortality. Co-habiting the few survivors with fish that had never been exposed to the virus did not appear to spread the disease. However fish exposed to KHV at a temperature of 21°C and then quickly lowered to a temperature of 12°C, that does not facilitate the growth of the virus, showed no initial mortality. These fish were then held at the lower temperature for a further six months with no mortality. When the temperature was raised to 18°C and then 23°C, permissive levels for KHV infection, the virus re-appeared in the previously exposed fish and was transmitted to fish that had not seen the virus before. It is likely that the exposed fish were covertly infected, with viable virus retained in the fish for the six months that they were held at the lower temperature. If such fish were to be stocked into a fishery during periods of low water

Figure 1. Wild carp showing extensive gill necrosis and secondary infection, typical of KHV infection.

Figure 2. Nick Beevers working on laboratory tests for KHV.

temperatures, then it is possible that a similar situation of viral re-activation may occur once temperatures increase in late spring, resulting in the entire stock of the fishery being exposed to the virus at a temperature likely to result in clinical infection.

With the growth of angling in the UK and the demand for larger numbers of expensive, specimen carp, the number of stocking events (which generally occur during the colder months of the year to minimise transport stress) increases the risk of introducing fish harbouring covert KHV infections. This creates a problem for the carp fisheries that may not be easily resolved unless detection of covertly infected fish is made possible.

Where KHV is causing mortality in fish and the fish show clear signs of disease, the methods for detecting the virus are very efficient and highly accurate. However, when the fish show no signs of disease, but could be harbouring a covert infection, the direct detection of the virus itself may be impossible. The key to resolving this issue may be antibodies specific for KHV produced by common carp after exposure to the virus. Antibodies are a very important defence mechanism against invading microbes and are produced by most vertebrates including fish. Antibodies produced by common carp after exposure to KHV provide a potential screening tool to identify carrier fish previously exposed to the virus, which may be undetectable using existing diagnostic methods.

Antibodies are easily detectable in fish, and at the beginning of the study we began the development of a test for carp antibodies and the results have been very encouraging. Firstly, carp do produce specific antibodies after exposure to KHV. Secondly, we tested surviving carp that had previously been exposed to KHV, and found that antibodies would reliably detect covertly infected fish. This technique is very promising as a screening tool to detect fish carrying the infection and so prevent their introduction into fisheries. The test appears reliable and reproducible and the level of antibody produced by individual fish was enough to detect exposed populations. In addition the benefits of using blood samples to detect antibodies to KHV is that the testing is not lethal, an important consideration with valuable specimen carp and highly prized ornamental koi.

A number of validation steps are currently being completed before the test can be employed as a screening tool but the results from this study strongly suggest that antibodies are a good indicator of exposure. The ECHO funded project has stimulated interest in this area of disease diagnosis and research is continuing in 2005 with Defra funding (Defra project codes: FC1167 and FC1170)

Until such time as tools are developed to detect the extremely low level of virus in covertly infected fish, detecting antibody to the virus gives an alternative option. It is likely that covert carriers of KHV caused the global spread of the virus and in a similar way our carp fisheries in the UK may be under threat. At present KHV research continues at Cefas including a national

survey of farms and fisheries to establish the distribution of KHV, which may provide valuable data for fishery managers and carp farmers.

This work was completed at the Cefas Weymouth Laboratory by Nick Beevers as a part of studies for a Master of Research (M.Res.) qualification awarded by the University of Plymouth

Further reading –

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STUDIES ON UNEXPLAINED MORTALITIES OF COMMON CARP: THE DETECTION OF NON-CULTURABLE VIRUSES CAUSING DISEASE IN FISH POPULATIONS

Kevin Denham (Cefas Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset, DT4 8UB) and Ian Woods (Aston University, School of Life and Health Sciences, Aston Triangle, Birmingham B4 7ET)

This project was developed in response to long-term problems of unexplained mortalities in common carp populations in fisheries that have occurred in the UK for many years. A study conducted in 1998/99 by the Environment Agency and Cefas with the aim of characterising the carp mortalities failed to reach a definitive conclusion on the cause of the deaths. Circumstantial evidence indicated that an infectious agent, possibly a virus, might be a contributory factor in the mortality events. In subsequent years the EA and Cefas worked together in investigating large numbers of unexplained carp mortalities but diagnostic techniques available at the time failed to identify a consistent cause of the fish deaths.

To facilitate an alternative approach to the investigation of carp mortalities the English Carp Heritage Organisation (ECHO) and the Environment Agency (EA) funded a research project at the Cefas Weymouth Laboratory on the identification of fish pathogens that are not detectable by conventional diagnostic techniques.

Traditional methods of diagnosing viral diseases rely on the use of cell culture to isolate the organism. However it is known that many viruses cannot be isolated by cell culture, and other means for their detection have to be used.

In recent years technological developments in disease diagnosis have opened up new opportunities for the rapid and accurate diagnosis of diseases in fish. In particular PCR (Polymerase Chain Reaction) technology has been used to identify fish diseases using the unique genetic fingerprint that each species of pathogen possesses. Whilst current methods for identification of fish pathogens using PCR are highly specific and sensitive, they are limited to the identification of known pathogens.

The first major objective of this project was the development of generic diagnostic tests that would identify the presence of any virus in diseased fish. Specific tests could then be utilized to confirm the presence of known viruses, or to generate specific sets of genetic data to assist in characterising and identifying unknown viruses. In short, the diagnostic techniques that have been developed will detect virus families rather than individual species of virus. The project has been very successful in the development of specific primer sets for the following virus families: cyprinid herpesviruses (which includes Koi Herpesvirus (KHV) and carp pox), vesiculoviruses (which includes SVC and Tench rhabdovirus), novirhabdoviruses, birnaviruses (such as IPN) and iridoviruses. These families represent some of the most important pathogens of fish. This is the first time that a PCR test has been developed for the detection of virus families associated with disease in fish. A major advantage with this approach is that viruses causing diseases in fish that are undetectable by standard diagnostic means may be identified using the generic PCR.

The second major objective of the project was the application of the generic PCR tests

as a diagnostic tool in the investigation of unexplained mortalities of common carp. Since the beginning of 2004 the Environment Agency has submitted 56 samples of fish tissue from mortalities of common carp that meet the unexplained carp mortality criteria. These criteria include a mortality event involving only common carp resulting in the death of a significant proportion of the population (>10-15%) over a short time scale, with no obvious attributable cause such as water quality problems.

These samples are currently undergoing testing using the generic primers developed during the project. To date KHV has been identified in 4 samples and Cyprinid Herpesvirus I (carp pox) in 2 samples. No other viruses have been identified associated with the unexplained mortalities of carp.

In terms of the development of the generic PCR assay this project has been highly successful. The generic PCR has now been incorporated into the standard suite of tests used by Cefas in the investigation of fish mortalities.

Following the success of the ECHO and EA funded project Defra is now contributing significant additional resources to research over the next four years on the development of new surveillance tools, including further work on generic primers for diseases of fish and shellfish (Defra project code: FC1170).

Cefas wish to express thanks to the Environment Agency and to the committee and members of ECHO for funding this project.

STUDIES ON RED MARK SYNDROME

David Verner-Jeffreys, Myriam Algoet, Steve Feist, Kelly Bateman, Edmund Peeler (Cefas Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset, DT4 8UB) and Edward Branson (Red House Farm, Llanvihangel, Monmouth, Gwent, NP25 5HL).

Red Mark Syndrome (RMS) is a transmissible disease of rainbow trout, characterised by the appearance of multiple ulcerated skin swellings, of varying intensity, on the flanks of affected fish (Figure 1). It shares some similarities with Strawberry Disease (SD), not least that the infectious agent responsible has yet to be definitively identified [(1)]. However, there are enough differences from SD, in terms of both its epidemiology and pathological effects, to regard RMS as a separate condition. RMS causes losses to farmers in that affected fish are down-graded at harvest. There are also some reports of increased losses of RMS-affected stock during grading and other stressful procedures.

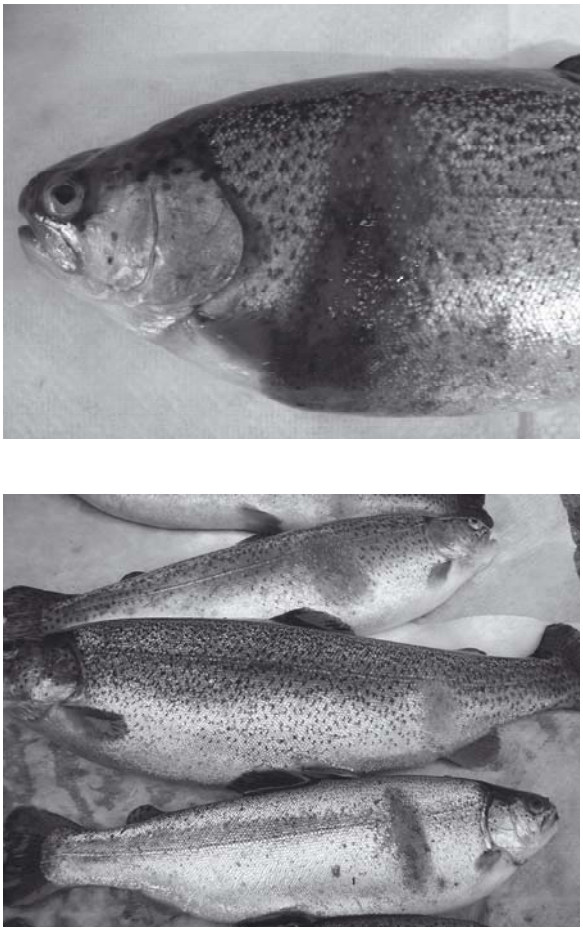

Figure 1. Rainbow trout affected by RMS.

History of the disease

The condition was first noted in Scotland in 2004, where it occurred on several farms, in fish originating from a single hatchery. Other fish on the farms were unaffected. Fish from this same hatchery delivered to farms in England were also unaffected. In early 2005, the condition was diagnosed for the first time in fish farmed in England, again in fish from this same hatchery. During 2005 fish from other sources on affected farms, in cages adjacent to affected fish, also

succumbed to the problem, suggesting an infectious aetiology. The condition, although causing significant losses due to downgrading, has not been associated with mortality. Farmers in both Scotland and England report that the disease is prevalent at lower temperatures (less than 16 °C) and this predilection for lower temperatures may explain the absence of the condition in the English farms in 2004, the fish having been delivered during the summer when temperatures would have been significantly higher. Early signs of the condition can include severe scale loss, prior to the emergence of the characteristic external lesions.

Cefas disease investigations

As part of our remit to investigate new and emerging diseases of farmed and wild fish, outbreak investigations of the two English farms suffering from RMS were instigated. Epidemiological analysis indicated that the condition on both farms originated in stocks of fish sourced from the same hatchery. This hatchery had, itself, suffered RMS outbreaks in the past. There were also indications that the condition had spread from the imported, infected, stock to other batches of fish on both farms. Samples of RMS affected fish from both farms were returned to the Cefas Laboratory for further tests, in an effort to learn more about the disease.

The affected fish presented with a range of lesions of differing severity. However, despite extensive analysis, including histopathological investigation of preserved material (by light and electron microscopy), as well as mycology, bacteriology and virology, no single potential disease agent could be consistently isolated from affected fish. Histopathologically, the condition was characterised as a non-suppurative dermatitis with extensive lymphocytic infiltration. Interestingly, when lesions were examined, it was noted that, even in the very early stages, areas of necrosis and associated inflammatory foci were seen well below the external epithelium in the dermal layer. What this means, in essence, is that the disease works 'inside out'. The first observable stage of the disease is necrosis in the area where the scales are attached to the dermis. Only after this has taken place will scales then be raised or removed and the integument breached, with formation of the characteristic external lesions. Farmers note that lesions are often more obvious after grading or other stressful handling procedures, which fits with these findings. Another observation was heart pathology in up to 20% of the fish examined.

We have run a transmission trial at the Weymouth Laboratory in an effort to see if the disease can be passed to unaffected fish in the laboratory. When we cohabited 20 RMS affected fish (average size 410 g) with 40 naïve rainbow trout (average size 75 g) in the same tank, only nine of the naïve fish survived to the end of the 96 day trial. Mortalities in the naïve group were not attributable to a particular disease agent and finished by Day 42. Of the remaining nine survivors, four showed external lesions characteristic of SD and RMS. Although this data is interesting, it also serves to illustrate the difficulties of working with a disease where a causative agent has not been identified.

Currently, there is no evidence that the mortalities in the trial were associated with the

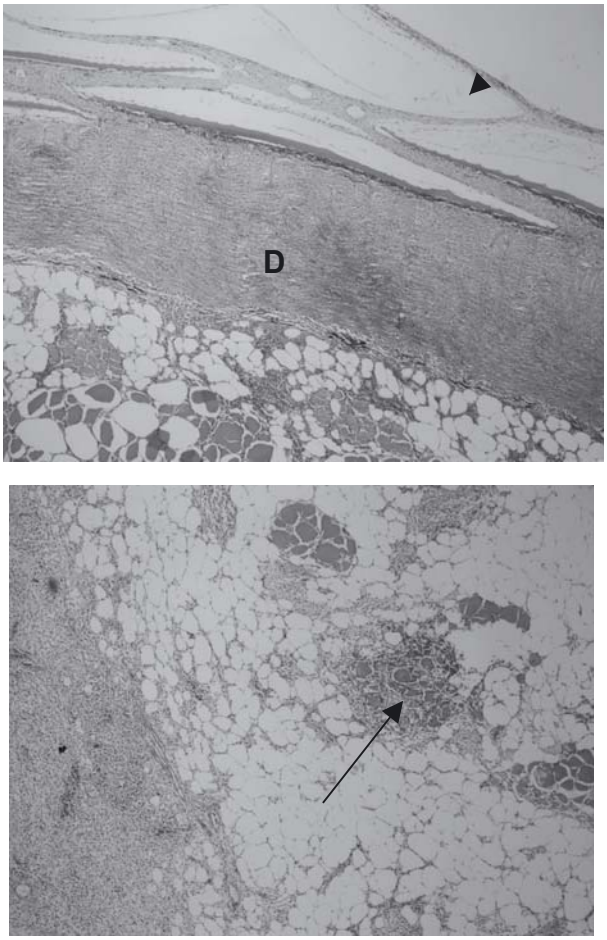

Figure 2. Sections of skin and muscle taken from a RMS lesion. Note erosion of the epidermis (arrow head), inflammatory cells in the dermis (D) and into the underlying adipose tissue and musculature, and associated myofibrillar degeneration (arrow).

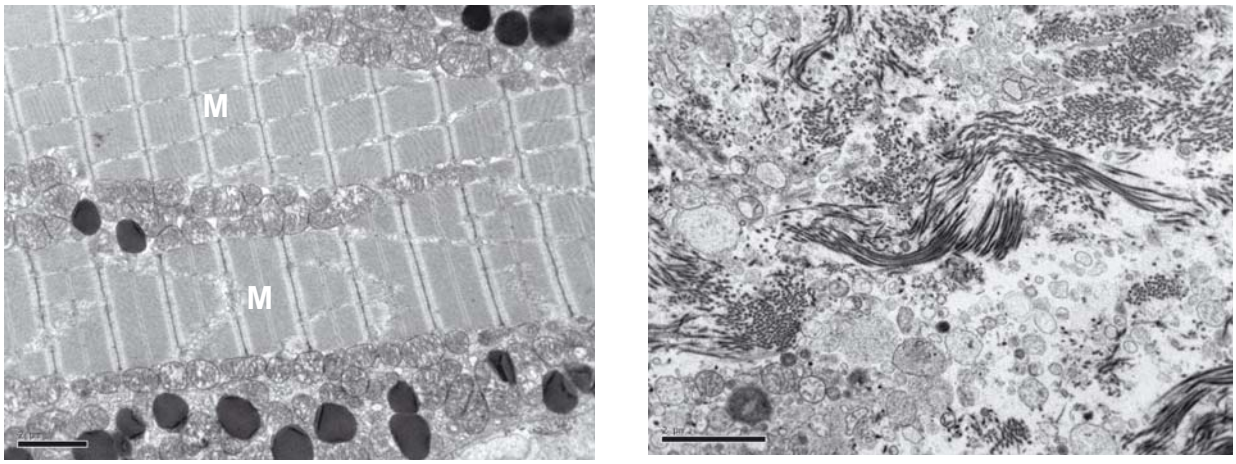

Figure 3. Transmission Electron Microscopy of an RMS lesion. A: Normal structure of the myofibrils (M) in longitudinal section with prominent mitochondria and dark staining lipid droplets. B: TEM of inflammatory focus revealing cellular necrosis and disassociated connective tissue fibres. No pathogens detected.

syndrome. It is entirely possible that the RMS affected fish were also carrying other diseases that killed the naïve fish. Although it appears likely that the condition was transmitted from the RMS affected fish to the surviving naïve fish, this cannot be stated with certainty since a confirmatory diagnosis, apart from presence of external lesions, is lacking.

The trial also provided other useful information. Out of the 80 RMS affected fish transported to our Laboratory, only one died during the trial and surviving fish showed signs that the initial lesions had healed up. We also noted no difference between a group of RMS affected fish that were maintained on the diet they had previously been fed at the farm and a group fed a control laboratory diet. Both groups of fish appeared to recover from the condition, suggesting that a dietary link was unlikely.

Treatment.

Treatment is complicated by lack of an identified disease agent, however farmers report that it responds to use of in-feed antibiotics, particularly oxytetracycline. A problem with treating with OTC is that it has a 720°C day withdrawal period. Florfenicol has also been used to treat the condition successfully and, although having a shorter withdrawal period than oxytetracycline, (500 °C days for rainbow trout), it has the disadvantage of being considerably more expensive. However, use of antibiotics should be considered a temporary measure, as their overuse may lead to the emergence of antibiotic resistance. As found in our tank experiments, it is also reported that, left untreated, affected fish will often spontaneously heal themselves. Unlike strawberry disease where encouraging results have been reported, there is no evidence that supplementing the diet with Vitamin C will affect the progression of RMS.

Likely causes of RMS

Although no pathogen has been consistently associated with the condition, observation that the condition responds to antibiotic treatment suggests a bacterial cause or influence, as with SD.

Future Work

One important thing that needs to be done is to agree on 'case definitions' for RMS, Strawberry Disease and other possibly linked conditions so we can accurately describe and track the spread of the diseases. There has been a proposal by Hugh Ferguson from the Institute of Aquaculture to now refer to both these conditions as Strawberry Disease, with the condition we refer to here as 'RMS' termed 'Coldwater Strawberry Disease' and what has previously been, and is more commonly understood to be, Strawberry Disease in the UK as 'Warm Water Strawberry Disease'. This position would also tie in with the possibility that the Strawberry Disease seen in other European countries and USA is more similar to what we currently know as RMS, although this remains to be confirmed. It is possible that the similar clinical signs for both syndromes are caused by a generalised hyper-inflammatory host reaction in the skin layers to the presence of different initial causes (such as different bacterial antigens).

If farmers note the appearance of symptoms similar to those described in their stock they should contact the Cefas Fish Health Inspectorate for further advice.

Acknowledgements

Funding for these studies was provided by Defra under contracts FC1151 and FC1166.

Reference:

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REGULATIONS GOVERNING THE USE OF DISINFECTANTS IN UK AQUACULTURE AND THE DEVELOPMENT OF A DEFRA AQUACULTURE DISINFECTANTS LISTING SCHEME

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Introduction

As all fish farmers are aware, disinfectants are vital tools in the implementation of effective farm biosecurity. They are used for two primary purposes in aquaculture:
1. the removal of potentially pathogenic microorganisms from surfaces, effluent and rearing facilities including equipment, tanks and clothing
2. the disinfection of gametes, principally ova.
Although their use may be well established and very effective in most cases, the rules governing their application and, often, which products should be selected for particular purposes, are not so well understood.

This lack of knowledge as to what may be used safely and effectively was brought into sharp focus by the Infectious Salmon Anaemia (ISA) outbreak in Scotland in 1998 [1]. In this example, the absence of identified alternatives lead to the emergency use of hypochlorite at high concentrations (100-1000 mg/L). This drastic action required a temporary derogation from SEPA (Scottish Environment Protection Agency) who maintain a presumption against the discharge of effluents containing active residual chlorine, a presumption that has since been reinstated.

The purpose of this article is to clarify the present regulations covering the use of disinfectants in the UK and to introduce readers of *Finfish News* to a voluntary aquaculture disinfectant listing scheme that is to be introduced by Defra shortly.

Regulations Governing Disinfectant Use

Health and Safety
Disinfectants used to treat equipment are classed as biocides. In the past, their use in fish farming has generally been covered as for the other chemicals farmers routinely use. For instance, if the chemicals were hazardous to the operators or the environment standard Health and Safety at work procedures would need to be followed, e.g. the provisions of COSSH (Control of Substances Hazardous to Health) should be adhered to, including production of Risk Assessments for their specific uses where appropriate. Items such as ordering, storing, handling, using and disposing of disinfectants are all, to some extent, covered under these regulations. A discharge consent from the appropriate regulatory authority would also generally be required before such chemicals could be discharged.

Discharge Permitting
With large volumes of disinfectant effluent being discharged each year into watersheds and the marine environment, discharge of disinfectant products is tightly controlled. In Scotland the discharge of disinfectants to the environment is controlled under the Food and Environment Protection Act 1985 Part II Deposits in the Sea, as amended by the Environment Protection Act 1990 (FEPA) and the Control of Pollution Act 1974 as amended by the Water Act 1989 and the Environment Act 1995 (COPA). A COPA discharge consent is issued by SEPA (Marine Laboratory Publication 1999).

A similar process exists in England and Wales, with consents issued by the Environment Agency (EA). In England and Wales applications for pipeline discharge consents are made under the Water Resources Act 1991 (as amended by the Environment Act 1995). The EA's fish farm consenting policy 'requires that fish farmers seek the prior approval of the Agency for the use of any chemical that could be discharged to the environment'. This requirement is enforced by a consent condition. Consents must be obtained for activities such as net and cage disinfection at both cage sites and shore bases and for effluent disposal at processing plants.

Biocidal Products Directive (98/8/EC)

As well as these existing controls, authorisation of biocides is now also under the control of the Biocidal Products Directive (BPD; 98/08/EC; implemented into UK law through SI 2001 No. 880 and S.R. 2001 No. 422). In the future all biocides will be authorised for the particular use claimed (Marketing Claim) following a review of a dossier of data in support of that claim. In the UK such authorisations will be administered by the Health and Safety Executive's Biocides & Pesticides Unit. However, as there are a great many chemicals already used as disinfectants and other biocides, it will take some time before they are reviewed against the updated criteria specified under BPD.

There are four priority lists for review. The active ingredients in veterinary disinfectants (Product Type 3) will be reviewed by HSE under BPD, as part of the third priority list, starting in mid-2007. Industry had to 'Notify' those substances they intended to support for review, including the Product Types they intended to support them in, to the European Commission. If an active substance has been Notified for review in Product Type 3, products can be placed on the market (subject to any existing national rules) until the review is complete. Once the review is complete, products containing that substance will have to be authorised under the Directive or be removed from the market. A system of 'mutual recognition' can take place under the Directive, so that once a product is authorised in one Member State, that authorisation can be carried across to the other Member States. If industry did not want to support a substance through the review programme they had the option to 'Identify' it to the Commission. Products containing substances that have only been Identified – or those containing substances that have been Notified, but not for the relevant product type – can remain on the market until 1st September 2006. For further details of the Directive, contact the Biocides & Pesticides Unit (biocides@hse.gsi.gov.uk).

Rules governing the use of egg disinfectants

The regulations governing the use of egg disinfectants essentially depend on the Marketing Claim for that product, as decided by Veterinary Medicines Directorate (VMD). If the claim is considered medicinal, the company requires a Marketing Authorisation from VMD before that product can be sold or distributed in the UK

Although the egg may not technically be an animal when the disinfectant product is applied, the product may affect the animal's future development (particularly if it is absorbed by the developing embryo) and the eventual consumer (in the case of food species).

If a company markets a product claiming to 'clean' an egg, rather than improve the health of the animal or protect against infection, the product would not be treated as a medicine. In this case the product is classed as a biocide and is subject to the regulations described previously.

It is suggested that any company wishing to market an egg disinfectant should contact VMD (details in Information File) who will assess the particular marketing claim for the product and advise whether it is a medicinal claim or not.

Definition of a "medicinal product": (Article 1 of Directive 2001/82/EC)

"Any substance or combination of substances presented as having properties for treating or preventing disease; or any substance or combination of substances which may be used in, or administered to, animals with a view either to restoring, correcting or modifying physiological functions by exerting a pharmacological, immunological or metabolic action, or to making a medicinal diagnosis."

Existing disinfectant listing and approval schemes

Animal Health Act 1981

Under the provisions of the Animal Health Act 1981, Defra maintains a list of disinfectants that are approved for the control of diseases of terrestrial animals. For the purposes of this approval scheme, disinfectants are divided into 5 groups: (1) for use against tuberculosis, (2) for use against foot-and-mouth disease, (3) for use against swine vesicular disease, (4) for use against diseases of poultry and (5) for use under General Orders made under the Animal Health Act. Manufacturers may apply for their products to be approved for one or more of these groups. At the present time this system of approvals does not extend to pathogens of fish or shellfish.

Norwegian Disinfectant Approvals Scheme

The Norwegians have regulations controlling the cleaning and disinfection of aquaculture sites (Norwegian Fisheries Regulations No. 194 and 195). The statutory basis for their aquaculture disinfectant approval scheme is No. 194. Their approval process is based upon a draft of BPD (98/8/EC) and they have published guidelines that are distributed to manufacturers wishing to have an aquaculture disinfectant approved. The guidelines state what claim-specific toxicity, ecotoxicity and efficacy data manufacturers should produce in support of an application to have a product approved as a 'Technical Disinfectant'.

Proposed UK listing scheme

Defra is proposing to produce a voluntary aquaculture disinfectant listing scheme. The purpose of the proposed scheme is to give manufacturers the opportunity to demonstrate to Defra that their products are effective against relevant aquaculture pathogens. The scheme will have UK-wide relevance and is being developed in consultation with representatives from FRS Marine Laboratory, Aberdeen (an agency of the Scottish Executive Environment and Rural Affairs Department, SEERAD) and the Department of Agriculture and Rural Development, Northern Ireland (DARD). The aim is to compile a list of approved disinfectants that is freely accessible to fish farmers and aquaculture health professionals, aiding them in the selection of effective products.

Although the importance of egg disinfectants is recognised, at this stage the scheme is primarily concerned with disinfectants that are intended for the disinfection of surfaces and equipment (Technical Disinfectants).

Testing Standards

To be listed in the proposed scheme, a product must pass standardised in vitro bactericidal and virucidal tests, performed under stipulated conditions. A working group of experts from the UK and Norway has been established to design these testing standards. At the moment it appears most sensible to recommend two separate standards; a bacterial and a viral testing standard.

Bacterial testing standard

It is proposed that a modification of the European Standard EN1656 (Quantitative suspension test for the evaluation of bactericidal activity of chemical disinfectants and antiseptics used in veterinary field) be used. It is suggested that the standard will be modified by substituting the specified test bacteria (pathogens of warm blooded terrestrial animals) for more relevant aquaculture pathogens (*Aeromonas salmonicida* subsp. *salmonicida* (ATCC 14174), *Yersinia ruckeri* (ATCC 29473), *Carnobacterium piscicola* (ATCC 35586) and *Lactococcus garvieae*). In summary, a standardised bacterial suspension (1.5 - 5 $x10^{8}$ CFU ml^{-1}) is exposed to product prepared in hard water in presence of organic loading for a specified contact time and temperature. For a product to pass the test, it must demonstrate a greater than 5 log reduction in the bacterial count.

Viral testing standard

Cefas are currently validating a modification of the draft European standard prEN 14675 (Quantitative suspension test for the evaluation of virucidal activity of chemical disinfectants and antiseptics used in veterinary field). Infectious Pancreatic Necrosis Virus (IPNV), Sp serotype, is to replace Bovine Enterovirus Type 1, as a suitable model virus. IPNV is already successfully used in the aforementioned Norwegian scheme. It is highly relevant to UK aquaculture, provides a very resistant model and, from a practical aspect, reaches high titres when grown in cell culture.

General testing conditions

Contact time and temperature are both critical parameters for disinfectant testing. Although precise details are yet to be confirmed, the current intention is to recommend that all volunteered products are tested in the presence of high organic loading for a contact time of 30 minutes at 4°C. These conditions are the same as those specified in the Defra terrestrial disease scheme. As the activity of disinfectants decreases with a reduction in temperature, and the presence of organic material interferes with many disinfectants, they theoretically represent challenging conditions for the disinfectant. There may also be scope for manufacturers to submit data on product activity at shorter contact times, although this still needs to be fully considered.

Stakeholders forum

A meeting of stakeholders, including industry representatives, aquaculture health professionals, other Competent Authorities (CA) and farmers is to be held prior to the scheme's finalisation. Meeting details are to be confirmed. Anybody interested in attending this meeting, or requiring further information on the proposed aquaculture disinfectants listing scheme or any of the other issues raised, should contact David Verner–Jeffreys (Cefas Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset, DT4 8UB. Tel: 01305 206600; Fax: 01305 206601; Email: D.Verner-Jeffreys@cefas.co.uk).

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RECENT ADVANCES TOWARDS OUR UNDERSTANDING OF THE LIFE CYCLE OF TETRACAPSULOIDES BRYOSALMONAE, THE CAUSATIVE AGENT OF PROLIFERATIVE KIDNEY DISEASE.

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Proliferative Kidney Disease (PKD) continues to be a major constraint on the UK rainbow trout industry. The parasite that causes the disease, *Tetracapsuloides bryosalmonae*, has two known hosts in its life cycle, bryozoans and salmonids[1]. Bryozoans are colony forming organisms which grow on submerged surfaces in rivers and lakes (Figure 1). While it is known that rainbow trout can develop PKD through exposure to infected bryozoans a number of questions remain about the life cycle of this parasite.

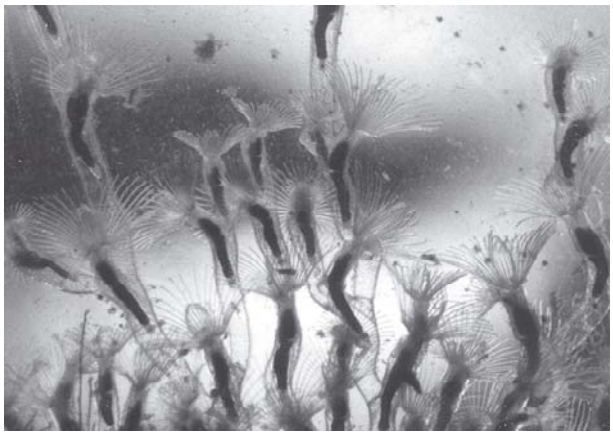

Figure 1. Bryozoan colony, showing feeding tentacles, growing on a Petri dish.

Work conducted at Stirling University has aimed to further elucidate the life cycle of the parasite to understand the epidemiology of PKD. Infectivity trials have demonstrated that a single *T. bryosalmonae* spore released from a bryozoan can infect a rainbow trout resulting in it developing clinical PKD[2]. The results also indicate that the severity of the disease in trout is not only a reflection of water temperature but also other environmental conditions and perhaps an innate, relative susceptibility of individual fish, rather than a reflection of the number of spores the fish was initially exposed to[3]. When it is considered that relatively small numbers of bryozoans have the capability of generating many thousands of spores it is clear that reducing numbers of bryozoan colonies upstream from farms may have a limited impact on reducing the levels of the disease on an affected farm[2].

While previous studies have indicated that rainbow trout in the UK are likely to be aberrant hosts to the parasite, we have recently demonstrated that brown trout are true hosts, with the parasite being able to cycle between a bryozoan and this fish species[4]. However, in addition to brown trout, the spread of infected bryozoans in a river system can be further increased by the ability of bryozoan colonies to fragment, drift downstream and attach elsewhere to form new colonies.

Experimental studies on infected bryozoans have demonstrated that this fragmentation could form a significant transmission strategy for the parasite, allowing *T. bryosalmonae* to further propagate within rivers[5].

Our increased knowledge of the life cycle of *T. bryosalmonae* and the ability to keep the parasite in the laboratory is a significant step forward in allowing us to understand PKD. Current work at Stirling, funded by the BBSRC (grant ref. BBC5050241), is focused on charting the development of *T. bryosalmonae* in both the bryozoan and salmonid host and how temperature affects spore production/ release. Related projects jointly funded by Defra/Schering Plough Aquaculture and Defra/ British Trout Association are working towards the development of a vaccine to prevent this important disease and examining the possibility of breeding resistant fish .

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THE 36TH INSTITUTE OF FISHERIES MANAGEMENT CONFERENCE, SALFORD QUAYS, 15TH – 17TH NOVEMBER 2005

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A total of 34 papers were presented over the three days of the annual Institute of Fisheries Management Conference. The talks covered a wide variety of issues of interest to fish farmers, fisheries owners and conservationists, which included river restoration, fish and water flow, climatic influences on freshwater systems, monitoring of habitats and fisheries. Poster presentations also covered a similarly diverse subject range. Various trade stands (Anglers Co-operative Association, APEM Ltd, Blackwell Publishing, Electra Catch International, Fishway Engineering Ltd, Northwest Marine Technology and Tyco Environmental) were also on hand to supply technical advice. Brief overviews of selected talks are summarised below.

Climate change in England and Wales: the implications for the establishment of non-native species

Robert Britton of the Environment Agency (EA) National Fisheries Laboratory, Brampton discussed the effects of climate change and increasing water temperatures on the establishment of non-native species. Non-native fish species that have, or may, become established within England and Wales include pumpkinseed, wels catfish and common carp. Future elevated temperatures may open greater opportunities for other non-native species to become invasive, by improved reproduction. The possibility was aired that largemouth bass in the

River Severn, catfish in the River Thames, and sunbleak in the Riddle may become the norm.

Consideration was also given to the effect that climate change may have on non-native parasites and disease vectors. These species may not yet be established within England and Wales, but have the potential to become problematic to our native fish if water temperatures increase. The example was given of anchor worms (*Lernaea cypinacea*). This parasitic copepod has previously only been recorded sporadically in England and Wales, as it is dependent on a temperature of 25°C to become established. Climate change and increasing water temperature may, however, enable an increase in reproductive rates and lead to heavy infestations.

It was concluded that threats to our freshwater native aquatic environment could occur with the introduction of non-native species. Legislation under the Wildlife and Countryside Act and ILFA is our best form of defence against these non-native species and, to be effective, requires enforcement and the help of fisheries managers and anglers supported by education.

The effects of global warming on the freshwater fish, *Gasterosteus aculeatus* (L.)

Kathryn Hopkins from the School of Biological Sciences at the University of Liverpool presented a paper on the potential effect of global warming on the three-spined stickleback. The talk commenced with an insight into the stickleback, which is native throughout much of the northern hemisphere. The reproductive behaviour of the males was illustrated - nest building, courting, fertilisation, followed by guarding and oxygenation of the eggs in the nest. The latter behaviour, termed 'fanning', is when the male stickleback moves water over the eggs through a vigorous movement of the tail and pectoral fins.

The question of whether an increase in temperature would affect reproductive behaviour and thus reduce the reproductive capacity of the stickleback was addressed by experimental trials. Fish were collected from the wild and their behaviour observed at water temperatures ranging from current to those that are predicted before the year 2100. The trials demonstrated effects of temperature on nest building and maintenance, the number of successfully incubated eggs and the number of fish that survived to the end of the experiment. It became clear that the fish which were producing young spent more time at the nest, fanning more frequently and for more time.

It was concluded that an increase in water temperature could impair the reproductive rate of the stickleback. However, this should not be looked at in isolation, as the wider ecosystem also needs to be considered. The stickleback helps maintain our aquatic systems and therefore disruption of its breeding cycle will have a knock-on effect on other aquatic organisms. The talk emphasized that the effects of climate change on individual fish species should be considered together with the resulting effects on other species.

The importance of habitat heterogeneity to fish diversity and biomass

A study presented by Adrian Williams of APEM Ltd examined the importance of habitat heterogeneity to fish diversity and biomass. The study was conducted on two artificial channels flowing though Heathrow Airport. The rivers contain areas of both naturalised habitat together with featureless shallow channels which posed site selection problems for representative sampling of the habitat.

Consecutive habitat types were isolated using a system of stop nets to prevent fish being frightened away from the study area and thus potentially giving a misleading result. A 'leap-frogging' stop-netting system was used to isolate sections of river approximately 40 m in length and samples were obtained by electro-fishing between the stop nets.

It was found that fish biomass and diversity varied between river sections with a total of 16 species of coarse fish being found. There were strong relationships between the number of fish species and biomass, and the distribution of emergent vegetation and macrophytes. Areas high in vegetation produced greater catches than un-vegetated areas. On the whole, it appeared that an increase in structural features

such as macrophytes and bridges gave higher fish diversity and biomass. Presumably the increase in habitat and flow heterogeneity provided areas for feeding, spawning and refuge. A lack of habitat was deemed to be the factor limiting fish biodiversity and biomass.

The study indicated that future surveys in coarse fish systems should include larger study sites comprising a wide range of habitats and allowing for more intra-site sectioning. It was suggested that this would improve representation of biomass and diversity within a sample.

Towards an understanding of river restoration for fish and fisheries

Brian Shields from the Cranfield University Institute of Water and Environment presented a talk assessing the river restoration projects. The talk commenced by stating that the success of a river restoration project is based on setting achievable objectives, which for fish can be relatively clear and focussed. The normal emphasis in fisheries management is on the size and structure of a population of an individual fish species. Spawning substrata can be built to increase the fry of a single fish species. However, by taking a more holistic approach of functional habitat diversity, areas for feeding, refuge and reproduction could be provided for a number of different species in one go.

Judging how successful a river restoration project has been will depend greatly on the context in which it is assessed. For example, if a spawning ground is constructed for a target species, and the numbers of the desired species increase following the construction, then the restoration could be deemed a success. However, changing or 'restoring' the construction and nature of the river and hydro-morphology may result in aquatic species, particularly benthic invertebrates, being lost downstream. The success of restoring a spawning ground should therefore question the effects on other elements of the system.

This example shows the importance of a wider assessment of river restoration, which considers both local and downstream effects of any changes. The wider appreciation of the river environment is necessary for fish and fisheries and will become mandatory with future EU political and ecological drivers. This will, in turn, affect the management style in which our fisheries are run.

The use of rotenone to eliminate topmouth gudgeon from a Lake District tarn

Matt Brazier of the Environment Agency (EA) presented a case study on eliminating topmouth gudgeon from the Ratherheath Tarn. He started by giving a background history of the site stating that topmouth gudgeon were first discovered there in October 2002 and that their presence posed a serious threat to the local ecosystem, which includes the River Kent and Lake Windermere.

A group was assembled to examine potential eradication options, drawn from the EA, English Nature, the Cumbria Wildlife Trust, Lake District National Park Authority, Royal Society for the Protection of Birds (RSPB), Friends of the Lake District, Cumbria County Council and the site owners. All fishermen and the public were notified of any work being carried out on the site.

The options available for eliminating the topmouth gudgeon were assessed looking at physical, biological and chemical options. After two years is was concluded that physical and biological methods would only control the problem, and would not eradicate the topmouth gudgeon. Chemical control was therefore the only option for eradication.

Between 12 February and 3 March 2005 as many native fish (including roach, tench, carp and bream) as possible were removed from the site. The water level was then reduced, thereby reducing the amount of chemical required. A rotenone-based pesticide (2.5% active rotenone content) was applied in liquid formulation.

Rotenone is a naturally occurring organic substance. A species-specific dose was derived from a bioassay application protocol. Two applications of rotenone were made one month apart. On completion of the second application no topmouth gudgeon were found. Six weeks after the final application the native fish were restocked and angling resumed at the site. To date no topmouth gudgeon have been found in the Ratherheath Tarn, which is undergoing continued assessment for the next three years.

Further applications for the use of rotenone within aquaculture and aquatic conservation were discussed, e.g. controlling sticklebacks within newt populations. However the use of rotenone as an aquatic management tool within Europe is uncertain. Such substances are regulated in accordance with the EU Biocides Directive, and as such their use could be prohibited from September 2006.

GRASS ROOTS AQUACULTURE R&D AND IMPORTANT NOTES FOR BEAN COUNTERS

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Another day, another meeting, the same old faces – largely the same issues! It is very easy to become jaded, numbed and unresponsive to the concerns of various aquaculture industry sectors – particularly those that have become equally blunted by unrelenting commercial pressures in what seems like a cascade of never ending regulation and change. Or, is this what we ironically mean when we describe a sector as "mature"? Not surprising then that a number of industry relevant gatherings that I have attended recently have lacked the spark of enthusiasm, coupled to the usually spirited desire to develop the industry. The hallmark of all these events has been audiences dominated by administrators, scientists, regulators, together with the all important sprinkling of agent provocateurs from various mainstream NGO's!

But, where is the industry - where are the folk that are actually engaged in the day to day activity of cultivating fish and shellfish? By any definition they are a rare and perhaps endangered species in need of conservation. Has the proportion of non-industry participants increased as the size and frequency of meetings has expanded, or has industry participation, in real terms, decreased? Intuitively one suspects a combination of the two. Perhaps industry trade bodies are becoming such effective representatives that those involved at the coalface no longer feel the need to participate.

Granted, most industry trade bodies worth their salt have established an array of committees and sub-groups to discuss and marshal their concerns. Government too, has established more transparent and democratic mechanisms for absorbing and acting upon the agendas of the plethora of stakeholders with an interest in aquaculture. In theory these processes should dovetail and result in the delivery of better governance and, in the case of R&D, the allocation of resources focused on industry generated priorities.

However, the key to maximising the benefits of these processes and opportunities is a combination of effective representation and accountability. As funding resources become ever more constrained, competition to secure them intensifies. In terms of R&D, effective representation means that the full spectrum of short, medium and long term research requirements needed to maintain and develop an industry must be carefully thought through and properly justified. Ideally, this information should be generated through open consultation with members of the industry, together with other trusted technical experts and scientists. Hopefully this informed dialogue will result in a cohesive and compelling set of research priorities – priorities that can be directed to appropriate funding bodies for consideration.

This brings us to "accountability" – having defined, justified, prioritised and delivered your research requirements through organisations such as the Committee for Aquaculture Research and Development (CARD), the Scottish Aquaculture Research Forum (SARF) and other coalitions of the willing, what should you expect?

In an ideal world, sponsors with priorities in-hand would rush forward with open cheque books to fund a flock of able scientists. To my knowledge this is a rare phenomenon and only tends to takes place towards the end of fixed financial years - when fiscally embarrassed officials discover pots of unspent funds. In

reality, we must rely on a combination of direct action and intellectual diffusion. Both Defra and SARF carefully assess industry's R&D priorities against their policies and remits, together with the resources they have to allocate. A list of possible project areas to be supported is then drawn up and the necessary projects commissioned – increasingly through open advertisement and competitive tender. Resource constraints dictate that funding is allocated to relatively short term, highly focused, applied R&D. Subsequent contact with the industry, inevitable cross examination at R&D related meetings, and the expectation of project outputs designed to inform the industry of progress, all help to ensure accountability.

Research with a medium to longer term horizon tends to be broadcast as "prioritised" and important, in the hope that the research councils, in particular, will look favourably on related research proposals that may float their way in the fullness of time. This latter process is not entirely satisfactory in the sense that it is a passive process which is largely unaccountable to those outside the academic community. How many other sectors I wonder, provide these organisations with a clear, well founded set of research priorities on a regular basis. How can we be sure that these organisations allocate their significant resources in a way that, at least in part, is driven by a reasonably transparent and industry/policy relevant agenda? Analysis of the projects funded by these organisations in recent years would suggest that they are supporting more aquaculture oriented work albeit fundamental and generic rather than applied and specific. One can only hope that by formally highlighting the research required to underpin the industry, combined with key individuals within the scientific community submitting relevant proposals, we can ensure that prioritised work is supported.

Seafish funds a modest but varied and expanding portfolio of R&D through its Aquaculture and Inshore Working Group. One of the most successful funding initiatives developed through this Group has been the Technology and Innovation Primers awards (TIP). The principle behind TIP awards is to provide seed-corn or primer funds to encourage the direct participation of members of the industry in developing novel ideas and technologies. TIP projects are usually less than a year in duration, have a minimal administrative burden and must be matched by an equivalent in-kind or cash contribution from the participant(s). The value of these awards has been no more than £3000 per project (soon to be raised to £5000). The quantity and quality of applications received for these awards has been exceptional. There is clearly a demand for resources to support grass-roots innovation and technology development which, with careful support and perhaps the capacity for additional mentoring and research facilitation, could help to encourage entrepreneurship and deliver real advances cost effectively.

The level of enthusiasm and interest in the TIP awards brings me back to the issue of accountability. The vast majority of the ideas submitted to the Group under this scheme do not appear in any of the recent research priority areas put forward by the relevant industry sectors. Does this anomaly hint at a disconnection between some organisations and their members when it comes to assessing the full spectrum of R&D required?

The Scottish Aquaculture Research Forum (SARF) is also progressing apace. A limited company and registered charity since 2004, SARF has 16 members ranging from the Scottish Executive Environment and Rural Affairs Department (SEERAD), the Scottish Environment Protection Agency (SEPA) and Scottish Natural Heritage (SNH) to aquaculture trade bodies, wild fisheries and NGO representation. SARF now actively commissions R&D around an annual cycle of spring and autumn meetings, based on the research priorities generated from its Members. In addition to sole sponsorship of projects, SARF co-funds a number of projects with sponsors such as Defra, Food Standards Agency Scotland and through additional commissions with SEPA for example.

In a broader context, the second major incarnation of the UK Aquaculture R&D database is about to be released and will be available on the Defra website (http://www.defra.gov.uk/science/Areas/aquatic/default.htm). The database, which now also contains a supplementary table of EU Framework 6 funded aquaculture related R&D, is the most comprehensive source for information on

UK aquaculture R&D available. In addition to providing details of individual projects, together with summary information (where available) the database is proving to be an important strategic source for looking at trends in the way resources are being allocated. Fine for train spotters and bean counters I hear you think – but take a look for yourself, whether you are a scientist or a member of the industry, you are likely to find a raft of R&D projects that may well address areas that are of concern to you in your every day work. The next time your trade body asks for your opinion on what "research" is needed why not use sources like the database to help you make informed decisions.

For the bean spotters and those lusting after locomotives, a few key facts plucked from the current UK Aquaculture R&D database!

The current estimated committed spend on aquaculture R&D in the UK (from UK sources) between 1999 and 2009 is about £81.6 million. A more accurate figure for the known cash commitment to UK funded R&D for this sector, based on the amount committed by individual sponsors, is about £51.4 million over the same period.

Figure 1 represents known expenditure between 1999 and 2009. Expenditure between 1999 and 2006 represents the full commitment; beyond 2006 further commitments are anticipated. At this stage we can only assume that they will be equivalent to previous years, however, after peaking in 2002, commitments have plateaued at around £6 million per annum and there is some evidence to suggest that they may be declining in real terms. The number of projects being funded may have started to decline also, but at this stage without some measure of "productivity" it is difficult to confirm whether there are fewer larger projects, fewer more expensive projects or a combination of these factors occurring against a backdrop of declining funding. However, analysis of the average annual cost of projects suggests that this has risen between 1999 and 2006 (Figure 2). If this

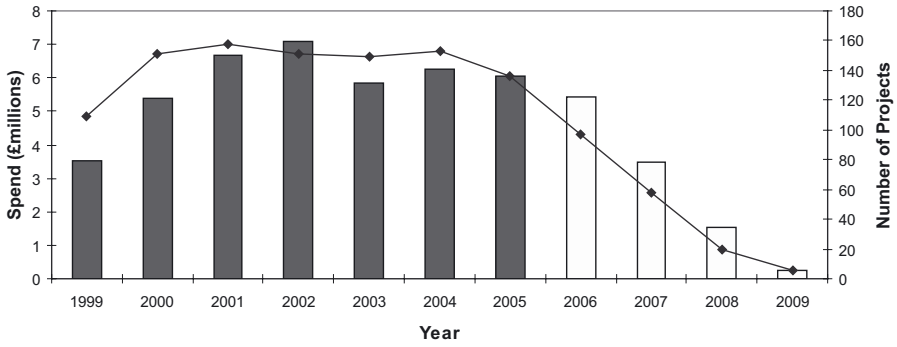

Figure 1. Known and committed expenditure on aquaculture R&D between 1999 and 2009 (bars) and number of projects funded (diamonds and connecting lines)

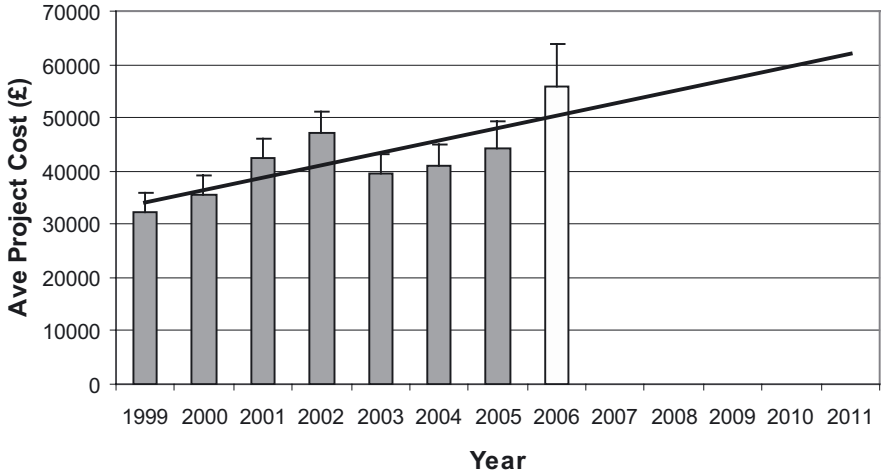

Figure 2. Average annual cost (£/year) of aquaculture R&D projects between 1999 and 2006. Upward trend line (R^2 = 0.6297) also shown.

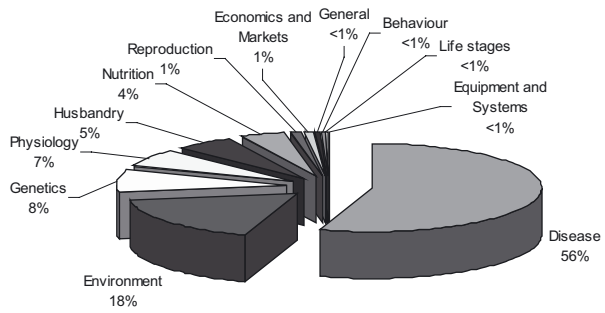

Figure 3. Distribution of aquaculture R&D spending since 1999 over subject areas.

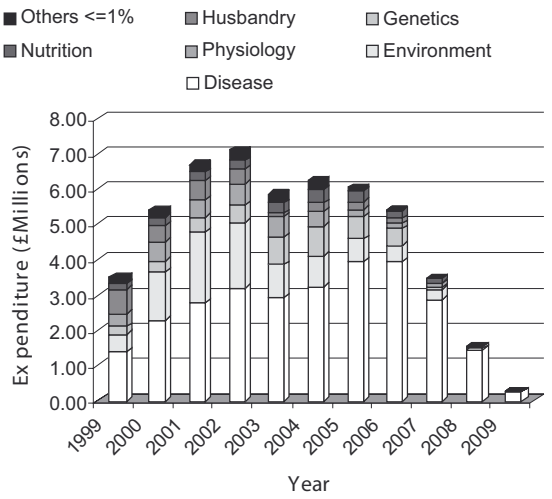

Figure 4. Expenditure in aquaculture R&D over subject areas 1999-2010

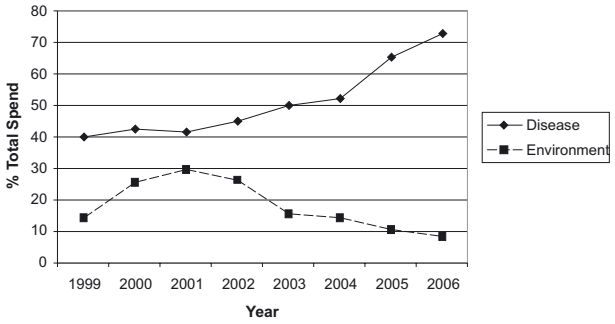

Figure 5. Proportion of aquaculture R&D expenditure on Disease and Environment subject areas.

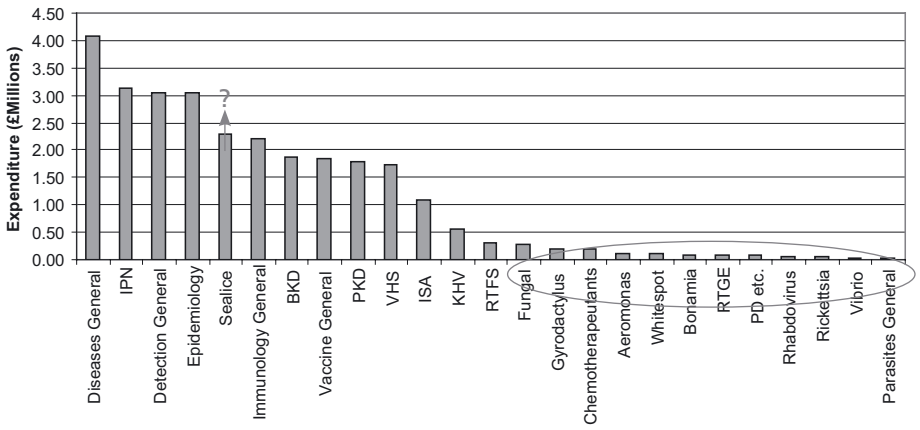

Figure 6. Distribution of R&D expenditure within Disease subject area. Strategically important diseases indicated by ellipse. Sealice expenditure believed to be an underestimate.

trend continues to 2011, the average cost of a project (for what ever reason) rises from about £48K to £62K – an increase of 30% over the next five years!

Figure 3 shows that disease and environment related R&D, account for about 75% of expenditure. The proportion of expenditure devoted to disease has increased significantly since 1999 (see Figure 4) and is now more than half the total commitment to aquaculture R&D in the UK.

Environment related research, which includes much of the shellfish organic pollution and biotoxin work, represents only 18% of spend. An increasing proportion is contributed by genetics, whilst little is spent on equipment and technology development.

Closer examination of expenditure of the two main subject areas- disease and environment - is revealing. Figure 5 shows the data indicate that over the past eight years disease expenditure has doubled, whilst environment related expenditure (as a percentage) has halved.

If we examine the "Disease" subject area in more detail, it is clear that the UK is, or has recently been, active in R&D related to a wide range of commercially important aquaculture diseases. Figure 6 shows the distribution of spend on the range of disease subject areas identified in the R&D database. The distribution is skewed towards significant levels of investment in a few key areas – principally, salmonid diseases and generic disease related themes (detection, epidemiology, immunology and vaccine development). In contrast, relatively modest funds have been allocated to a wide range of other disease areas – some of which, such as Gyrodactylus could be considered as strategically very important (ringed). The figure for sea lice R&D is undoubtedly much higher than is reflected in the database as some figures for work in this area have not been provided. By far the largest area of expenditure falls under the heading "Diseases General" – largely because it is not possible from the information provided for many of these projects to determine exactly what work is being conducted. It would certainly be helpful to develop mechanisms to ensure greater clarity in this area.

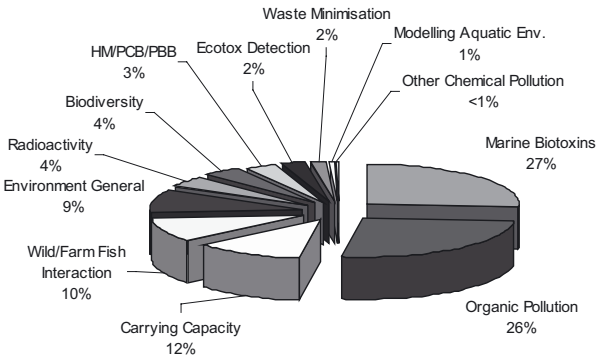

Figure 7: Distribution of R&D expenditure within Environment subject area.

As Figure 7 reveals, environmental research has been dominated by studies related to the impact, detection and amelioration of marine biotoxins and organic pollution in relation to the shellfish sector. Figure 3 clearly illustrates a significant investment in this area between 2000 and 2005. Much of this funding has been committed by the FSA and indications are that this has now come to an end.

Work on carrying capacity has increased significantly from 2003 onwards. The figures quoted do not include investment in Northern Ireland through the SMILE project and related R&D. Carrying capacity work is developing apace and this is an area where careful co-ordination is required to prevent duplication of effort. Our capacity to collect, collate and model data has never been greater. The development of robust carrying capacity models can, perhaps for the first time, be considered a realistic prospect with relatively modest resources.

For those readers who are still awake and interested in some real punishment we will now take a brief foray into the world of EUROSTAT! The following data has been extracted from the extremely useful EUROSTAT database (http://epp.eurostat.cec.eu.int) and provides some compelling and sobering insights into levels of R&D expenditure as a function of Gross Domestic Product (GDP). For comparison, in Figure 8 the GDP data for the main aquaculture producing countries in Europe has been combined and compared with the UK, Norway, the US and Japan. The thicker line represents the EU's Lisbon Agenda target for the percentage GDP R&D expenditure. This is the magic target figure that has been chosen with the aim of "making the [EU] region the worlds most dynamic and competitive knowledge based economy by 2010".

The results show that in contrast to other "developed" European aquaculture producers, the UK's %GDP spend on R&D has declined over the past 20 years – with every prospect that if the trend continues we will fall below the EU average and be allocating significantly less than half the Lisbon target of 3%.

So much for EUROSTAT, but what should we be using as a possible benchmark for current levels of investment in aquaculture R&D. Notionally, the percentage of UK R&D spend as a function of the first sale value of aquaculture might be a useful starting point. For 2005 the total estimated UK expenditure on R&D for this sector (including ornamentals) was about £6.1 million. Excluding the ornamental sector (because Defra together with the Ornamental and Aquatic Trade Association are currently sponsoring a project to assess the value of this industry), the

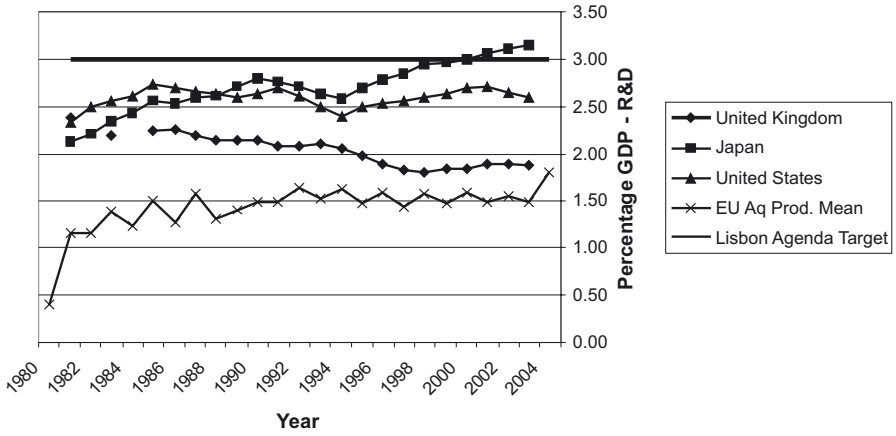

Figure 8. Levels of R&D expenditure as a percentage of Gross Domestic Product (GDP).

first sale value of "mainstream" aquaculture has been estimated as approximately £344 million in 2005. On this basis about 1.74% of the sector's first sale value was invested in R&D, which is very much in line with the generic estimate for the percentage GDP spent on all UK R&D for 2003 (most recent estimate) of 1.88%.

If the forecast of project costs increasing by 30% by 2011 is accepted– rather than simply an anomaly generated by a trend towards fewer larger projects, investment in R&D will need to increase by more than twice the current background level of inflation. The likelihood of securing such an increase from public sources is highly unlikely. Our best option is to become more efficient by establishing structures to ensure more effective competition for available resources coupled to better co-ordination and management of projects.

Obviously we should reflect upon the EUROSTAT figures - the UK's economy has expanded significantly over the last two decades which means that the overall funding commitment to R&D has increased, but the level of investment has not kept pace with economic expansion. These facts beg the questions – has this reduced slice of GPD for R&D had a detrimental impact, has the potential growth of the UK economy over the last 20 years been constrained or, as with many deferred payments, are we simply storing up an innovation and technology deficit which will manifest itself with vengeance as the grip of global warming, diminishing energy reserves and intensifying economic competition takes hold over the next 20 years?

NEW FOREST BARRAMUNDI

From early spring 2006 barramundi will be available to UK consumers fresh from the farm to the plate within 24 hours. This warm-water fish usually found in Australasia and with a reputation for excellent eating will come from New Forest Barramundi, a state-of-the-art indoor fish farm built by Aquabella Group plc.

Led by Les Green, Aquabella has constructed the recirculation farm on a 3.5 acre site in the New Forest, Hampshire. Initially, the company is on-growing imported juvenile barramundi (*Lates calcarifer*) but, within a year, there are plans to implement an in-house hatchery.

Several million pounds worth of investment, coupled with a strategy of employing leading specialists in each part of the operation, has seen a former frozen pizza factory transformed into one of the world's leading aquaculture centres in just 12 months.

An ambitious build

New Forest Barramundi is one of Europe's largest indoor fish farms and initially will produce more than 400 tonnes of barramundi every year. Work only commenced on the design and development of the farm based in Lymington in January 2005 yet the company already has "fish in water" and will commence the first commercial harvests by the end of March 2006.

As with any complex construction work, there have been many challenges during the past year but the project has been delivered almost to schedule. Specialist Norwegian aquaculture system designer AquaOptima combined with UK engineers Blenheim House Construction (BHC) and project management specialists Paradigm to create a close working project team that was responsible for the installation and commissioning.

Words don't really convey the size or quality of the facilities: 48 indoor tanks with an array of water treatment facilities; over 2.5 million litres of water; pristine growing conditions; no additives or hormones given to the fish and a constant room and water temperature of around 28°C.

The site also provides ample room for expansion. New Forest Barramundi can increase production from the initial 400 tonnes to many times that level.

Unique and sustainable technology

New Forest Barramundi has created an ideal growing environment to deliver consistent quality barramundi for UK consumers. The farm uses an advanced recirculation aquaculture system pioneered in Norway during the last 20 years.

Unlike most fish farms, which still use basic outdoor facilities giving little or no control over water temperature or quality, New Forest Barramundi is grown indoors in a pristine environment. There is computerised control over the water and air parameters (such as temperature, dissolved oxygen and pH levels).

Nearly all the water used in the farm is recycled – around 99.68% - meaning low water replacement and hence minimum drain on local

resources. The fish receive a high quality feed that is produced by Skretting (part of Nutreco) and was specially formulated with Aquabella to optimise the use of fish from non-endangered species.

The recirculation system being used by New Forest Barramundi has sustainability at its heart and is generally considered a very environmentally friendly method of farming. Unlike outdoor fish farms, this approach allows full control over the water environment. Also, many governments around the world are starting to actively encourage companies to use this method because of dwindling fish stocks in the sea.

A special team

From the outset, the company made the decision to minimise the total project time by running as many activities in parallel as it could. It also decided to employ leading system designers, project managers and construction engineers to ensure the work was delivered on time.

CEO Les Green is a business developer with successes outside aquaculture, and brings a 'thinking outside the box' approach to a notoriously inward-looking industry. This is evident in how Aquabella intends to sell the fish: with more emphasis on the direct approach to a burgeoning restaurant business rather than through the usual 'middle men' or agencies.

New Forest Barramundi has also sought out some of the best talent to be responsible for the daily operations and management of the company. The reason is New Forest Barramundi wants to be recognised as a business that not only delivers high quality product to its customers but also has sales and support services to match.

A unique product

Barramundi is a premium white fish found primarily in Australia and in parts of Asia. It is extremely popular as a table fish, due to its delicate taste, versatility and manageable bone content. The fish is arguably most comparable to sea bass, although some describe it as similar to monkfish and Dover sole. It is easy to cook and is usually steamed, fried or grilled and most commonly served with a lemon and herb butter. Not only is it a great tasting fish but it is very healthy too – being low in fat and high in essential Omega-3 oils.

Future plans

New Forest Barramundi may be growing an Australian fish using Norwegian technology but it is determined to be a local company contributing to the New Forest community. Most of the staff already employed are local to the New Forest, including many graduates from Sparsholt College (one of the UK's leading aquaculture centres).

Although initial stocks of fingerlings will come from Australasia there are plans to build a hatchery, due for completion at the end of 2006. This will mean future supplies of fish will be uniquely hatched and harvested in the New Forest!

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VETERINARY RESIDUES COMMITTEE'S ANNUAL REPORT FOR 2004 HAS BEEN PUBLISHED

The VMD's residue surveillance results for the whole of 2004 were published in September 2005 in the Annual Report of the Independent Veterinary Residues Committee (VRC). This reported a generally good picture for the trout industry. For most substances tested, no residues above statutory limits were detected.

However, two samples of trout muscle tested contained residues of leucomalachite green, one of which also contained residues of malachite green. Follow-up investigations confirmed

the recent use of malachite green. Movement restrictions were placed on the two farms and the affected fish were required to be slaughtered and destroyed.

The report also explains the work of the Committee in assessing the health implications from food containing residues of veterinary medicines and other substances. It also explains the most significant results from the VMD's surveillance programmes in all livestock sectors.

The report is available to download from the VRC website: www.vet-residues-committee.gov.uk. Paper copies are available free of charge from Isabel Sharma on 01932 338330. e-mail i.sharma@vmd.defra.gsi.gov.uk or by writing to:

Secretariat
Veterinary Medicines Directorate
Woodham Lane
New Haw
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KT15 3LS

THE VETERINARY MEDICINES DIRECTORATE REPORTS NO RESIDUES IN 2005, TO DATE

The Veterinary Medicines Directorate (VMD) has reported that its 2005 programme of statutory sampling of farmed trout had found no violative residues of veterinary medicines or illegal substances to date. This is reassuring after the discovery of two non-compliant samples from the 2004 programme.

It is particularly pleasing that no residues of malachite green or leucomalachite green have been found. This indicates that the industry has responded to calls for its use to stop. To help maintain this position, you may recall VMD's offer of an amnesty for any stocks of malachite green that might have been gathering dust in storerooms. This initiative had the support of Nick Read, chairman of the British Trout Association.

Trout producers in England and Wales had three weeks up to the 19 December to phone Cefas and have any malachite green collected – free of charge. Several producers contacted Cefas to take advantage of the offer. Possession, as well as use, of unauthorised substances, such as malachite green, is an offence under the Veterinary Medicines Regulations, which came into force in October 2005. Any business found in possession of unauthorised substances could now face prosecution.

SPARSHOLT OLD BOYS AND GALS

A reunion get-together for past Sparsholt students is planned for Saturday 2 September 2006, the brainchild of Stuart Leach at Padworth Trout Farm and his famous year class. A barbecue, a few pints and fun and games are all in the offing.

Come and be part of the reunion. Why not try to coordinate your whole year class attending? If you haven't been back recently, you will not believe the change. We have proper classrooms (with roofs and no leaks!), an amazing Aquatic Centre with over 100 weird and wonderful fish species, the Hatchery as ever it was and a fantastic 2 acre lake, fed by water from the Hatchery.

For further information, contact Shaun Leonard at Sparsholt on sleonard@sparsholt.ac.uk or 01962 797266.

OPINION OF THE SCIENTIFIC PANEL ON CONTAMINANTS IN THE FOOD CHAIN ON A REQUEST FROM THE EUROPEAN PARLIAMENT RELATED TO THE SAFETY ASSESSMENT OF WILD AND FARMED FISH

Question N° EFSA-Q-2004-23 Adopted on 22 June 2005

SUMMARY

EFSA was requested by the European Parliament to conduct a scientific assessment of the health risks related to human consumption of wild and farmed fish. An EFSA Interpanel working group was set up to conduct this assessment. The opinion focused on the following finfish species as being marketed to a significant amount in the European Union: salmon, herring, anchovies, tuna, mackerel, pilchards, rainbow trout and carp. A special focus was also given to Baltic herring at the request of the European Parliament.

Of the selected fish, salmon, rainbow trout and carp are predominantly or exclusively farmed. The other species are predominantly caught from the wild.

About two-thirds of fish consumed in the EU is caught from the wild. Species, season, diet, location, lifestage and age have a major impact on both the nutrient and contaminant levels of fish. These levels vary broadly within species and between species in both wild and farmed fish. There is a need for standardisation of sampling procedures before a robust comparison of wild and farmed fish can be made. From the limited data available it seems that if there are any differences between farmed and wild fish, they are small when taking into account the above mentioned factors. However, regional differences exist, e.g. in the Baltic Sea. Contaminants in fish derive predominantly from their diet, and levels of bioaccumulative contaminants are higher in fish that are higher in the food chain. Whilst it is not possible to control the diet of wild fish, the levels of contaminants, and of some nutrients, in farmed fish may be modified by altering their feed. Fish meal and fish oil, are the most important sources of contamination of farmed fish feed with dioxin-like compounds. EU regulations on polychlorinated dibenzo-*p*-dioxins and furans (PCDD/F) in fish feed were introduced in 2002; the planned inclusion of the dioxin-like polychlorinated biphenyls (DL-PCBs) in the regulations may help to reduce levels of these contaminants in farmed fish.

Fatty fish is an important source of long chain n-3 polyunsaturated fatty acids (LC n-3 PUFA). Other substantial natural sources of LC n-3 PUFA are human milk and marine algae. Farmed fish tend to have higher total lipid levels with lower proportions of LC n-3 PUFA than wild fish. Together, these differences mean that the amount of LC n-3 PUFA per portion of fish is similar. Replacement of fish products by vegetable protein and oils in fish feed or decontamination procedures may be a possible means of reducing some contaminant levels. However modification of the fish oil inclusion rate may change the fatty acid composition and in particular reduce the LC n-3 PUFA levels in farmed fish.

There is evidence that fish consumption, especially of fatty fish (one to two servings a week) benefits the cardiovascular system and is suitable for secondary prevention in manifest coronary heart disease. There may also be benefits in foetal development, but an optimal intake has not been established.

Fish can contribute significantly to the dietary exposure to some contaminants, such as methylmercury, persistent organochlorine compounds, brominated flame retardants and organotin compounds. The most important of these are methylmercury and the dioxin-like compounds, for which high level consumers of certain fish may exceed the provisional tolerable weekly intake (PTWI) even without taking into account other sources of dietary exposure. Such exceedance is undesirable and may represent a risk to human health if repeated frequently. However, eating for example meat instead of fish will not necessarily lead to decreased exposure to dioxin-like compounds. Intakes of the other contaminants in fish reviewed in this opinion were not a health concern, because they do not contribute significantly to total dietary exposure and/or it is very unlikely that even high level consumers of fish exceed the health-based

guidance values, if available.

The greatest susceptibility to the critical contaminants, e.g. methylmercury and the dioxin-like compounds occurs during early development. Exposure during this life stage results from the total amount in the mother's body. For methylmercury it is possible for a woman to decrease the amounts in her body by decreasing intake in the months preceding and during pregnancy, whereas this is not possible for the PCDD/Fs and DL-PCBs because it would take many years to decrease the levels in the body significantly. This evaluation focussed on fish that are widely available in the EU, and likely to be consumed most frequently. Of these, the highest levels of methylmercury are found in tuna, which is mostly caught from the wild. The fish with the highest levels of PCDD/F and DL-PCBs are herring which are caught from the wild and salmon which are mostly farmed.

Frequent consumers of Baltic herring and wild Baltic salmon are more likely to exceed the PTWI for PCDD/F and DL-PCBs than other consumers of fatty fish Overall the Panel concluded that with respect to their safety for the consumer there is no difference between wild and farmed fish.

SCIENTISTS HOST CONFERENCE FOR FISH FARMERS

Cefas Weymouth Laboratory, 19 January 2006

Scientists at the Centre for Environment, Fisheries & Aquaculture Science (Cefas) hosted a conference for coarse and ornamental fish farmers at their Weymouth laboratory recently. The conference, entitled "Working Together to Control Disease", was organised to support a government initiative to encourage the development of farmer discussion groups.

Stakeholders and trade associations are encouraged to inform themselves about new reforms and changes in legislation that affect their members. The conference aimed to

- encourage open debate, greater understanding and consensus with coarse and ornamental fish farmers on fish health issues
- update English and Welsh farmers on recent legislative changes and other issues likely to affect their businesses
- identify and discuss problems affecting fish farmers
- provide helpful and informative advice to the industry
- encourage the further development of the recently formed Coarse Fish Farmers and Traders Association (CFFTA).

Speakers from Cefas, the Environment Agency and the Department for Environment, Food and Rural Affairs (Defra) covered such topics as new fish health legislation, emerging fish diseases, the EU's Water Framework Directive, the role of an aquaculture development officer, codes of practice for fish farmers, and the future development of the new trade association.

Eric Hudson of the Fish Health Inspectorate (FHI), part of Cefas, said: "Providing the fish farmers with an opportunity to tour the laboratory, learn about the work of Cefas, and ask questions went a long way towards developing greater understanding and closer working with the industry. The fish farmers present voiced their thanks for this opportunity."

Bernice Brewster, chair of the newly formed Coarse Fish Farmers and Traders Association (CFFTA) thanked Cefas for organising the day and all the advice provided. She said: "In future, the CFFTA hope to be able to speak on behalf of farmers from across the country and to represent them in talks with government agencies on issues affecting their industry."

2004 SURVEY OF TROUT PRODUCTION IN SCOTLAND

Data supplied from SEERAD (Scottish Executive Environment and Rural Affairs Department) Annual Production Survey, 2004 via the website: www.marlab.ac.uk

Rainbow trout were produced from 43 sites involving 38 companies with an overall production of 6,352 tonnes in 2004 (7,085 tonnes in 2003) a decrease of 733 tonnes on the previous year (just over 10%). Trends in production over the last 10 years are given in Table 1 below.

Table 1. Total (table and restocking) production for the period 1995 - 2004 (tonnes)

Year	Tonnes
1995	4,683
1996	4,630
1997	4,653
1998	4,913
1999	5,834
2000	5,154
2001	5,466
2002	6,659
2003	7,085
2004	6,352

Table 2. Production of table fish for the period 1995 - 2004 (tonnes)

Year	<450g <1lb	Fish Size 450 - 900g 1-2 lb	>900g >2lb	Total
1995	2736	199	1149	4084
1996	2701	181	1002	3884
1997	2,646	104	1,098	3,848
1998	3,009	173	887	4,069
1999	3,151	144	1,562	4,857
2000	3,005	203	1,103	4,311
2001	3,053	404	1,217	4,674
2002	2,937	1,056	1,718	5,711
2003	2,531	1,181	2,477	6,189
2004	1,553	1,946	1,917	5,416

Table production

Table 2 gives trends in production for table fish over the past 10 years. Production in 2004 amounted to 5,416 tonnes representing a decrease of 773 tonnes (just over 12%) on the previous year and accounting for 85% of total production. Fish in the weight class of 450 - 900g were the most prevalent, representing 36% of table production.

Restocking production

Table 3 provides production data for the restocking trade for the last 10 years. Production for restocking increased by 40 tonnes (just over 4%) to 936 tonnes representing 15% of the total production (just over 12% in 2003).

Table 3. Production of restocking fish for the period 1995 - 2004 (tonnes)

Year	<450g <1lb	Fish Size 450 - 900g 1-2 lb	>900g >2lb	Total
1995	107	411	81	599
1996	188	484	74	746
1997	97	589	119	805
1998	69	538	237	844
1999	236	552	187	975
2000	41	609	193	843
2001	18	526	248	792
2002	28	484	436	948
2003	63	490	343	896
2004	64	509	363	936

Escapes

There were no reported escapes from rainbow trout sites in 2004.

Method of production

Table 4 provides a breakdown of trout farms by system and scale of production. Freshwater production accounted for 5,238 tonnes (82% of the total) while seawater production decreased by 20% on the previous year to 1,114 tonnes (18% of the total).

Production and manpower by region

The regional production and manpower information shown in Table 5 relate to Scottish Local Government Regions following their reorganization in 1996. Productivity ranged from 23.3 to 71.5 tonnes/person between production areas, being greatest in the West and least in the Southern area.

Mean productivity in tonnes/person for the four population areas reached 41.8 tonnes. In 2004 staff employed totalled 152.

Rainbow trout ova production in Scotland

The number of rainbow trout eyed ova laid down for hatching from home-produced stock, from other sources within Great Britain and from foreign imports are given in Table 6 for the period 1995 – 2004. The number of ova laid down from GB broodstock decreased to 0.65 million representing almost 2% of the total. The total number of eyed-ova laid down increased by 6.2 million (23.5%) to 32.6 million.

Type of ova

Details of the number and type of ova laid down for hatching in Scotland are given in Table 7. The preference for all female diploid stock was again evident, accounting for 90% of all ova laid down. Triploid ova increased to almost 10% of the total, while mixed sex ova showed a slight increase from 60,000 to 138,000, though still forming less than 1% of the total.

Table 4. Analysis of rainbow trout farms by system and scale of production

Production method	Total tonnage and Production grouping (tonnes) in 2004					(%) by method		Number of sites	
	<10	10-25	26-50	51-100	>100	2003	2004	2003	2004
FW cages	0	2	0	0	7	3,664 (51.8)	3,320 (52.3)	9	9
FW ponds and raceways	2	6	7	7	5	1,998 (28)	1,910 (30.1)	27	27
FW tanks and hatcheries	3	0	0	0	0	42 (0.6)	8 (0.1)	4	3
SW cages	1	0	0	0	3	1,391 (19.6)	1,114 (17.5)	3	4
SW tanks	0	0	0	0	0	0	0	0	0
Total	**6**	**8**	**7**	**7**	**15**	**7,085**	**6,352**	**43**	**43**

Table 5. Rainbow trout production and staffing by area in 2004

Area	No. of sites*	Production			Mean tonnes/ sites	Staffing			Productivity tonnes/ person
		Table	Restocking	Total		F/T	P/T	Total	
North	10	601	117	718	71.8	14	3	17	42.2
East	18	1,382	367	1,749	97.2	39	14	53	33
West	18	2,850	80	2,930	162.8	31	10	41	71.5
South	16	583	372	955	59.7	31	10	41	23.3
All	**62**	**5,416**	**936**	**6,352**	**102.4**	**115**	**37**	**152**	**41.8**

* The number of sites includes farms specialising in the production of ova and young fish for ongrowing

Imported rainbow trout eggs in 2002

The number and source of imported rainbow trout ova for the period 1997 – 2004 are given in Table 8. The total imported in 2004 (32.9 million) represents an increase of 8.8 million (just over 37%) on the previous year.

Other species

Production of other finfish species farmed in Scotland together with the production figures for the previous year is given in Table 9.

Table 6. Number (000s) and proportions (%) of rainbow trout ova types laid down for hatching in 1995-2004

Year	All female diploid (%)	Triploid (%)	Mixed sex diploid (%)	Total ova
1995	19,546 (94)	1,170 (6)	119 (<1)	20,835
1996	21,308 (94)	935 (4)	435 (2)	22,678
1997	21,118 (90)	1,386 (6)	1,000 (4)	23,503
1998	23,222 (92)	1,515 (6)	504 (2)	25,241
1999	16,324 (88)	1,853 (10)	456 (2)	18,633
2000	17,264 (82)	1,202 (6)	2,513 (12)	20,979
2001	20,788 (90)	2,107 (9)	140 (1)	23,035
2002	19,733 (89)	1,822 (8)	570 (3)	22,125
2003	24,692 (94)	1,586 (6)	60 (<1)	26,338
2004	29,272 (90)	3,146 (10)	138(<1)	32,556

Table 7. Number (000s) and sources of rainbow trout ova laid down for hatching in 1995 - 2004

Year	Own Stock	Other GB Stock	Total GB	Total 3rd Country	Grand Total	% GB
1995	165	360	525	20,310	20,835	2.5
1996	420	988	1,408	21,270	22,678	6.2
1997	1,232	837	2,069	21,434	23,503	8.8
1998	2,559	60	2,619	22,633	25,252	10.4
1999	878	392	1,270	17,361	18,631	6.8
2000	1,397	900	2,297	18,686	20,983	10.9
2001	918	525	1,443	21,590	23,033	6.3
2002	530	200	730	21,394	22,124	3.3
2003	430	280	710	25,628	26,338	2.7
2004	330	320	650	31,906	32,556	2.0

Table 8. Number (000s) and sources of ova imported into Scotland during 1997-2004

Source	1997	1998	1999	2000	2001	2002	2003	2004
Northern Ireland	2,425	2,065	3,335	1,085	710	-	-	405
Isle of Man	4,205	3,273	4,222	5,842	6,670	6,775	6,855	8,012
Denmark	5,354	5,700	4,546	4,225	6,135	5,000	5,270	6,370
France	-	-	-	-	-	-	875	-
Other EU	-	-	-	-	-	-	-	17,335
South Africa	9,450	11,585	6,036	7,762	8,075	7,750	50	800
USA	-	-	-	-	-	1,700	11,035	
Totals	**21,434**	**22,623**	**18,139**	**18,914**	**21,590**	**21,225**	**24,085**	**32,922**

Table 9. 2003 and 2004 production (in tonnes) of other finfish species farmed in Scotland

	Production	
Species	2003	2004
Atlantic salmon	169,736	158,099
Arctic char	3.1	3.25
Brown trout/Sea trout	198.3	167
Cod	82.1	8
Halibut	231.8	186.8

TROUT PRODUCTION - NORTHERN IRELAND 2004 (TONNES)

	Table	Restocking	Total
Production of rainbow trout	431	112	543
Trout production (all trout)	435	116	551

SUMMARY OF UK RAINBOW TROUT PRODUCTION IN 2004

Detail of rainbow trout production in 2004 for both the table and restocking trades are given below for England and Wales, Northern Ireland and Scotland. Total production of rainbow trout amounted to 15,917 tonnes.

	Production in tonnes		
	Table	Restocking	Totals
England and Wales	5,858 (65%)	3,164 (35%)	9,022
Scotland	5,416 (85%)	936 (15%)	6,352
Northern Ireland	431 (79%)	112 (21%)	543
Totals	**11,705 (74%)**	**4,212 (26%)**	**15,917**

EUROPEAN TROUT PRODUCTION

The latest production figures for rainbow trout released by the Federation of European Aquaculture Producers (FEAP) on its website (http://www.feap.org) are given below for 22 European countries. The figures for large rainbow trout are for fish in excess of 1 kg in weight and include both fresh-water and sea-grown (salmon trout) production.

Total European production for 2004 is estimated to be nearly 334,105 tonnes with Norway again as the leading producer at 55,000 tonnes, followed by Turkey, Denmark, France and Italy with 40,250, 40,000, 37,500 and 35,500 tonnes respectively. UK production estimated at 17,200 tonnes ranked eighth in the league of European trout producing countries.

European production of portion-sized (P) and large (L) rainbow trout for the period 1999 - 2004

Country	1999	2000	2001	2002	2003	2004
Austria	3,000 P	3,000 P	3,000 P	3,000 P	3,000 P	3,000 P
	400 L	400 L	400 L	400 L	400 L	400 L
Belgium/Luxemberg	700 P	600 P	600 P	400 P	400 P	400 P
	100 L	100 L	100 L			
Cyprus	66 P	90 P	90 P	90 P	90 P	90 P
Czech Republic	723 P	700 P	700 P	656 P	650 P	650 P
Denmark	30,000 P	30,000 P	30,000 P	31,000 P	27,000 P	27,000 P
	7,500 L	7,500 L	7,000 L	6,500 L	13,000 L	13,000 L
Faroe Islands	2,169 L	1,141 L	4,000 L	10,000 L	10,020 L	10,020 L
Finland	15,300 L	15,200 L	15,200 L	14,500 L	13,920 L	13,920 L
France	37,000 P	37,500 P	37,500 P	32,500 P	27,500 P	27,500 P
	8,000 L	10,000 L	10,000 L	10,400 L	10,000 L	10,000 L
Germany	22,500 P	22,500 P	22,500 P	23,000 P	23,000 P	23,000 P
	2,500 L	2,500 L	2,500 L	2,500 L	2,500 L	2,500 L
Greece	2,800 P	2,500 P	3,000 P	3,000 P	3,000 P	3,000 P
Hungary		27 P	30 P	29 P	25 P	25 P
Iceland	100 L	180 L	500 L	248 L	180 L	100 L
Ireland	1,000 P	1,000 P	1,000 P	2,000 P	1,000 P	
	1,100 L	1,400 L	1,600 L	700 L	350 L	350 L
Italy	43,200 P	43,700 P	43,000 P	41,900 P	37,400 P	34,900 P
	800 L	800 L	1,000 L	600 L	600 L	600 L
Netherlands	200 P	200 P	200 P	200 P	200 P	200 P
Norway	50,000 L	47,000 L	60,000 L	83,000 L	71,000 L	55,000 L
Poland	9,000 P	10,160 P	11,000 P	11,000 P	13,000 P	13,500 P
Portugal	1,500 P	1,500 P	1,500 P	1,500 P	1,500 P	1,500 P
Spain	27,000 P	28,500 P	29,500 P	29,500 P	31,500 P	31,500 P
	700 L	1,500 L	1,500 L	4,500 L	1,500 L	1,500 L
Sweden	7,250 L	7,000 L	7,000 L	3,500 L	3,000 L	3,000 L
Turkey	17,200 P	18,220 P	18,220 P	35,250 P	38,250 P	38,250 P
	2,200 L	2,400 L	2,400 L	1,240 L	2,000 L	2,000 L
UK	13,200 P	15,200 P	16,500 P	16,200 P	16,200 P	16,200 P
	600 L	2,600 L	2,600 L	1,200 L	1,000 L	1,000 L
Total portion size	209,089	215,397	218,340	231,225	223,715	220,715
Total large size	98,719	99,721	115,800	139,288	129,470	113,390
Grand Total	307,808	315,118	334,140	370,513	353,185	334,105

1. Cormorant impact on fisheries

Numbers of great cormorants feeding in inland waters during winter have increased throughout Europe resulting in concerns over their impacts on fisheries. Loch Leven is a world-renowned sport fishery for trout and supports a nationally important population of wintering cormorants. This study on Loch Leven examined the relationships between brown trout stocking, regional cormorant numbers and cormorants counted during winter. The data suggest that the number of cormorants at this site is influenced by both the stocking policy and the regional population level. Stocked brown trout were fin-clipped before release and gut contents of a sample of 96 cormorants shot under scientific licence were analysed. Overall, trout made up 85% of the diet by weight - brown trout predominated (70%), rainbow trout occurred less frequently (6%), and the remainder (9%) was composed of trout which could not be identified to species. There was no difference in the ratios of wild:stocked brown trout sampled from the loch and from cormorant stomachs. A model was constructed to investigate the likely loss of trout to cormorants. It was estimated that cormorants consume 81,000 brown and 5,000 rainbow trout over a 7-month period. These estimates compared to average annual (1996-2000) fishery catches of 6,000 brown and 13,000 rainbow trout. Estimates of the trout populations in Loch Leven indicate competition between the birds and the fisheries for available fish. It is suggested that stocking has led to an increase in cormorant numbers and the subsequent increase in predation may have prevented any increase in the trout population or in fishery catches.

Stewart, D.C. (D.C.Stewart@marlab.ac.uk), Middlemas, S.J., Gardiner, W.R., Mackay, S., Armstrong, J.D. (2005). Diet and prey selection of cormorants (*Phalacrocorax carbo*) at Loch Leven, a major stocked trout fishery. *Journal of Zoology*, 267: 191-201.

2. Finnish study of whitespot chemotherapeutants

Since the use of malachite green was banned in many European countries, new alternative treatments are being tested to prevent white spot disease caused by *Ichthyophthirius multifiliis*. This study tested the effectiveness of formalin, potassium permanganate, chloramine-T, hydrogen peroxide and Per Aqua or Desirox alone and in combination with formalin at two farms producing salmon smolt. Per Aqua and Desirox are combinations of peracetic acid, acetic acid and hydrogen peroxide. The alternative chemicals or their combinations were found to successfully lower the parasite burden to such a level that no high mortality occurred during the first 4 weeks after the start of an infection. This period of time allows the fish to develop immunity against these ciliates, and treatments can then be reduced and stopped in due course. *I. multifiliis* decreased in number 3-4 weeks after the beginning of the infection in all the treatments. Large differences in parasite burden and mortality occurred among the replicates in all except the Desirox-formalin tanks, which means that they are not as reliable as the malachite green-formalin used previously. It was also evident that the chemicals and their concentrations must be planned carefully to suit the conditions on each farm.

Rintamaki-Kinnunen, P. (paivi.rintamaki@oulu.fi); Rahkonen, M., Mannermaa-Keranen, A.L., Suomalainen, L.R., Mykra, H., Valtonen, E.T. (2005). Treatment of ichthyophthiriasis after malachite green. I. Concrete tanks at salmonid farms. *Diseases of Aquatic Organisms*, 64: 69-76.

3. Fungal control using copper

This study evaluated the antifungal efficacy of copper for rainbow trout eggs by running the inflow water through copper fibre. Fungal infection in eggs was lower in the copper fibre groups than in control groups. An in vitro experiment using copper nitrate demonstrated that a concentration of 0.006 ppm prevented the zoospore germination of *Saprolegnia diclina*. The potential side-effects of copper on embryonic development were also examined for two weeks. A copper concentration of 0.006 to 0.020 ppm did not affect the rate of eyed eggs or, after transferring eggs to water without copper, on the rates of hatching or deformity.

Miura, M. (miura-ajf@pref.yamanashi.lg.jp), Oono, H., Tuchida, N., Hatai, K., Kiryu, T. (2005). Control of water mold infection in rainbow trout eggs by using copper fiber. *Fish Pathology*, 40: 81-86.

4. Identifying attributes of sustainable farming

Recent developments in agriculture have stirred up interest in the concept of "sustainable" farming systems. However, it is difficult to determine the extent to which agricultural practices can be considered sustainable or not. This study aimed at identifying the necessary attributes with respect to sustainability in Dutch dairy farming. Initially a list of attributes was compiled referring to all farming activities with their related side effects with respect to economic, internal social, external social, and ecological sustainability. A wide range of experts and stakeholders contributed to the list of attributes. This consultation showed that only one attribute was selected for economic and internal social sustainability, i.e. profitability and working conditions, respectively. The list for external social sustainability contained 19 attributes and the list for ecological sustainability contained 15 attributes. To assess their relative importance, the same experts and stakeholders ranked the attributes for external social and ecological sustainability by using a questionnaire. The most important attributes for external social sustainability were food safety, animal health, animal welfare, landscape quality, and cattle grazing. For ecological sustainability they were eutrophication, groundwater pollution, dehydration of the soil, acidification, and biodiversity. This method for identifying and ranking attributes is universal and can therefore be used for other agricultural sectors, for other countries, and for other time periods.

Van Calker, K.J. (KlaasJan.vanCalker@wur.nl), Berentsen, P.B.M., Giesen, G.W.J., Huirne, R.B.M. (2005). Identifying and ranking attributes that determine sustainability in Dutch dairy farming. *Agriculture and Human Values*, 22: 53-63.

5. Acute stress affects intestine of rainbow trout

Groups of rainbow trout in fed or food-deprived states were subjected to 15 min of acute stress. Blood and intestinal tissue samples were collected and prepared for physiological, chemical and ultrastructural analysis immediately before stress, and at 4 and 48 hours post-stress. Haematocrit, plasma cortisol and lactate levels increased following stress, and the response appeared to be more pronounced in food-deprived than in fed fish. Plasma glucose appeared to increase more in fed fish. Stress did not cause massive tissue damage as measured by cellular leakage of transaminase enzymes into the blood. However, ultrastructural studies showed that stress caused widening of the tight junctions between enterocytes in the midgut, with fed fish experiencing more damage than food-deprived fish. These changes were to a large extent transient and cellular organization in the midgut returned to normal values within 2 days. The hindgut adherent microbial population level was reduced following stress, while the level in faeces increased. This suggests that substantial amounts of mucus are peeled off following stress. It is concluded that acute stress caused cellular alteration in the rainbow trout gastrointestinal tract. Stress induced changes in adherent intestine microbial population level and compositions together with increased intestinal paracellular permeability suggest an increased susceptibility to bacterial infections, and that active feeding may have a protective role.

Olsen, R.E. (rolf.erik.olsen@imr.no), Sundell, K., Mayhew, T.M., Myklebust, R., Ringo, E. (2005). Acute stress alters intestinal function of rainbow trout, *Oncorhynchus mykiss* (Walbaum). *Aquaculture*, 250: 480-495.

6. Transportation stress in rainbow trout

This study investigated the behavioural and energetic responses of rainbow trout to a brief transportation episode. Fish implanted with radio transmitters measuring muscle activity (electromyogram; EMGi) were transported in a standard commercial shipping tank for 50 min by truck, and then allowed to recuperate for 48 hours in stationary culture tanks. The EMGi telemetry data indicated that vigorous swimming activity occurred during transportation. Telemetry recordings also indicated that the fish's swimming activity returned to baseline levels within 48 hours after transport. However, even beyond the 48 hour resting period, the swimming performance (measured as critical speed and endurance) of transported fish was still impaired relative to non-transported controls. Respirometry measurements of fish taken after transportation indicated that oxygen consumption was elevated. The rise in oxygen consumption of post-transport fish could be attributed to handling procedures, as well as the intense swimming behaviour observed during transportation. Therefore, the behavioural responses of fish during transportation

produced physiological consequences that persisted long after the transportation event. This study demonstrates the potential for utilizing behavioural measures, in concert with biotelemetry technologies, as tools to assess the impacts of routine aquacultural procedures on the health and welfare of captive fish.

Chandroo, K.P., Cooke, S.J., McKinley, R.S., Moccia, R.D. (rmoccia@uoguelph.ca) (2005). Use of electromyogram telemetry to assess the behavioural and energetic responses of rainbow trout, *Oncorhynchus mykiss* (Walbaum) to transportation stress. *Aquaculture Research*, 36: 1226-1238.

7. DNA vaccines for farmed fish

DNA vaccination is based on the administration of the gene encoding the vaccine antigen, rather than the antigen itself. Subsequent expression of the antigen by cells in the vaccinated hosts then triggers the host immune system. Among the many experimental DNA vaccines tested in various animal species as well as in humans, the vaccines against rhabdovirus diseases in fish have given some of the most promising results. A single intramuscular (IM) injection of microgram amounts of DNA induces rapid and long-lasting protection in farmed salmonids against economically important viruses such as infectious haematopoietic necrosis virus (IHNV) and viral haemorrhagic septicaemia virus (VHSV). DNA vaccines against other types of fish pathogens, however, have so far had limited success. The most efficient delivery route at present is IM injection, and suitable delivery strategies for mass vaccination of small fish have yet to be developed. In terms of safety, no adverse effects in the vaccinated fish have been observed to date. As DNA vaccination is a relatively new technology, various theoretical and long-term safety issues related to the environment and the consumer remain to be fully addressed, although inherently the risks should not be any greater than with the commercial fish vaccines that are currently used. Present classification systems lack clarity in distinguishing DNA-vaccinated animals from genetically modified organisms (GMOs), which could raise issues in terms of licensing and public acceptance of the technology. The potential benefits of DNA vaccines for farmed fish include improved animal welfare, reduced environmental impacts of aquaculture activities, increased food quality and quantity, and more sustainable production. Testing under commercial production conditions has recently been initiated in Canada and Denmark.

Lorenzen, N., LaPatra, S.E. (2005). DNA vaccines for aquacultured fish. *Revue Scientifique et Technique-Office International Des Epizooties*, 24: 201-213.

8. Wild and farmed reservoirs of ISA virus

Infectious salmon anaemia virus (ISAV) is an important pathogen of farmed salmon in Norway, Scotland, the Faeroe Islands, Ireland, Canada, the USA and Chile. It has been suggested that wild salmonids, mainly trout, act as reservoirs of benign wild-type variants of ISAV, with a change in virulence occurring after transmission to farmed salmon. Hence the frequency of new outbreaks of ISA in farmed salmon may partly reflect natural variation in the prevalence of ISAV in wild salmonid populations. In this study wild salmonids caught during spawning in rivers were screened for ISAV and the pathogenicity of resultant isolates was determined. The prevalence of ISAV in wild brown trout in the same rivers varied from 62 to 100% in 2001, 13 to 36% in 2002, and was only 6% in 2003. All ISAV isolates were non-pathogenic when injected into disease-free Atlantic salmon, but were capable of propagation. Non-pathogenic ISAV has also been found in farmed salmon, at prevalences as high as 60%. Based on the results of this and other studies, it is concluded that vital information is still lacking on the relative importance of wild and farmed stocks as reservoirs for ISA.

Plarre, H., Devold, M., Snow, M., Nylund, A. (are.nylund@bio.uib.no). (2005). Prevalence of infectious salmon anaemia virus (ISAV) in wild salmonids in western Norway. *Diseases of Aquatic Organisms*, 66: 71-79.

9. Finnish trout breeding programme

This paper reports on the Finnish breeding programme for rainbow trout. The analysis included two pedigreed populations with three generations and over 117,000 individuals recorded for skeletal deformities, growth and age at maturity. Because the breeding station is located in freshwater but sea is the main production environment, each family was split to test performance in fresh and sea water. Progress was assessed by estimating genetic trends in growth, maturity age and skeletal deformations and by calculating rates of

inbreeding and additive genetic relationships. Estimation of breeding values across the generations showed that multitrait selection has produced an average of 7% genetic gain per generation in fresh and sea water growth of market-sized fish. In the population with high frequency of early maturing males, phenotypic culling of early maturing males has prevented an increase in the frequency of early maturing fish. In the other population, the frequency of early maturing females has increased, the genetic change being unfavourable. Weak favourable or no correlated genetic changes were observed in the frequency of deformations in response to selection for the production traits. Rate of inbreeding has remained low, the maximum value being 0.7% per generation.

Kause, A. (Antti.Kause@mtt.fi), Ritola, O., Paananen, T., Wahlroos, H., Mantysaari, E.A. (2005). Genetic trends in growth, sexual maturity and skeletal deformations, and rate of inbreeding in a breeding programme for rainbow trout (*Oncorhynchus mykiss*). *Aquaculture*, 247: 177-187.

10. US trout breeding programme

This study estimated genetic (co)variance parameters for body weight (BW), condition factor (K-f) and resistance to acute thermal shock (upper thermal tolerance; UTT) in a three-generational rainbow trout pedigree derived from two commercial strains (Spring Valley (SV), Rainbow Springs (RS)). Two grandsires and several granddams in each strain were bred to create 63 second-generation pure strain families which were bred in turn to form 118 mixed third-generation half sib families. Heritability was high for all three traits in an extended animal model including terms for strain origin and hybrid effects. Genetic correlations between UTT and BW were essentially zero, and positive between UTT and K-f, and BW and K-f. RS fish had higher UTT, but lower BW and K-f than SV fish, suggesting fixed genetic effects of strains. Hybrid fish were less thermotolerant and heavier but had lower K-f than pure strain individuals, but hybrid effects accounted for relatively little genetic variance overall. The results indicate substantial selective potential on these traits, but that the efficacy of selection might depend on more complex genetic architecture.

Perry, G.M.L. (guy.perry@giroq.ulaval.ca), Martyniuk, C.M., Ferguson, M.M., Danzmann, R.G. (2005). Genetic parameters for upper thermal tolerance and growth-related traits in rainbow trout (*Oncorhynchus mykiss*). *Aquaculture*, 250: 120-128.

11. Canadian salmon breeding programme

The Atlantic Salmon Broodstock Development Program is a partnership of researchers and producers that aims to breed salmon with an optimal combination of fast growth rate, low incidence of early sexual maturation, and good carcass quality for commercial aquaculture in Atlantic Canada. Estimation of genetic parameters for these traits is an essential step in the development of this breeding program. Four year classes of Atlantic salmon were produced, each consisting of 48-93 full-sib families. Marked fish from each of these families were randomly distributed to several producers to be raised under commercial conditions. At harvest, gutted body weights and sexual maturation level were observed in 812-3471 individuals per year class at processing plants. Additionally, colour score, astaxanthin, canthaxanthin, fat and moisture contents were recorded on 472 immature individuals from one year class. Genetic parameters were estimated with single- and multiple-trait animal models. Body weight, astaxanthin, canthaxanthin, colour, fat and moisture all exhibited moderate heritabilities (0.1-0.2), indicating that these traits should respond to selection. Positive genetic correlations were found between body weight and the carotenoid pigments, colour, and fat. These results indicate that direct selection for weight may have favourable indirect responses of higher colour scores and pigmentation but also an undesirable increase in flesh fat content. A properly weighted selection index should therefore be used to select broodstock for increased harvest weight and flesh colouration, while controlling flesh fat content.

Quinton, C.D. (cquinton@uoguelph.ca), McMillan, I., Glebe, B.D. (2005). Development of an Atlantic salmon (*Salmo salar*) genetic improvement program: genetic parameters of harvest body weight and carcass quality traits estimated with animal models. *Aquaculture*, 247: 211-217.

12. Structure in rearing tanks improves fins

This study assessed whether structural enrichment reduces dorsal fin erosion in hatchery-reared fish by comparing the dorsal fin condition of juvenile steelhead reared in conventional hatchery tanks, enriched hatchery tanks (i.e. additional submerged structure,

overhead cover, underwater feeders), and a natural stream. Dorsal fin height at 27 days post-emergence (dpe) did not differ between the two hatchery rearing treatments. However by 50 dpe, fish reared in the conventional tanks had dorsal fins 78% as long as steelhead reared in enriched tanks and in the natural stream, and only 50% as long at 64 dpe. Variation in fin length did not substantially affect the ability to achieve dominance in agonistic contests for feeding territories. Rearing methods (such as structural enrichment), that simultaneously improve several attributes of juvenile salmonid morphology, physiology, or behaviour may be important in the development of conservation hatchery rearing strategies.

Berejikian, B.A. (barry.berejikian@noaa.gov), Tezak, E.P. (2005). Rearing in enriched hatchery tanks improves dorsal fin quality of juvenile steelhead. *North American Journal of Aquaculture*, 67: 289-293.

13. Overhead cover improves brown trout rearing

Overhead cover is an essential component of the habitat of wild brown trout but is generally not provided during hatchery rearing. To evaluate the effect of cover during hatchery rearing, this study grew feral brown trout in circular tanks that were either completely open or partially covered. In two separate experiments the total biomass of fish per tank and individual size were greater, and feed conversion was reduced, in the partially covered tanks compared to the open tanks after 51 days of rearing. There were no differences in mortality between groups reared in the partially covered and uncovered tanks. The use of partial tank covers can therefore increase the growth of feral juvenile brown trout during hatchery rearing.

Barnes, M.E. (mike.barnes@state.sd.us) (2005). Partial overhead tank cover use during feral brown trout rearing. *North American Journal of Aquaculture*, 67: 319-323.

14. Size distribution of suspended solids

The efficiency of the mechanical effluent treatment in flow-through fish farms depends mainly on the size distribution of the suspended solids. In this study the particle size distribution throughout a commercial flow-through trout farm was measured using a high-resolution laser technique. This enabled identification of fish density, fish contact surface area, and distance from inlet as general factors controlling particle size distribution. Furthermore, it was shown that turbulence generated by aeration and fish-feeding activity induces particle breakdown. Contrary to the common perception, however, the size of suspended particles increased, rather than decreased, as they progressed through the farm. The waterfall at the end of the fish farm reduced the size of the suspended solids and hence the efficiency of the drum filter installed behind it. It was calculated that removing the waterfall would increase the effectiveness of the drum filter by about 33%. These findings enable advice to be given on aquaculture facility design and management that will help to maintain or even increase the size of suspended solids, and hence aid removal.

Brinker, A. (alexander.brinker@lvvg.bwl.de), Rosch, R. (2005). Factors determining the size of suspended solids in a flow-through fish farm. *Aquacultural Engineering*, 33: 1-19.

15. Effluent improvement by stabilising faeces

This study investigated the effect of adding guar gum to a commercial extruded rainbow trout diet as a binder to stabilise the faeces. The effects of binder addition on particle size distribution, nutrient retention, and the effectiveness of drum filtration of effluent were examined in a land-based raceway trout farm. Fish given feed containing the dietary binder produced larger faecal particles. Furthermore, the particle-bound fractions of phosphorus and nitrogen increased and the dissolved fractions decreased, indicating a reduced leaching of nutrients from the larger particles. Drum filter removal efficiency was higher for the effluents from the fish fed the binder-containing diet. Removal of both total suspended solids and total phosphorus was improved by 40%. The addition of the binder to the trout diet proved to be an effective means of improving mechanical effluent treatment and thus to developing environmentally sound fish production opportunities.

Brinker, A. (alexander.brinker@lvvg.bwl.de), Koppe, W., Rosch, R. (2005). Optimizing trout farm effluent treatment by stabilizing trout feces: a field trial. *North American Journal of Aquaculture*, 67: 244-258.

16. Review of VHS

Viral haemorrhagic septicaemia virus (VHSV) is being isolated from an increasing number of free-living marine fish species. So far, it has been isolated from 15 species (inc. herring, sprat, cod, Norway pout and flatfish) from northern European waters and a total of 48 species from the northern hemisphere (North America, Asia and Europe). The high number of VHSV isolations from the Baltic Sea, Kattegat, Skagerrak, the North Sea and waters around Scotland indicate that the virus is endemic in these waters. The VHSV isolates originating from wild marine fish show no to low pathogenicity to rainbow trout and Atlantic salmon, although several are pathogenic for turbot. Marine VHSV isolates are, so far, serologically indistinguishable from freshwater isolates. Genotyping of VHSV reveals four groups: one group representing traditional European freshwater isolates and isolates of north European marine origin, a second group of marine isolates from the Baltic Sea, a third group of isolates from the North Sea, and a forth group representing North American isolates. Examples of possible transfer of virus from free-living marine fish to farmed fish are discussed, as are measures to prevent introduction of VHSV from the marine environment to aquaculture.

Skall, H.F. (hfm@dfvf.dk), Olesen, N.J., Mellergaard, S. (2005). Viral haemorrhagic septicaemia virus in marine fish and its implications for fish farming - a review. *Journal of Fish Diseases*, 28: 509-529.

17. IPN in salmon

This paper provides a clinical and histopathological review of 21 outbreaks of acute infectious pancreatic necrosis (IPN) in Scottish Atlantic salmon farms (13 marine and 8 freshwater) over the period 1991-2004. A distinctive syndrome was evident in both post-smolts in sea water and fry in freshwater, where in addition to the typical pancreatic and intestinal changes, a consistent finding was liver lesions which had not previously been associated with IPN. Initial cases were recorded in post-smolts in Shetland, but by the end of the period of investigation this type of pathology had extended down the west coast of Scotland and into Ireland. Limited viral strain analysis suggested that similar strains were involved in both fresh water and sea water and that these differed from earlier isolates from rainbow trout. In fresh water, recovered fish frequently developed a greatly distended intestine associated with accumulation of undigested food. In sea water, after the initial, often significant (≥50%) losses, many fish failed to grow and became chronically emaciated and prone to sea louse infection. Although use of transfer diets containing immune enhancers and the selection of IPN resistant broodstock has reduced losses, the disease remains a serious cause of economic loss.

Roberts, R.J. (heronpisces@btinternet.com), Pearson, M.D. (2005). Infectious pancreatic necrosis in Atlantic salmon, Salmo salar L. *Journal of Fish Diseases*, 28: 383-390.

18. Alternative protein sources: fisheries by-catch and by-product meals

Fisheries by-catch and by-product meals are portrayed as ingredients with great potential as ingredients in aquaculture feeds. This study was designed to evaluate the nutritional value of shrimp by-catch meal, shrimp processing waste meal and two fish meals made from Pacific whiting (meal with and without solubles) for rainbow trout by determining digestibility and conducting a feeding trial. Comparisons were made with a control diet based on anchovy fish meal. Apparent digestibility coefficients (ADCs) for protein were 76% for shrimp by-catch meal, 79% for shrimp processing waste meal, 88% for Pacific whiting meal without solubles, and 92% for Pacific whiting meal with solubles. ADCs for lipid were higher than 94% for all the diets. ADCs for energy were 57% for shrimp by-catch meal, 73% for shrimp processing waste meal, 70% for pacific whiting meal without solubles, and 73% for Pacific whiting meal with solubles. Fish fed the shrimp by-catch meal diet had weight gain and feed conversion ratios similar to fish fed the control diet. Fish fed diets containing shrimp processing waste and Pacific whiting meal with solubles had lower weight gain and higher feed conversion ratios than the control diet. Growth was lower in fish fed the Pacific whiting meal diet compared to fish fed the anchovy fish meal. The lower growth of fish fed diets containing Pacific whiting meal appeared to be a result of lower feed intake, indicating perhaps a lower palatability of this ingredient. Additional research addressing processing methods, nutritional manipulations and

palatability enhancement is needed to improve the potential of some fisheries by-product meals as ingredients in the diets of rainbow trout.

Hardy, R.W., Sealey, W.M., Gatlin, D.M. (2005). Fisheries by-catch and by-product meals as protein sources for rainbow trout *Oncorhynchus mykiss*. *Journal of the World Aquaculture Society*, 36: 393-400.

19. Soya in trout diets

The objective of this study was to evaluate changes in trout performance, quality and flesh fatty acid profile when supplying a substantial proportion of dietary protein using full-fat soya. Six feeds were formulated with extracted soya (7.5%) and full-fat soya (0-25%) representing 7.5-32.5% of the formulation. The feeds were fed to duplicated tanks of rainbow trout for 8 weeks at 11°C. Survival and growth rate were not affected, but feed intake and FCR increased linearly in response to increased dietary soya level. Carcass yield decreased linearly in response to increased soya level. However, other basic quality attributes, e.g. fillet proximate composition and colour, were not affected by the soya content of the feeds. The relative percentages of most flesh fatty acids responded linearly to changes in those derived from the soya lipids, although notably the relative percentages of 22:6n-3 and total n-3 fatty acids were not affected. There was no histological evidence of soya-induced hind-gut enteritis. Thus, a combination of extracted and full-fat soya provided between 18% and 36% of the crude protein without adverse effects on growth, survival or basic quality attributes. This was achieved in the absence of hind-gut enteritis without compromising the healthy eating image of farmed trout.

Morris, P.C. (paul.morris@nutreco.com), Gallimore, P., Handley, J., Hide, G., Haughton, P., Black, A. (2005). Full-fat soya for rainbow trout (*Oncorhynchus mykiss*) in freshwater: effects on performance, composition and flesh fatty acid profile in absence of hind-gut enteritis. *Aquaculture*, 248: 147-161.

20. No effect of vegetable oil on salmon health

As the supply of marine fish oil is becoming a limiting factor in the production of salmonids, new diets and alternative sources of energy are being tested. Plant oils are natural potential candidates to replace fish oil, but the different levels of essential polyunsaturated fatty acids may influence health and growth. This study investigated the resistance to transport stress and bacterial infection, and phagocytic activity in head kidney macrophages in salmon fed three different diets. In high-energy fishmeal based diets, 50% and 100% of the supplementary fish oil (FO) was replaced with soybean oil (SO). The three dietary groups were fed for 27 weeks at 5°C and for 11 weeks at 12°C before challenging the fish with *Aeromonas salmonicida*. No effect of diet was observed on transport stress or susceptibility to bacterial infection with *A. salmonicida*. The phagocytic activity of kidney macrophages in vivo and in vitro was not also affected by diet. Atlantic salmon therefore seem to tolerate a diet solely based on soybean oil as a lipid source, without any detrimental effects on growth, health and immune functions.

Gjoen, T. (tor.gjoen@farmasi.uio.no), Obach, A., Rosjo, C., Helland, B.G., Rosenlund, G., Hvattum, E., Ruyter, B. (2004). Effect of dietary lipids on macrophage function, stress susceptibility and disease resistance in Atlantic salmon (*Salmo salar*). *Fish Physiology & Biochemistry*, 30: 149-161.

21. No effect of vegetable oil on gamete quality

This study investigated the effects of vegetable oil in broodstock diets on gamete quality of Atlantic salmon. The fish (2nd sea winter) were fed a broodstock diet with 100% South American fish oil (at a dietary lipid level of 27.6%) in one treatment group and with 50% (the rest replaced with rapeseed oil) in the others for 13 months and maturing fish were then transferred to freshwater. Dietary treatment did not affect egg number or egg weight. The eggs from a sub-set of females from each treatment were fertilised using a pool of milt from three males of the same treatment. Rates of fertilisation, eyeing, hatching, survival to first feeding and the fry weight at first feeding were not affected by dietary treatment. The fatty acid profiles of the eggs and fry did differ between dietary treatment, the rapeseed oil treatment producing lower levels of DHA (22:6n-3) and EPA (20:5n-3) and higher levels of 18:1n-9, 18:2n-6 and 18:3n-3. These results suggest that it is possible to replace a portion of the fish oil with rapeseed oil in a broodstock diet without compromising the early survival

and initial growth of offspring, although there could be implications for some developmental processes not tested for in this study.

Rennie, S. (0007504r@student.gla.ac.uk), Huntingford, F.A., Loeland, A.L., Rimbach, M. (2005). Long term partial replacement of dietary fish oil with rapeseed oil; effects on egg quality of Atlantic salmon *Salmo salar*. Aquaculture, 248:135-146

22. Rainbow trout prefer fish oil to vegetable oils

This experiment examined the capacity of groups of juvenile rainbow trout to differentiate between two isolipidic diets containing distinct oils and whether dietary preferences existed. The choice was offered by means of two self-feeders per tank. One feeder distributed a standard diet with fish oil (FO), the other a diet containing vegetable oil, either rich in linolenic acid (linseed oil, LO), linoleic acid (sunflower oil, SO), or oleic acid (rapeseed oil, RO). Preferences were expressed as relative changes in feed demands for a specific feeder. Averaged over all groups, the preference tests demonstrated the capacity of rainbow trout to discriminate between a diet with FO and a diet containing vegetable oil, and indicated a general preference for the diet with FO over the other diets irrespective of previous diet. The tests also indicated a difference in the extent of relative avoidance of each of the three vegetable oil diets. Diet LO was the most avoided (37-39% decrease in demands for the feeder). Diet RO was the best accepted (15-17% decrease in demands for the feeder). The avoidance of diet SO at the end of the preference test was 30% after an initial avoidance of 43%. In all groups, the lower demands for the vegetable oil diets were compensated by increased demands for diet FO. Hence, changes in diet selection had no effect on total feed or energy intakes, measured as the sum of both selections. It is believed that the metabolic consequences of the excess of linolenic or linoleic acid negatively affected the feed acceptances of diets LO and SO.

Geurden, I. (inge@st-pee.inra.fr), Cuvier, A., Gondouin, E., Olsen, R.E., Ruohonen, K., Kaushik, S., Boujard, T. (2005). Rainbow trout can discriminate between feeds with different oil sources. *Physiology & Behavior*, 85: 107-114.

23. Communication of stress in rainbow trout

The objective of this study was to determine whether exposure of rainbow trout to water or skin extract from a stressed conspecific would elicit a stress response. Juvenile rainbow trout were exposed for 1 hour to water containing a stressed fish, homogenized skin extracts from a non-stressed fish, skin extract from a stressed fish and water with none of these factors. The stress response was measured over a 24-h period (1, 6, 12, 24 h after exposure). Plasma cortisol levels increased at 12 h in fish exposed to water from a stressed fish and skin extract from a stressed fish indicating that rainbow trout do elicit a stress response when exposed to stress-related alarm cues released from conspecifics.

Toa, D.G., Afonso, L.O.B. (luis.afonso@nrc-cnrc.gc.ca), Iwama, G.K.(2004). Stress response of juvenile rainbow trout (*Oncorhynchus mykiss*) to chemical cues released from stressed conspecifics. *Fish Physiology & Biochemistry*, 30: 103-108.

24. Effects of CO_2 on trout

This study exposed rainbow trout to one of three CO_2 treatments: control (22 mg/L), medium (35 mg/L) or high (49 mg/L) at 13°C. The fish were checked daily for survival, and were sampled on days 0, 28, 56, and 84 for assessments of physiological response, growth, and fillet quality. Chronically exposed trout showed nearly 100% survival through 84 days exposure (1 of 1,500 fish died). The medium and high CO_2 treatments reduced growth resulting in smaller fish by 84 days. The medium and high CO_2 exposed trout also showed decreased plasma chloride compared to the control from 28 to 84 days. The trout were also challenged to a 15-min crowding stress on day 93 to assess their ability to initiate a stress response during hypercapnia. Exposure to the additional stress resulted in changes in hematocrit, plasma cortisol, glucose, and chloride for all treatment groups. CO_2-specific changes were detected in hematocrit, plasma cortisol and plasma chloride responses.

Danley, M.L., Kenney, P.B., Mazik, P.M., Kiser, R., Hankins, J.A. (2005). Effects of carbon dioxide exposure on intensively cultured rainbow trout *Oncorhynchus mykiss*: physiological responses and fillet attributes. J*ournal of the World Aquaculture Society*, 36: 249-261.

25. Cold storage of stripped eggs

This study examined the cold storage of salmonid eggs. Unfertilised eggs of steelhead and chinook salmon were stored at a low temperature (ca. 0°C) either without or with antibiotics (penicillin and streptomycin) for up to 24 days and fertility was assessed. Fertility did not decrease under these conditions. Steelhead eggs were then maintained at 4°C for up to 15 days with or without added bacteria and with or without gentamicin. Gentamicin inhibited bacterial growth during 4°C storage, and its use resulted in a less pronounced decline in fertility with storage. These results suggest that low temperatures and antibiotics can play an important role in extending the period over which salmonid eggs can be successfully stored.

Holcomb, M., Cloud, J.G., Ingermann, R.L. (rolfi@uidaho.edu) (2005). Impact of bacteria on short-term storage of salmonid eggs. *Aquaculture Research*, 36: 1555-1561.

26. UV irradiation of bacteria in recirculation systems

The objective of this research was to determine the ultraviolet (UV) irradiation dosages required to inactivate bacteria in recirculating salmonid culture systems. The research was conducted in a commercial-scale recirculating system used for Arctic char growout which uses a UV channel unit to treat 100% of the 4750 L/min recirculating water flow with an approximately 100-120 mW s/cm^2 UV irradiation dose. To test the effect of UV dose, a second experimental UV unit was installed to irradiate a side-stream flow of water. This unit operated at a constant intensity, but the side-stream water flow was regulated to produce a range of water retention times and thus a range of UV irradiation doses (75, 150, 300, 500, 980, and 1800 MW s/cm^2). The dose required to inactivate bacteria was estimated from the total heterotrophic bacteria and total coliform bacteria counts measured immediately before and after the side-stream UV irradiation unit. The maximum dose applied (1800 MW s/cm^2) achieved a 98% reduction in heterotrophic bacteria. In contrast, coliform bacteria were more susceptible to UV inactivation and complete inactivation was consistently achieved at the lowest UV dose of 77 mW s/cm^2. These results suggest that: (1) the UV dose required to inactivate total heterotrophic bacteria-and thus disinfect a recirculating water flow-was nearly 60 times greater than the 30 mW s/cm^2 dose typically recommended in aquaculture and (2) inactivating 100% of bacteria in a given flow can be difficult, even at excessive UV doses, because UV irradiation cannot always penetrate particulate matter to reach embedded bacteria. The authors suggest that the recirculating system, where the bacteria are exposed to 100-120 mW s/cm^2 of UV irradiation every 30 min, may provide a environment that favours selection of bacteria that embed within particulate matter or form bacterial aggregates providing shading from the UV irradiation.

Sharrer, M.J., Summerfelt, S.T. (s.summerfelt@freshwaterinstitute.org), Bullock, G.L., Gleason, L.E., Taeuber, J. (2005). Inactivation of bacteria using ultraviolet irradiation in a recirculating salmonid culture system. *Aquacultural Engineering*, 33: 135-149.

27. Pigmentation used to differentiate wild from hatchery brown trout

This study measured five qualitative and seven quantitative colouration and spotting pattern features in 23 brown trout populations and two hatchery stocks. A gene diagnostic for stocked and native populations from southern Europe was also analysed to classify the brown trout according to their origin: native, hatchery stock and hybrids. There were differences in the colouration and spotting features of the three genotypes, and a discriminant function analysis correctly identified 79% of the individuals. The most discriminating variables were dorsal fin margin colour, number of opercular spots, presence of the preopercular mark and diameter of black spots. Given the low cost, ease and possibility of field identification of native fish, the results indicate great opportunities for the application of morphological-based classification models in the conservation and management of native brown trout stocks.

Aparicio, E., Garcia-Berthou, E. (emili.garcia@udg.es), Araguas, R.M., Martinez, P., Garcia-Marin, J.L. (2005). Body pigmentation pattern to assess introgression by hatchery stocks in native Salmo trutta from Mediterranean streams. *Journal of Fish Biology*, 67: 931-949.

Ardtoe lab to focus on cod, research and pilot unit

THE Ardtoe Marine Research Laboratory has been given a new, and distinctly more commercial, lease of life with the announcement that it has been acquired from the receivers by Viking Fish Farms Ltd. The Nottingham based company were looking for a site to develop their land-based aquaculture concept when they were made aware of the plight of the 40 year old Ardtoe station.

Colin MacLeod, chairman of Viking Fish Farms, told *Fish Farming Today* that they quickly became aware of the possibilities at Ardtoe in the short time they had available to look at the site.

The result is a three pronged approach towards development of the site. The good news for the experienced research team at Ardtoe is that research activities will continue – the station will continue to offer facilities for aquaculture research and will honour existing research commitments.

The cod hatchery will be expanded and commercialised. An initial shipment of 70,000 cod fingerlings should be ready in three weeks time and they expect to produce at least four batches per year from their own broodstock.

A pilot-scale fish farming plant will be established on the dry lagoon area at Ardtoe with the aim of running it for 12-15 months. If the concept is successful the pilot-scale unit will be expanded.

Mr MacLeod explained: "We were originally looking for land for a site for our pilot scale fish farm but were pointed in this direction by SEERAD. There's a valuable mix of commercial and research expertise already here. The people are first class."

Keith Isard, technical director of Viking Fish Farms expanded on the development strategy for the site.

"We will establish commercial cod fingerling production and ramp up the numbers. It appears that the quality of eggs will improve as broodstock spawn more frequently," said Mr Isard. "The feeling is that many fish farming companies are waiting to see how the pioneering companies get on with cod farming and will then convert themselves from salmon to cod, so hopefully there will be high demand for our fingerlings."

Viking intend to apply for organic certification for their cod and may develop commercial production of halibut and haddock fingerlings using the broodstock already at Ardtoe.

The site will initially have seven staff, all of whom have stayed at Ardtoe through the receivership process. The site will be known as Viking Fish Farms Ltd – Ardtoe Marine Laboratory and will be managed by Tim Atack, general manager and research manager, Jim Treasurer.

The pilot scale fish farm will consist of a single on-growing tank with a fluidised bed bio-filtration system. It is a new system which Viking Fish Farming has been developing for some time.

Mr MacLeod emphasised that the environmental credentials of their new fish farming system are a top priority.

"It was always at the top of my list to make sure that the environment is not polluted. As a mining engineer I'm very familiar with the smell of methane and I can smell that anywhere near a cage farm. We intend to develop a better way of fish farming with minimal environmental impact and absolute traceability," he added.

MacLeod and Isard said that they had learnt a lot over the last three weeks. Mr MacLeod is originally from Lewis but left when seven years old to go to school in Glasgow. He had a career in the mining industry, based in the Nottingham area but retired from mining 4-5 years ago. He has a house in Harris and became interested in fish farming, convinced that it was an industry for the future.

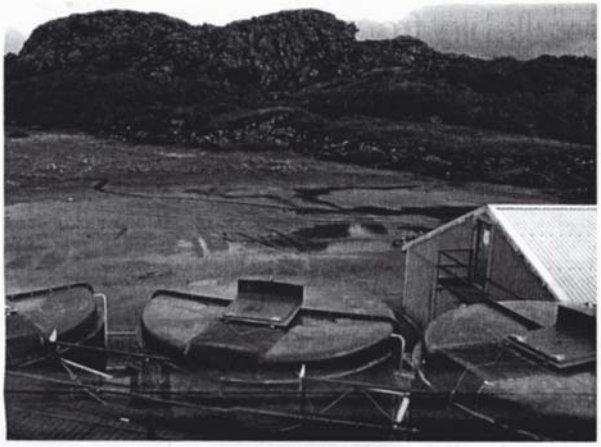

Colin MacLeod (L) and Keith Isard (R) of Viking Fish Farms

Viking Fish Farms acknowledge the support of the Scottish Executive, and also Lochaber Enterprise. They anticipate that some support will be needed during the transitional phase but the intention is to develop a commercially viable facility.

They have already had meetings with SAMS and say they are keen to honour existing research contracts. The research facility is open for business and they are keen to continue links with SAMS, Stirling University and Lochaber College and others such as commercial research projects for feed companies.

The transfer of licences and consents to the new company is on-going.

The Ardtoe marine laboratory has a total of over 1000m² of covered fish rearing and holding areas supplied by a 120m³/hr filtered seawater supply. It also has offices, lab space, conference facilities and library.


The likely site for the Viking Fish Farms pilot unit at Ardtoe

Fish Farming Today, July 2005

Farmed halibut 'safe to eat'

NORWEGIAN farmed halibut weighing less than 35kg are safe from dioxins and PCB, according to Norwegian Food Safety Authority which sponsored the research.

In the wild, halibut can weigh in excess of 200kg and live past 50 years, accumulating a large amount of contaminants as they do.

In Norway, halibut of more than 120kg are rare and make up only around 5% of the total turnover, with most farmed halibut harvested before exceeding 5kg.

However, there was still concern about farmed halibut's ability to accumulate toxins so the study was ordered.

The farmed halibut tested was found to be either free of toxins or at a very low, safe level, as was found wild halibut under 35kg.

Fish Farming International, July 2005

Now Ardtoe will be pump-ashore

THE NEW owner of Ardtoe – the former UK Sea Fish Industry Authority Aquaculture Unit that was recently closed by the Scottish Association for Marine Science (*FFI*, May 2005) – is aiming to use the facility to prove land-based salmon can work, reports **ANGUS MACDONALD**.

Colin MacLeod, chairman of new owner Viking Fish Farms Ltd, reckons he can cut the cost of shore-based salmon farming by 75% and make pump-ashore finfish farming profitable.

He said: "It is amazing how in mature industries they think they know it all, but still using cages at sea to rear fish is doing things the difficult way."

MacLeod spent three years researching the viability of pump-ashore finfish production, and his company has taken over the cod, halibut and haddock stocks which were part of the research at Ardtoe.

It is likely that turbot will also be included in the research.

Research operations will continue at Ardtoe, where seven jobs will be saved. The facility will also continue to produce fingerlings for cod farming.

But Viking will also farm salmon using modified techniques for pumping ashore seawater – a method that has proven costly due to the large volumes of seawater required, the initial capital required to set up tanks and filtration systems, and marine fouling of pipes.

It does have advantages, however: no boats, crews and feed barge systems are required, while harvests can continue in rough weather.

"There are wonderful people working at Ardtoe and we are keeping the staff there to continue their R&D work," said MacLeod.

"We will also start rearing salmon using pump-ashore methods. We've been offered cheap electricity, around half the normal price. We are also going to pump water ashore only at high tide, so that we don't need to use electricity all the time to do the pumping.

"This will reduce the costs of pump-ashore to one quarter of the costs people were faced with before.

"We will also oxygenate the water, rather than use the old method where you had to have a constant flow of seawater going through the tanks to give fish the oxygen that was in the seawater."

Fish Farming International, July 2005

Galician guide...

THIS USEFUL identification guide for European farmed fish has just been produced by the Xunta de Galicia in Spain with the help of the EU's European Social Fund. An English version of a Spanish-language guide produced in 2002, the guide includes photos of every finfish farmed in the European Union, giving scientific and national names for each, as well as illustrations with identification marks. It also gives helpful information on culture systems and production figures, market sizes, advantages and general problems found in growing them.

The guide will be sent free – while stocks last – to anyone emailing a request to Xosé Luis Rodriguez Villanueva, one of the guide's authors.

■ xose.luis.rodriguez.villanueva @xunta.es

Fish Farming International, July 2005

Project will optimise broodstock

A RESEARCH project to optimise the productivity of cod broodstock through a better understanding of nutritional and environmental influences is underway at Nutreco Aquaculture Research Centre (ARC) and three Norwegian cod hatcheries.

ARC researchers have also come up with an innovation to produce large-sized feed to suit the broodstock of marine species such as cod and halibut.

The cod broodstock project, which began last year, is following the long-term developments of broodstock held in commercial conditions at three participating hatcheries in Norway – Cold Culture Norway (a Marine Harvest company), Sagafjord Sea Farm and Havlandet Marin Yngel.

These are leading Norwegian suppliers of juvenile farmed cod.

Other participants are the Norwegian Institute of Marine Research and NIFES (the National Institute of Nutrition and Seafood Research). The project has funding support from the Norwegian Research Council and Skattefunn, a fund to promote innovation in the industry, and is scheduled to run until mid-2007. Feed is being provided by Skretting.

Unlike salmonids, broodstock of marine finfish such as cod and halibut are kept and used for breeding over several years. The project aims to stabilise the reproductive performance of the broodstock throughout this period.

Dr Grethe Rosenlund of ARC tells *FFI*: "Broodstock may only be a very small part of the market, but maintaining a healthy and productive broodstock is crucial for the success of aquaculture with marine species. Part of our research is looking for long-term nutritional trends."

By working at several commercial sites, it will help those involved in the project identify key factors much faster, claims Nutreco.

"Over several seasons of breeding it is possible that minor nutrients such as vitamins and minerals may become depleted in the broodstock – vitamin E for example, which is important in egg quality and larval mortality. You could call it reproductive exhaustion," says Rosenlund.

"On the other hand, feeding conventional diets rich in vitamin A over a prolonged period could lead to a build-up of this vitamin, also with negative effects."

Unlike salmon, cod broodstock can be used for several seasons

Inset: Cold Culture Norway is one of the three participating cod broodstock hatcheries in the programme to optimise broodstock

Essential long-chain unsaturated fatty acids represent another focus of the study. Rosenlund says getting the right balance is important for egg 'hatchability' and to minimise larval deformities.

Another part of the project is researching basic physiology, looking at enzymes, hormones and gene expression, and the effects that controlling the spawning cycle has at this level.

Nutreco believes the results will be relevant to many species, and not just cod.

In addition to nutrition, the research team is investigating environmental factors.

"We know how to control the spawning season through light manipulation, but we know a lot less about the effect of other external cues that need to be controlled to improve synchronisation and productivity of spawning in off-season populations," says Rosenlund.

Broodstock feed

The largest fish feed pellet normally produced is around 20mm in size, and this is near the limit of conventional production technology, according to Nutreco.

However, there is a small but definite demand for larger pellets. Cod and halibut broodstock, for example, can typically weigh 20kg and will take feed that is much larger than 20mm.

Kjell Arne Hoff, manager of feed production at Nutreco ARC, has devised a simple and effective answer, which is now the subject of a patent application.

First, feed formulated to meet the nutritional needs of the broodstock or other large fish is produced as conventional pellets. These are mixed with an aqueous binding agent, which has a neutral nutritional value, and the mix is added to moulds where the binding agent solidifies to provide blocks of feed at whatever size is needed.

Feed blocks have been tested with halibut and cod broodstock. Large halibut have readily taken blocks up to 1kg at a single bite. Other species where the blocks may prove valuable are turbot and tuna.

Although a relatively small market, the blocks fulfil a genuine need for some Skretting customers.

In addition, in a new project ARC is getting to grips with the factors that drive growth.

"We know it is basically genetic potential fulfilled through feed, but it is not yet clear whether we have reach the full potential, or 90% or just 70% for example, says Viggo Halseth, Nutreco ARC managing director.

"As every fish farmer knows, you can sometimes get unexpected differences."

Feed may be a factor in some cases, he says. Differences could be caused by the way feed is processed, by pellet structure or by the presence or absence of minor nutrients. It is believed to be more than palatability and this is a topic ARC is exploring.

Fish Farming International, July 2005

Farmed cod 'taught to be wild'

SCIENTISTS in Scotland and Norway are working on teaching farmed Atlantic cod 'life skills' as part of an effort that could help replenish overfished stocks in the North Sea.

The work, being carried out in Norway by researchers from Edinburgh University's School of Biological Science and Bergen University, could help cage-reared cod survive in the wild, dispelling fears that released farmed cod would cause environmental problems

According to a report in The Scotsman newspaper, the scientists have fiound that cod fed at irregular times of the day and reared "in a more lifelike environment" developed greater spatial awareness.

Feed was given to young cod from different parts of their cages, which for the study featured plastic 'seaweed' and 'rocks'.

"The scientists are now convinced that the research will dispel the belief that farmed stock threaten native fish because they either breed or fight with them as they hunt for food," states the report.

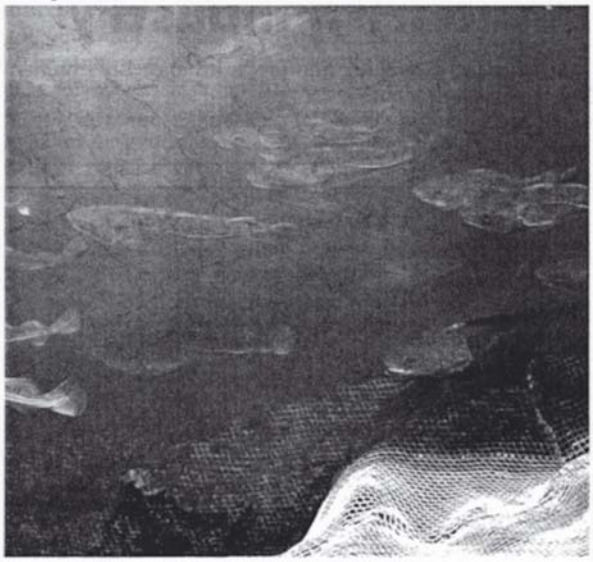
It adds that the scientists suggest restocking initiatives fail not just because farmed cod lack 'life skills', but also because they are being set free among the wrong types of fish.

Fish Farming International, July 2005

Double netting the way ahead in organic cod farming?

By Josephine Wood

COD farming pioneers Johnson Seafarms are using double netting on their cages in an innovation which may be copied by others.



Johnson Seafarms uses double nets for organic cod

Alan Bourhill, the company's fish health officer, told *Fish Farmer* that the use of double netting has two functions, to keep predators, mainly seals, from getting to the fish and also to prevent escapes. The nets are both used under tension, by 750 kg weights at the points at the bottom so they don't distort. There is a minimum of 1 metre gap between the outside and inside nets. He said: "The outer net acts as a deterrent, since if the seals cannot get access, they soon lose interest. The outer nets also acts as a backup to the inner net in case of escapes."

This double-netting system obviously involves increased costs in terms of labour, he said. "The labour involved means extra costs as we do not use antifouling nets so the nets need to be changed every 2-3 months. If you use antifouling nets they only need changing every 6 months or so."

The company first took delivery of the first small batch of cod juveniles in January 2002 and these were harvested early in 2004 and then in October 2003 they took delivery of the first large batch of juveniles from two hatcheries on Shetland and the Scottish mainland. They are being raised to maturity over a 2 to 3 year cycle.

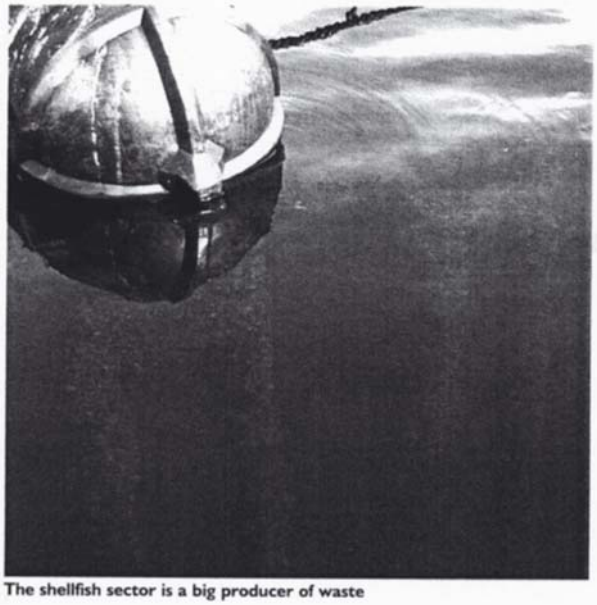
The company works closley with the Organic Food Federation (OFF), the Soil Association and the RSPCA to ensure their farmed cod meets the most stringent standards for quality and sustaiability.

Fish Farmer, July/August 2005

Fish waste policy has been a key concern

MAJOR research has gone on into establishing an infrastructure for fish waste management.

Part of the study process has been into establishing the extent to which fish pathogens are inactivated under a range of conditions including heating, acid and alkali treatments.



The shellfish sector is a big producer of waste

According to Aberdeen's world-famous FRS Marine Laboratory, this research will provide baseline information not only on pathogens that are a problem in the UK, but also on exotic disease agents.

Waste levels generated by the aquaculture sector are massive and it is not only the finfish sector that generates significant waste volumes.

The shellfish sector is also a big producer of waste particularly from shells.

In a Scottish context alone, by-products from finfish processing amount to more than 25,000 tonnes a year and mortalities due to disease and catastrophic events such as jellyfish kills or algal blooms, exceed 8,000 tonnes in some years.

For years, the aquaculture sector in a global sense, has struggled to find acceptable cost effective methods of dealing with some of the by products of its operations.

The most pressing is the disposal of fish carcasses following disease outbreaks or mass mortalities caused by jellyfish or algal blooms.

By-products from fish processed for human consumption are less problematic, for the most part being converted into animal feeds or pet foods.

Mortalities however require to be disposed of by rendering, incineration or exceptionally, by burial in controlled landfill sites.

Fish Farmer, July/August 2005

REPLACEMENT of fish meal by alternative sources of protein

MUCH research is nowadays focused on the replacement of marine fish sources of protein by more sustainable, alternative sources of protein, in particular plant proteins. Several studies have indicated that a substantial proportion of the fish protein in fish feed can be replaced by plant protein without adverse effects on growth rate and feed conversion ratios.

The amount of fish meal protein that can be replaced is also dependent on the species of the fish. Some species only need a small amount of fish protein in their diets whereas other species require a larger proportion. However, a complete substitution of fish meal by other proteins usually results in lower growth performance parameters.

There are several factors that may cause the lower growth performance when fish are fed a diet without any fishmeal. In particular plant proteins may contain various anti-nutritional factors. Another factor may be the amino acid composition of plant proteins compared to that of fishmeal. Fishmeal has an amino acid composition that is identical to that of the fish that consumes the protein and should therefore be considered as having the optimal amino acid composition. Fishmeal has an amino acid composition that resembles closely that of chicken egg protein which has a chemical score of 100 and which is considered as a reference protein. A chemical score of 100 indicates that this protein has the ideal essential amino acid composition and the various essential amino acids in this protein can be optimally utilised. Plant proteins have in general a lower chemical score because of a low level of various essential amino acids.

In animal nutrition it is common practice to add single essential amino acids to feeds in order to increase the chemical score of the proteins. This procedure could also be applied in fish nutrition in order to improve the chemical score of (plant) proteins that could be a substitute for fish meal. However, recent studies have indicated that adding single amino acids to plant protein based feeds still resulted in lower growth performance parameters. There are indications that single amino acids in fish feed are more rapidly absorbed and transported to the liver than amino acids derived from intact proteins. As a consequence, the single amino acids added to the feed may not be utilised together with the amino acids derived from the intact protein. The rapidly absorbed amino acids cannot be processed in the liver together with the amino acids in the intact proteins and might be de-aminated and converted into fat or used for energy. Thus, there is still a mis-match of amino acids in the liver despite that the composition of the amino acids in the feed appears to be similar to that of fishmeal.

This problem of non-synchronous processing could be solved by ways that would delay the absorption of the single amino acids. Coppens International has carried out several studies for alternative methods to add amino acids, which gave a good indication for the way forwards. Nevertheless, further research will be done by Coppens International to explore these possibilities. Experiments will be done, particularly in trout, and we will investigate several ways to manipulate the absorption rate of the added amino acids so that the added amino acids and the amino acids derived from the intact proteins are absorbed at a similar rate and will be delivered to the liver simultaneously. These studies involve both measuring the absorption rate of the amino acids and determining the growth rates.

Fish Farmer, July/August 2005

Organic standards for farmed fish still not approved by Soil Association

By Josephine Wood

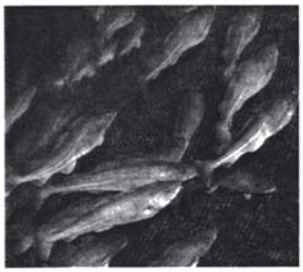
THE Soil Association is still to set organic standards for farming fish, years after first looking at the issue.

Final standards are still not in place, leading to fears of confusion for consumers in what qualifies as organically produced fish.

Hugh Raven, from the Soil Association, said he hoped final standards will be agreed by the end of next year.

He said that they wanted to harmonise standards between the soil association and other UK organic associations and then between the UK standards and other European countries standards, and finally between the EU and other parts of the world.

Difficulties for the Association in endorsing cod production's organic credentials are feed sustainability, diseases and treatments and escapes and welfare. He also said that standards for shellfish are almost at the stage where they can go out, but standards for organic cod is still at a very early stage.



Final standards for organically farmed fish are still not in place

The Soil Association risks being marginalised by other UK schemes, in particular those run by major retailers to validate the claims being made by producers.

Fish Farmer, July/August 2005

Aquaculture training from Seafish

SEAFISH offers a wide variety of training specifically tailored for the aquaculture sector across the UK.

We provide a range of training materials, from manuals and videos to distance learning materials. We also offer practical courses, such as basic safety training in operating fish cages and are currently developing a safety course for foreshore gatherers which will offer advice and guidance on identifying and overcoming hazards. Courses on quality standards, for example harvesting and distribution of molluscs, are available. Seafish is also developing new guidance on HACCP awareness for people who handle or trade in live bivalve molluscs, in advance of new food industry wide regulations which will come into force next year.

And to make sure you can access the training when and were you want, our network of Group Training Associations (GTAs) can organise training throughout the UK, where and when it's needed.

For further information tel: 01482 327 837, email training@seafish.co.uk or go to www.seafish.org

Fish Farmer, July/August 2005

Cod producer buys hatchery

takeover secures organic supplies

THE PRODUCER that expects next month to deliver the world's first organic cod to market has acquired one of the only two cod hatcheries in the EU and taken on leading cod scientists to help secure its future, reports **HANS J MARTER.**

In a £3 million-plus (US$5.2 million) investment programme, Shetland Organic Seafoods (SOS) – holding group of Johnson Seafarms Ltd, Johnson Hatcheries Ltd, Johnson Shellfish Ltd and Grading Systems Ltd, all based in Vidlin – has taken over the isles' Nufish hatchery operation and employed all the R&D staff from the recently closed aquaculture department of the North Atlantic Fisheries College (NAFC), also in Shetland.

In addition, the programme allows for the group to increase its farm sites around Shetland to 30, farming organic cod and other species such as seatrout and mussels.

The research team is expected to form the backbone of a new leading R&D facility for finfish farming at the Sandwick hatchery, now part of Johnson Hatcheries.

Earlier this year, Johnson Seafarms secured £20 million (US$35 million) worth of investment from London-based venture capitalists EAC following a management buyout. The company aims to produce 15,000 tonnes of organic cod annually by 2010.

Managing director Karol Rzepkowski cites four reasons for the Nufish takeover:

- Controlling and guaranteeing the continuous supply of codlings
- Nufish is already certified organic, enabling Johnson Seafarms to guarantee codling quality
- Retaining the knowledge base by recruiting the former NAFC staff – they are credited with having successfully produced the first ever farmed cod eggs
- Investment in the local economy.

"Nufish represents an important strategic acquisition and is another step towards achieving vertical integration of the organic farming process," said Rzepkowski.

Dr Lesley McEvoy, former head of aquaculture at NAFC, will run the new hatchery operation, while Nufish partners Peter Tarrant, Maria Sympsiridou and Dennis Blackmore have left the company.

Now as Johnson Hatcheries, there are plans for the operation to triple its current annual output of 600,000 codlings.

Nufish is one of only two commercial-scale cod hatcheries in the EU, the other being Macrihanish in south-west Scotland, jointly operated by Stirling University and specialist company Marine Farms, which also has a cod hatchery in Norway.

Johnson Seafarms has an agreement to take a proportion of the Macrihanish output.

Now with the Nufish takeover, Johnson Seafarms will be able to "create a well financed, world class knowledge base on Shetland", according to Rzepkowski.

"The company remains on track to deliver the world's first organic cod to consumers this September and is in discussions with various parties, including a major retailer, to make the product widely available."

Johnson Seafarms was founded by fish farming brothers Angus and Ivor Johnson who, together with their father Gibbie Johnson, started experimenting with cod farming around five years ago.

One of the first Johnson codlings as they were put into cages – now the Shetland producer has its own hatchery supplying organic juveniles

Fish Farming International, August 2005

Council develops fish health code

A BINDING European code of practice promoting the health of farmed fish is being developed by the committee of the Council of Europe's European Convention for the Protection of Animals kept for Farming Purposes, reports KEITH NUTHALL.

The code has been written because of concerns that new aquaculture techniques are posing health and welfare problems.

It contains guidelines on stockmanship, inspections, enclosure and building standards, farm construction, management, feeding, water quality, emergency killing, changes of genotype and physical appearance, research and other issues.

A preamble to the detailed rules states: "Basic requirements for welfare, including health of farmed fish, consist of good stockmanship, husbandry methods appropriate to the biological characteristics of the animals and a suitable environment."

It continues that the guidelines consider the "possibility that... developments in breeding and biotechnology may further influence the welfare of farmed fish".

The Council of Europe is separate from the EU, covering most European countries, including Russia. Although it cannot enforce its guidelines, they are always approved by consensus.

That said, the code is likely to receive EU support when it is debated for for formal adoption at a November meeting of the convention's standing committee.

Fish Farming International, August 2005

Benzoak for sedating fish

ANAESTHETIC Benzoak Vet can be used in most operations related to Atlantic salmon and trout when immobilisation and anaesthetisation is required , according to manufacturer ACE Pharmaceuticals of Alesund, Norway.

Tests with Benzoak vet have been conducted on seabass and seabream as well and ACE says that a survey of users concludes that the drug is very effective, safe and user friendly in sedation and anaesthetizion for both species in connection with injection vaccination.

Benzoak vet has market authorisation in Norway for Atlantic salmon and trout, and the product is produced at licensed GMP facilities. The active compound benzocaine has an established MRL value (Maximum Residue Limit) for salmonides according to demands in Council Regulation 2377/90, according to ACE.

■ www.acdpharma.com

Fish Farming International, August 2005

Guides to protecting freshwater fish published

THE UK Department for the Environment, Food and Rural Affairs (Defra) has published two further leaflets as part of its 'Keep Fish Disease Out' campaign. These follow the success of the gyrodactylosis leaflets launched last year.

These newly published leaflets are 'A guide to protecting freshwater fish stocks from Gyrodactylosis and other serious fish diseases', and 'A guide to protecting freshwater fish stocks from Spring Viraemia of Carp'.

The leaflets contain a description of the diseases, the species they affect and the action that fish farmers, fisheries managers and anglers should take to prevent the introduction or spread of freshwater fish disease in the UK.

The leaflets are being sent out to the industry and are also available on line at http://www.efishbusiness.com/formsandguides/default.asp.

Fish Farming Today, August 2005

Secure nets for cod and sea bream farming

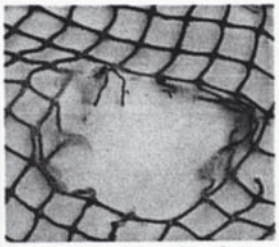
THE problem of escapes from cod farms could be a thing of the past thanks to the super strong Plexus Net from Mørenot.

Most cod farmers have experienced that cod bite holes in the nets or find holes and escape through them. The result is loss of fish and reduced earnings.

But Mørenot has developed the Plexus Net, a secure cod net that uses the world's strongest fibre (Dyneema), which ensures cod are unable to bite through.

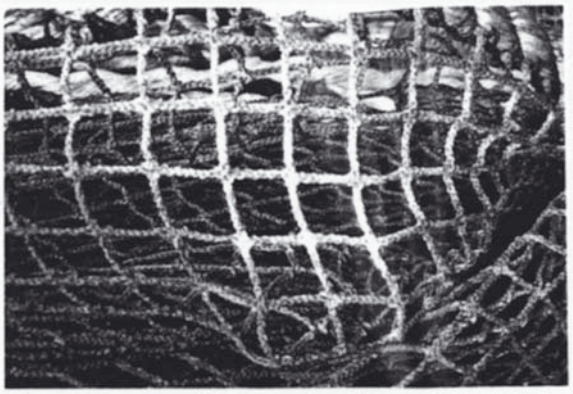
"Farming of sea bream in the Mediterranean and cod in Norway created a need for netting that withstands biting. But construction of netting in pure Dyneema proved to be very expensive. We decided to mix in polyester, to get a cheaper alternative and a more stable construction," said Alf Hildre, marketing manager at Mørenot.

The Plexus Net, has many advantages, including being lighter and therefore easier to handle, UV resistance and lower service and antifouling costs. In addition, it has considerably longer lifetime than other nets and produces a better water flow through the net.



Holes in normal nylon netting caused by cod

"We have now supplied several of the Plexus Nets – and still no complaints about holes have been registered. Even if the purchase costs of the Plexus net is higher than nylon, it is definitely worth it in the long run," Hildre added.



Dyneema net - white area has been chewed but still intact

He also recommends that cod farmers use Netwax T4 Antibite, a special product for coating fishing nets used in cod farming, supplied by NetKem AS. This product contains cuprous oxide in addition to special components, which reduces gnawing on the nets. According to Hildre, it is easy to apply and gives an even and homogeneous film. It also keeps the nets soft and flexible and aids cleaning.

For more information, please contact Nina Hildre - Tel: +47 70 20 95 00. E-mail: nina.hildre@morenot.no.

Fish Farming Today, August 2005

Sole 'breakthrough'

REGARDING last month's News in Brief item on a "new formulated feed for sole", this feed has already been successfully developed by feed manufacturer Ewos under the name Ewos AgloNorse. Ewos's James Deverill told *FFI*: "AgloNorse is already a successful and unique weaning feed for many marine fish species including sole, cod, seabass and seabream. In keeping with the scientific foundation of AgloNorse, Ewos continues to collaborate with our partners to further develop AgloNorse and produce the next generation of this product."

Fish Farming International, August 2005

Guide to seafood hygiene

A GUIDE to assist companies implement seafood hygiene management has been published by Eurofish.

Other organisations involved in the publication are: SIPPO/Norwegian Ministry of Fisheries and Coastal Affairs/HIFF:

A Guide to Seafood Hygiene Management has been written by Prof. Hans Henrik Huss; Dr. Mike Dillon and Dr. Simon Derrick, Humber Institute of Food & Fisheries, Grimsby, UK, and is priced at €30.

This practical guide offers:

- Examples of hygiene requirements during processing
- Information on standards and legal requirements
- Principles of management control and monitoring

"Safe production of seafood is vital in order to sell to an international market. Management of all components in the production chain is, therefore, important to achieve the required level of food safety," says Eurofish.

■ www.eurofish.dk

Fish Farming International, August 2005

Crown Estate announces annual figures

THE Crown Estate in Scotland has announced an 18% increase in net revenue surplus to £11.8 million for 2004/05, representing 6.4% of The Crown Estate's UK total. All of this money is paid to the Treasury for the benefit of the taxpayer.

The Scottish marine estate, which includes over half of the foreshore and almost all the seabed out to the 12 nautical mile territorial limit, represented over a fifth of the Scottish capital value (£38.2 million) and more than a third of the overall Scottish revenue (£5.5 million), including £2.7 million from the aquaculture industry.

The aquaculture income includes income from shellfish farming and the farming of emerging species, such as halibut and cod, but is largely made up of rental charges relating to salmon farms, which amounted to £17.12 per tonne harvested for mainland Scotland and inner isles growers, and £15.41 per tonne harvested for growers in the Western and Northern Isles.

Ian Grant

During the course of the year, The Crown Estate's marine estate re-invested more than £500,000 in marine stewardship in Scotland, including £100,000 to the Scottish Aquaculture Research Forum (SARF), a similar amount to other aquaculture-related research projects, £200,000 on salmon industry development measures and £110,000 on marine-related local, community-led projects.

Ian Grant, chairman of The Crown Estate, said: "These are excellent results and not only reflect improved market conditions, but also the continued improvements in the efficiency of our operations. Increased efficiency has been coupled with greater focus on improved customer service to ensure our desire to be regarded as 'the landlord of choice' is not merely an ambition, but becomes the accepted norm."

Roger Bright, chief executive of The Crown Estate, said: "We have delivered excellent results this year. We have done this by managing our business activities to protect revenue generation through lease restructuring, and creating capital value by active asset management, developing and improving existing properties, and enhancing the quality of our portfolio through acquisitions and disposals."

Commenting on the figures Alistair Carmichael, MP for Orkney and Shetland said: "In the opening line of their annual report the Crown Estate management state, 'There is no organisation in the world quite like The Crown Estate'. They are not wrong there.

"Aquaculture in other countries does not have to pay additional taxes to their governments in this way. This hampers the ability of our industry to compete on a level playing field with international competitors. It is another burden that our industry has to bear.

"The government has the power to limit harmful Crown Estate charges on our salmon and shellfish farmers and to reduce rents on piers and marinas. However, while the Estate keeps making record profits every year they appear quite happy to sit back and let the money roll in."

Fish Farming Today, August 2005

Tench developed for farming

A EUROPEAN research project called PRO-TENCH has started with the aim of introducing the freshwater tench (Tinca tinca) to aquaculture.

Similar to carp, tench is a bottom feeder which can grow up to 6kg in the wild. Aquaculture researchers are interested in developing the fish because of its taste – supposedly superior to carp – its ability to live with a low level of oxygenation and its tolerance to high stocking densities.

Ten aquaculture research and technological development centres in the UK, Norway, Spain, Czech Republic, Rumania and Greece are taking part in the CRAFT (Co-operative Action for Technology) initiative, which started in January of this year and will finish December 2006.

Fish Farming International, August 2005

Organic cod farming gets off the ground in Shetland

A SHETLAND-based aquaculture group has acquired the islands' only cod hatchery as part of a programme to become the world's first organic cod farming business, writes **Hans Marter**.

Shetland Organic Seafoods (SOS) said that bringing Nufish under its wing would secure a long-term supply of baby cod. It has also employed all the researchers from the recently closed aquaculture department of the North Atlantic Fisheries College (NAFC) in Scalloway, with a view to building a new research facility for fin-fish farming at Nufish's base in Sandwick.

The company hopes to achieve organic status for its farmed cod later this summer, and wants to produce 15,000 tonnes of the product annually by 2010.

The £3m investment programme will also include the establishment of more farm sites in Shetland's waters.

Nufish is one of only two commercial cod hatcheries in the EU. It has now been renamed Johnson Hatcheries and will be run by Dr Lesley McEvoy, the former head of aquaculture at NAFC.

The hatchery has an estimated annual output of 600,000 codlings, but SOS managing director, Karol Rzepkowski, revealed plans have been drawn up to triple production.

Fishing News, August 2005

BKD hits two English trout farms

MOVEMENT of live fish to and from two English trout farms has been prohibited following the identification of Bacterial Kidney Disease (BKD) at Nidderdale Trout farm. Low Laith, North Yorkshire and Test Valley Trout (lichen). a rainbow trout farm based in Hampshire.

BKD, caused by the bacterium. Renibacterium salmoninarum, is a notifiable disease under the Diseases of Fish Act 1937. It can cause large numbers of mortalities in both farmed and wild salmon and trout. It is not widespread in Great Britain and occursonly sporadically but is notifiable under EU law. Designated Area Orders were issued by Defra (Department for Environment, Food and Rural Affairs) following identification of BKD by Fish Health Inspectors.

A Fish Health Inspectorate spokesman explained: "In the case of Nidderdale, BKD was identified following a regular monitoring exercise by Fish Health Inspectors. We have undertaken contact testing on the farms which supplied Nidderdale and they have been negative.

"The TVT outbreak is different because there have been a number of cases of BKD in Scotland and we were informed that the TVT site had received fish from a farm with a BKD outbreak. As a result of that information we then undertook sampling on suspicion of disease and the TVT site proved to be positive."

He continued: "Our controls stop the movement of live fish from the sites but because both sites are table producing farms the impact is unlikely to be significant. We are conducting a much wider epidemiological survey of the catchment."

Fish Farming Today, August 2005

White spot breakthrough – for trout

A "PATENTED mechanical system" that removes the threat of white spot (*Ichthyophthirius multifiliis*) in trout – one of the major causes of mortality to worldwide aquaculture – has been successfully trialed on a commercial scale with dramatic results.

In a joint research programme by the Institute of Aquaculture and Pisces Engineering Ltd, both based inn Stirling, Scotland, a raceway system was used in the field trials, and "other trials in lined ponds and tanks are about to commence with similar results anticipated," explains the research team.

The programme has been funded by British Trout Association and the UK Government's Depratment of the Ennvironment, Foof and Rural Affairs (Defra).

"The primary device in the system is a special suction head connected to a pump," says Pisces. "Rather than being brushed or cleaned in other ways, the bottom is vacuumed, removing the unwanted cysts.

"The design of the vacuum ensures that even very small fry are not drawn in or damaged by it, while retaining sufficient suction and mechanical action to remove the cysts and other debris

Pisces adds that, as an additional benefit, the vacuum is also "very effective" at removing uneaten feed and faeces, resulting in improved water quality and probable other environmental and pathogenic benefits to the fish.

"A secondary and equally necessary device used in the trial was to line the concrete raceways with a special low adhesion polymer sheeting which eliminated the problems of cyst adhesion and the potential for cysts to settle and develop in the cracks and pores of the rough surface."

The team also expects the system to have far-reaching benefits for other pathogenic and environmental problems in aquaculture.

"The labour time for using the device is offset against the time that would normally be taken up for deading and treating infected stock, plus there is less stress on the fish and no need to starve prior to treatments."

Pisces adds that as well as being good news for aquaculturists the system also represents a positive move towards more environmentally sound solutions as it eliminates the need for formalin or other chemical treatments.

■ **www.pisces-aqua.co.uk**

Fish Farming International, August 2005

EU says new rules needed for fish health

THE EU Commission has proposed tougher new rules for the health of farmed fish to stem the high cost of diseases in the industry.

It estimates that the financial losses due to disease (mortalities, reduced growth and reduced quality) are 20% of the production value, equivalent to €500 million within the EU.

The proposed legislation, for both finfish and shellfish, aims to simplify and upgrade existing legislation in order to improve the general aquaculture health situation across Europe. It also aims to better facilitate safe trade in aquaculture animals and products, and to boost the competitiveness of this important sector for the EU.

A central aspect of the proposal is a shift in focus to preventing disease occurrence at each point in the production chain rather than dealing with it only when an outbreak occurs.

Markos Kyprianou, commissioner for health and consumer protection, said: "Disease outbreaks undermine consumers' confidence in the safety and wholesomeness of farmed fish and shellfish. They can also devastate the stocks of farms affected by them."

Prevention, he says, is the best cure and that is what the legislation aims at.

Aquaculture is an important growing sector in the EU, with a production value of around €2.6 billion a year. The proposed directive responds to the need to update current animal health legislation for aquatic animals, taking into account the developments in aquaculture, as well as international experience and scientific knowledge.

A key objective of this proposal is to simplify and modernise existing legislation and procedures on aquatic animal health. It also aims to improve intra-Community trade and make it easier for third countries to trade with the EU by providing harmonised, clear-cut rules on aquaculture.

Fish Farming International, September 2005

Akvaforsk secures cod gene patent

By Josephine Wood

THE Norwegian Research Institute, Akvaforsk, has taken out the world's first cod genetics patent, protecting a key technology advance which they say promises to increase the profit potential of cod farming globally.

The Akvaforsk patent covers an important cod breeding advance which the institute says makes it possible to match cod families to their specific farming environment. Breeding cod which are specially suited to their local conditions has never been done before.

The technology advance does not involve any gene manipulation whatsoever, according to the institute. It is, however, a way to identify the most advantageous genes for farming across a large number of fish, creating highly potent breeding families and making traditional husbandry far more effective than is the case at present.

Leading cod breeders

In 2002, Akvaforsk was the first to start a family based cod breeding programme. Since then, the Institute has built a globally leading cod breeding competence and has produced the world's first second generation families of farmed cod.

This programme is now being commercialized through the company Marine Breed AS who, this season, sold roe for millions of cod fry. Cod harvested from this roe is set to increase farming profits by some 0.6 Euro per kilo compared to the use of fry from earlier generations.

With the help of the newly patented gene technology, these improvements are likely to speed up even more. Akvaforsk now has the tool to create breeding families which contain more promising individuals, so raising the starting point for breeding to an even higher level.

Scientifically based

The Akvaforsk gene patent is based on established documentation which shows that haemoglobin levels differ in cod from different waters. Norwegian arctic cod has a different haemoglobin capacity to, say, North Sea cod, while both of them for example differ from the Baltic variety.

The result of this discovery is a future production of cod roe and fry which it is claimed, are ideally suited to their environment. This makes them healthy, fast growing and enables them to produce a more meaty fillet than has been possible in the past.

Akvaforsk researchers are claimed to be the the first to identify the genes which control haemoglobin production in cod. From this base they can now proceed to the development of an effective screening tool for haemoglobin variants, enabling breeders to screen large numbers of potential brood stock to identify those with the greatest potential.

This will make it possible to breed one type of cod for each region, clearing the way for significant yield, growth and profit improvements.

Cod Juveniles

Fish Farming Today, September 2005

White spot breakthrough

A JOINT research programme funded by the British Trout Association and DEFRA between the Institute of Aquaculture, Stirling and Pisces Engineering Ltd., has led to the development of a patented mechanical system which removes the threat of white spot (*Ichthyophthirius multifiliis*) - one of the major threats and causes of mortality to worldwide aquaculture.

The system has been successfully tested in the field on a commercial scale with dramatic results. A raceway system was used in the field trials, and other trials in lined ponds and tanks are about to commence with similar results anticipated.

White spot on trout

The primary device in the system is a special suction head connected to a pump. Rather than being brushed or cleaned in other ways, the bottom is vacuumed, removing the unwanted cysts. The design of the vacuum ensures that even very small fry are not drawn in or damaged by it, whilst retaining sufficient suction and mechanical action to remove the cysts and other debris.

An additional benefit is that the vacuum is also very effective at removing uneaten feed and faeces, resulting in improved water quality and probable other environmental and pathogenic benefits to the fish.

A secondary and equally necessary device used in the trial was to line the concrete raceways with a special low adhesion polymer sheeting which eliminated the problems of cyst adhesion and the potential for cysts to settle and develop in the cracks and pores of the rough surface. The team also expects the system to have far reaching benefits for other pathogenic and environmental problems in aquaculture. The labour time for using the device is offset against the time that would normally be taken up for removing dead fish and treating infected stock plus, there is less stress on the fish and no need to starve prior to treatments.

As well as being good news for aquaculturists the system also represents a positive move towards more environmentally sound solutions as it eliminates the need for formalin or other chemical treatments. Further information about the system and the trials can be found at the Pisces Engineering website www.pisces-aqua.co.uk.

Fish Farming Today, September 2005

New home for cod breeding programme

THE Norwegian Institute of Fisheries and Aquaculture Research, Fiskeriforskning, has developed a cod breeding programme, which is based on combined selection of families and individuals.

The programme requires facilities for production of a large number of family groups. Production of family groups started in 2003 in temporary quarters at the Aquaculture Research Station in Tromsø. The work to establish a permanent breeding station gained impetus in 2004 with the purchase of Troms Marin Yngel's new hatchery.

This advanced plant has undergone reconstruction and refurnishing, transforming it into a functional breeding station with capacity to simultaneously start-feed 300 family groups. The new facility was put to use for hatching and start feeding in March 2005.

When the fry are big enough, they are transferred to net cages.

For veterinary reasons, the fry are not kept together with other species, which excludes use of the Aquaculture Research Station's new sea hatchery. Further growth to a sexually mature size must take place in a separate net cage facility.

A new, tailor-made one, built for this purpose, was delivered in June 2005 and immediately put to use.

In addition to the breeding station complete with the net cage facility, two test stations have been established: One in connection with the Institute of Marine Research's Aquaculture Research Station in Austevoll, and one in North Cape Marine's plant in Båtsfjord.

The purpose of these facilities is to discover whether the performance of the different families varies with different farming environments (genotype-environment interaction).

The test stations strengthen the data basis for the selection, and function as safeguards should the fish at the breeding station be lost due to damage, disease or other reasons.

With everything in place, the cod breeding programme is now fully operative with modern and functional facilities. Comprehensive gene technology laboratories complete the picture.

Fish Farming Today, September 2005

National Aquatics Centre opened at Sparsholt

SPARSHOLT College, Hampshire received a visit from His Royal Highness the Earl of Wessex to officially open the new National Aquatics Training Centre within the college's Fishery Studies section. Although the stylish building was completed a year ago, the installation and establishment of the many tanks and aquaria, housing hundreds of fish from wide ranging species, has taken months of careful work, by both staff and students, to reach its finished level of presentation and operation.

In welcoming His Royal Highness, Geoff Healy, chairman of governors, noted with wry humour how impressed he was by the ability of the Earl of Wessex in laying the foundation stone of this same building two years previously; a stone which had now found its way above the lintel of a door which hadn't existed at the time. He remarked that the college would ensure that this skill would be passed onto the students on construction courses.

He added: "This wonderful building, which has cost around £1 million - about a tenth of what the college has spent over the past few years – shows that we firmly believe that the youngsters of this country deserve and need first class facilities to inspire them and enhance the learning process. Sparsholt's going to make sure that we play our full part in that."

HRH the Earl of Wessex opened the new training centre

The Lord Lieutenant of Hampshire, Mrs Mary Fagan, introduced the Earl of Wessex to a number of guests, including the Chairman of Hampshire County Council, Mr John West, and the Mayor of Winchester, Councillor Neil Baxter, and then to College Principal, Tim Jackson, and Fishery Studies Section Manager Shaun Leonard. Shaun led the royal party on a guided tour of the building.

During the tour of the building, as well as paying fascinated attention to the vast array of fish, the Earl met representatives of the fisheries and aquatics industries, together with other staff and a number of students, and the designers and constructors of the building.

The Centre, a unique building of its type in the UK, is divided into two main sections, Aquatics (representing many exotic and tropical species of fish) and Aquaculture (representing the management of native fish and their environment in UK fresh waters, such as lakes and rivers). Sparsholt College is known internationally for its training of aquaculture and fishery technical staff and managers and student graduates spread throughout the country and the rest of the world for employment in lake and river fisheries, marine life tourist centres, public aquaria, fish farms, water gardens and ornamental fish retail outlets. Additional investment and donations from the industry have now enabled the stocking and establishment of many spectacular aquaria and tanks with a huge range of species ranging from massive koi to African lungfish, from catfish to "Nemo" clownfish and from giant (lettuce-eating) gourami to piranha.

At the conclusion of the tour, His Royal Highness unveiled the plaque that declared the new facility officially open and congratulated the huge team involved in its conception and application. He said that he hoped that the relationship between the college, its students and the business community would continue, to ensure that what young people learn in the building is placed in its appropriate context, and he hoped that the many visitors to the building that day had been as impressed as he himself had been.

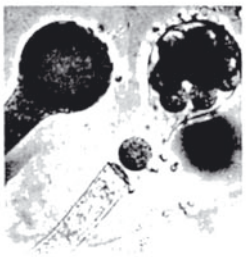
The Earl of Wessex was thanked by principal Tim Jackson for opening the Aquatics Centre on behalf of both the staff and the students, many of whom he had met during the visit.

Fish Farming Today, September 2005

Kenifine – an effective alternative to Malachite Green?

JAPANESE researchers claim to have found an alternative method of combating fungal problems in fish hatcheries. Fuji Trout Hatchery at the Shizuoka Prefectural Fisheries Experimental Station has been conducting research on reducing the occurrence of fungal infections which can drastically affect the production yield of eggs and fingerlings of rainbow trout and other fish species. The study found that an antibacterial coating, Kenefine, made by Kobe Steel, is effective at reducing fungal moulds.

The break-through is important because malachite green, the chemical which has been widely used to control fungi such as Saprolegnia in fish culture for many decades, has now been banned from use in fish destined for the international food trade. This means that fish hatcheries throughout the world have been grappling with fungal outbreaks.



Saprolegnia

Since the mid-1970s, malachite green has been suspected of being a carcinogen. In 1981, the United States prohibited the use of the substance in food-related applications. The EU and Norway placed a similar ban in 2002.

In July 2003, Japan revised its Pharmaceutical Affairs Law, which curtailed the use of malachite green in egg incubation facilities and fish farms. An extension until July 2005 allows the use of the chemical on eggs raised at seedling production facilities on land and young fish of 1 gramme or less.

Companies have been investigating alternatives to malachite green. New chemical agents have gained approval and are anticipated to go on the market in the near future. Owing to growing regional and consumer interest, expectations have risen on the non-reliance of chemicals in fish farming, or if used at all, to minimize the amount.

At the Fuji Trout Fishery, researchers verified that Kenifine was not only effective in reducing fungal mould on fertilised eggs, but it had no adverse effects on the eggs.

Kenifine is an electrolytic plating that contains nickel and trace amounts of other elements. When plated to the substrate, the ions in the Kenifine coating have antibacterial properties. It has demonstrated that it is effective at controlling microorganisms in comparison to conventional surface-treated products, such as antibacterial paint and antibacterial stainless steel. Highly resistant to corrosion in fresh water, the alloy coating also has outstanding antifungal and antialgal properties. Kenifine has also passed various safety tests, including acute toxicity tests, set by the Society of Industrial-Technology for Antimicrobial Articles (SIAA).

Following development in 2001, Kobe Steel has licensed the Kenifine technology to six companies and five other firms are using it on a trial basis. Improvements to Kenifine have made it resistant to discoloration. In addition to metals, the coating is also available in powder form for use on plastic surfaces.

Fish Farming Today, September 2005

Johnson Seafarms brings cod to the table

SHETLAND Aquaculture's member company. Johnson Seafarms. is a prime example of how the industry is undergoing significant change.

The company recently underwent a highly publicised management buyout with a £21 million investment from the city.

This major development has allowed Johnson's to expand its pioneerng move into rearing cod. With wild cod fish quotas undergoing a significant reduction. Johnson Seafarms plans to replace wild fish on menus with the farmed variety. By 2007. the company aims to be producing 3.000 tonnes of organic cod.

The priorities for Johnson Seafarms are clear: achieving the organic standard, protecting the environment and the welfare of the fish, and long-term planning for the sustainability of the industry. It is already becoming clear that those priorities have laid a firm foundation for the company, with many experts finding Johnson's organic cod superior to the wild variety.

Fish Farming Today, September 2005

International aquaculture health commission

THE AQUATIC Animals Health Standards Commission, of the Office International des Epizooties (01E) is setting up an expert group on improving surveillance of stocks for fish disease outbreaks.

The committee is to make recommendations to the next Commission meeting in March, probably in Paris, France. The decision follows new assessments on surveillance. particularly by an ad hoc group on fish disease. which has been considering when controls on whether a disease has been eradicated should be restricted to infected zones, or also to buffer zones. Detailed guidance will be released in the Commission's Aquatic Manual.

The Commission is also changing its disease-related quarantine rules, so thatrather than specifying a quarantine time for each disease, more flexible guidelines should be supplied to "minimise the risk of spread of the disease".

Meanwhile. the March meeting is expected to discuss detailed proposals for improving the standard of transporting finfish by land and water, the slaughter of finfish, and new research on antimicrobial resistance. The Commission is also drafting new guidelines on the safe disposal of farmed fish waste and carcasses.

The organisation recently delisted finfish diseases infectious pancreatic necrosis and bacterial kidney disease as internationally notifiable, as well as mollusc disease mikrocytos mackini.

Fish Farming International, November 2005

Good news for halibut lovers

FARMED halibut fillets can last for up to three weeks, according to new research by the Norwegian research site forkning.no in co-operation with fiskeriforskning. This finding should be good news for producers of seafood and retailers as longer durability means better possibilities for distribution and good news for consumers.

The research findings increase the possibility of getting more fresh, pre-packed and ready-to-be-cooked products into retail chilled sections.

The research project found that fillets of farmed halibut have a durability of 20 days, if they are packed and preserved in the right way. The requirement is that they are packed in a modified atmosphere where ordinary air is replaced with a mix of various types of gas. In the trials, a mix of 50 percent carbon dioxide and 50 percent oxygen gave the durability of 20 days, whereas halibut packaged in ordinary air only lasted for 10 days.

Fish Farming Today, October 2005

Researchers investigating the life of a cod discover surprising results

By Christina Reid

RESEARCHERS in the United States, who have been studying the movements of offshore farmed cod in a bid to learn more about the species, have announced some unexpected results.

Scientists at the Cooperative Institute for New England Mariculture and Fisheries have been studying the motives behind the frenetic movements of cod farmed 80 feet below sea level.

Due to the inaccessibility of their habitat, little is known about cod behaviour in the wild. However, by combining bio-telemetry and video techniques, scientists have been able to study cod in a setting that approximates their natural habitat.

To trace the movements of a few cod in a swirling mob of thousands, researchers rely on 'pingers' – ultrasonic transmitters surgically implanted in the fish. As the tagged cod swim and feed, their pingers emit high-frequency 'chirps' that are picked up by underwater microphones. The cod also wear external tags so the researchers can monitor them by video camera. The video and telemetry signals are recorded with instruments located in a buoy floating above the cage, relayed to a receiving station on shore, and picked up by internet in the lab at the University of New Hampshire.

A cod's jerky advances, revolving retreats and smooth glides may lack pattern or purpose to the untrained eye, but these movements are allowing researchers to piece together a cod's life.

Speaking to *Fish Farming Today*, director of the institute, Dr Richard Langan said that when researchers embarked upon the cod tracking study they really didn't know what to expect. However, the study, which has now been suspended to allow for harvest, has produced some interesting data.

"It seems they use very little of the actual cage space," Dr Langan said. "They seem to stay right around the mid point of the cage and, unlike salmon and even unlike haddock, which seem to swim in a counter-clockwise rotation continuously around the cage, the cod move rather randomly, even though they're staying around the middle of the cage.

"We do see that they have some fidelity in terms of being at a certain part of the cage at a certain time of the day when they expect food. They seem to home in and have some innate biological clock that lets them know when food is going to be delivered."

Dr Langan said that a number of the results have surprised researchers.

"The other thing that we have found, which is counter to what the conventional wisdom is, relates to the use of lights in the cage to delay the onset of sexual maturity," he continued. "Delaying the onset of sexual maturity is important because you want to have the fish putting most of their energy into body weight growth rather than reproductive development. When the lights went on in the cage, what we found was that the cod increase their swimming speed which means they're burning more energy. We're now trying to determine what the difference is between the amount of energy they're burning and the amount of energy they're putting into sexual reproduction."

The researchers are comparing the information gathered from the cod tracking study to lab studies that calculate how much energy cod burn when they swim at different speeds, and to environmental data on currents, storm activity, and temperature changes at the cage site. From this mountain of data they are painting a picture of a cod's life – how much food it needs in different conditions, what temperatures it thrives in, what kind of environment it prefers. This knowledge will be used to help fish farmers prevent overfeeding, to inform the design of cages that fish will fully utilise and to help determine at what depth and in what temperature cod grow best.

Cod in the lab prior to their transfer to the offshore net pens.

Fish Farming Today, November 2005

Scottish aquaculture receives £600,000 boost

MORE than £600,000 worth of grants have been awarded to Scottish, aquaculture companies in the latest round of the European Financial Instrument for Fisheries awards.

In the Highlands and Islands the awards were as Johnson Seafarms Lid, based in Vidlin, Shetland, was awarded £208,200 towards the expansion of its cod farming facility; Balta Island Seafare Ltd, based in Unsi, Shetland, was awarded £27,180 to develop its organic salmon farming site; Loch Fyne Oysters Ltd, based in Ardkinglas, Argyll, was awarded £20,000 towards the expansion of its Oyster and mussel farm; Shetland-based East Voe Shellfish was awarded £18,225 towards the expansion of its existing mussel farm, and Shetland Mussels Ltd was granted £30,752 for the purchase and installation of mussel culture equipment.

Elsewhere .in Scotland, the awards £11,333 to Dunbar Trout Farmers, based at Langholm and Stow; for the installation of drum filters; £10,570 to Yarrow Fishery, Selkirk, towards a micro screening plant for inlet water supply, and £285,750 to Scot Trout Farming Ltd for the expansion of facilities to enable production increases.

The aquaculture companies are among 67 businesses set to benefit from the latest FIFG grant awards. The £6.5 million funding boost is expected to create 100 new jobs in Scot- land's fisheries and aquaculture sectors.

Announcing the awards, Fisheries Minister Ross Finnie said they area further substantial commitment to the future ofi Scotland's fisheries and aquaculture industries on top of £30 million invested over the last five years. . , "The scheme in the Highlands and Islands has been regularly oversubscribed with high quality bids and for that reason I have topped up the available EU FIFO aid With Executive funds to benefit a larger number of projects across Scotland," Mr Finnie said.

"I am particularly delighted to announce support of improvements to facilities at Mallaig arid Carradale harbours and the further expansion of cod farming facilities on Shetland. I am committed to a profitable and sustainable fisheries sector and see grant support as contributing to achieving this objective."

This is the ninth round of FIFG awards which were introduced in 2000 and will run until the end of 2006. Over the period of the FIFG programme. £55 million has been made available to Scotland (£17 million for the Highlands and Islands area and £38 million for the rest of Scotland).

Fish Farming Today, November 2005

Danish organic trout hits market

THE FIRST organic Danish trout is now on the market. announces Jacob Bregnballe, chairman of Dansk Akvakultur. "We have long wished to ire able to produce organic fish like other countries, but first the Danish rules had to be put into place," he says.

According to Bregnballe, Danish organic rules are stricter than in other countries regarding fish health and well-being and it was a challenge putting them all into place. There are limitations regarding the usage of medicines and chemicals, such as organic-labelled fish can only be medicated once in its lifetime. In addition, the feed has to be GMO and dye-fee. It is predicted that the organic trout will be around 30% more expensive than non-organic trout in Denmark.

Fish Farming International, October 2005

'SmartTag' to monitor stress levels of farmed fish

NEW monitoring technology makes it possible to measure whether farmed fish are thriving, according to Norwegian fisheries research body Fiskeriforskning.

A small device is being developed which can be fitted to fish to register their breathing activity and stress levels.

The project is part of the EU-financed research programme SEAFOODplus, which studies how fish react to the fish farm environment. The company Thelma, based in Trondheim, has been given the task of developing the technology, named 'SmartTag'.

Testing and development of the equipment for use on cod has been carried out this autumn. The technology will initially be used in research work.

The equipment makes it possible to measure how often, and how much, the pressure changes in the cod's mouth. Audio signals are sent, from a box on the cod's back, to an underwater microphone, which sends the sound to a computer. There, a programme calculates the breathing activity.

"Traditionally, a number of individual factors are measured to map the fish's well-being, such as density of fish in the net cage, the oxygen level in the water and the amount of waste products," said Fiskeriforskning researcher, Øyvind Aas-Hansen. "But such measurements do not take into account how the sum of all the factors affects the fish. Also, only a few known factors are measured.

"Now we can measure how the total effect of the farming environment affects the fish. We envisage that the breeders can have a certain number of fish with this equipment in the net cages and can thus monitor the fish. Abnormal breathing activity indicates something is wrong, and measures can be implemented."

As well as measuring breathing activity, work is being done to develop the equipment so that it can also register how often the fish eats.

Norwegian scientists have been testing the SmartTag on cod.

Fish Farming Today, November 2005

New turbot farm

A LINCOLNSHIRE farmer's son has set up the first turbot fish farming business in England with the help of a grant from Defra's Rural Enterprise Scheme (RES).

Jonathan Stow of Grayingham, near Gainsborough, has always been keen on fishing and, after gaining specialist qualifications in Scotland and practical experience in the fish farming industry, he decided it was time that the family holding diversified.

This summer he travelled to France to collect and place 6,500 juvenile turbot into his newly installed re-circulation system in a temperature controlled building on the five acre holding. By January the fish should have grown from 5g to between 500g and 1kg and will be ready for sale to restaurants and fishmongers throughout the UK. The farm plans to produce up to 25,000 fish per annum.

Fish Farmer, November/December 2005

Soybean meal aquaculture database established

THE United Soybean Board's Soy-in-Aquaculture(SM) Managed Research Program (SIA) and Archer Daniels Midland Company (ADM), announce a collaborative effort to establish a new soybean meal (SBM) database designed to help feed formulators use SBM in diets fed to aquatic animals. The goal is to link biological responses of targeted aquaculture species with nutrient and anti-nutritional factor (ANF) concentrations in SBM. This characterization is important because ANF levels in SBM vary depending on factors such as cultivar and growing conditions and there are relatively few definitive data on the effects of ANF in aquaculture species.

The purpose of this newly-established program is to develop a database that will serve as a ready source of information for the use of SBM in diets fed to aquatic animals, and will reduce the speculation regarding the factors limiting its use. Beginning this year, SIA/ADM will, free of charge, quantify the concentrations of lectins, oligosaccharides and trypsin inhibitors in SBM samples prior to testing in diets fed to any aquatic animal. These data and resulting biological responses will then be available to all interested parties to aid in the formulation of diets and to serve as an important summary of SBM use for future evaluations. The following information must be available for the intended species:

- An estimate of the optimal dietary crude protein concentration;
- An estimate of the optimal ratio of crude protein to non-protein energy; and
- Quantitative requirements for lysine and methionine in the target species (if the essential amino acid concentrations have not been quantified and/or the methodology for quantifying them is suspect, this requirement may be waived).

Investigators will be responsible for characterizing the nutrient content of the SBM sample and other ingredients used in test diets such that diets are formulated on an amino acid basis. Minimal sample size for characterization is 200 g dry weight and all samples must be finely ground prior to submission. Samples must be submitted at least four weeks prior to starting studies.

Investigators are also expected to provide the biological response data (feed intake, weight gain, feed conversion ratio, survival, nutrient digestibility, and all other data collected as part of the trial) for inclusion into the SIA database. Investigators are free to choose what response data are collected. Submission of biological responses to the database does not preclude publication in other venues.

For more information, please contact http://www.soyaqua.org/, Dr. Paul Brown, Purdue University, pb@purdue.edu, or Gil Griffis, Soy-in-Aquaculture Project Coordinator, United Soybean Board, giljangriffis@earthlink.net

Fish Farmer, November/December 2005

Kiwi company hopes to export 'humane'fish anaesthetic to Europe

A NEW Zealand company claims to have developed a product that allows "harmless and humane" preparation of fish for harvesting, the Waikato Times has reported. Aqui-S says the product makes salmon less agitated during harvest and therefore reduces the production of stress-induced hormones and chemicals. It claims this results in a higher quality end product.

The product is added to water and works in the same way as a human anaesthetic, putting the fish to sleep by shutting down their nervous systems. Aqui-S claims the product, which is made from food materials, has no side-effects for humans. The anaesthetic has been used in New Zealand since 1996 and is exported to Chile, Australia and South Korea. Exports account for around 80% of sales.

The company has been working with the Food and Drug Administration in the United States and hopes it will approve the product within the next couple of years. It is also seeking to have the product approved for export to Europe.

Managing director, Dr Don Bell said that although the product was developed for salmon, it could also be used on species such as bream, bass and lobster. He claims it can also be used to reduce stress during transportation and handling.

Aqui-S is a joint venture between The New Zealand Institute for Crop and Food Research and private interests, and has been supported by Technology New Zealand funding.

Fish Farming Today, November 2005

WHERE TO GET HELP AND ADVICE

Policy Matters

Department for Environment, Food and Rural Affairs,
Nobel House, 17 Smith Square, London SW1P 3JR
(Switchboard tel. 020 7238 3000)
(General fax. 020 7238 6591)

Fish farming policy:-
Fisheries Division II, Area 5E, 8-10 Whitehall Place,
London, SW1A 2HH
(Tel. 020 7270 8826) (Fax. 020 7270 8827)

Grant Aid:-
Fisheries Division 1B, Area 6D, 3-8 Whitehall Place
London, SW1A 2HH
(Tel. 020 7270 8041) (Fax. 020 7270 8019)

Research and Development Programmes:-
Fisheries Science Unit, Area 6C, 3-8 Whitehall Place,
London, SW1A 2HH
(Tel. 020 7270 8274) (Fax. 020 7270 8020)

You can also visit the Defra website at www.defra.gov.uk/

The Welsh Assembly Government, Agriculture and Rural Affairs Department,
Agricultural Policy Division 5,
New Crown Buildings, Cathays Park, Cardiff CF1 3NQ
(Tel. 02920 823567) (Fax. 02920 823562)
www.wales.gov.uk

Scottish Executive Environment and Rural Affairs Department,
Pentland House, 47 Robbs Loan, Edinburgh EH14 1TW
(Tel. 0131 244 6224) (Fax. 0131 244 6313)
www.scotland.gov.uk/who/dept_rural.asp

Department of Agriculture and Rural Development for Northern Ireland,
Fisheries Division, Annexe 5, Castle Grounds,
Stormont, Belfast BT4 3PW
(Tel. 028 9052 3431) (Fax. 028 9052 2394)
www.dardni.gov.uk

Scientific and technical advice

Health regulations and disease control -
Cefas Weymouth Laboratory, Barrack Road,
The Nothe, Weymouth, Dorset DT4 8UB
(Tel. 01305 206673/4) (Fax. 01305 206602)
Email: Fish.Health.Inspectorate@cefas.co.uk

Pollutants and their effects -
Cefas Burnham Laboratory, Remembrance Avenue,
Burnham-on-Crouch, Essex CMO 8HA
(Tel. 01621 787200) (Fax. 01621 784989)

You can also visit the Cefas website at www.cefas.co.uk

Farm animal welfare -
Department for Environment, Food and Rural Affairs,
Animal Welfare Division, 6th Floor, 1A Page Street
London SW1P 4PQ

Environmental issues -
Environmental Agency, Rio House, Aztec West,
Almondsbury, Bristol BS32 4UD
(Tel. 01454 624400) (Fax. 01454 624033)
www.environment-agency.gov.uk

Veterinary medicines -
The Veterinary Medicines Directorate,
Woodham Lane, New Haw,
Addlestone, Surrey KT15 3LS
(Tel. 01932 336911) (Fax. 01932 336618)
www.vmd.gov.uk

Food hygiene -
Food Standards Agency
Aviation House, 125 Kingsway, London WC2B 6NH
(Tel: 020 7276 8000)

Fisheries Research Services,
Marine Laboratory, PO Box 101, Victoria Road,
Aberdeen AB9 8DB
(Tel. 01244 876544) (Fax. 01224 295511)
www.marlab.ac.uk

Advice on commercial activities

The British Trout Association,
The Rural Centre, West Mains, Inglistone
Mid-Lothian EH28 8NZ
(Tel. 0131 472 4080)
www.britishtrout.co.uk

Wildlife conservation

Joint Nature Conservation Committee,
Monkstone House, City Road, Peterborough PE1 1JY
(Tel. 01733 562626) (Fax. 01733 555948)
www.jncc.gov.uk

English Nature,
Northminster House, Peterborough PE1 1UA
(Tel. 01733 455000) (Fax. 01733 568834)
www.english-nature.org.uk

Countryside Council for Wales,
Ffordd Penrhos, Bangor LL57 2LQ
(Tel. 01248 385500) (Fax. 01248 355782)
www.ccw.gov.uk

Scottish Natural Heritage
12 Hope Terrace, Edinburgh EH9 2AS
(Tel. 0131 447 4784) (Fax. 0131 446 2277)
www.snh.org.uk

Other Useful Numbers

Co-ordinator for Defra - CARD R&D
Dr Mark James, Fisheries Resource Management Ltd,
Coillie Bhrochain, Bonskeid, Pitlochry, Perthshire
PH16 5NP (Tel/fax. 01796 474473)
www.frmltd.com

USEFUL PUBLICATIONS

Readers of *Finfish News* may be interested in the leaflets listed below. These are available by contacting the relevant Department/Agency or via the websites (see contact details in Where to get Help and Advice).

Defra
- A guide to importing fish
- Combating fish disease
- A guide to protecting freshwater fish stocks from gyrodactylosis and other serious fish diseases
- A guide to protecting freshwater fish stocks from Spring Viraemia of Carp

Cefas / Environment Agency
- Controls on the keeping or release of non-native fish in England and Wales

Cefas
- The Fish Health Inspectorate and you – our code of practice and Customer Charter

Veterinary Medicines Directorate
- Code of practice on the responsible use of animal medicines on the farm
- Veterinary Medicines Guidance Note 15: Controls on the administration of veterinary medicines
- Veterinary Medicines Guidance Note 16: Record keeping requirements for veterinary medicinal products
- Veterinary Medicines Guidance Note 21: Medicated feedingstuffs prescriptions

SEERAD Fisheries Research Services (Aberdeen and Pitlochry Laboratories)
Information leaflets

- How new diseases emerge
- Identifying risk factors for Infectious Pancreatic Necrosis
- *Gyrodactylus salaris*
- What are freshwater lice?
- Supporting new aquaculture species in Scotland
- Scotland's freshwater fish populations: stocking, genetics and broodstock management
- Scotland's Arctic charr
- Scotland's freshwater fish populations – introductions and movements
- Ferox trout
- Water quality in salmon spawning gravels
- How groundwater can affect the survival rate of salmon eggs
- How river flow affects rod catches of Atlantic salmon
- Signal crayfish – an unwelcome addition to Scottish streams
- Grayling
- Pike
- Catch and release – a guide to best practice

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