

Finfish News

(incorporating Trout News)
Number 3, Winter/Spring 2007



CENTRE FOR ENVIRONMENT, FISHERIES AND
AQUACULTURE SCIENCE

FINFISH NEWS

Incorporating Trout News

Number 3
Winter/Spring 2007



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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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KOI HERPESVIRUS DISEASE: NOTIFICATION AND CONTROL

Defra published new measures on 21 May designed to combat the introduction and spread of Koi Herpesvirus (KHV) Disease and to improve the health and welfare standards of fish. It became a legal obligation to notify suspicion of KHV disease from 6 April 2007.

Organisations participating in the Fish Welfare Group representing ornamental, fish farming, fish supply, fishery management and angling sectors have worked closely with government to develop a partnership approach to the control of future outbreaks of KHV.

Under new statutory control arrangements, the Fish Health Inspectorate of the Centre for Environment, Fisheries and Aquaculture Science (Cefas), working with the Environment Agency, will investigate reports of suspicion of clinical infection of KHV disease. If the disease is confirmed, the affected site will be identified and placed under movement restriction so that industry can take precautions to reduce the risk of further spread.

The Industry sectors concerned have developed guidance and codes of practice on the risks posed to businesses and to fish in the wild from KHV infection, as well as the means of mitigating those risks through robust biosecurity.

Details of the statutory and voluntary controls announced are as follows:

KOI HERPESVIRUS (KHV) DISEASE: STATUTORY CONTROLS

*Department for Environment, Food and Rural Affairs
Welsh Assembly Government
Centre for Environment, Fisheries and Aquaculture Science
Environment Agency*

Legal Obligation to Notify KHV Disease

1. The Diseases of Fish (England and Wales) Order 2007 (SI 2007 No.864), which came into force on 6 April 2007, makes it a legal obligation to report suspicion that inland waters have become infected with KHV Disease.

2. This legal obligation applies to any person entitled to take fish from inland waters, or responsible for the care of inland waters. This will include riparian owners, fish farmers, fisheries owners, and their staff (anglers may also notify suspicion of disease). Anyone required to notify, and who fails to do so without reasonable excuse would be guilty of an offence under the Diseases of Fish Act 1937 (as amended).

What constitutes suspicion of KHV Disease?

3. Dead or dying fish with other clinical evidence such as bleeding from the gills, white patches on the gills or skin, sunken eyes and hyperactive behaviour in fisheries. These signs usually appear when water temperatures are between 15° and 28°C. For more advice

about KHV Disease please refer to <http://www.efishbusiness.co.uk/>

Who should be notified and what happens next?

4. The Fish Health Inspectorate (FHI) at the Centre for Environment, Fisheries and Aquaculture Science (Cefas), Weymouth should be notified using the contact details at the end of this notice. They will aim to investigate suspected clinical signs of KHV disease within 3 working days.

5. Where clinical signs of disease are present, samples will be taken for diagnostic testing to see if the outbreak is due to KHV Disease. Results from the diagnostic tests may take up to 14 days.

6. If the FHI strongly suspects that the mortalities are due to KHV Disease, they may immediately prohibit movements on and off the site by means of a thirty-day notice (TDN) in the case of Fish Farms and a Designated Area Order in the case of all other sites.

What control arrangements apply when KHV disease is confirmed?

7. The control arrangements may vary in approach depending on the facilities, environment in which the fish are kept, and the risk of further spread of infection. Details are given below.

Fisheries, other inland sites, Fish Farms, Fish Dealers and Retailers

- The FHI will advise on the most appropriate methods for the control of the disease. This may require the culling of stocks of affected fish, and the cleansing and disinfection of the site. Where cleansing and disinfection is not practicable (as may be the case in most fisheries and some farms), a Designated Area Order (DAO) will be placed on the affected site.
- The effect of the DAO will be to make public the location of the affected site and place restrictions on the movement of live fish on and off the site. The DAO will remain in place for at least 12 months pending the outcome of joint Defra/industry funded research, currently taking place, to determine the extent of KHV infection in English and Welsh waters.
- Live fish movements on and off site will not be allowed while there is evidence of clinical disease on the site. However, in the absence of clinical disease, farm and other site owners may apply to the FHI for a relaxation of the restrictions to help facilitate the continuity of business.
- The FHI will consider the need for follow-up inspection of contact sites on a case-by-case basis but this will not involve the sampling of fish unless clinical signs of disease are observed or reported.
- The Environment Agency will consider applications for the introduction of fish to affected fishery sites but will not consent to the introduction of live fish sourced from infected sites.

Fisheries and Angling Activities

- The FHI may (on application) allow movements of non-susceptible species or in certain cases, susceptible species, onto affected fisheries to enable angling activity to continue. However, such movements will only be permitted if site owners introduce and ensure the application of appropriate biosecurity measures for all those using the site including anglers. Providing the biosecurity measures are observed there should be negligible risk of transfer of KHV disease to other fishery sites through angling activity. All movements will also be subject to consent from the Environment Agency.

Aquaria and Garden Ponds

- Hobbyists and other owners of ornamental fish should notify the FHI of suspicion of infection with KHV Disease. The FHI will make a diagnosis on the basis of information provided about clinical signs of disease and assess the potential for the spread of infection.
- Where the spread of infection is assessed as negligible, no further action will be taken by the FHI. Site owners will instead be provided with written advice on the management of KHV Disease in aquaria and garden ponds.
- Where the assessment indicates potential for spread to inland waters, a sample will be taken for diagnostic purposes and, on confirmation of the disease, a cull of the affected fish and disinfection of the facility will be advised. If this is not feasible, a DAO will be placed on the site to prohibit the movement of fish on or off the site.
- Diagnostic testing on sites assessed as negligible risk will be available only on a commercial basis through Cefas Technology Ltd (CTL).

Please Note: The Animal Welfare Act 2006 makes owners and keepers responsible for ensuring that the welfare needs of their animals (including fish) are met. This includes taking appropriate measures to protect them from disease.

Contact for Notification

Fish Health Inspectorate
 Cefas
 Barrack Road, The Nothe
 Weymouth, Dorset, DT4 8UB
 Tel: 01305 – 206600
 Fax: 01305- 206602
 Email: fishhealthinspectorate@cefas.co.uk

Environment Agency
 Fish Health, Ageing and Species
 Bromholme Lane
 Brampton, Huntingdon
 Cambridge PE28 4NE
 Tel: 01480 483 802
 Fax:01480 433 873
 Email: nffishhealth@environment-agency.gov.uk

FISH WELFARE GROUP - PRESS NEWS**Strong Support For KHV Statutory Controls**

The disease caused by Koi Herpesvirus (KHV) became notifiable in England and Wales on April 6th 2007. This regulation places a statutory obligation on anyone suspecting the presence of KHV in fish stocks to report it to the authorities.

However, to limit the damage caused by the disease, much more is needed by all involved in managing recreational fisheries, supplying those fisheries and importing, selling and keeping ornamental fish. Control measures could have been introduced directly by Government, but following a detailed consultation process with industry bodies, an innovative approach of joint industry/Government co-operation has been agreed.

Organisations participating in the Fish Welfare Group have welcomed the opportunity to work with DEFRA and the industry sector generally to formulate the strategy to control KHV. Many representatives, from a wide variety of organisations, have worked together with government officials to develop this joint approach.

Codes of best practice have been developed to provide a variety of interlinked actions to protect the UK's wild and ornamental fish stocks. They will help prevent outbreaks of KHV and other novel diseases that will threaten fish welfare in future. These codes are designed to improve general bio-security in the ornamental, fish farming, fish supply and fishery management sectors. Use of these codes will ensure rising standards of competency in fishery

management, fish transport, fish purchase and husbandry. This initiative is founded on bio-security principles and correctly places the emphasis of fighting diseases on those who purchase and care for fish in situations as diverse as natural fisheries or ornamental fish retailing outlets.

These codes have been recognised and supported by DEFRA, Cefas, the Environment Agency and other governmental bodies, and they should be used to help make informed choices on buying and moving fish by fish-related businesses. Commercial organisations, the voluntary sector and individuals following these codes will be helped not only to fight KHV but also to meet legal obligations under new regulations concerning animal transport and animal welfare.

It is now imperative that each individual buying or moving fish, whether importing ornamentals or moving stock between lakes, puts these codes and guidelines into operation. By doing so they will publicly demonstrate their wish to protect their businesses, the sectors that provide their and others livelihoods, and the natural and managed fish communities in the country.

Co-operative Action

For perhaps the first time the industry has co-operated in lobbying Government to mount a robust response to the KHV threat. In response, DEFRA has approached this complex problem with an open mind and has proved prepared to accept a mixed system of legislative measures and self-regulation by its industry partners.

KOI HERPESVIRUS - AN UPDATE

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INTRODUCTION

Koi herpesvirus (KHV) causes a severe disease and mass mortalities in populations of cultured common carp (*Cyprinus carpio carpio*) and koi carp (*Cyprinus carpio koi*). The disease has spread rapidly around the world and devastating losses have occurred in intensive and extensive carp culture facilities with the most severe disease outbreaks being reported in Asia. Although initially the disease was seen to have most impact on the ornamental carp trade, more recent years have seen disease outbreaks in populations of common carp cultured for food ⁽¹⁾ and in wild carp ⁽²⁾. In Europe, severe KHV disease outbreaks have been reported on carp farms in Germany and Poland ^(1,3) and in carp angling waters in England ⁽⁴⁾. In response to a call from European Union (EU) member states, the World Organisation for Animal Health (commonly known by the Organisation's original acronym as the OIE, Office International des Epizooties) have now added KHV disease to its list of serious diseases whose occurrence must be reported to the OIE.

SPREAD OF KHV

The disease transmits horizontally (fish to fish) very rapidly. Exposure of naïve common carp for 5 minutes to between 10 and 40 virus particles per ml of water was sufficient to cause approximately 70% mortality in 15 days ⁽⁵⁾. Mortalities occur 7-21 days following exposure of naïve fish to infected fish depending on water temperature ⁽¹⁾. Disposal of infected fish by selling them below the market price was one suspected route of dissemination of the virus in Indonesia ⁽⁶⁾. It was suggested that outbreaks of disease in public parks and ponds in Taiwan that had not had recent introductions of fish were a result of members of the public releasing infected fish into the ponds ⁽⁶⁾. The practice of mixing koi carp in the same tanks at koi shows has been responsible for spreading the disease, particularly within a country, and the disease has also been spread nationally and internationally by movement of infected fish not showing any signs of disease ^(5,6,1). Hence the virus may have been introduced into some countries with carrier fish before there was awareness of the disease

and its consequences. Also, it is likely that the virus is present in many countries, but has not yet been identified there or reported.

KHV IN THE UK

From analysis of archive histological material for the presence of viral DNA, Cefas has evidence for the presence of KHV in England since 1996⁽¹⁾. However, until 2003, KHV had only been detected and isolated from sites in the UK holding imported ornamental carp. Then in 2003 Cefas detected KHV in common carp, during investigations into large mortalities of carp in angling waters ⁽⁷⁾. Further detections of KHV were made at a handful of angling waters in 2004 and 2005 and then in 2006 KHV outbreaks were reported and confirmed at 23 sites in southern England ⁽⁴⁾, Figure 1).



Figure 1: High mortalities from KHV disease were seen at fishery sites in Southern England in 2006

SUSCEPTIBLE FISH SPECIES

Koi or common carp are often raised in polyculture with other fish species, but no signs of disease or mortalities have been reported in other fish species, either under normal polyculture conditions or following experimental cohabitation with infected fish, or direct exposure to the virus. Species reported to be 'resistant' to the disease include goldfish (*Carrassius auratus*), silver perch (*Bidyanus bidyanus*), silver carp (*Hypophthalmichthys molitrix*), grass carp (*Ctenopharyngodon idellus*), fathead minnow (*Pimephales promelas*), tench (*Tinca tinca*), bighead carp (*Aristichthys nobilis*) and channel catfish (*Ictalurus punctatus*).

However, investigators at the Fredrich Loeffler Institute (FLI) in Germany have reported experimental transmission of KHV to goldfish and crucian carp (*Carrassius carassius*) (2, S. Bergmann pers.comm.). They co-habited goldfish and crucian carp with KHV-diseased koi carp from Thailand, and 15 days following the start of co-habitation, some goldfish died. The dead goldfish had swollen abdomens and a pronounced lateral line, and were positive for KHV DNA by PCR (see below). Goldfish, which had been co-habited with koi carp infected with a "European" KHV isolate survived the co-habitation period. Surviving goldfish were able to transmit the disease to naïve common carp. The crucian carp survived the co-habitation, and showed no signs of disease but appeared to be able to transmit the virus to naïve fish.

Furthermore, the FLI have carried out tests on non-*C. carpio* species following KHV disease outbreaks in culture facilities in Poland and also at retail sites in Germany and these have indicated that tench, silver carp, big-head carp, grass carp and sheatfish (*Siluris glanis*) may also act as carriers of the virus (S. Bergmann, pers. comm.). Further investigations are required to determine if the virus is persisting in the tissues of these other fish species or they are merely contaminated with KHV following co-habitation with heavily infected carp.

HOW ARE WE RESPONDING TO THE PROBLEM?

The European Community has recently expanded to the East. With the inclusion of the new Eastern European member states comes an increase in intensive and extensive pond

culture of carp and other cyprinid species and an increase in the disease problems associated with these species. With this in mind, in 2005 the European Union (EU) member states called upon the OIE to consider KHV disease for inclusion in their serious disease list. The disease was then assessed against rigorous criteria and the Aquatic Animal Health Standards Commission approved the listing in March 2006. When a disease is listed there is a requirement for OIE member countries to report occurrences of the disease to the OIE. That knowledge is of value in controlling the trans-boundary movement of potentially infected fish.

The EU will follow the OIE recommendations and KHV is currently listed in the draft replacement directive for 91/67 on fish and shellfish health.

In the UK, on 31 October 2006, Defra issued proposals for making KHV disease notifiable and options for controlling outbreaks of the disease. Defra also established a Steering Group on KHV to consider control arrangements for the disease in more detail. The group includes representatives from those most concerned to control the impact of KHV disease (importer, supplier/farmer and fishery owners). The inaugural meeting of the steering group took place in September 2006 and will meet again to consider comments received during the consultation, which ends on 30 January 2007.

ADVANCES IN DIAGNOSIS OF KHV DISEASE

The most sensitive diagnostic tool currently available is amplification and detection of virus DNA by a polymerase chain reaction (PCR) assay⁽¹⁾. The PCR assay can be used to detect KHV DNA directly in samples of fish tissue. However, a number of diagnostic laboratories around the world have developed different PCR-based assays and there is now a need to standardise and validate the most sensitive and reliable assays.

In 2005 a PCR, developed in Israel, based on the thymidine kinase (TK) gene of KHV was reported to be more sensitive than published PCR methods available and could detect 10 femtograms (fg, 10⁻¹⁵g) of KHV DNA⁽⁸⁾. In Japan, previously published PCR assays have been improved and have been incorporated in

the official Japanese guidelines for the detection of KHV. Also, in Japan, a PCR based on the DNA polymerase gene has been developed and reported to detect 100 fg of KHV DNA.

The loop-mediated isothermal amplification (LAMP) method has also been adapted to detect KHV. This PCR method requires no specialised laboratory equipment and is relatively simple to perform. A LAMP assay, based on the KHV TK gene, has been developed in Japan and shown to be as sensitive as a PCR method developed by the same researchers, but was more rapid than the PCR ⁽⁹⁾.

A working group at an international KHV workshop, held in London in 2004, highlighted the need for standardisation of detection methods, and in particular PCR assays, for KHV. The growing number of PCR-based assays that have been developed means that selection and standardisation of the most accurate detection methods is an important step in providing the best tools to diagnostic laboratories to enable them to test carp populations for KHV.

A 1-year student project, funded by Defra and the Ornamental Aquatic Trade Organisation (OATA) was initiated at Cefas Weymouth in response to this need. The aim of this project was to: 1) compare published PCR protocols for KHV with PCR protocols based on protein coding regions of the KHV genome for sensitivity and specificity; 2) to optimise the tissue sampling, extraction and amplification protocols of the most effective assays and 3) to develop standardised protocols in preparation for a validation ring-trial. This resulted in a standardised protocol that has been adopted for routine use at the Cefas Weymouth Laboratory.

In September 2005 a summary of the results of the KHV PCR project at Cefas was presented at a KHV workshop held at the 12th International conference of the European Association of Fish Pathologists (EAFP) in Copenhagen (2). In the workshop it was announced that validation of the standardized PCR methods was to be carried out by proficiency testing of the selected protocols by ring trials in other diagnostic laboratories around the world.

Cefas organized and co-ordinated the first of these proficiency tests in 2006 as part of the

research project on KHV funded by Defra. Initially, participating laboratories were asked to incorporate the PCR primers recommended by Cefas into their existing standard PCR assays and compare them with the primers that they currently use. This is because laboratories that have been running PCR assays for many years tend to have traditional assay protocols and parameters that fit well with their other PCR assays for other pathogens. However, all of the laboratories were urged to trial the standardised protocols used at Cefas Weymouth and details of the DNA extraction and PCR protocols were supplied to all potential participating laboratories.

For the first ring trial 22 laboratories, in 20 countries worldwide, were sent a number of vials of freeze-dried tissue homogenate spiked with KHV (Table 1). So far, results have been received from 20 of the participating laboratories.

Asia/Australasia	Australia; Hong Kong; Indonesia; Japan; The Philippines; Singapore; Thailand.
Europe	Czech Republic; Denmark; Germany (2 laboratories); Hungary; Italy; Republic of Ireland; Latvia; The Netherlands; Poland; UK-England; UK-Scotland.
Middle East	Israel.
North America	USA (2 laboratories).

Table 1. Countries who agreed to participate in the KHV PCR ring trial

Currently, the aspect of KHV disease that most concerns researchers is the latent characteristics of the virus in the host, making it very difficult to confirm the presence/absence of the virus in apparently healthy fish with a latent KHV infection. Further development of diagnostic assays will aim to improve the sensitivity so that they may be capable of detecting latent virus. Also, a number of laboratories, including Cefas, are developing both PCR-based and immunoassay-based, non-lethal screening tests for KHV. Enzyme immunoassays (aka ELISA) have been developed in Israel, the USA and at Cefas to detect antibody to KHV ^(10,11). The ELISA developed at Cefas has been used to detect antibody to KHV in koi and common carp that have survived both experimental and natural KHV infections and in vaccinated carp. Detection of KHV antibody is currently the only method of determining previous exposure to the virus if the viral DNA is not detectable by PCR-based methods.

KHV PATHOGENICITY STUDIES AT CEFAS

It is not known whether under natural conditions survivors of KHV disease are persistently infected with virus, and if so, whether they shed the virus or for how long the fish retain the virus. Investigators at Cefas examined some of these aspects in experimentally infected fish ⁽¹²⁾. They showed that virus could persist in common carp infected at a permissive temperature and subsequently maintained at a lower than permissive temperature. Fish were held post infection for approximately 25 weeks at 12°C (during which time approximately 10% died), then the temperature was raised to 18°C and naïve fish were introduced into the tank. The temperature was then raised further to 23°C. By approximately 32 weeks post initial infection all of the naïve fish had died and 57% of the survivors of the initial infection had died. Approximately 30% of similarly treated survivors of the same initial infection in another tank died following reactivation of the virus, but in that case no naïve fish had been introduced into the tank. However, in other trials naïve fish co-habited with previously infected fish did not succumb to infection, and reactivation of virus did not occur, even following immunosuppression by cortisol injection. The

investigators considered that this was because none of the fish in those trials were persistently infected, and that only a small percentage of fish would be persistently infected following KHV infection.

CONTROL OF KHV DISEASE

Some countries have invoked policies of compulsory slaughter and disinfection as a means of controlling the disease (6). Other national policies include import restrictions from countries where KHV disease is known to occur, compulsory inspection, quarantine and testing of fish from countries positive for KHV disease or fish movement controls when the disease is diagnosed within a country ^(6,13).

Effective biosecurity has been shown to help reduce the spread of disease during KHV outbreaks in Indonesia ⁽¹³⁾ and the efficacy of disinfectants and physical means to inactivate the virus has been studied by researchers in Japan ⁽¹⁴⁾. The virus was inactivated by UV radiation, and temperatures above 50°C for 1 minute. Disinfectants were more effective as the temperature increased, but at the mid-range temperature of 15°C, an iodophore was effective at 200 mg/l for 30 seconds, benzalkonium chloride was effective at



Gill necrosis in a KHV infected carp

60 mg/l for 30 seconds and ethyl alcohol was effective at 40 mg/l for 30 seconds. The concentration of sodium hypochlorite required for virus inactivation was affected by the amount of protein present; also the amount of active chlorine present was reduced when the hypochlorite was mixed with river or pond water. The recommended concentration of active chlorine was 3 mg/l (11.2 mg/l sodium hypochlorite) for disinfection of fish farms.

Researchers in Israel have investigated the use of resistant strains of common carp ⁽¹⁵⁾. The progeny of crosses of two strains of domesticated carp and one strain of wild carp were challenged with KHV by experimental or natural infection. The lowest survival rate was approximately 8%, but the survival rate of the most resistant strain was 61-64%.

VACCINATION

There have been a number of studies assessing the efficacy of vaccinating carp, or exposing them to virus under controlled conditions. In Israel, Ronen and colleagues ⁽⁸⁾ co-habited naïve common carp with diseased fish for 3-5 days at 22-23°C, then transferred them to ponds at 30°C for 30 days. Following transfer back to ponds at 23°C, the fish were re-challenged by co-habitation with diseased fish, which produced 39% mortality in the temperature manipulated fish. The surviving temperature manipulated fish were protected for 6-12 months, and they had antibody against KHV. That process is costly, results in the loss of 30-40% of the fingerlings, and there is the possibility that virus may recur in treated fish, or be transmitted to naïve fish ⁽⁸⁾. However, the procedure is successful in reducing the mortalities in locations in Israel where the disease is endemic, and carp production is significantly recovering (H. Bercovier, pers. comm.).

Attenuated virus has been used to vaccinate carp in Israel ^(8,5). The virus was attenuated by serial passage 26 times in cell culture, and selection by cloning. The cloned virus was injected into carp, which were challenged 25 days later by cohabitation with diseased carp. Although itself causing a low-level mortality, the cloned attenuated virus protected the fish from challenge, which caused 95% mortality in non-vaccinated control fish. The passage 26 KHV was shown to induce antibody against the virus, but the duration of the protection is

unknown. The cloned virus was also effective at protecting fish when administered by a 10 minute bath ⁽⁵⁾. However, the cloned virus was only active in the water for 2 hours at water temperatures of 22-24°C and the efficacy was lost when fish were introduced to virus that had been in the water for 4 or more hours. One of the concerns with using attenuated virus is that the virus might revert to being virulent. Virus was UV-treated to induce mutations that might reduce that occurrence, and UV-treated virus did protect carp against challenge ⁽⁵⁾. However, there were no data to show that any mutations had been induced, nor to demonstrate that the virus would not regain virulence.

At the KHV workshop held during the EAFP conference in Copenhagen in 2005 it was stated that, according to publications and internet reports, studies on KHV vaccines were being conducted at Mie and Tokyo Universities in Japan, at the Hebrew University in Israel and North Carolina State University in the USA ⁽²⁾. Recently, Henderson Morley in the UK announced that, after 10 months research on a KHV isolate provided by the Cefas Weymouth Laboratory, it was now ready to start field trials of a candidate vaccine in collaboration with the Hagerman Aquaculture Research Institute, Idaho USA.

Currently there are no KHV vaccines licensed for use in Europe. The attenuated KV3 vaccine developed at the Hebrew University was authorised for use as an emergency measure and less safety and efficacy data was required than would be expected for normal registration of a vaccine. Carp exposed to the KV3 vaccine have been imported into the UK and Defra have made fishery owners and fish farmers aware that there are risks associated with the import of vaccinated carp. The risks have been assessed as low, but it should be noted that the vaccine used on live fish for export to the UK has no marketing authority for use in the UK or other parts of the EU. Also, no evaluation is currently available on the possible risks that imported vaccinated carp may pose to indigenous fish populations in UK environmental conditions.

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FISH LICE IN THE UK

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Over 140 species of *Argulus* have been described throughout the world. The majority of these crustaceans are ectoparasites of fish and are often referred to as fish lice. Three species are known to occur in UK freshwaters: *Argulus foliaceus*, *Argulus coregoni* and *Argulus japonicus*. Two of these species, *A. foliaceus* and *A. coregoni*, are regarded as native to the UK (Fig. 1). These species are easily discriminated since adult *A. coregoni* are over twice the size of adult *A. foliaceus* and have pointed, rather than rounded, abdominal lobes. *A. japonicus* is thought to be non-native and introduced from Asia through the ornamental trade. This species looks very similar to *A. foliaceus* and can only be discriminated at the microscopic level.

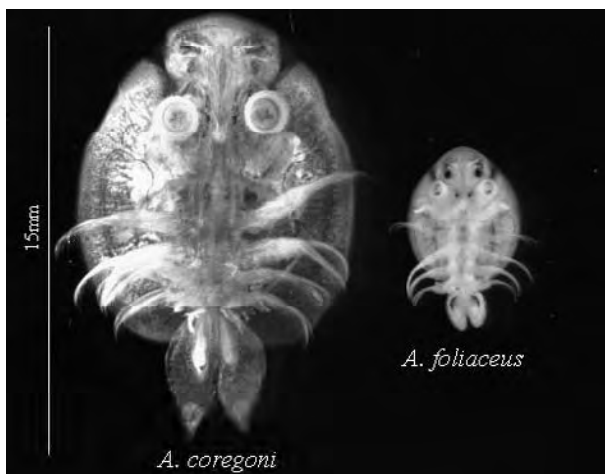


Figure 1. Ventral view of adult *A. coregoni* and *A. foliaceus*.

A. foliaceus is widely recorded throughout the world, typically inhabiting nutrient rich lakes, although it can tolerate salinities of up to 8-12ppt at temperatures up to 25°C. *A. coregoni* typically infects fish in rivers, streams and cool oligotrophic lakes with a large flow. *A. japonicus* is recorded throughout Europe, Africa, North America and Asia. At present there are limited records of *A. japonicus* in the UK, and due to difficulty in differentiating the two species it is possible that in some cases it has been misidentified as *A. foliaceus*.

Many of the early records of *Argulus* spp. in Europe refer to them as a problem in carp farming, with much of the German literature referring to the 'Carp Louse'. In recent years

however, *Argulus* spp. have been reported to cause problems in UK stillwater trout fisheries. A survey of such fisheries found 29% of them suffered from problem infections by the parasite in the year 2000. *A. foliaceus* was responsible for all but one of the observed infections, the other being caused by *A. coregoni*.

Infected fish can suffer significant reductions in condition factor, reducing the aesthetic appeal to anglers of fish in a sports fishery. Heavy infections may also cause noticeable behavioural changes, which develop as the severity of the outbreak increases. In the early stages of an infection, fish in lakes are reported to jump, flash and swim erratically, possibly in an attempt to rid themselves of lice. Following this, feeding is reduced and the fish lose condition and become difficult to catch by angling. As infection levels rise, fish have been observed to swim in tight shoals, and in serious cases substantial mortality can occur.

Argulus spp. reproduce sexually and male and female parasites can mate on or off the host. The adult female has a single median ovary, which runs the entire length of the body. Although several matings may be observed, it is thought that one is sufficient to fertilise all the eggs that a female will ever produce. Adult males and females are easily distinguished as males have large dark spots on each of the abdominal lobes, and females have spotted pigmentation running up the centre of the dorsal surface of the carapace, covering the ovary (Fig. 2).



Figure 2. Dorsal view of adult female and male *A. foliaceus*.

Argulus spp. in the UK lay their eggs off the host on a suitable hard surface, in rows that are attached by a gelatinous material that hardens on contact with water. Eggs of *A. foliaceus* and *A. japonicus* are laid in batches comprising 2-4 rows of up to 400 eggs, whereas *A. coregoni* lays its eggs in mats containing up to 900 eggs. The parasite can lay up to 10 batches of eggs, but most only lay once. Individual eggs are ovoid, and measure approximately 0.2 mm x 0.3 mm. On laying, the eggs are white to pale yellow in colour, but within 24 hours their colour changes to a deeper yellow / light brown. Eggs are firmly adhered to their attachment surface and, unlike snail eggs, are not coated in jelly. The parasite hatches as a stage known as a metanauplius, which is between 0.6 and 0.8mm in length (Fig. 3).

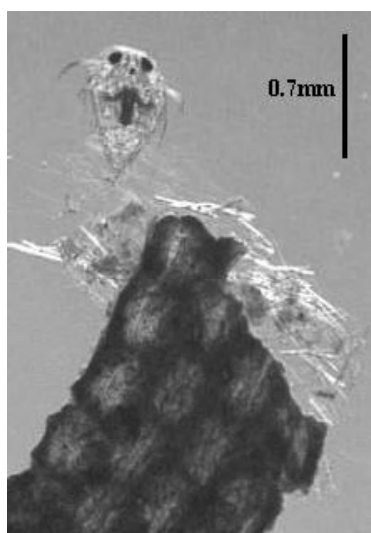


Figure 3. *A. foliaceus* metanauplius hatching from egg string.

Hatching times are dependant on temperature, becoming shorter as temperature increases. Below 8-10°C, eggs of the three UK species do not appear to develop, which is possibly a mechanism to increase survival of the metanauplius by ensuring hatching only occurs in the more favourable conditions of spring and summer. Eggs that over-winter have a much-reduced hatching success, but can survive at low temperature for up to 2 years.

In the UK, numbers of argulids on fish tend to be low in winter, with laboratory experiments

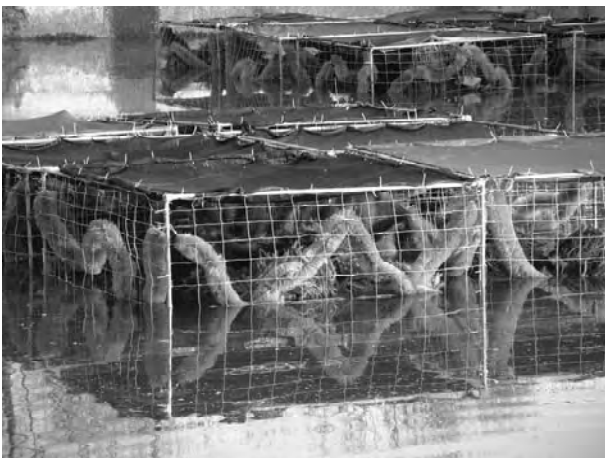
suggesting that most lice die in cold conditions and after periods of reproduction. A rise in temperature in spring causes eggs to start hatching. These early generations give rise to subsequent generations that cause the population number to peak towards the end of summer/start of autumn. As the temperature falls with the advent of winter recruitment stops and the population decreases once again. Any adult lice surviving the winter become relatively inactive until the water temperature increases above 10°C, when they will leave their host to lay eggs.

Studies have shown that in trout fisheries, low water clarity, slow rates of stock turnover (the rate at which the lakes standing stock of trout is removed and replaced) and high temperatures show a significant correlation with high numbers of *A. foliaceus* on trout. Low water clarity was also associated with reduced stock turnover, possibly as the reduced clarity changes the distance over which trout are likely to react to prey items, thus reducing the likelihood of being caught. These results suggest that high numbers of *A. foliaceus* alone may not affect the catch rates unless working in combination with other environmental factors. The mechanisms behind the effects of water clarity and stock turnover on the parasites dynamics are currently unknown, although several hypotheses have been developed. It is likely that fast stock turnovers reduce the parasite numbers through removing infected fish before the parasite can leave its host to lay the eggs required to produce subsequent generations. Low water clarity may influence the parasites dynamics in several ways. Firstly through its effect of slowing stock turnover, secondly through a reduction in predation on the parasite by trout (which readily eat them in the laboratory), and finally reduced water clarity may change host behaviour in a way that would increase infection success. Further research is being conducted between Cefas and the Institute of Aquaculture (University of Stirling) in order to determine the mechanisms driving these relationships and to develop targeted management strategies.

PROTECTING FISH FROM CORMORANTS – THE POTENTIAL FOR USING FISH REFUGES

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Over the last 30 years the number of cormorants over-wintering in Britain has increased substantially. The latest estimates suggest there are now around 30,000 wintering birds in the country, many of which are present at freshwater sites. This rise has increasingly brought cormorants into conflict with inland fisheries. Case studies on stillwaters and rivers in England and Wales have indicated that the impact of cormorants can be significant at some fisheries, and it is recognised that where stocks of fish are significantly reduced this can have potentially serious economic implications. In such circumstances, management action may be appropriate to limit the impact that birds have on stocks of fish and associated fisheries. However, there is a clear need to strike an appropriate balance between protecting fisheries and the conservation of a protected species. In England and Wales, cormorants are protected under the Wildlife and Countryside Act 1981, which implements the 1979 European Community Directive 79/409 on the Conservation of Wild Birds. Where conflicts with fisheries are 'serious', and other methods of deterrence are either ineffective or impractical, licences can be issued permitting the shooting of some birds at these specific sites. However, there is also a need to develop effective non-lethal management measures to reduce cormorant impact. Providing underwater refuges for fish is one such possible technique.



Fish refuges in situ (as ponds are filling) at a trial site showing the main design features – overhead shading, 'structure' for the fish to hide in and mesh to keep cormorants out.

During the winter, cormorant numbers increase significantly at inland fisheries. This is the time when, due to low water temperatures, fish swim more slowly and the amount of aquatic vegetation used as cover by the fish is greatly reduced. It is believed that such cover plays an important role in allowing fish to escape detection by predators and hence for them to avoid being eaten. Increasing the amount of cover for fish in winter through the addition of artificial refuges (such as that shown) may therefore be an effective way of reducing the availability of fish to cormorants. It is thought that a decrease in their foraging success may make sites less attractive, leading to a reduction in use by feeding birds.

Defra-funded research being carried out by Cefas, in collaboration with the Central Science Laboratory (CSL) and with support from the Environment Agency, is providing clear evidence that refuges can protect fish and reduce the foraging efficiency of cormorants. For example, in a series of four trials conducted in 2003 and 2004, two identical adjacent ponds, one with refuges and the other without, were stocked with equal numbers of fish (roach, perch and carp) and bird numbers and behaviour were then monitored closely. After 4 to 6 weeks, the ponds were drained and the surviving fish recovered. The results were consistent in all four trials, and are summarised in the table overleaf.



Experimental ponds at Fobney showing the control (left) and refuge (right) ponds. The refuges are underwater once the ponds have filled.



Recovering fish from the trial ponds as the water is drained away

Parameter	Observed effect* (average of 4 trials)
Cormorant dive duration	Increase by 21%
Prey capture rate	Decrease by 69%
Successful foraging bouts	Decrease by 51%
No. of cormorants	Decrease by 72%
Weight of fish consumed	Decrease by 79%
Weight consumed per cormorant	Decrease by 67%

*Observed effect = measurement for pond with refuge relative to measurement for control pond.

Cormorant dive duration in the refuge pond increased and the foraging efficiency of the birds (prey capture rate and the proportion of successful foraging bouts) decreased significantly. In effect, the birds were working harder for fewer captured prey. As a result, birds found the refuge pond less attractive and used it less; on average, there were 72% fewer cormorant visits to the refuge pond than the control pond over the trials. The effect of these changes was to reduce the overall fish losses in the refuge pond by almost 80% and, when adjusted for numbers of bird visits to the respective ponds, this amounted to an average reduction of 67% in the weight of fish consumed per cormorant visit for birds feeding on the refuge pond. This clearly demonstrates that, where alternative foraging sites are available, the presence of refuges can dramatically reduce the quantity of fish eaten by cormorants at a site

It is recognised that the potential benefits of using refuges are likely to vary with the fish species present and from site to site. Initial evaluation suggests that refuges might be most suitable for smaller shoaling species

such as roach, perch, rudd and small bream, but a range of other freshwater species may also benefit. The size of a fishery will also be important in deciding whether fish refuges are a practical option. Refuges are likely to be most effective in smaller stillwater fisheries, and costs and practicalities may preclude extending the technique to large water-bodies.

Refuges are increasingly being used by angling clubs and fishery owners, and initial feedback from anglers at a range of sites where refuges have been deployed has been very positive. While some anglers felt that it was too early to assess whether there had been benefits, half of those consulted felt catches had got better and almost three quarters considered that fish stocks had improved, with better survival, more smaller fish present and with less adverse impact of cormorants on fish behaviour. Many anglers also reported that catches around fish refuges were good and that refuge structures were often targeted as favoured angling 'marks'.

Investigations into the potential use of fish refuges have therefore provided some very encouraging early results and suggest that refuges have considerable potential for safeguarding fish from cormorants and thus benefiting some fisheries. While this should be seen as good news for fishery owners and anglers, it should also be recognised that, on their own, fish refuges will not solve 'the cormorant problem'; the technique rather provides another tool in the toolbox for managing cormorant/fishery conflicts. Research is continuing to address questions such as the optimum number of refuges to use at a site and how they should be placed to best effect.



Counting and measuring the fish recovered.

Further information on cormorants, including a more detailed advisory leaflet on fish refuges can be found on the Defra website: www.defra.gov.uk/wildlife-countryside/vertebrates

Researchers would warmly welcome feedback from any angling clubs and fishery managers who have practical experience or relevant comments on the design, installation and efficacy of fish refuges in fisheries. Please forward your comments to:

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Pakefield Road, Lowestoft, Suffolk NR33 0HT.
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APPRAISAL OF THE OPPORTUNITY FOR OFFSHORE AQUACULTURE IN UK WATERS

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For many years, there has been a growing tide of interest in taking aquaculture “offshore”, but despite regular surges of research and some commercial activity, there has been relatively little progress towards realising the anticipated potential of this “unexploited” environment (Figure 1). In a recent Defra and Seafish sponsored study⁽¹⁾, we were charged with providing a critical assessment of the potential for open ocean offshore aquaculture in UK waters using candidate species which would have similar growth and performance characteristics to Atlantic salmon (*Salmo salar* – Species A) and Atlantic cod (*Gadus morhua* – Species B) and with due reference to other potential species candidates. This appraisal addresses economic, financial and marketing issues, with specific reference to modelled scenarios of a conceptual large-scale open ocean mariculture system. The environmental, legal and technical implications for offshore aquaculture development are examined in a general context and this article summarises some of the report’s conclusions.

Financial and Economic Perspective

The study presents a wide range of information about economic modelling, including ‘Core’ models for the two species options, based upon a suit of realistic assumptions, together with sensitivity analyses, varying a range of assumption categories. The key point for offshore aquaculture is that it must make good returns on capital right from the start. A faster-growing species is more likely to achieve the necessary returns.

The outcome of the modelling exercise does not suggest any particular ‘economy of scale’ advantage for large installations. Even modelling across a range of unit pen costs from £5.00 to £1.00 per m³ only improves the core Species A IRR (internal rate of return) from 14% to 17%. It would appear that there is no overwhelming economic advantage or disadvantage of the offshore system concept in terms of replacing existing inshore pen aquaculture, unless such

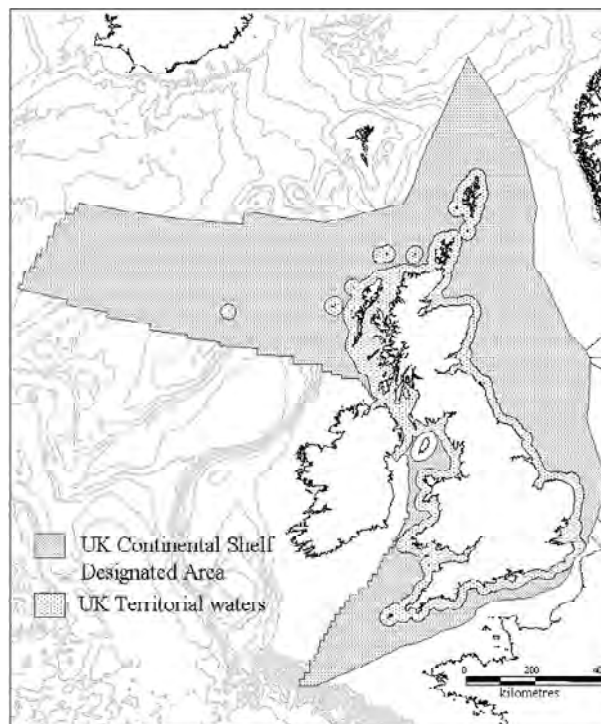


Figure 1. Likely maximum extent of UK offshore area. Based on UK Continental Shelf designations, and including UK limit of territorial waters (12nm). (Note that the area is not coincident with the 200nm fisheries limit.) (After - www.jncc.gov.uk/page-1478 - March 2006). World Vector Shoreline copyright US Defense Mapping Agency, Bathymetry copyright GEBCO Digital Atlas, British Oceanographic Data Centre on behalf of IOC and IHO 1994 & 1997. UK Continental Shelf designations courtesy Department of Trade and Industry via DEAL website www.ukdeal.co.uk

inshore systems became more expensive due to as-yet unforeseen additional regulatory or other costs.

The sales price of the fish being grown is the most important variable and would-be investors in offshore aquaculture must have a very clear market-led vision, and a robust marketing plan. There are several species of marine finfish being farmed around the world with market values in excess of £3.00 per kg, which would appear to be a viable price level for offshore aquaculture.

This initial overview seems to indicate that for any future high-volume offshore aquaculture

in UK waters, and with UK markets in mind, species with a market proposition that can deliver fillets to consumers at around £7 to £8 per kg will need to be considered.

The economic modelling in the study has followed the same presumption as that made by Ryan⁽²⁾, i.e. that a production scale in the region of 10,000 tonnes per annum (tpa) would be required. One of the key factors to consider is the nature of the staffing for offshore aquaculture. The model has been predicated on 5,000 tpa 'farming units' with just 8 staff assigned to each. It is difficult to contemplate much smaller units, since there would need to be a pro-rata reduction in staff numbers.

Offshore aquaculture would appear to be a potentially viable way of farming fish, but the scale of operation would need to be significant in order to achieve proper economy of scale. Investment packages in excess of £20 million are indicated for a 10,000 tpa operation. Industrial investors, i.e. existing major aquaculture companies, are unlikely to be persuaded that there is any compelling advantage to moving offshore at this time. Pure financial investors would probably be very cautious.

The study indicates that there may be interesting prospects for offshore finfish cultivation (and in relation to market expectations) if considered in a global (rather than UK) context.

Ecological Considerations

Whilst it is likely that offshore aquaculture production will have less direct environmental impact than is typically attributed to inshore sites⁽³⁾, there is little scientific evidence to support some of the acclaimed benefits. The total volume of water exchange may be greater and therefore the dilution factor may be higher for any given pollutant, but this may need to be assessed on a site-by-site, system-by-system basis.

If the biological limitations of the stock dictate that cultivation takes place in conditions which are the same as those that apply inshore, the impacts may indeed be similar. Take for example a situation where, despite a water depth of 80m, the prevailing wave climate and current regime suggests that optimal cultivation would need to take place at a depth of 20 – 30m.

In reality, this situation is perhaps not very different from some deeper inshore sites. If one also assumes that farms may need to be of significantly greater scale to offset the additional cost of offshore operations, the notion of less environmental impact may be challenged – particularly, if at such depths the processes of degradation of solid waste material are much slower due to lower temperature and a generally more impoverished benthic community.

Given the proposed scale of some offshore aquaculture ventures, the issue of stock containment and stock security is an important consideration. The escape or release of large numbers of hatchery reared stock would be considered unacceptable and could have a disproportionate impact on some wild stocks where the relative number of wild fish is low – as a result of over fishing for example!

There is anecdotal evidence suggesting that disease incidence is lower in fish farms in exposed conditions and the assumption is that there will be less disease in fish cultivated offshore. However, there is little scientific evidence or practical commercial scale experience in offshore sites to support this assumption. Physical separation from disease agents, particularly parasites which may require intermediate hosts located inshore would be advantageous. But wild stocks of fish could provide a reservoir for disease transfer which may be capable of infecting offshore sites. If the offshore site or resident fish population is "disease" free, it is also possible that farm stock could be a disease vector.

The proposed siting of offshore aquaculture farms in close proximity to offshore oil and gas platforms, with a view to re-use or co-use of facilities and logistics is, in theory, an attractive proposition. But, the potential impact of produced water discharges, drill cuttings and other spillage for example, will need to be considered.

Legal Implications

Beyond the 3nm limit there are some serious legal and regulatory anomalies that would need to be addressed before aquaculture could take place and for the UK to remain compliant with its obligations under international and EU legislation. It is possible that the landmark

judgement which now requires the UK to observe the Birds and the Habitats Directives out to 200nm could apply to other EU Directives pertinent to aquaculture.

In Scotland, planning authorities have the capacity to grant permission for a fish farm site out to the 12nm limit, whereas the principal regulator of fish farm discharges (SEPA), has a remit to 3nm only. Beyond the 12nm territorial limit, the legal and regulatory picture becomes even more confused in that the UK has not formally declared an EEZ, but through UNCLOS relies upon the designation of zones to cover specified activities regulated by a competent authority, none of which currently refer to aquaculture per se. Whilst some of the established zonal regulations would have some relevance to aquaculture activities, it would seem likely that additional regulation would be required to properly consent and regulate the activities of this industry out to 200nm.

Technical, Biological and Logistical Considerations

Typically, marine cage farming sites in Scotland are in sea lochs in relatively unexposed (Class 1 and 2) locations. The technology and expertise to conduct cage culture aquaculture in an economically viable context already exists in relatively near shore environments with significant wave heights of up to 1.0 – 2.0 meters (Norwegian site Class 3). The biologically limiting factor in such cases is normally the effect of current speed on the stock. At present, there is no aquaculture production occurring in UK waters in high or extreme exposure environments (Class 4 or 5). Elsewhere, offshore cage culture is of relatively limited scale and largely experimental.

Table 1: Norwegian aquaculture site classification scheme (after ²). The average height of the highest one third of waves recorded in a given monitoring period. Also referred to as $H^{1/3}$ or H_s

Site Class	Significant Wave Height (H_s)(Meters)	Degree of Exposure
1	<0.5	Small
2	0.5-1.0	Moderate
3	1.0-2.0	Medium
4	2.0-3.0	High
5	>3.0	Extreme

Such exposed environments remain challenging and are unexploited in the UK because economically more favourable sites in sheltered near shore situations have been sufficient, particularly in Scotland. The wave climate that exists in the UK offshore environment, coupled to prevailing weather conditions strongly suggests that finfish aquaculture will need to be conducted in cages or enclosures capable of being submerged for up to several tens of metres for periods of several days and possibly for prolonged periods at lesser depths.

Whilst there is some potential to further adapt existing cage systems it is widely accepted that novel technologies are required to successfully prosecute aquaculture in most open ocean situations. Many of the cage structures tested over the last 20 years have failed to progress beyond the pilot stage as a result of high cost, structural failure and simply being unfit for the purpose of on-growing fish.

There is a need to focus effort on the development of remote systems for monitoring every aspect of production at sea. Much of this technology and expertise could be developed in existing fish farms situations.

At present, there do not appear to be any "offshore" cages in use in the UK. Of the designs that are either available or in pilot scale trials, the Farmocean (⁴, Figure 2) and OceanGlobe (⁵, Figures 3 & 4) cage systems would seem to be the most practical for offshore conditions. The OceanGlobe, if successful in trials and of reasonable capital cost, appears to be the most "holistic" design produced thus far. Neither of these systems is designed to function in the offshore



Figure 2 Farmocean cage deployed (<http://www.farmocean.se>).

conditions which characterise the vast majority of UK waters beyond territorial limits. Some of the more extensive enclosures which rely upon tension to maintain net volume are appealing in concept, but present significant practical challenges in terms of husbandry and maintenance.

The biological scope of the fish may prove to be a significant limitation on offshore cultivation. The conditions within the cage must be conducive to optimise the growth performance of the fish and there appears to be little information on the optimal depth, current speed, light regime etc., applicable to cultivating fish in offshore conditions. Current speeds outside the cage which exceed 1 m/s are, for example, not generally recommended. Photoperiod control may be required to minimise maturation, whilst maintaining optimal growth and feeding opportunities. Anadromous fish requiring to take-in air to equalise their swim bladders will need special provision if they are to be cultivated in submerged cages. The speed with which cages can be raised and lowered will need to be dictated by the fish's ability to physiologically accommodate the change in pressure.

Options

The notion of developing large scale fish cultivation in the offshore (open ocean) is clearly appealing if framed in the context of virtually unlimited space, less rigorous regulation, significant economies of scale (if achievable), reduced environmental impact and reduced reliance on wild caught fish stocks etc. From

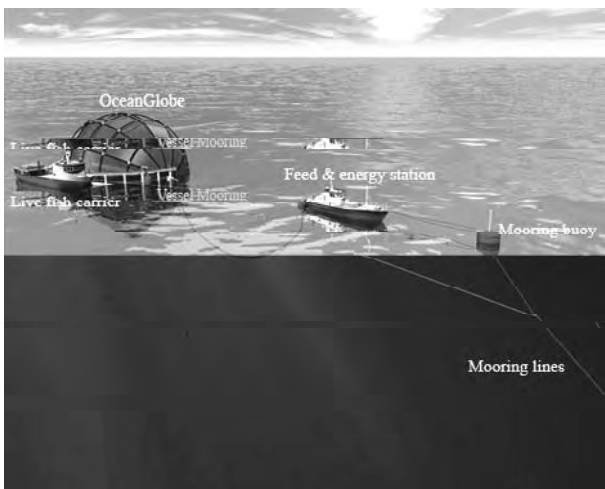


Figure 3 Diagram of OceanGlobe in service position at the surface (<http://www.byks.no>)

a strategic perspective, greater control over the supply and quality of fish available within the UK and for export may also be a valid consideration. However, thus far, commercial interest in offshore cultivation has been confined to countries where conditions dictate that aquaculture can only develop in more exposed locations – most of which are, in reality, Class 3 sites rather than open ocean.

Worldwide, interest in offshore aquaculture is showing resurgence, fuelled for example, by fears over the predicted FAO fish gap and in the US by recent legislative changes which now permit offshore aquaculture development.

If the UK aquaculture industry is to expand significantly both in terms of production and geography, there will be a requirement to consider more exposed farm sites (Class 3) in the first instance and, if necessary, offshore sites. Logically, this progression would probably involve adapting and exploiting established technology and expertise, rather than the more costly and much higher risk scenario of developing systems capable of truly offshore operation.

Co-use or possible re-use of the UK's considerable inventory of fixed offshore oil, gas and now renewables structures could, in principle, offer a shortcut to offshore aquaculture becoming established. But, economic and practical aspects of combining aquaculture production with operational oil and gas platforms would seem to preclude

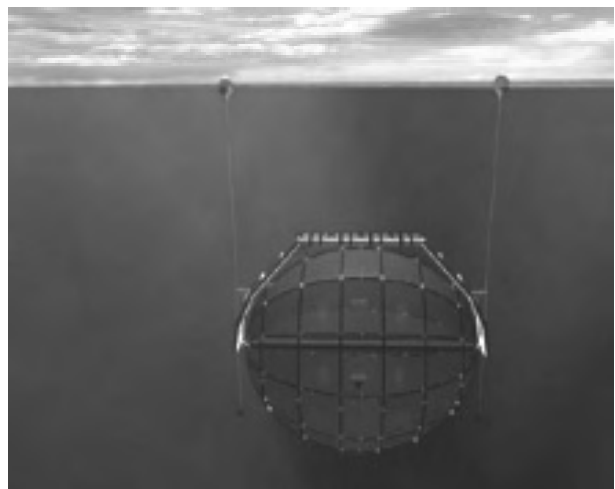


Figure 4 Submerged to avoid bad weather, algal blooms, jellyfish or comply with optimal growing conditions for cultivated species.

this as a viable option. The growth in offshore renewable energy may provide a genuine opportunity for certain types of aquaculture and the sector should seek to align itself with offshore renewables development with a view to capitalising on potential synergies.

If offshore aquaculture is to be considered as a strategically desirable way forward, the UK (both government and industry) would need to allocate additional resources for R&D or refocus current budget priorities. To spread both cost and risk the UK should actively seek to engage with international efforts to develop offshore technology. Specific, well planned and rigorously co-ordinated pilot scale initiatives could also be considered.

If pilot scale projects are to be taken forward, it would seem logical for these to be conducted within the 3nm limit in the first instance because, at present, this is the only area where a proper consenting and regulatory framework exists for aquaculture in UK waters. Many of the biological and technical precursors highlighted in the report, which would be required to underpin the viability of offshore aquaculture, could

potentially be tested with existing cage systems in appropriate exposed sites.

The report advocates careful consideration of properly justified calls for R&D in support of aquaculture development in more exposed locations with a view to better defining the prospects for full offshore operations in the future.

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IS THE TROUT INDUSTRY READY FOR WELFARE ASSESSMENT?

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Introduction

Like it or not, fish welfare legislation is on the horizon. The actions that the trout industry takes now may influence the measures that are introduced by legislators in the future. Whilst it is common knowledge throughout the industry that fish have to be well cared for if they are to thrive, there is a need to demonstrate this to consumers/legislators. It has therefore been recognised that fish welfare will have to be assessed, although the form that any assessment takes has still to be agreed.

Welfare assessment could be for legislative reasons, as part of a quality assurance/certification scheme, such as Quality Trout UK, or as a management/advisory tool⁽¹⁾. Although the specific nature of an on-farm welfare assessment scheme has yet to be agreed, certain information is central to safeguarding and assessing welfare. As part of a project funded by Defra and the BTA, we have tried to find out what information is currently measured on commercial UK trout farms and what additional measurements are possible.

This study followed on from a series of focus groups that were held in 2004/2005 involving stakeholders in the UK trout industry (see ² for more details). The purpose of these focus groups was to ask how should we assess fish welfare. There was general agreement that information was required on:

- Environmental quality
- Farm records (including mortality data, production data, disease treatments)
- Targeted fish sampling
- Demonstration of good stockmanship
- Harvest measures

It was stressed that the use to which the information was put depended upon the context of the welfare assessment, i.e. whether it be for daily welfare monitoring, for retrospective analysis of welfare or demonstration that good welfare standards were adhered to.

In 2005, we contacted 109 trout farmers by telephone and obtained brief details of the

farming operation. Out of these 109 farmers, we visited 58 from May to July 2005 to obtain more detailed information about the farming operation, including many of the criteria identified by the stakeholders as important to contribute to welfare assessment. The results are displayed related to the categories above.

Environmental Quality

Farming for the table market or for restocking/fishery purposes often leads to differences in production techniques, therefore our findings differentiate between the two, with farms classified according to the primary purpose of production.

Water quality was recognised to be fundamental to welfare, with dissolved oxygen (DO) and temperature having the most influence. Whether it be for daily monitoring, retrospective analysis or demonstration of good welfare, measurement of water quality was considered to be important.

From the telephone questionnaires, 37% of restocking farmers and 78% of table farmers measured DO, while 43% of restockers and 83% of table farmers respectively measured temperature. The same question asked during the farm visits for restocking farmers resulted in different percentages. From the farmers we visited, 74% of restockers and 80% of table farmers measured DO, and 78% of restockers and 80% of table farmers measured temperature. A possible explanation is that there were more smaller farms (<50 tonnes per annum production) in the respondents to the telephone study than were visited, who were less likely to measure water quality than those who ran larger farms.

Other water quality parameters, such as suspended solids and ammonia, were monitored by the Environment Agency or SEPA, although the frequency of the visits varied. Of all the farmers, 95% received the results of this regular monitoring from the respective environment agencies.

Farm Records

The stakeholders suggested that accurate records allowing individual batches of fish to be tracked was likely to reflect good husbandry practices. Such records also provide transparency and traceability for the production process, both of which are necessary to facilitate external auditors' assessment of the welfare of the fish. Table 1 describes the percentages of farmers that can track the performance of individual batches of fish, that record biomass, the food conversion ratio (FCR), mortalities and disease treatment, with records of the latter two required to be kept by law.

Table 1. Percentages of farmers that can track the performance of an individual batch of fish, that record biomass, FCR, mortalities and disease treatment (results from farm visits component of study).

	Track Performance (%)	Biomass (%)	Food Conversion Ratio (%)	Mortality (%)	Disease Treatment (%)
Primarily restocking	78	63	67	78	81
Primarily table market	92	92	80	96	96
Total	86	76	72	88	90

Targeted Fish Sampling

The data collected from targeted fish sampling was considered to be useful by the stakeholders for a post-mortem assessment of fish welfare. A total of 74% of restockers and 88% of table farmers either sampled fish themselves or appoint a vet to do this on their behalf. The frequency of sampling varied, with the bulk of sampling being conducted on an ad hoc basis.

Demonstration of Good Stockmanship

There are many possible ways to demonstrate good stockmanship, such as evidence of staff competence, regular maintenance of equipment, protection against predators, fish sampling and keeping accurate farm records, as described above. Also included under this heading was the provision of a veterinary health plan (VHP): from the farm visit component of the study, 33% of restockers and 96% of table farmers had a VHP.

Establishing contingency plans and emergency back-ups also demonstrate good stockmanship, the provision of which are included in the British Trout Association Code of Practice⁽³⁾ and the Quality Trout UK (QTUK) Farm Standards⁽⁴⁾. From the farm visits, 15% of primarily restockers and 84% of table farmers were members of the QTUK scheme, while 67% of primarily restockers

and 92% of table farmers were members of the BTA, and thus abide by their Code of Practice. From the telephone questionnaires, 62% of respondents were members of the BTA, split 33% primarily table farmers and 29% primarily restockers (9% of table farmers and 29% of restockers were not members of the BTA). Non-membership of either the BTA or the QTUK scheme does not mean that those farmers have no contingency plans for emergencies, however we did not ask that specific question during the initial, brief contact with farmers.

Harvest Measures

Feedback from processors was considered to be a potentially useful source for assessing what the welfare of the fish had been, although this is obviously a snap shot of the final condition of the fish and also will not apply to fish reared for restocking/fishery purposes. Out of the 58 farms visited, 35 harvested fish, with 13 farms (37%) processing the fish themselves and 22 (73%) having fish processed off site.

Conclusions

For 2004/5, the estimated annual production for the UK trout industry was around 16,000 tonnes⁽⁵⁾. For the 109 respondents to the first component of the study, the telephone questionnaire, the annual production for 2005 was estimated at 13,500 tonnes, accounting for over 80% of UK trout production. The 58 respondents who were visited on site accounted for over 60% of UK trout production (9,750 tonnes). We therefore consider this study to be representative of the industry.

From this study it would seem that providing information relevant to the welfare of farmed trout is possible and need not necessarily involve significant additional work. Parameters such as the condition of the fish, mortality rates, growth, water quality etc, all indicate

the welfare status of the stock. We now need to decide what levels of these parameters demonstrate that the welfare of the fish is acceptable and that reasonable precautions are being taken to avoid deterioration in welfare.

Acknowledgements

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RED MARK SYNDROME/COLD WATER STRAWBERRY DISEASE WORKSHOP, BRISTOL, 13TH SEPTEMBER 2006

Report compiled by Michelle Pond, Cefas Weymouth Laboratory, Barrack Road,
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A range of researchers and other stakeholders gathered to discuss what is known about the skin condition of farmed rainbow trout termed Red Mark Syndrome or Cold Water Strawberry Disease. This disease is having a significant economic impact on affected farms (due to downgrading of product) and it appears to be spreading across the UK.

The Chairman, Edward Branson MRCVS, welcomed attendees and opened the workshop with a brief overview of the disease. Red Mark Syndrome (RMS) was first reported in late 2003/early 2004. Edward stressed the need for a case definition and the importance of appropriate terminology to differentiate RMS from Strawberry Disease (SD), proposing:

UK RMS \equiv USA SD \equiv Cold Water
Strawberry Disease (CWSD);
UK SD \equiv Warm Water
Strawberry Disease (WWSD)

Five presentations then followed covering the epidemiology of the disease and current research in the UK and USA.

Epidemiology of RMS/CWSD in England

Dr Birgit Oidtmann, an epidemiologist at Cefas Weymouth, began by stating that five farms were known to be affected in England and Wales, two being affected in 2004 and a further three farms affected in 2005. The involvement of an infectious agent was suspected, as the



RMS affected fish

disease appeared to be transmissible. The experience of farmers suggested a bacterial agent, because RMS responds to antibiotic treatment. However, RMS is thought to be a multifactorial condition, and a causal web hypothesis illustrated that the environment, host and pathogen are interlinked with certain farming conditions / practices increasing the risk of RMS. Dr Oidtmann emphasised the need to develop case definitions for RMS/CWSD and WWSD, which would be a prerequisite for any epidemiological study to investigate the risk factors for RMS. She proposed both a retrospective and prospective study, which would include the use of questionnaires. Once risk factors and beneficial changes are identified, suggestions could be made which might allow farmers to manage the disease. Dr Oidtmann concluded by emphasising the need to combine data from different groups so that the industry was not burdened with multiple questionnaires.

RMS/CWSD

Professor Hugh Ferguson, Professor of Diagnostic Pathology & Microbiology presented the work carried out at the Institute of Aquaculture, Stirling describing the pathology of CWSD/RMS in rainbow trout in Scotland and its association with *Flavobacterium psychrophilum*⁽¹⁾. A technique for amplifying DNA (Polymerase Chain Reaction - PCR), from archived paraffin wax sections, was used to test for the presence of this bacterium (*Fp*). Skin lesion samples from Scotland were positive for *Fp* (controls were negative) and fish from Idaho with Strawberry Disease (SD) tested negative. It was concluded that although RMS has the same pathology as SD described in Idaho, it may have a different cause. The Scottish RMS affected fish showed a chronic dermatitis, a response suggesting an immunological hypersensitivity. The CWSD/RMS pathology was therefore different to the vitamin C responsive condition WWSD.

RMS/CWSD in England and Wales

Dr David Verner-Jeffery, a microbiologist at Cefas Weymouth, described a series of laboratory studies demonstrating the horizontal transfer of RMS. The main study involved the introduction of RMS affected fish from two different farms to tanks containing naïve fish. Following a very long incubation period (600 degree days) some naïve fish showed symptoms of RMS (>60% in some tanks). At the end of the trial (960 degree days) a range of samples were taken for analysis. Histopathology samples confirmed that previously naïve fish with lesions were affected by RMS/CWSD. No predominant organism was isolated from bacterial culture, and samples for virology and parasitology were also negative. An in-house PCR protocol was optimised for detection of *Fp* using the published primer sequences⁽¹⁾, but all lesion (and internal control) samples were negative. As an alternative method, a 16S rRNA clone library was prepared, but again *Fp* was not detected, nor was any other predominant organism identified.

Strawberry Disease in the USA

Dr Sophie St-Hilaire, Assistant Research Professor at Idaho State University, USA, presented her work on SD in rainbow trout in Idaho. Pathological findings suggested a similarity to UK SD (which appears in the summer); however, SD in Idaho occurs all year round due to stable water temperatures (14°C). The disease can be treated with oxytetracycline, is non-lethal and appears more prevalent in market size fish. It was suggested that *Aeromonas hydrophila* (found in water of poor quality) might be the cause as it produces haemolytic enzymes, is found worldwide and is not highly pathogenic. This hypothesis was tested in three *in vivo* studies, but with little success. Further planned studies include an evaluation of water quality and a comparison of the microflora of affected and non-affected fish using a variety of techniques.

RMS/CWSD in Scotland

Mr Daniel Pendrey, a Fish Health Inspector at FRS Marine Laboratory, Aberdeen, opened by

thanking the fish farmers for all the information they had provided. He suggested (based on anecdotal observations) that 20 of the 45 rainbow trout farms in Scotland were affected with RMS/CWSD, as well as a small number of fisheries. Affected fish showed superficial lesions with scale displacement. Although numerous tests had been carried out, no dominant organism had been found. A bacteriological aetiology was again suggested by the epidemiology seen in Scotland and the apparent response to antibiotic treatment. Further observations from site managers indicated that the disease had only shown up in the last 2-3 years, could be treated with antibiotics, limited with vitamin C, and cleared up when water temperatures increased to 15°C. Affected fish were usually around 500 g and spinal deformities were sometimes observed.

General Discussion

General discussions included farm experiences of RMS and notably the effectiveness of control measures that included:

- antibiotics, e.g. Aquatet (oxytetracycline), Branzil (oxolinic acid), Florocol (florphenicol)
- other chemicals, e.g. Chloramine T, salt (3%)
- special diets, e.g. Skretting 'Response'
- mild stress, e.g. grading, warm water.

It was proposed that information on control could be gathered using the questionnaire for the epidemiological studies. Further work was recommended to discover the causal agent, assess its potential risk to wild salmonid populations and to develop control strategies. A steering group was formed to help co-ordinate this research effort, consisting of researchers and other stakeholders from across the UK. Anyone requiring more information about the disease is welcome to contact the Cefas Fish Health Inspectorate.

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FISH WELFARE DURING TRANSPORT FORUM

Organised by the Humane Slaughter Association – Inverness, 25/10/06

Report of the meeting compiled by Tim Ellis, Cefas Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset, DT4 8UB.

The forum on fish transport was opened by Tess Benson (Humane Slaughter Association). She welcomed the 50 attendees comprising fish farmers and industry representatives, fish transporters, fish vets, researchers, and affiliated certification and legislative groups. She explained that the remit of the HSA included transport, and that the forum had been precipitated by an apparent lack of scientific information (in comparison to transport of terrestrial livestock) to support the production of training materials. She reiterated the aims of the forum which were to:

- Gather industry representatives and scientists involved in fish transport
- Review current knowledge, technology and methods
- Establish research requirements and knowledge gaps
- Encourage transfer of information and technology throughout the industry.



Craig MacIntyre (University of Stirling) opened the formal talks by providing an “**Introduction to welfare and water quality**”. He started by discussing the difficulty in defining animal welfare which reflects the largely abstract concepts of comfort and happiness. There are three different ways of viewing animal welfare:

- Function-based: reflecting the ability of the animal to perform in the farm environment.
- Feelings-based: reflecting whether the animal has what it wants and how it feels.
- Nature-based: reflecting whether the animal can express its natural behaviour

Craig discussed the fact that the definitions tend to be exclusive. Different interest groups may not see welfare in the same way, which hampers interchange. A function-based view is adopted by many scientists, because it allows the relatively straightforward measurement of parameters representing health and condition, e.g. stress hormones and condition factor. A feelings-based view assumes that animals (and fish) have mental experiences and that we can interpret these. Preference testing and behaviour are being used, but such methods are difficult to apply under farm conditions and during transport. He then questioned whether the nature-based view (held by animal rights groups) was quantifiable.

Craig then focused on the issue of fish welfare, asking whether fish can experience pain and suffering. There are two components to pain—firstly the detection of the damaging stimulus and secondly an emotional component. We currently do not know whether fish have a conscious experience of events or circumstances as unpleasant, and the emotional capacity to suffer. Nevertheless, the welfare requirements of fish will ultimately be determined by society through consumers and retailers. Increasingly, a clearly defined duty of care is being placed on farmers, transporters and processors.

Attention then focussed on water quality. Tables are available prescribing recommended

limits for numerous water quality parameters. However, such limits can prove to be too simplistic. For example:

- the impact of suspended solids on fish health depends on the specifics of the particle size, shape and material, rather than just the concentration
- the toxicity of nitrite is highly dependent upon the chloride concentration

There are numerous interactions between the most significant water quality parameters (oxygen, salinity, pH, carbon dioxide, ammonia, hardness, nitrite, suspended solids, temperature) that determine the impact on the fish. An example was given for ammonia: in typical Scottish loch water (10°C, pH 6.5) with a total ammonia concentration of 3 mg/L, there would only be 0.0018 mg/L present as the toxic unionised form (NH₃); in a typical English chalk fed river (15°C, pH 7.8) the same amount of total ammonia would result in 20 times as much of the toxic form.

Craig finished by emphasising four take-home messages: water quality interactions are complex; it is very important to maintain oxygen levels in the water as fish are then far better able to cope with other challenges; fish probably need time to adapt to changes in water chemistry so it is important to consider the implications of transporting fish between waters with different water chemistries; disease is possibly the biggest threat to fish welfare and the susceptibility of fish is affected by water quality.

Pete Southgate (Fish Vet Group) then discussed **“Fitness to travel and its assessment”**. He started by stressing that it is a legal requirement that fish have to be fit to travel under the Welfare of Animals (Transport) Order 1997, commonly termed WATO. There are two key paragraphs in this main legislative plank, i.e.

“No person shall cause or permit the transport of an animal that is unfit by reason of it being in the state of being newborn, diseased, infirm, ill, injured or fatigued or ...for any other reason.”

“No person shall cause or permit an animal to be transported in a way which causes or is

likely to cause injury or unnecessary suffering to the animal.”

These requirements have been incorporated into codes of practice such as the Freedom Foods standards.

The requirement of not transporting unfit fish is due to a variety of reasons: loading and transport are stressful procedures and unfit fish will not be able to cope so well; the high concentration of fish in transport tanks will facilitate the transmission of disease; transport presents a high risk of breaching biosecurity and introduction of disease to the destination.

So who is responsible for assessing fitness to travel, and how can it be done? Both the stockperson and the transporter have some measure of responsibility. Fitness to travel has to be assessed in a variety of ways:

- visual inspection by a competent person a few days prior to transport. A variety of indicators can be used such as fish behaviour, the presence of moribund and dead fish, the condition of the fins and body, and the presence of lesions and damage. Visual inspection may be difficult in sea cages but is possible using a camera or diver. Further investigation for external skin and gill parasites can also be included.
- assessing the recent disease history using veterinary reports, treatment records and mortality figures. If there has been a recent disease outbreak, then there is the risk of residual infection or fish acting as carriers.

Any obviously unfit individuals should be removed from the population, and if necessary the movement of suspect populations should be delayed pending further examination.

The fish should also be observed during the crowd prior to loading, when sick or dead individuals are removed. Again the planned movement should be stopped if judged necessary. Pete concluded by pointing out that if a checklist is made of all such observations and conclusions, this would provide a certificate for fitness to travel in case of inspection.

John Barrington (Scottish Sea Farms -SSF) then used his experience in the commercial sector

to discuss “**The importance of transport management and contingency planning for fish welfare**”. SSF have three freshwater sites and numerous sea-cage farms on the west coast of Scotland and in Shetland. Each year SSF transport 5 million smolts to the marine sites, and a corresponding number of fish are harvested. Fish are transported in a variety of ways depending upon the stage - freshwater stage fish are moved in trucks and contracted helicopters, and smolts and harvest fish are transported in wellboats.

Transport involves feed withdrawal, physical handling and keeping fish in a modified environment during transport (due to potential differences in temperature, water quality, light, water flow, density). The main aim in managing transport is to provide a safe environment and minimise unnecessary stress or discomfort to the fish before, during and after transport. Such management includes:

- Planning, risk assessment and contingency plans
- Ensuring training and competence
- Appropriate equipment design, maintenance and servicing
- Standard operating practices
- Biosecurity
- Specified supervisory responsibilities for each stage and overall
- Monitoring of water quality parameters and fish performance / behaviour
- Recording
- Communication

Planning involves identification of the method (truck, helicopter, wellboat) and route, stock details (numbers, weight, biomass, type), date and timing, the haulage contractor, and who will be responsible for each area. John emphasised that risk assessments are vital for each stage of operation. He provided an example of a risk assessment template for loading (e.g. fitness to travel, inadequately smoltified, experience of staff at crowding, etc). The likelihood of occurrence and the impact of each risk are scored on a scale of 1 to 10, and a subjective risk score is derived from the product.

Management of wellboat transport needs to include factors such as a route plan and an emergency plan in case of bad weather that

includes suitable mooring sites and emergency contact numbers. All pumps and pipes used for loading and unloading must be suitable for the size of the fish, and their operation checked before use. Contingency plans for equipment must be in place with spare parts available. It is important to specify the levels of the water quality parameters which are going to be adhered to, with action levels. Wellboats have oxygenation systems and sensors enabling continuous monitoring of dissolved oxygen, temperature and carbon dioxide; cameras are also used to monitor the fish throughout the trip. A moveable bulkhead is now commonly used in wellboats - this condenses the fish into a smaller volume, thereby avoiding the need to drain the well completely when removing the fish. John stressed the need to provide the wellboat with precise instructions on the cages intended to receive the smolt.

Management includes ensuring that staff are trained in basic fish health and welfare, and that personnel are competent to gauge the fitness of the fish and have the authority to stop the transport if necessary. Fitness is assessed from samples of 100 fish taken 4 weeks prior to transport and immediately prior to loading. Behaviour is noted on unloading and a further assessment is made 30 d after transport. All such monitoring is recorded and this enables a retrospective look at any effects of the transport. Any impacts identified are fed back into the risk assessment, which is revised and communicated to all relevant personnel.

Paul Armstrong-Wilson (Solway Transport) then gave a very lucid talk on the “**Specific requirements for road transport**” based upon his experience as a haulier. He emphasised that pre-transport preparation of the stock by the farmer is vital. The appropriate number / biomass of fish should be separated, they should have been able to recover from any handling, grading, or treatments, and they should have been starved. The haulier accepts the fish from the farmer in good faith and therefore needs to be made aware of any changes in behaviour and mortality that may affect his conclusion on fitness to travel. Paul also emphasised the need for the farmer to have the correct paperwork ready to accompany the fish.

The drivers of transport vehicles are a very important part of the transport process, and good drivers are difficult to come by. In addition to being conversant with basic HGV requirements such as the tachograph, drivers should be interested in the process of fish transportation. They also need to have a combination of attributes, being reliable, trustworthy, responsible, physically fit and practical. Drivers are given on-the-job training due to the lack of suitable courses.

Transporters need to have an operators licence. Any vehicle must be suitable for the purpose, designed so that it can legally carry the weight of the fish and water. The transport vehicle must be well maintained, checked daily, and spares (e.g. fan belts) should be carried to minimise delays due to mechanical problems. Reliable breakdown cover should also be organised for all areas that the vehicle is travelling through.

Transport tanks on the vehicles are commonly made of fibreglass, plastic or stainless steel. They should have smooth walls free of chips that could harbour pathogens, and be insulated to minimise temperature changes. The hatch should be large enough to prevent damage to the fish during loading, and lids should fit tightly so fish and water is not lost en route. The tanks should be supplied with oxygen and compressed air. The oxygen supply should have the capacity to sustain twice the nominal biomass of fish in the tank, so oxygen levels can be increased rapidly in the event of a problem, or if the actual number of fish is greater than intended due to weighing or counting errors. The additional aeration helps circulate the water within the tank, and remove carbon dioxide. Any compressor for the air supply must be oil free to avoid contaminating the water. The aeration rate will depend upon the type and size of fish.

The water that is put into the tanks is the key to successful transport. It should be from the same source as the fish have been reared in, and be taken from the inlet rather than pond itself (or outlet) to ensure that it is free from contamination and suspended solids. Water temperatures should be within the range 4 - 12°C; any lower and the fish tend to settle on the bottom and smother each other; at higher temperatures there is too little dissolved oxygen, and the fish are more prone to stress.

Loading of the fish into the transport tanks should be made as stress free as possible. Stress on loading will cause the fish to shed mucus and faeces, compromising water quality. Ideally the fish should be pumped to avoid dry netting. The farm has a duty to ensure that sufficient staff are on hand to make loading a smooth and quick operation, thereby minimising delays and the total time that the fish are in the tanks. There are no hard and fast rules for determining fish densities. The deterioration in water quality is the overriding factor, so the journey length, the size and species of fish, and the quality of the original water will determine density.

The route needs to have been planned beforehand, with consideration given to any potential traffic problems, road-works and the weather. Alternative routes and contingency plans need to be decided beforehand. During the journey, dissolved oxygen levels are typically monitored in the cab. The ideal is to aim for 100% oxygen saturation throughout the whole water column; it is important to monitor the whole water column, as fish tend to aggregate at the bottom. Paul strongly advised against changing the water en route due to biosecurity risks and the stress of the water change to the fish.

Once the vehicle arrives at the destination, unloading should be a smooth and quick operation, again with as little handling as possible. Paul advocated self-draining tanks with the caveat that the valves should be large enough for fish to easily pass through. He also suggested that pumping water back into the tank during unloading should be considered if there is a risk of the tanks running dry. It is also important to facilitate the recovery of the fish by minimising any temperature change at unloading, and ensuring the fish are put into good quality water.

Paul finished his talk by stressing the importance of keeping systems simple (so there is less to go wrong), and the need for biosecurity. The transport tanks themselves are routinely washed inside and out before disinfection, and vehicles should be disinfected on entering, and again on leaving, each farm.

Ian Armstrong (Nevis Marine) spoke on "**Specific requirements for wellboat transport**". He started by highlighting the

potential impact poor biosecurity during transport can have on the industry. Fish movements contributed to the spread of Infectious Salmon Anaemia (ISA) during the 1998/9 outbreak and, although the disease was eliminated in 2 years, there was a large human cost in terms of jobs and income. The outbreak precipitated the development of specialised harvest stations and changes in fish transport practices.

Seawater transport of fish in Scotland is currently dominated by Norwegian based companies that lease wellboats to Scotland. These boats probably comprise the most modern wellboat fleet in the world. Purpose-built wellboats have the superstructure at the front to give good view of well. There is sophisticated remote monitoring on board with video camera observations of the wells, and dissolved oxygen sensors with alarms. Protein skimmers are incorporated to improve water quality, and there is a moveable bulkhead to improve unloading of fish.

Wellboats are used for transporting smolts to on-growing sites and harvest fish to slaughter. The bulk (70%) of Scottish salmon production is now collected by 6 direct harvest wellboats. These are closed valve Refrigerated SeaWater (RSW) wellboats which enable the fish to be chilled prior to slaughter. Once the fish are loaded, the valve is closed and the water is chilled. A code of good practice specifies that chilling should be from ambient, gradual ($\leq 1.5^{\circ}\text{C}/\text{hour}$) and steady, and stop before 4°C . There are also guidelines on the density of fish ($100\text{-}125\text{ kg/m}^3$) in the well, which depends upon size of the fish (3.5 - 5 kg).

Ian emphasised that it is the quality of the wellboat journey that is important, rather than the duration. In Norway, smolts are transported the entire length of coastline which takes 5-6 days. Preparation is vital to good transport practice and involves grading, ensuring a good health status, appropriate food deprivation, and a good crowding technique for loading. During unloading a suitable mooring is vital, as is an efficient working practice which includes communication between workers on the boat and cage.

Tony Wall (Fish Vet Group) then discussed “**Specific requirements for helicopters and towing cages**”. Helicopters represent an expensive means of transport and are mainly used for moving smolts and broodstock to cages. The duration is typically short (maximum times approx 20 mins) and high densities are used ($300\text{-}400\text{ kg/m}^3$) to maximise the number of fish moved. To sustain the high density of fish, the water is supersaturated with oxygen before the fish are added and there is continuous oxygenation during transport. The “buckets” used for transporting the fish are specifically designed - when lowered into the water at the destination a spring-loaded float lever releases the hatch so the fish can swim out.

A major issue for helicopter transport is that good weather is needed, and it must be possible to abort any planned movements in the event of adverse weather conditions. The importance of good communication and planning is especially important with helicopter transport to ensure that the fish are released into the correct cage. Biosecurity was emphasised, with the need to ensure removal of biofilms from all parts of the bucket. A particular issue for helicopter transport, for which there is no information, is the potential effects on the fish of rapid changes in altitude, and the forces generated during sudden movements.

Tony then assessed the risk areas for helicopter transport. Physical damage at loading and during transport was illustrated by a photograph of a split cornea. Hypoxia during transport is a potential risk if there is insufficient oxygen, and conversely hyper-oxygenation may lead to gas bubble disease (illustrated with a photograph of bubbles formed behind the cornea). Technical problems can also occur, such as the bucket opening mechanism not functioning or the helicopter being unable to fly.

Tony then moved on to discuss towing cages. This method is usually used to move sea-cages from summer sites to inshore/sheltered sites for winter, and freshwater trout and salmon cages to shore for harvesting. It has clear advantages in that the fish are not handled and large numbers of fish can be moved at once. A major consideration is that the speed of the tow should not cause the cage net to deform and become “bagged” trapping the fish, or

the fish to become exhausted and crowded and entrapped on the trailing wall. Towing speed therefore depends upon the size and species of fish. Recommendations to reduce net deformation are that the nets are clean, net tensioning is considered, and directional currents are used. Other issues are that the propeller noise may cause fear in the fish, jellyfish swarms should be avoided, and large cages may become unwieldy if there is a significant current or high winds. Tony finished by questioning the fitness to travel of fish with deformities - mouth and gill abnormalities could affect ventilation ability, and spinal deformities could affect the ability of fish to swim with the cage during towing.

John Avizienius (RSPCA) then spoke on **“Monitoring fish welfare during transport”**. He started by explaining the distinction between the RSPCA and Freedom Foods: the RSPCA develop standards which are then monitored by Freedom Foods through inspections. Monitoring requires an initial assessment of the relevant measures to appraise, and is necessary as it adds integrity to a scheme. Feedback from members is welcomed which goes to the authors of standards who, in consultation with an expert working group, make changes to standards as appropriate. The aim is always to have high standards, but these do need to be achievable. The development of scheme standards is therefore an interactive, evolutionary process.

John then discussed the development of monitoring for fish transport, which is based upon the assumption that handling and journeys are stressful for the fish. Standards for monitoring are developed by breaking the transport process into stages (e.g. crowding, loading, recovery in wellboat, transport, unloading, stunning and bleeding), and then identifying a suitable set of indicators for each stage. The aim is to develop a checklist of fish-based indicators signifying whether conditions are good, bad or benign. Such indicators are based upon behaviour, morphology and physiology. Examples of indicators would include aggressive behaviour, non-aggressive behaviour, mouth gaping, rapid gill movements, obvious scale loss, mesh injuries to snouts, and visual observation of swimming pattern. A difficulty in applying such indicators is determining appropriate threshold levels to denote when remedial action is needed.

John emphasised the importance of challenging accepted practices and ensuring even the simple things are thought about so conditions are improved for the fish. For example it is important to wait for the wellboat to arrive before starting to crowd the fish, and measuring oxygen in the corners of a crowd. Also using any novel indicators is welcomed, e.g. seagulls eating transferred smolt shows that the fish have been compromised.

John concluded his talk by asking the question why does such monitoring matter? He answered this by stating that there is always room for improvement and it enables problems to be identified, so that solutions can be found and the fish get a better deal. Product quality should also improve so producers also get a better deal with fewer downgrades and less loss to disease. Monitoring also provides a 3rd party verification, and Freedom Foods is currently the only independent welfare venture in Europe, providing traceability and transparency for improved consumer confidence. He finished by stating that fish welfare is the “new black” with increasing interest from the EU, retailers, Greenpeace and the Marine Conservation Society.

Bob Waller (Freedom Foods) provided a brief resume of the role of Freedom Foods in implementing the RSPCA standards via inspection and monitoring. Monitoring is a three-stage process of observe, record and review. Observation allows identification of good and bad practices, recording provides documentation, and reviewing provides the opportunity to change practices. He emphasised the requirement that members of the scheme need to

- Say what you do – i.e. have written procedures
- Do what you say – i.e. ensure protocols are communicated to staff who are aware of any revisions
- Be able to prove it – i.e. have records

Chris Elmer (Defra) then spoke on **“Implications of new regulations”**. Currently the Welfare of Animals (Transport) Order 1997 implements Council Directive 91/628/EEC on the protection of animals during transport. This applies to the commercial movements of all vertebrate animals

and cold-blooded animals (fish and crustaceans). From 5 January 2007, the new Welfare of Animals (Transport) Order 2006 comes into force, which applies Council Regulation 1/2005 on the protection of animals during transport to the transport of all vertebrates in connection with any economic activity. Transport of fish in connection with food, sporting, ornamental, display aquaria, and research activities therefore all fall under the regulations. The conditions for fish transport are not detailed, and the relevant general provisions that apply to fish require that:

- No person shall transport or cause animals to be transported in a way likely to cause injury or undue suffering
- The fish are fit for transport
- They are transported in accordance with any written instructions about feeding and watering, and any special care required is taken into account
- The means of transport is designed, constructed, maintained and operated so as to avoid injury and suffering, and provides protection from extreme temperatures

The new order requires that road vehicles used to transport livestock for over 8 hours are inspected and issued with an approval certificate. However, fish transport vehicles are believed to be exempt from this requirement, as fish tanks are not considered to be an integral part of the vehicle. However, a new requirement is that transporter authorisation will be required by anyone transporting fish on journeys over 65 Km. These will be subject to:

- The transporter having no serious breaches of animal welfare legislation recorded against them
- Being trained or entrusting the handling of the animals to personnel who have received training
- Demonstrating that they have appropriate staff and equipment to transport animals in a proper way

Authorisation will be issued free of charge (if applied for within this financial year), and will be valid for 5 years*. It is difficult to relate the new regulations to transport by means other than road vehicle (e.g. wellboats, helicopters) because the legislation was primarily drafted for

traditional farm livestock, horses and poultry. To summarise, the new rules require little change for most fish transport, other than the need to apply for an authorisation.

Chris concluded by indicating that more conditions specific to fish could be introduced in the future. In March 2004 the European Food Standards Authority made recommendations on transport of fish that covered loading, transport management, space allowances, water temperatures, oxygen availability, and recovery after transport. These recommendations may be adopted by the Commission in future, but are not expected before 2011.

Tony Wall (Fish Vet Group) finished the formal talks by briefly discussing “**Indicators of poor welfare following transport**”. Dead or moribund fish could be caused by poor handling, exhaustion, suffocation, or poor water quality (low oxygen, high ammonia or carbon dioxide), depending upon when it is observed. Abnormal behaviour may indicate an aversive response (e.g. burrowing due to lights, noise, vibration) or may be a general, non-specific indicator that something is wrong (e.g. congregating in corners, surface swimming, porpoising, increased ventilation and gaping, exhaustion). Some abnormal behaviours may indicate specific problems: cod are susceptible to swimbladder inflation that results in them becoming trapped at the surface; “skittering” of salmon across the water surface is thought to indicate supersaturation. Skin colour changes may indicate stress. Physical damage (to the snout, jaw, eye, scales, fins) can occur during loading and unloading due to poor handling, excessive crowding, or burrowing behaviour. The nature of physical damage can be used to identify a problem, e.g. discrete areas of damage may indicate an obstruction in a pipe. Longer term indicators of poor welfare include an increased susceptibility to disease and poor performance.

Tony finished with his personal view of the three major fish welfare problems associated with transport:

- The transfer of smolt into seawater before physiological competence, resulting in poor osmoregulation. He suggested that the

* See announcement (Implementation of EU Regulation (Council Regulation (EC) 1/2005) on the protection of Animals During Transport) on p. 43 for details of application form.

industry needed to improve its ability to identify when fish were ready for this abrupt change in environment.

- The temperature changes that fish are exposed to during transport which includes wellboat chilling
- Mechanical breakdowns, which result in significant mortalities during transport.

The meeting finished with a general **Discussion** in which the audience and speakers debated various issues including:

- the maximum temperature drop during chilling in refrigerated seawater wellboats that should be permissible on welfare grounds
- appropriate periods for starvation prior to transport
- the use of sedatives during transport
- the implications of transporting fish between waters with different water chemistries
- the effect on the fish of height differences (water-head) when using fish pumps
- the potential to analyse the effects of transport conditions on fish by using the routine records of fitness 30 days after transport

Overall impressions

The meeting provided an excellent overview of fish transport in the UK. Numerous speakers stressed that transport represents a major biosecurity risk for pathogen transfer. It came across clearly that transport involves far more than just shipment, and numerous stages need to be considered: sorting of stock (handling / grading), feed withdrawal, crowding for loading, loading, transport within a tank/well/bucket, unloading, introduction into a novel environment, and recovery. The quality of the physical handling (during loading and unloading), pre-transport husbandry, and sudden change in water chemistry on unloading, are likely to be as significant to fish welfare as the transport itself.

The key to good transport is the water that the fish are transported in. Water quality deterioration is seen as determining transport duration and density. Oxygen level is the key factor in the transport tanks which become "life support" systems. The closed nature of the tanks results in water quality problems that do not normally occur in open culture systems. Technology to deal with these problems (e.g. faecal and mucus contamination) is apparently being transferred from recirculation aquaculture. Despite the lack of qualified information on the response of fish inside the transport tanks, it is nevertheless assumed that transport itself causes stress, fear and physical damage due to exposure to novel physical stimuli such as lights, noise, vibration, sudden water movements, and possibly rapid altitude changes.

The field of fish transport is poorly supported by scientific research, and that conducted to date has either been irrelevant to, or has not been communicated appropriately to, the industry. There appears to be a lack of standardised guidance on environmental conditions (densities, water quality limits, temperatures) and transport duration across the industry. Where guidelines are available, it is unclear as to how they were derived. Nevertheless, operators seem to be working largely to their own limits arrived at by experience, which enables adaptation for the specifics of the journey, season, species, size and stage of the fish. Fitness / welfare in relation to transport is being assessed using a variety of methods. However, these measures again do not appear to be standardised across the industry, and the methods for assessment and their interpretation are vague, and therefore dependent upon the individual operator.

N.B. A more comprehensive report of the meeting will be available from the HSA website from the beginning of February or by emailing info@hsa.org.uk

QUALITY MANAGEMENT SYSTEMS WITHIN THE CEFAS FISH HEALTH INSPECTORATE

Gill Taylor, Fish Health Inspectorate, Cefas Weymouth Laboratory, Barrack Road, The Nothe, Weymouth, Dorset, DT43 8UB

Quality and Quality Management are terms often used in business and in service delivery but rarely defined. In considering the requirements for a quality system it is often useful to go back to first principles. Among the many definitions one of the more useful is:

Quality is difficult to define, it's an abstract term, requiring continuous and dynamic adaptation of products and services to fulfil or exceed the requirements or expectations of all parties in the organization and the community as a whole.

In my view, this concisely summarises quality systems and quality management. Quality systems should not be fixed entities but be flexible enough to encompass change while remaining sufficiently structured to control change. However the underlying remit is always to fulfil the requirements of all parties concerned, be it in the case of Cefas; the Defra Customer, the Fish Farmer or indeed Cefas itself. It also follows that the starting point for any quality system is to determine the precise requirements of all parties involved.

In 1998 the Cefas Fish Health Database was launched. This database stores information on registered fish and shellfish farms in England and Wales such as ownership and contact details, facilities and species held. The Fish Health Database has proven to be a valuable resource in terms of the management of the work of the Fish Health Inspectorate. Subsequent developments have included a Laboratory Information Management System (LIMS), and modules for the management of import and export licensing, and ILFA (Import of Live Fish (England and Wales) Act 1980) licensing. It is now also used by the Environment Agency for recording movements of fish through the Section 30 consenting system.

The LIMS element of the database introduced the principle of blind testing for diagnostic samples at Cefas Weymouth. Prior to the introduction of the database the Inspectorate,

responsible for sampling in the field, and the diagnostic laboratories worked within the same business unit. Laboratory staff were therefore aware of the origin of the samples and because of this there was always the perception that some samples could be tested more 'rigorously' than others. Restructuring of the business units within the Laboratory has ensured that a clear division exists between the work undertaken on sites by the Fish Health Inspectors and the diagnostic testing such that the laboratory staff have no knowledge of the site of origin of the samples to be processed. Fish Health Inspectors stipulate the diagnostic tests to be carried out on samples, which are automatically encoded by the LIMS. Laboratory staff receive samples and associated paperwork labelled with unique reference numbers only. In short, there is no site name or other reference details that would allow laboratory staff to identify the source of the sample. In addition only laboratory tests requested by the Inspectorate are permitted to be carried out; any additional test that may be needed requires the authority of a Senior Inspector. The business relationship between the Fish Health Inspectorate and the diagnostic laboratories are documented through Service Level Agreements that stipulate in detail the standards of service required.

Towards the end of the 1990's it was becoming evident that the European Commission, following the lead of the Office International des Epizooties (OIE), were moving towards a requirement for all National Reference Laboratories, such as Cefas Weymouth and FRS Aberdeen, to hold formal accreditation standards. A number of laboratories across Europe were already either accredited or had plans to gain accreditation status. With the support of Defra, Cefas made the decision that the Fish Health Inspectorate should seek accreditation to an international standard, ISO 17025 for VHS and IHN testing. ISO 17025 is an internationally recognised standard specifically designed for laboratory testing. It includes all aspects of the work carried out in the laboratory, and also aspects of fieldwork



Microscopic view of SVC

where the quality of this work could affect the work undertaken in the laboratory. A member of Fish Health Inspectorate staff was seconded to this project to undertake the additional work involved in putting the quality system in place. As part of this exercise a quality management system was implemented and all methods and techniques utilized in diagnostic testing of samples were reviewed and formally documented through Standard Operation Procedures (SOP's) with a view to improving the quality, tracability and dependability of the service provided to the Defra customer and the industry. This was an enormous exercise involving staff from various disciplines from both the diagnostic laboratories and the Fish Health Inspectorate.

In 2004 the Fish Health Inspectorate applied to the United Kingdom Accreditation Service (UKAS) for formal accreditation. UKAS is a Government body that oversees quality standards and is responsible for auditing companies for compliance to standards. During the accreditation process, assessors visit the company and audit the system in depth; where there is fieldwork involved they also accompany staff to audit the work being carried out on sites. Following the audit, a report is sent to the company either rejecting the application for accreditation, or more usually, providing a list of non-compliances with actions to be taken within a time-frame to gain accreditation. Once UKAS are satisfied the required actions have been taken, formal accreditation is awarded. An accredited company is revisited for further audits



Clinical signs of VHS

by UKAS initially every six months and then at intervals that UKAS deem to be appropriate depending upon the results of the audits.

By 2004 Cefas decided to expand the areas to be accredited with the inclusion of testing samples for BKD and screening samples for SVC. For VHS and IHN the standard accredited - conformed with the requirements of EC directive 2001/183/EC, with confirmation tests for VHS by enzyme linked immunofluorescent assay (Elisa) and for IHN by immunofluorescent antibody testing (IFAT). For BKD and SVC the standard methods from the current Manual of Diagnostic Tests for Aquatic Animals published by the OIE was adopted; BKD is culture on SKDM plates with confirmation by three methods – co-agglutination, IFAT and biochemical tests. SVC screening was by isolation on tissue culture and confirmation by Elisa. Following a successful visit by UKAS assessors, accreditation in these areas was achieved in October 2005.

Building on this success, Defra agreed that the scope of the accreditation should be expanded. In 2006 accreditation was sought for fish and shellfish farm site visits undertaken by the Fish Health Inspectors, associated with registration of farms and also the documentation checks carried out during visits to registered sites. The standard for this is ISO 17020 and is specifically designed for Inspection work; it does not include laboratory testing which remains under ISO 17025. Much of the work was already in place for ISO 17020 as there are close links with the areas of work previously accredited, and

staff had become more aware of working within quality and quality standards. UKAS assessed the work of the Inspectorate during three site visits and one visit to the Weymouth Laboratory in 2006. Accreditation in these areas will hopefully to be achieved in early 2007.

What does this mean to the fish farmer?

- All Fish Health Inspectors complete a rigorous, comprehensive and thorough training programme through the Inspectorate core competency framework. Their work is subsequently monitored to ensure that all Fish Health Inspectors will give the same standard of service.
- All laboratory testing on samples is carried out following strictly documented and controlled protocols.
- All samples can be tracked so that everything that happens to a sample is documented. For example, all equipment used in the processing of a sample is recorded. Each of these pieces of equipment are monitored to ensure they are operating within specified parameters, and each has its own maintenance and cleaning record.
- All reagents used in testing are quality controlled to ensure they are of a specific quality suitable for the work. This involves quality monitoring of suppliers, testing of significant reagents when they are received in the laboratory, and storage of reagents to ensure that the quality of the reagent has not decreased prior to use. Media such as the bacteriology plates and virology transport media undergo a quality control assessment before being taken into the field for use on farm sites.
- Both Fish Health Inspectorate and diagnostic staff training is kept up to date by refresher training in tasks they undertake regularly. Staff are also retrained if they have not undertaken a task recently. Field Inspectors are not authorised to undertake visits to

sites until they can demonstrate that they have been effectively trained and are competent in discharging their responsibilities to the required standard. They can also have authority to undertake work on site withdrawn if they do not meet the required standard.

- Regular validation of the work carried out by Fish Health Inspectors on farms is undertaken by experienced Assessing Inspectors to ensure quality is maintained. In addition, audits of the work by the Cefas Quality Team within Cefas and by UKAS occur on a regular basis.

All staff have ownership of the Quality System and as such are encouraged to contribute to changes, developments and improvements. All of the procedures are regularly reviewed and all staff have the opportunity to make changes and to comment on any proposed changes. The system is thus dynamic and Cefas promotes a culture of continual improvement within the Fish Health Inspectorate and laboratories.

Future development of quality systems at Cefas will provide further challenges. Planned extensions to the scope for 2007 are focussed on accrediting all of the statutory actions carried out under fish health legislation on registered sites. The scope will be further extended to include inspections for all listed notifiable diseases of fish and shellfish. In Spring 2007 Cefas plans to add BKD screening by Elisa, confirmation of SVC by molecular methods, confirmation of notifiable shellfish diseases by histology, and screening for *G. salaris*. From there it is planned to extend the accreditation to other areas of work undertaken by the Fish Health Inspectorate and to make adjustments to the present system to encompass new EU legislation due for implementation in 2008. While undertaking this additional work we are also committed to continual improvement in the areas in which we have already achieved formal accreditation status.

APPLYING FOR FISH MOVEMENTS ON-LINE

Fish Movements Authorisations Team, Environment Agency

In accordance with legislation protecting native fish stocks from disease introductions and transfers, anyone who wants to

- introduce, remove or transfer freshwater fish
- carry out fish surveys
- trap crayfish

in inland waters in England and Wales must apply to the Environment Agency for consent. Currently applications have to be submitted, in writing, to the Fish Movements Authorisations Team (FMAT) at the National Fisheries Laboratory.

However a new and exciting development is taking place within the fish movements industry in England and Wales. From April 2007, you will be able to access the application forms via the web, at home or in the office, and submit them electronically. You will also receive our decision electronically.

So what benefits do you get when you register and apply on-line?

1. A 24/7 facility: You will be able to apply at any time of the day or night with the on-line system.
2. Information: You will have access to all your previous applications, even paper-based applications, back to 2003. The on-line system will be a useful business tool. For example, if you have a surplus of a species of fish a search of your previous applications can highlight which customer has purchased these before. You can then contact them to see if they want to buy more.
3. Speed: A set of drop down menus has been developed that will speed up the application process. These will detail all of your customers, receiving or source waters, water owners, fish farms etc that you have used in the past. You will have the ability to duplicate and overwrite old applications. If you are stocking or netting a water that you have done previously and the details are the same, you will be able to access the previous application form, change the dates of the task and resubmit it. This will avoid writing out another application from scratch. On

such a duplicate application you will also be able to change task details, e.g. the fish species, sizes or numbers.

4. Security: For business confidentiality purposes you will only have access to "your" previous applications details and information; you will not have access to any other applicant's details. Security for this has been installed at the same level as that of on-line banking.

5. Monitoring progress: You will be able to see the status of your application on-line, i.e. whether it needs a health check, if it is consented, refused or still being processed. This will reduce the time you spend having to telephone the EA.

6. Mapping: The system development includes a detailed mapping facility. This will give you the ability to search for stillwaters and rivers around England and Wales, similar in process to google or multimap. Once found, you will be able to extract the exact National Grid Reference (NGR) of the water you are carrying out the task on.

7. Flexibility: You may need to change the date of a consent that you have already received or one that is still pending, because of the weather, vehicle breakdown etc. With the new system you will be able to change the date on-line. There will be business rules that mean you may not be able to change the dates and receive your consents at weekends. You will also need to provide one working day's notice, but the date can be changed within a 3 month (12 week) window of the original consent.

8. Financial savings: If you already have a computer and paid for Internet access, you will obviously save on fax/postage costs.

What are the benefits to the Environment Agency?

1. Encouraging legal fish movements: As applying for fish movement applications on-line will be a fast, modern, easy process, there will be less incentive for people to do things illegally.
2. Data accuracy: As the majority of the data

entry will be completed by the applicant there will be increased data accuracy. If the applicant links in with the mapping facility there is less opportunity for water locations to be confused.

3. Financial savings: As the consent/refusal documents will be sent electronically there will be less printing and postage costs. Less time will be spent clarifying unreadable handwriting, as the applications will be typed rather than hand written. Last year we returned over 10% of the fish movement applications to applicants as we could not read some of the details on them. The decreased need for data entry will save on labour costs which can be re-allocated elsewhere in fisheries.

Simple Consents.

Some applications are considered to be "simple consents" and can be processed quicker than others. Simple consents are those that are issued on an annual/monthly basis and are of low risk to the environment, e.g. ongoing fish removals/cropping from waters, and stocking in put-and-take trout fisheries.

Simple consents are identified by your local Fisheries Officers and then relayed to the FMAT as such. By compiling these lists the Fisheries Officers are effectively pre-authorising the consents. This way the FMAT can issue the consents on their behalf. The target turn-around time from receiving the application at the FMAT to issuing a simple consent is one day, if you have registered and applied on-line.

System Roll-out.

The system has been developed this summer, with the help and input of some farmers and suppliers within the fish movements industry. This was to ensure that the system is tailored to meet the requirements of those people who will be using it.

This announcement is part of a publicity drive over the winter and spring; the roll-out timetable is set for early April 2007. The user application forms and link will be posted on the website www.efishbusiness.co.uk in 2007.

How to contact the FMAT

If you want more information about fish movements in general or about the on-line application process, please contact the team on the numbers or email below.

Fish Movement Authorisations Team Leader:

Paul Newman

Fish Movement Authorisations Officer:

Rebekah Davis

Fish Movement Authorisations Assistant:

Katie Critchley

Fish Movement Authorisations Assistant:

Audrey Collings

Tel: 01480 483968

Fax: 01480 483955;
01480 483026

Email: fmapplications@environment-agency.gov.uk

KHV NEWS LETTER

KHV Notification and Control Arrangements

On 31 October 2006, Defra issued proposals for making Koi Herpesvirus (KHV) Disease notifiable and options for controlling outbreaks of the disease. The package consists of a covering letter explaining the need for action, a copy of the draft Order making the disease notifiable, a paper on the options for controlling the disease once the legislation is made and a partial regulatory impact assessment of the control options.

The consultation will end on 30 January 2007 and Defra hopes that as many interested parties as possible will use this opportunity to make their views known on this important matter. It would be particularly helpful if comment could be submitted to Defra well before the end of the consultation.

A copy of the consultation document may be accessed for the following web link <http://www.defra.gov.uk/corporate/consult/khv-control/index.htm> or by telephoning or e-mailing Marcus Brooks on 020 7904 8702 or Marcus.brooks@defra.gsi.gov.uk

Action during the consultation period

Defra has established a Steering Group on KHV to consider control arrangements for the disease in more detail. The group includes representatives from those most concerned to control the impact of KHV disease (importer, supplier/farmer and fishery owners). The group had its inaugural meeting in September and will meet again to consider comments received during the consultation.

During November three sub group meetings were held with representatives of the importer, supplier/farmer and fishery interests to draft guidance to help identify the risks to businesses from KHV disease and the means of mitigating them. The groups are aiming to produce easy to read documents for use by each of the three sectors, supported by more detailed guidance for those that need to know more. This work has received strong support from all sector participants in the groups. Good progress is

being made and the aim of the groups is to produce guidance early in the New Year that will also be useful for dealing with other diseases that might emerge in the future.

Import of KHV susceptible species

Under current EU aquatic animal health certification arrangements no specific import requirements apply in respect of KHV disease (or vaccinated fish) although the certificates do require that live fish come from a source that has not experienced clinical disease outbreaks causing significant impact on stocks in the 6 month period prior to export to the EU. We have advised importers to check the source of their supply and to seek assurances in their commercial contracts that the fish are free of diseases of concern to them.

Vaccinated carp

There are risks associated with the import of vaccinated and unvaccinated carp because we remain in the process of establishing the scientific evidence in respect of the disease risks they pose. Even if the risks are assessed as low, they are risks that nonetheless exist. It is therefore for fishery operators themselves to decide whether the level of risk of stocking fish is acceptable to their business. In the case of vaccinated carp, that assessment should also take account of the fact that the vaccine used on live fish for export to the UK has no marketing authority for use in the UK or other parts of the EU and, as far as we know, no evaluation has been carried out by those engaged in this trade on the possible risks that imported vaccinated carp may pose to indigenous fish in UK environmental conditions.

Latency issue and research

The most important issue concerning this disease is the latent characteristics of the virus in the host, making it very difficult to confirm the presence/absence of the virus in apparently healthy fish suspected of being infected. Defra has, in recognition of the importance of the disease in terms of impacts on farmed and wild carp, funded research to improve diagnostic tests for the disease (worth £1.3m over the last 5 years) including the development of non-lethal antibody screening tests, use of which might mitigate the necessity of destroying valuable

adult fish. Work scheduled under a current research project at Cefas, Weymouth aims to validate this antibody test to help eliminate cross reactivity, and increase sensitivity. Ring trials of the optimised KHV PCR diagnostic test developed at Cefas have been carried out at

other national fish disease laboratories across the world this autumn.

Defra
December 2006

IMPLEMENTATION OF EU REGULATION (COUNCIL REGULATION (EC) 1/2005) ON THE PROTECTION OF ANIMALS DURING TRANSPORT

The new EU Regulation on the welfare of animals during transport is due to come into force on 5th January 2007.

From that date, anyone transporting any vertebrate animals (including fish) over 65 kilometres (approx. 40 miles) in connection with an economic activity, will be required to hold a transporter authorisation. The authorisations are issued by the State Veterinary Service, once an application has been submitted. The authorisation will be valid for 5 years.

A further requirement of the Regulation is that road vehicles used for transporting animals on long journeys (those in excess of 8 hours) must also be inspected and approved by the competent authority of a Member State or a body designated by a Member State. However, Defra has considered the position of vehicles used to carry containers transporting animals (such as those commonly used for transporting fish) which are either free standing or permanently or temporarily secured to a vehicle and forming the sole means of containing the animals. Defra is of the view that these do not require inspection and approval as it is the

container the animal is transported in rather than the vehicle, which is critical to the welfare of the animal. Only containers used to transport horses and farmed livestock (cattle, sheep pigs and goats) for transport on long journeys require inspection, so this requirement does not apply to fish containers.

There are no exclusions or exemptions from the general obligation to transport any animals in ways which do not cause, or are unlikely to cause injury or unnecessary suffering, and the general requirements on fitness for transport and transport practices must be adhered to. More detailed guidance on how the Regulation will be enforced and information on obtaining a transporter authorisation, including the application form, is available on the Defra website at the following link:

<http://www.defra.gov.uk/animalh/welfare/farmed/transport/eu-transportreg.htm>

Alternatively, further information can be obtained by calling Defra on 020 7904 6581 or the State Veterinary Service on 0845 603 8395.

ANNOUNCEMENT TO EVERYONE WITH AN INTEREST IN FISH WELFARE

Fish Welfare Meeting

If you have an interest in fish welfare and want your opinion to be heard, then there is the perfect forum. In September 2007, all stakeholders in the UK trout industry are invited to attend a meeting to discuss farmed fish welfare. Issues to be debated include what fish welfare actually is, how we can measure it, and how can we assess welfare on a farm.

The more people who attend this meeting, the greater the debate and the more that can be achieved. We particularly want as many farmers as possible to attend, as they potentially have the most to contribute to the debate.

Notification of the location and final date of the meeting will be given through the BTA and the Finfish News summer issue.

Final details of the meeting will also be posted on www.fishwelfare.net.



FISH WELFARE WEBSITE

www.fishwelfare.net is a website dedicated to fish welfare and aims to serve as a repository and reference point for relevant information relating to the various fish welfare related research initiatives. In addition to providing general information about fish welfare the

site aims to increase awareness of fish welfare research projects and emerging fish welfare concerns. The site will also act as a means of rapid dissemination of research findings and improve access to other project outputs such as peer-reviewed publications.



SOIL ASSOCIATION EMBRACES ORGANIC AQUACULTURE PRESS RELEASE 15/08/2006

Following eight years developing the most rigorous aquaculture standards and assessing every aspect of UK farmed fish production, the Soil Association - the original and best-respected organic standards organisation in the world - has taken the highly significant step of giving its full backing to organic aquaculture.

Although the Soil Association's aquaculture standards have had full organic status from the Government's Advisory Committee on Organic Standards (ACOS) since 1998, the Association's own governing body has demanded improvements above this baseline, and far greater clarity on the potential impacts of fish farming. To encourage this process, the standards had been held in 'interim' status by Soil Association's trustees. The removal of this 'interim' qualification reflects the results of three years' intensive work by the Association's aquaculture team.

Most of the world's wild fisheries face serious over-exploitation, and fish-farming yields are set to exceed wild catches over the next 20-30 years. As one of the world's leading organisations dedicated to sustainable food production, the Soil Association felt aquaculture was something it could not afford to ignore.

And notwithstanding the rapid growth in consumer interest, the Soil Association Council maintained interim status for eight years - uniquely across the sectors we license - whilst instigating an intensive three-year scientific research and development programme. That development programme led to a set of new, radically-improved standards - approved by Council in July, following field visits, seminars, and detailed briefing by staff.

Soil Association Scotland Director Hugh Raven hailed this crucial step-forward in organic aquaculture:
"The Soil Association has followed a responsible and pragmatic path to bringing aquaculture

fully into the organic fold. It would have been a dereliction of duty to ignore this hugely important food sector - and one with the potential to vastly reduce the unsustainable exploitation of wild fisheries.

"But fish farming has been highly controversial - as is any food production system that puts profit before principles and good practice.

"As with land-based organic farming, the Soil Association's aim is to achieve the most sustainable production for aquaculture. Our new standards represent carefully targeted key improvements on their 'interim' predecessors. We are delighted Council recognises the progress we've made by unanimously granting them full approval.

"We now embark on a major programme of continuing work to develop the standards further - focusing on priorities such as sustainable fish feeds, moving away from potentially polluting veterinary treatments, and farming multiple species of fish, sea-weed and crustaceans to minimise nutrient losses - replicating the diversity of cropping and species found on land-based organic farms. "

Soil Association aquaculture specialist Peter Bridson added:

"This is great news for our certified fish-farmers who've been producing top-quality organic fish for several years. They and we take our responsibility to justify the trust of consumers extremely seriously. Though there's more work to do, we now feel confident that Soil Association-certified organic salmon and trout are the most sustainably produced fish consumers can buy. Another key factor in choosing organic farmed-fish is that this premium product allows smaller-scale, locally-based producers to make a living whilst respecting the ecological constraints of the aquatic environment."

NEW EU RESEARCH PROJECT ON CONTROL OF FISH MALFORMATIONS

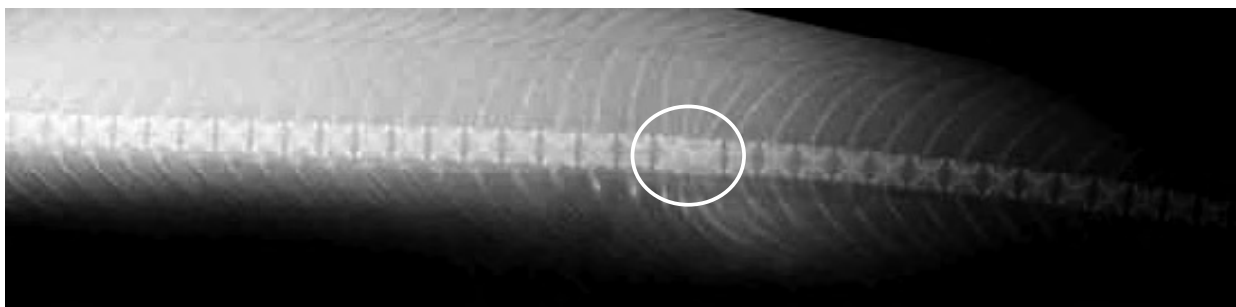
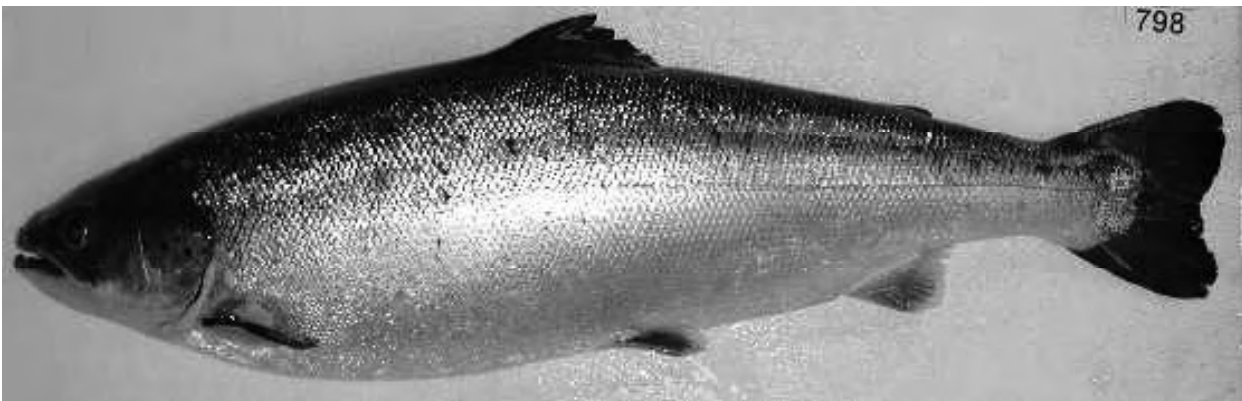
A new EU-funded Collective research project – “Finefish” - has been launched to generate new practical knowledge on how to reduce the incidence of malformations in the major fish species used in European aquaculture. The results will be applied to the professional hatchery sector.

“FineFish” has as its core goal the improvement of the sustainability of European fish aquaculture by better control of malformations and, in particular, will seek to combine available information on the causal relation of malformations between species so as to obtain new results faster and with higher precision.

Available scientific knowledge and practical experience on the causes of malformations in young fish led to the identification of the following focus areas: rearing temperatures (with emphasis on early life stages), nutrition and tank environment, including gas supplementation and hydrodynamics. The species to be investigated by the project are Atlantic salmon, cod, rainbow trout, sea bass and sea bream, thus covering most of the professional sectors within European fish farming that depend on hatcheries for their livestock.

Coordinated by the FEAP (Federation of European Aquaculture Producers), this 3-year project combines hands-on experience and scientific know-how, joining ten top European fish hatcheries with scientists specialising in fish development, for a long-range study of the health of young fish. Hatcheries from around Europe are included as SME partners within the project.

“FineFish” was established as a response to conclusions made in the PROFET workshops (organised by the FEAP, the European Aquaculture Society and AquaTT), specifically one that looked to assess the situation in European hatcheries. During this meeting (held in Bordeaux in 2004), hatchery managers from across Europe reported high levels of skeletal, backbone and gill malformations in fingerlings – juvenile fish about the size of a human finger. Such malformations represent a major source of financial losses for both SME hatcheries and producers due to the loss of production efficiency and quality aspects. Thus, finding ways to reduce or prevent malformations was identified as one of the major research tasks for the European aquaculture industry.



Fusion of vertebra in rainbow trout. The lower picture shows a radiograph image of the vertebral column of the fish as shown in the top photo.

Source: AKVAFORSK



Malformed jaws in Atlantic salmon.
Source: AKVAFORSK

The new knowledge generated on strategies to avoid malformations will be summarised as guidelines for use in 'Best Practise' hatchery operating manuals. Such manuals will provide clear recommendations for the improvement of operations within the hatcheries concerned. Besides 'Best Practise' manuals, a Classification handbook for deformity identification will be prepared – helping the operators to identify and determine malformations at an early stage.

A special monitoring programme is to be developed so as to establish benchmarks for the

measurement of improvements; this programme may be enlarged to include other hatcheries at a later stage in the project.

The FEAP is responsible for ensuring that the new strategies developed by the project are transferred to small and medium enterprises in the EU via workshops, training programmes and other dissemination means.

The project's website, www.finefish.info, will be an important source for information, providing actualised information on the project. The website will also provide a free subscription-based electronic newsletter.

For more information, Contact details:
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www.finefish.info

NEW AQUACULTURE TITLES PUBLISHED

Aquaculture Biosecurity Prevention, Control and Eradication of Aquatic Animal Disease

By David Scarfe, Cheng-Sheng Lee & Patricia O'Bryen

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Published in Cooperation with THE WORLD
AQUACULTURE SOCIETY.

Aquaculture loses millions of dollars in revenue annually due to aquatic animal diseases. Disease outbreaks continue to threaten profitable and viable aquaculture operations throughout the world. As a result, aquaculture biosecurity programs that address aquatic animal pathogens and diseases have become an important focus



for the aquaculture industry. Aquaculture Biosecurity: Prevention, Control, and Eradication of Aquatic Animal Disease provides valuable information that will increase success in combating infectious aquatic disease.

Key representatives of international, regional, and national organizations presented their views on this important issue as part of a special session at the 2004 World Aquaculture Society

Annual Conference. The chapters of this book cover a wealth of experience from the varied perspectives of these experts on biosecurity, policies, and measures to take the offensive against the spread of diseases in aquatic animals.

With contributions from renowned international experts, covering approaches to biosecurity policies and measures currently practiced, *Aquaculture Biosecurity: Prevention, Control, and Eradication of Aquatic Animal Disease* is a vital reference for all those concerned about protecting aquaculture from impacts of aquatic animal disease.

Aquaculture Marketing Handbook First Edition

By Carole Engle & Kwamena Quagraine

Publishing 29th March 2006 / 288 Pages / ISBN: 0813816041 / ISBN13: 9780813816043 / Paperback / £59.50 / US\$99.99 / AUS\$229.00

For more information or to buy this book visit www.blackwellpublishing.com/0813816041

Markets, marketing, and trade have become ever more important to growing aquaculture industries worldwide. The diversity and idiosyncrasies of the aquaculture and seafood markets call for understanding information that is unique to these markets. Presenting fundamental principles of marketing and economics from a user-friendly, how-to perspective *The Aquaculture Marketing*

Handbook will provide the reader with the tools necessary to evaluate and adapt to changing market conditions.

The *Aquaculture Marketing Handbook* provides the reader with a broad base of information regarding aquaculture economics, markets, and marketing. In addition, this volume also contains an extensive annotated bibliography and webliography that provide descriptions to key additional sources of information.

Written by authors with vast international aquaculture marketing experience, *The Aquaculture Marketing Handbook* is an important introduction to aquaculture marketing for those interested in aquaculture and those new to the professional field. The body of knowledge presented in this book will also make it a valuable reference for even the most experienced aquaculture professional.

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NEW NON-TOXIC ANTIFOULING FOR AQUACULTURE NETS USING DYNEEMA® FIBERS FIND FIRST COMMERCIAL ADOPTION

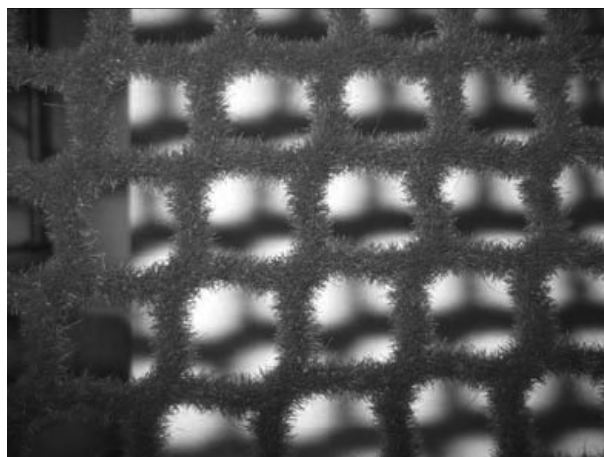
DSM Dyneema announces the first commercial success of its collaboration with the Dutch company Micanti. DSM Dyneema and Micanti are engaged in the development of strong and tough aquaculture nets with a new, revolutionary non-toxic antifouling treatment. Pinar Deniz, part of Yasar Holdings and one of the largest fish farms in Turkey and Europe, signed a contract in September for the deployment of the netting system at its farms. The combination of the new developed non-toxic Thorn-D® antifouling, from Micanti, with durable Dyneema® fibers, provides long-term, non-toxic resistance to fouling and thus avoids most environmental and fish-health issues. The benefit for the fish farmer is reduced maintenance and lifecycle costs for fouling prevention as well as healthier and larger sized fish.

Pinar Deniz stated: "We believe that the use of nets made with Dyneema® fiber and coated with Thorn-D® is an important step in reducing operational cost and towards non-toxic antifouling. We gladly participate in the project."

Nets made with ultra-strong and tough Dyneema® fibers are established in the fish-farming industry as helping reduce stock escapes and running repairs. Due to their strength, thinner twines can be used, which in turn provides less resistance to water currents for improved cleanliness and oxygenation for healthier fish. Thinner twines also mean less surface area for algae to grow. In addition to the accepted benefits of Dyneema®, DSM Dyneema is constantly looking to further address industry needs.

The Thorn-D® antifouling treatment was developed by Micanti, an innovative provider of fouling defense solutions, and has been tested in various salt and fresh water environments. The major benefit of the coating, besides being non-toxic, is that the coating will remain on the net for a number of years – longer than current, traditional antifouling solutions, decreasing the maintenance cost and the life cycle cost for fouling prevention. Reduction in fouling prevention will also decrease the stress endured by the fish when nets need to be cleaned.

"This is an exciting moment for the fish farming



Aquaculture nets made with Dyneema® and the non-toxic Thorn-D® antifouling treatment (Photo DSM Dyneema, DYNPR068)

industry. The combination of non-toxic Thorn-D® antifouling with durable Dyneema® fibers in netting will help improve the economics as well as environmental aspects of fish farming," declared Rik Breur, co-founder of Micanti.

This optimism is shared by André van Wageningen, Market Segment Manager Aquaculture for DSM Dyneema: "As part of our pursuit of innovation to meet market demands, we regularly participate in joint projects to develop new technologies and applications. We are therefore delighted to be involved in this collaboration with Micanti and other leading institutes in the field of aquaculture. We expect this new system will receive recognition in response to the strong drive for non-toxic antifouling in the fish farming industry, as well as to reduce cost of operation and increase profitability at farm level."

COMMISSION PROPOSES MEASURES IN AQUACULTURE TO ENSURE GREATER PROTECTION FOR BIODIVERSITY

The European Commission has proposed measures to regulate the introduction of non-native species in aquaculture so as to prevent their possible negative impact on the surrounding environment. Non-native or alien species, such as rainbow trout or Pacific oyster, have played a crucial role in the rapid growth of the European aquaculture industry. However, in some cases, the introduction of non-native species can have an adverse impact on ecosystems and cause significant loss of biodiversity. These measures would therefore regulate the introduction of such species through the setting up of a permit system. The Commission proposal, which was subject to wide consultation with stakeholders, would not only enhance the protection of ecosystems but would also contribute to the continued development of the aquaculture industry.

“Aquaculture plays an increasing role in our fisheries sector. Diversification is essential to its continued development, as is the need for a balanced and healthy environment. These measures will help ensure that the two are more compatible.,” commented Joe Borg, European Commissioner for Fisheries and Maritime Affairs.

The core of the present proposal is the establishment at national level of a system of permits for all new species that are introduced for aquaculture. Under the proposed measures, all projects to introduce a non-native species would have to be submitted for approval to a national advisory committee, which would determine whether the proposed introduction was ‘routine’, or not. In the case of non-routine introductions, an environmental risk assessment (ERA) would have to be carried out. Only movements that are assessed as being low risk could then be granted a permit. If the risk was considered to be medium or high, the advisory committee would enter into dialogue with the applicant to see whether adequate mitigation procedures or technologies that could reduce the risk to an adequately low level were available.

In the case of non-routine movements, the proposal provides for quarantine procedures, and in certain cases, the national authorities may

also require a pilot release to be implemented prior to full-scale commercial introduction. The proposed regulation also sets out a number of requirements concerning contingency plans, monitoring procedures, and the keeping of national registers.



The scope of the current proposal is limited to movements of fish stocks, which fall under the Common Fisheries Policy. Ornamental fish are therefore not concerned by these measures. The spreading of parasites and pathogens is already covered by Community legislation on animal health, so this issue is not addressed here either. The Commission is aware of the problems potentially posed by genetically modified organisms, but believes that these are best addressed by the substantial and evolving Community legislation specific to this field.

Non-native fish and shellfish species are species that are brought from an area, sometimes located on another continent, to an aquaculture installation in the EU. Such species represent a real economic opportunity for European aquaculture, both as a form of diversification, and for their characteristics that may make them better suited to rearing in captivity than native varieties. However, their introduction into European ecosystems has, in some cases also led to a loss of biodiversity. Addressing this issue thus represents a major step forward in the process of integrating environmental concerns into the Common Fisheries Policy (CFP).

The new measures should not lead to undue delays as strict time limits are set out in the proposal. Member States will decide who pays, but it is envisaged that industry will normally bear the cost. Aquaculture operators could form associations to share the costs. As the permit can cover a five-year period, costs should not hinder the future development of aquaculture.

The measures contained in the present proposal have been informed by an extensive consultation exercise carried out over a period of several years. They build on the voluntary codes of practice formulated by the International Council for the Exploration of the Sea (ICES) and the European Inland Fisheries Advisory Commission (EIFAC), as well as on existing Community instruments for biodiversity protection. In 2001, in its Biodiversity Action Plan for Fisheries,

the Commission undertook to examine the impact of the introduction of non-indigenous species on the wider environment. The EU 2002 Strategy for Sustainable Development of European Aquaculture included a commitment to introduce management rules to address the possible negative consequences of such movements.

The proposed Regulation will make a real contribution to achieving the objective of halting biodiversity loss as set out in the EU's 6th Environmental Action Programme and in the EC Strategy for Sustainable Development. The proposed measures will also contribute to implementing the Community's international commitments under the Convention on Biological Diversity and the follow-up process to the World Summit on Sustainable Development.

£3.7MILLION BOOST FOR FISHING INDUSTRY

Grants worth almost £4million to modernise and improve the competitiveness of England's fishing industry have been announced today.

A total of 30 projects ranging from upgrading fishing boats to sustainability and promotional initiatives will receive cash under the Financial Instrument for Fisheries Guidance (FIFG) scheme, funded by Defra and the European Union.

Successful bids include:

- £248,000 to upgrade an East London food processor
- £245,000 to improve facilities at Billingsgate Fish Market, London
- £200,000 for a live shellfish handling facility at Wells, Norfolk
- £129,000 to improve the harbour at Brancaster, Norfolk
- £197,000 for a new fish grading line at Hull and £74,000 for new grading capacity at Grimsby

- £83,000 for a new internet seafood information network

The Marine Fisheries Agency, which considers the bids, has awarded more than £7million in FIFG grants since 2005.

Fisheries Minister Ben Bradshaw said:

"This money will pay for better equipment, better working conditions and more measures aimed at making our fisheries more sustainable and profitable in the long run."

Next year the FIFG scheme will be succeeded by a new European Fisheries Fund. Details will be announced in 2007 after public consultation. Applications for the final round of FIFG grants should be submitted to the Marine Fisheries Agency no later than 2 March 2007.

AQUACULTURE

Company	Location	Project	FIFG (£)	MFA (£)
Wilmington Trout Farm	Devon	Bio-filtration and circulation equipment	12,000	20,000
Padworth Trout Farm	Hampshire	Extension of production capacity	39,040	65,057
			51,040	85,057

CATEGORY 2 HEALTH CHECKS ON SALMONID FARMS

Fish introductions can have significant and irreversible impacts on fisheries and the wider environment. This is why anyone wishing to stock fish into rivers and stillwaters in England and Wales must apply to the Environment Agency for a consent. In giving consent, we consider the risk associated with the species, number and, most importantly, the health status of the fish being stocked.

To establish health status, the Environment Agency insists that any fish being stocked into rivers, on-line stillwaters and stillwaters liable to flooding, hold a valid health check. A health check is not needed for restocking fully enclosed stillwaters.

Over the last three years, we have offered free health checks to all trout restocking farms. These have been carried out by Cefas. The latest round of health checks should provide cover up to April/May 2008.

From 2008, fish farms will have to arrange and pay for their own health checks. The Environment Agency will write to all affected fish farms, informing them of the new arrangements. In the meantime, please contact Paul Lidgett at the Environment Agency on 08708 506 506 if you have any queries.

2005 SURVEY OF TROUT PRODUCTION IN ENGLAND AND WALES

Paul Tyson, Peter Dunn, Jason Mewett & Caroline Crane, Fish Health Inspectorate, Cefas Weymouth Laboratory, The Nothe, Barrack Road, Weymouth, Dorset DT4 9UB

Each year, the inspection and monitoring programme of salmonid farms in England and Wales is undertaken by the Cefas Fish Health Inspectorate, on behalf of Defra and the Agriculture Department of the National Assembly for Wales under the European Council Directive 91/67/EC. A total of 230 registered salmonid farm sites were visited during 2006. During 2005 and 2006, 17 sites were registered while 32 farms ceased trading and were de-registered, though some of these still reported production. The data included in this report and provided by the site owners represents the production from a final total (as of 31st Dec 2005) of 233 registered salmonid farms in England and Wales.

Rainbow trout production

A summary of the production details for all sites farming rainbow trout is presented in Table 1. The sites are grouped according to regional divisions of the Environment Agency (EA), to allow comparison with previously published data. Sites are classified into one of four different categories as follows:

- 1) Sites that did not produce any rainbow trout during 2005
- 2) Sites that produced rainbow trout for the table market only
- 3) Sites that produced rainbow trout for restocking fisheries and/or for ongrowing
- 4) Sites that catered for both table and restocking/ongrowing markets.

The total annual production of rainbow trout for the table market in 2005 was 5,900 tonnes from 63 farm sites. This figure is a very slight rise on 2004 table production (5,858 tonnes) although the number of sites producing fish for the table decreased (82 in 2004). A total of 102 farms produced rainbow trout for restocking fisheries or ongrowing purposes, which is a decrease of 12 from 2004. These sites together produced 2,805 tonnes during 2005. This represents a decrease of 359 tonnes on the total restocking and ongrowing production recorded for 2004 (3,164 tonnes).

The overall rainbow trout production (combining table and restocking/ongrowing figures) for England and Wales in 2004 was 8,705 tonnes, a decrease of 317 tonnes on 2004 production equating to a drop of just over 3.5%. This follows a decrease in production between 2003-2004 indicating that rainbow trout production in England and Wales is declining slowly.

Table 2 provides a breakdown of trout production where farms are classified according to their scale of production. Data for brown trout production are also included because the majority of brown trout are produced from sites also farming rainbow trout.

Although just under 45% of the trout farms in England and Wales are in the 0-10 tonnes category, their combined output accounts for only 3.3% of total production. These proportions have decreased from 2004, and the number of these smallest registered farms has decreased by 33 sites from 2004. Other categories have remained stable from 2004, with the exception of the 51-100 tonne production farms which have also decreased by 8 farms. The biggest farms (those producing over 200 tonnes annually) account for 46% of total trout production although they only represent 5.2% by number of the trout farms in England and Wales. In short, the majority of farms produce a relatively small weight of fish, whilst a handful of large sites produce the majority of trout in England and Wales. The South West area continues to contain the highest number of farms (57) and produces the most trout of any region (around 45% of trout production) in England and Wales; however this region has seen the sharpest drop in production, down 152 tonnes with 16 fewer farms.

Production of other farmed salmonids

The 2005 production information for brown trout and Atlantic salmon is summarised in Table 3. Fry production is recorded in thousands rather than by weight as the latter measure tends to seriously under-represent the value of that production.

Of the 233 registered salmonid farms producing fish during 2005, 87 sites produced brown trout (a large decrease of 47 sites from 2004) and 19 farms produced Atlantic salmon. Total production of brown trout in England and Wales has decreased to 469 tonnes (from 596 tonnes in 2004), which includes 203 tonnes produced for the table. Seven sites held brook trout (*Salvelinus fontinalis*) in 2005, with 2 tonnes being produced for the table market and 0.3 tonnes for the restocking trade. Four sites held Arctic char (*S. alpinus*) over the period although there was less than 1 tonne produced for the table market.

Commercial units that supply farms in Scotland produced the majority of salmon smolts. A total of 1.7 million smolts were produced from 5 sites. This is a similar level of production to 2004, which was a slight increase from 2003. Eight commercial sites also produced just over 570 thousand salmon parr, a large increase on 2004 data. In addition, one grant-maintained and five Environment Agency salmonid rearing sites operated during 2005, producing fry and juvenile salmon for specific river stock enhancement programmes. These sites together produced 847,000 salmon parr and 756,000 salmon fry. The numbers of salmon parr produced by the EA sites has increased by 155,000 while the numbers of fry produced has risen 7% from last years total, continuing the trend from 2003. The changes in production from these sites suggest that salmon stock management is continuing to shift towards stocking of younger fish in conjunction with habitat improvement programmes.

Ova production

The recorded figures for salmonid ova production over the period running from late 2005 through to early 2006, from sites

holding broodstock are summarised in Table 4. The majority of rainbow trout eggs produced were all-female. Production of this type of egg totalled almost 25 million, down over 7 million from 2004/2005. These figures continue the trend from the previous year when a decrease from the 2003/2004 season of 5 million eggs was seen. Mixed-sex rainbow trout egg production dropped to 3.2 million from the previous level of 6.1 million, returning to 2003/2004 levels. This trend is repeated for production of triploid rainbow trout eggs: just over 5.3 million which is a decrease from the 2004/2005 level of 10.2 million, but again represents a return to the levels of 2003/2004. Overall rainbow trout egg production was just over 33 million eggs, a decrease of 15 million eggs from 2004/2005, although an overall increase on the 2003/2004 levels of just under 20 million.

The majority of brown trout ova produced were mixed-sex and production totalled almost 3.5 million, a decrease of around 1 million on last year's figures. A total of 175,000 all-female brown trout ova were produced, which is a drop of more than half from last year's reported level of 396,000. Triploid ova production was recorded at almost 1.4 million – a slight increase over last year. Overall production of brown trout eggs has decreased from 2004/2005 by around 1 million eggs, a return to the levels of 2003/2004. The production of triploid eggs is likely to be a continued response from the industry to the Environment Agency's stocking policy proposals, in which triploids are desired for restocking as they are perceived to pose no genetic threat to natural trout populations. The majority of brown trout ova were produced from sites in the Thames region; this is a shift from 2004/2005 when the South West was the main brown trout producing region.

Table 1. 2005 rainbow trout production in England and Wales by Environment Agency region

Environment Agency region	Number of Sites				Rainbow Trout Production		
	Total Number	Table Production	Restocking / Ongrowing Production	Both (Table & Restocking)	Table (tonnes)	Restocking / Ongrowing (tonnes)	Fry (thousands)
Anglian	10	1	7	2	21	215	0
Midlands	9	0	7	2	2	295	0
North East	29	4	16	9	1,123	546	4,972
North West	12	0	6	6	78	147	0
Southern	21	5	13	3	1,465	135	156
South West	54	11	28	15	2,653	1,034	13,778
Thames	16	4	8	4	367	239	281
Welsh	25	1	17	7	191	193	2,496
Totals	176	26	102	48	5,900	2,805	21,527

Table 2. Analysis of rainbow trout and brown trout production according to region and scale of farm output. The number of farms in each size class is given in brackets

Environment Agency region	Production according to farm output category in tonnes				
	0-10	11-50	51-100	101-200	>200
Anglian	11 (5)	68 (4)	183 (3)	0 (0)	0 (0)
Midlands	7 (9)	128 (6)	5 (1)	122 (1)	0 (0)
North East	40 (11)	310 (9)	290 (4)	416 (3)	654 (2)
North West	14 (4)	161 (7)	65 (1)	0 (0)	0 (0)
Southern	44 (15)	135 (8)	0 (0)	0 (0)	1,454 (4)
South West	80 (21)	640 (22)	334 (5)	863 (6)	2,035 (3)
Thames	26 (7)	121 (5)	150 (2)	112 (1)	222 (1)
Welsh	83 (19)	155 (6)	164 (2)	0 (0)	0 (0)
Totals	305 (86)	1,718 (67)	1,241 (18)	1,513 (11)	4,365 (10)
% Total Production	3.33	18.79	13.57	16.54	47.74
% Farms Involved	44.7	34.8	9.37	5.7	5.2

Table 3. 2005 production of brown trout and Atlantic salmon in England and Wales by Environment Agency region

Environment Agency region	Brown trout production			Atlantic salmon production			
	Total Number of sites	Restocking / Ongoing (tonnes)	Fry (thousands)	Total Number of sites	Post Smolts (tonnes)	Parr / Smolts (thousands)	Fry (thousands)
Anglian	6	25	0	1	3	282	0
Midlands	5	14	0	1	0	4	168
North East	14	43	149	3	0	1,080	0
North West	5	15	7	4	0	1,512	2,536
Southern	19	32	107	1	0	0	30
South West	18	62	714	1	0	0	14
Thames	9	32	35	2	0.2	20	0
Welsh	12	22	26	6	0	255	592
Totals	87	245	1,038	19	3.2	3,153	3,340

Table 4. 2005/2006 eyed ova production from sites holding broodstock salmonids in England and Wales (not including sea trout and salmon produced from wild broodstock by the Environment Agency)

Environment Agency region	Rainbow trout			Brown trout			Atlantic salmon
	All females (thousands)	Mixed sex (thousands)	Triploids (thousands)	All females (thousands)	Mixed sex (thousands)	Triploids (thousands)	Mixed sex (thousands)
Anglian	0	0	0.5	0	80	0	0
Midlands	175	0	75	0	308	0	0
North East	12,115	4	2,031	104	206	583	0
North West	0	0	0	0	385	0	0
Southern	60	10	280	0	123	93	0
South West	9,306	3,248	1,506	71	492	350	90
Thames	2,458	0	1,493	0	1,836	359	0
Welsh	230	35	0	0	87	0	149
Totals	24,344	3,297	5,385.5	175	3,517	1,385	239

2005 SURVEY OF TROUT PRODUCTION IN SCOTLAND

Data supplied from SEERAD (Scottish Executive Environment and Rural Affairs Department) Annual Production Survey, 2005 via the website: www.marlab.ac.uk

Rainbow trout were produced from 70 sites involving 42 companies with an overall production of 6,989 tonnes in 2005 (6,352 tonnes in 2004) an increase of 637 tonnes on the previous year (just over 10%). Trends in production over the last 11 years are given in Table 1 below.

Table production

Table 2 gives trends in production for table fish over the past 11 years. Production in 2005 amounted to 6,170 tonnes representing an increase of 773 tonnes (just over 14%) on the previous year and accounting for 88% of total production. Fish in the weight class of <450g were the most prevalent, representing 46% of table production.

Restocking production

Table 3 provides production data for the restocking trade for the last 11 years. Production for restocking decreased by 117 tonnes (12.5%) to 819 tonnes representing 12% of the total production (15% in 2004).

Escapes

There were 6 reported escapes from rainbow trout sites in 2005 involving the loss of 7,967 fish.

Method of production

Table 4 provides a breakdown of trout farms by system and scale of production. Freshwater production accounted for 5,747 tonnes (82% of the total) while seawater production increased by 11% on the previous year to 1,242 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 28.9 to 70.4 tonnes/person between production areas, being greatest in the West and least in the South area. Mean productivity in tonnes/person for the four population areas reached 49 tonnes. In 2005 staff employed totalled 143.

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 – 2005. The number of ova laid down from GB broodstock decreased to 0.386 million representing almost 2% of the total. The total number of eyed-ova laid down decreased by 12 million (38%) to 20.2 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 83% of all ova laid down. Triploid ova decreased by 1.4 million to just 8% of the total, while mixed sex ova showed a significant increase from 0.14 to 1.7 million.

Imported rainbow trout eggs in 2002

The number and source of imported rainbow trout ova for the period 1997 – 2005 are given in Table 8. The total imported in 2005 (19.9 million) represents an decrease of 13 million (just under 40%) on the previous year.

Other species

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

Table 1. Total (table and restocking) production for the period 1995 - 2005 (tonnes)

<u>Year</u>	<u>Tonnes</u>	<u>Year</u>	<u>Tonnes</u>
1995	4,683	2001	5,466
1996	4,630	2002	6,659
1997	4,653	2003	7,085
1998	4,913	2004	6,352
1999	5,834	2005	6,989
2000	5,154		

Table 2. Production of table fish for the period 1995 - 2005 (tonnes)

Year	Fish Size			Total
	<450g <1lb	450 - 900g 1-2 lb	>900g >2lb	
1995	2,736	199	1,149	4,084
1996	2,701	181	1,002	3,884
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
2005	2,856	1,203	2,111	6,170

Table 3. Production of restocking fish for the period 1995 - 2005 (tonnes)

Year	Fish Size			Total
	<450g <1lb	450 - 900g 1-2 lb	>900g >2lb	
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
2005	21	390	408	819

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

Production method	Production grouping (tonnes) in 2005					Total tonnage and (%) by method		Number of sites	
	<10	10-25	26-50	51-100	>100	2004	2005	2004	2005
FW cages	1	2	0	0	7	3,320 (52.3)	3,771 (53.9)	9	10
FW ponds and raceways	5	7	5	7	5	1,910 (30.1)	1,972 (28.2)	27	29
FW tanks and hatcheries	3	0	0	0	0	8 (0.1)	4 (0.1)	4	3
SW cages	0	0	0	0	5	1,114 (17.5)	1,242 (17.8)	4	5
SW tanks	0	0	0	0	0	0	0	0	0
Total	9	9	5	7	17	6,352	6,989	43	47

Table 5. Rainbow trout production and staffing by area in 2005

Area	No. of sites	Production			Mean tonnes/sites	Staffing			Productivity tonnes/person	
		Table	Restocking	Total		F/T	P/T	Total		
North	14	917	96	1,013	72.4	16	4	20	50.6	
East	19	1,516	294	1,810	95.3	34	8	42	43.1	
West	21	3,009	89	3,098	147.5	35	9	44	70.4	
South	16	728	340	1,068	66.8	23	14	37	28.9	
All	70	6,170	819	6,989	95.5	108	35	143	9	4

Table 6. Number (000s) and sources of rainbow trout ova laid down for hatching in 1995 - 2005

<u>Year</u>	<u>Own Stock</u>	<u>Other GB Stock</u>	<u>Total GB</u>	<u>Total 3rd Country</u>	<u>Grand Total</u>	<u>% GB</u>
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
2005	281	105	386	19,861	20,247	1.9

Table 7. Number (000s) and proportions (%) of rainbow trout ova types laid down for hatching in 1995-2005

<u>Year</u>	<u>All female diploid nos. (%)</u>	<u>Triploid nos. (%)</u>	<u>Mixed sex diploid nos. (%)</u>	<u>Total ova</u>
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
2005	16,773 (83)	1,729 (8)	1,745 (9)	20,247

Table 8. Number (000s) and sources of ova imported into Scotland during 1997-2005

Source	1997	1998	1999	2000	2001	2002	2003	2004	2005
Northern Ireland	2,425	2,065	3,335	1,085	710	-	-	405	1,710
Isle of Man	4,205	3,273	4,222	5,842	6,670	6,775	6,855	8,012	1,700
Denmark	5,354	5,700	4,546	4,225	6,135	5,000	5,270	6,370	9,225
France	-	-	-	-	-	-	875	-	-
Other EU	-	-	-	-	-	-	-	17,335	4,440
South Africa	9,450	11,585	6,036	7,762	8,075	7,750	50	800	200
USA	-	-	-	-	-	1,700	11,035	-	2,600
Totals	21,434	22,623	18,139	18,914	21,590	21,225	24,085	32,922	19,875

Table 9. 2004 and 2005 production (in tonnes) of other finfish species farmed in Scotland

Species	Production	
	2004	2005
Atlantic salmon	158,099	129,588
Arctic char	3.25	3
Brown trout /Sea trout	167	122
Cod	8	69.6
Halibut	186.8	272.4

SUMMARY OF UK RAINBOW TROUT PRODUCTION IN 2005

Rainbow trout production in 2005 for both the table and restocking trades are given for England and Wales, Scotland and Northern Ireland. The percentage for each class is given in brackets.

	Production in tonnes		
	Table	Restocking	Total
England and Wales	5,900 (68%)	2,805 (32%)	8,705
Scotland	6,170 (88%)	819 (12%)	6,989
Northern Ireland	412 (81%)	97 (19%)	509
Totals	12,482 (77%)	3,721 (23%)	16,203

2005 EUROPEAN TROUT PRODUCTION

The Federation of European Aquaculture Producers (FEAP) publishes finfish production figures for 24 European countries on its website (<http://www.feap.info/feap/>). The production of rainbow trout is divided into various categories: portion-size (maximum size 400 g) fish are classed as either 'pink' or 'white', reflecting the colour of the flesh that is determined by the food; large trout which are on-grown to a size >1 kg for processing as salmon; restocking fish which are produced to stock rivers and lakes for sport fishing. The data is provided to FEAP by the national trade associations, and the production figures (in tonnes) for rainbow trout and all finfish for 1999-2005 have been collated from the FEAP website (Jan 07) within Table 1. The data may therefore differ from that collected by the national governments, and reliability is dependent upon the provision and accuracy of data and transcription (N.B. the up-loaded data for Germany appears to be that for France).

Rainbow trout are produced across Europe, with only the Netherlands and Malta recording no production. Total European production of rainbow trout for 2005 was estimated to be nearly 335,000 tonnes. Norway was again the leading producer at 60,000 tonnes, followed by Turkey, Italy and Denmark with 40,250, 39,600 and 35,000 tonnes respectively. UK production,

estimated at 18,600 tonnes, ranked 8th in the league of European trout producing countries. The UK rainbow trout industry is apparently unique within Europe, producing fish for restocking and pink (but not white) portion size fish.

Production figures for other finfish species farmed across Europe are also available on the FEAP website. These include other trout (sea trout, Arctic char, brook trout), salmon, carps (common, grass and silver), other freshwater fish (perch, tench, pike, pike-perch), eel, tilapia, catfish (African, European, channel), sturgeon, sea-bass, sea-bream, flatfish (turbot, halibut, sole) and other marine fish (cod, northern bluefin tuna, meagre). Norway was the largest producer of farmed finfish (combined production of 655,364 tonnes), largely due to its salmon industry. The UK ranks 2nd among the European nations with a combined finfish production of 141,793 tonnes, 70% more than the 3rd ranked nation, Greece.

Average ex-farm prices of trout (i.e. the value obtained by the producer) listed on the FEAP website for the years 1998-2005 are provided in Table 2. It can be seen that pink portion trout command a premium over white portion fish, while large trout attract a higher price than portion-sized fish. The prices of Arctic char (twice that of trout) are included for comparison.



Table 1: European production (in metric tonnes, fresh whole (round) weight) of rainbow trout (RT) and all finfish for 1999-2005. See text for further explanation.

Country		1999	2000	2001	2002	2003	2004	2005
Austria	RT White portion	2,097	1,950	1,735	1,738	1,594	1,600	1,600
	RT Large	191	162	188	188	217	230	230
	Total finfish	2,883	2,732	2,308	2,229	2,148	2,170	2,170
Belgium/ Luxembourg	RT White portion	600	400	400	250	250	250	250
	RT Pink portion	100	200	200	150	150	150	150
	RT Large	100	100	100				
	Total finfish	1,640	1,520	1,520	1,200	1,200	1,200	1,200
Croatia	RT White portion	471	680	1,042	913	791	800	800
	Total finfish	5,780	6,551	9,840	9,605	8,456	9,350	9,950
Cyprus	RT Pink portion	66	90	90	180	90	91	70
	Total finfish	1,378	1,690	1,790	1,861	2,090	3,515	3,598
Czech Republic	RT White portion	723	700	700	656	650	564	597
	Total finfish	18,165	18,460	18,660	17,946	18,337	18,798	19,892
Denmark	RT White portion	23,000	23,000	24,000	24,000	22,000	22,500	22,500
	RT Pink portion	7,000	7,000	7,000	7,000	5,000	6,500	6,500
	RT Large	7,500	7,500	7,000	6,500	6,500	5,500	6,000
	Total finfish	40,200	40,175	40,100	39,800	35,550	36,000	36,610
Faroe Islands	RT Large	2,169	1,141	3,125	10,000	10,220	3,918	3,977
	Total finfish	39,150	32,581	49,138	55,000	62,746	37,518	22,677
Finland	RT Large	15,300	15,200	17,000	14,894	13,920	12,000	13,000
	Total finfish	15,300	15,200	17,000	14,894	13,920	12,000	13,000
France	RT White portion	2,000	2,500	2,500	2,500	2,000	2,500	4,000
	RT Pink portion	35,000	35,000	35,000	30,000	25,000	25,000	21,000
	RT Large	8,000	10,000	10,000	10,400	10,000	10,000	9,000
	Total finfish	57,323	59,635	59,155	55,300	49,470	51,010	48,767
Germany	RT White portion	2,000	2,500	2,500	2,500	2,000	2,500	4,000
	RT Pink portion	35,000	35,000	35,000	30,000	25,000	25,000	21,000
	RT Large	8,000	10,000	10,000	10,400	10,000	10,000	9,000
	Total finfish	57,323	59,635	59,155	55,300	49,470	51,010	48,767
Greece	RT White portion	2,800	2,500	3,000	3,000	3,000	3,000	3,000
	Total finfish	52,450	61,800	66,550	73,500	78,500	79,500	83,600
Hungary	RT White portion		27	32	29	25	25	25
	Total finfish	17,670	19,524	17,773	18,408	17,735	17,735	17,735
Iceland	RT Large	100	180	500	248	180	142	50
	Total finfish	4,710	5,116	8,070	3,467	6,147	8,917	8,355
Ireland	RT Pink portion	1,000	1,000	1,000	2,000	1,000	1,000	1,100
	RT Large	1,100	1,400	766	700	350	350	550
	Total finfish	20,395	20,213	24,213	24,173	19,340	15,421	13,220
Italy	RT White portion	19,200	19,000	18,800	17,500	16,200	22,000	22,000
	RT Pink portion	24,000	24,700	24,500	22,800	21,200	17,000	17,000
	RT Large	800	800	700	600	600	600	600
	Total finfish	59,950	61,800	62,500	59,700	56,500	58,700	58,620
Malta	Total finfish	2,002	1,746	1,235	1,116	1,000	913	931
Netherlands	RT Restocking	200	200	200	200	200		
	Total finfish	6,280	6,700	6,700	6,400	8,275	8,475	9,650
Norway	RT Large	50,000	47,000	65,000	83,000	71,000	65,000	60,000
	Total finfish	463,080	470,531	485,400	543,400	594,570	580,570	655,364
Poland	RT White portion	9,000	10,160	11,000	11,000	13,000	13,500	14,000
	Total finfish	29,130	34,590	34,310	30,750	33,760	33,431	33,240
Portugal	RT Pink portion	1,500	1,500	1,500	1,500	1,500	1,500	1,500
	Total finfish	4,619	5,350	4,940	5,040	6,040	6,040	6,040

Table 1: European production (in metric tonnes, fresh whole (round) weight) of rainbow trout (RT) and all finfish for 1999-2005. See text for further explanation. *Continued*

Country		1999	2000	2001	2002	2003	2004	2005
Spain	RT White portion	12,000	8,000	8,000	5,800	9,000	9,000	14,000
	RT Pink portion	15,000	20,500	21,500	23,200	22,500	22,500	11,000
	RT Large	700	1,500	1,500	4,500	1,500	2,250	1,500
	Total finfish	43,990	49,483	54,620	57,200	57,514	62,668	65,205
Sweden	RT Large	7,250	5,010	5,882	4,817	5,585	5,951	6,000
	Total finfish	7,886	6,151	7,254	6,084	6,506	6,828	6,922
Turkey	RT White portion	36,870	42,572	36,827	35,000	38,000	38,000	38,000
	RT Pink portion	200	220	220	250	250	250	250
	RT Large	1,700	1,961	1,240	1,240	2,000	2,000	2,000
	Total finfish	62,870	78,290	66,972	62,510	67,250	71,250	78,850
UK	RT Restocking	4,000	4,000	4,000	4,000	4,000	4,000	3,100
	RT Pink portion	12,100	15,200	12,000	12,200	12,200	12,200	12,500
	RT Large	600	2,600	2,600	3,000	1,000	2,000	3,000
	Total finfish	137,231	156,820	165,259	162,461	179,248	168,550	141,793
All RT	Total % UK	349,437 5%	363,153 6%	378,347 5%	388,853 5%	359,672 5%	351,371 5%	334,849 6%
Total finfish	Total % UK	1,151,405 12%	1,216,293 13%	1,264,462 13%	1,307,344 12%	1,375,772 13%	1,341,569 13%	1,386,156 10%

Table 2: Prices of farmed trout (Euros / Kg) according to FEAP website.

Product	1998	1999	2000	2001	2002	2003	2004	2005
White portion rainbow trout	2.29	1.84	2.1	2.16	2.07	1.87	1.9	1.98
Pink portion rainbow trout	1.93	1.96	2.17	2.26	2.02	1.95	2.03	2.14
Large rainbow trout	2.53	2.67	3.49	2.42	2.39	2.46	2.5	2.84
Arctic char	4.24		5.28					5.1

RESEARCH NEWS

1. Ectoparasites increase susceptibility to bacterial infection

In this study rainbow trout were infected concomitantly with *Argulus coregoni* (an ectoparasitic fish louse) and the bacterium *Flavobacterium columnare*. Survival was compared to that of fish infected with either the parasite or the bacterium alone. The mortality of fish challenged with *A. coregoni* was negligible while infection with *F. columnare* alone decreased survival. However, compared with single infections, the mortality was higher and the onset of disease condition was earlier among fish which were concomitantly infected by the parasite and bacterium. This study therefore provides the first experimental support for the hypothesis that an ectoparasite infection increases susceptibility of fish to a bacterial pathogen.

Bandilla, M. (matband@byti.jyu.fi), Valtonen, E.T., Suomalainen, L.R., Aphalo, P.J., Hakalahti, T. (2006). A link between ectoparasite infection and susceptibility to bacterial disease in rainbow trout. *International Journal for Parasitology*, 36: 987-991.

2. Lactococcosis review

Lactococcus garvieae is the etiological agent of Lactococcosis, an emergent disease which affects many fish species and causes important economic losses in both marine and freshwater aquaculture when water temperature increases over 16°C in summer months. Normally it causes a hyperacute and haemorrhagic septicemia. This paper presents a state of the art review of fish Lactococcosis including aspects such as pathogen characterization, pathogenesis, epidemiology, diagnosis and control measures of the disease in farmed fish.

Vendrell, D., Balcazar, J.L. (balcazar@unizar.es), Ruiz-Zarzuola, I., De Blas, I., Girones, O., Muzquiz, J.L. (2006). *Lactococcus garvieae* in fish: a review *Comparative Immunology Microbiology & Infectious Diseases*, 29: 177-198.

3. Guide to parasite identification in tissue sections

The identification of protozoan and metazoan parasites is traditionally carried out using a series of classical keys based upon the morphology of the whole organism. However,

in stained tissue sections prepared for light microscopy, taxonomic features will be missing, making parasite identification difficult. This paper highlights the characteristic features of representative parasites in tissue sections to aid identification. The parasite examples discussed are derived from species affecting finfish, and predominantly include parasites associated with disease or those commonly observed as incidental findings in disease diagnostic cases. Emphasis is on protozoan and small metazoan parasites (such as Myxosporidia) because these are the organisms most likely to be missed or mis-diagnosed during gross examination. Figures are presented in colour to assist biologists and veterinarians who are required to assess host/parasite interactions by light microscopy.

Bruno, D.W. (d.bruno@marlab.ac.uk), Nowak, B., Elliott, D.G. (2006). Guide to the identification of fish protozoan and metazoan parasites in stained tissue sections. *Diseases of Aquatic Organisms*, 70: 1-36.

4. Egg-laying patterns of a fish louse

Argulus foliaceus is a damaging fish ectoparasite for which new control measures are being developed based on egg-removal. This study therefore monitored egg-laying patterns in this parasite over the period 14 April to 17 November 2003 in two rainbow trout fisheries in Northern Ireland. At Site 1, egg-laying was continuous from 21 April to 17 November, when water temperature was above 8-10°C. At Site 2, egg-laying was continuous from 4 June to 29 October. In the early months of the season, egg-laying was recorded mainly within the top 1 m of the water column; however, a significant shift to deep water egg-laying was recorded between 7 July and 17 November at Site 1 and between 20 August and 29 October at Site 2. Egg clutches were preferentially laid at depths of up to 8.5 m during this time (Site 2), a feature of egg-laying hitherto unappreciated. Temperature and dissolved oxygen did not differ significantly between depths, but there was an increase in water clarity over time. However, the precise environmental triggers for deep water egg-laying are still unclear. These new insights into the reproductive behaviour of this species will be useful in developing control methods based on egg-removal.

Harrison, A.J., Gault, N.F.S. (norman.gault@dardni.gov.uk), Dick, J.T.A. (2006). Seasonal and vertical patterns of egg-laying by the freshwater fish louse *Argulus foliaceus* (Crustacea: Branchiura). *Diseases of Aquatic Organisms*, 68: 167-173.

5. Global warming and parasite risks

The link between climate changes and disease risks from various pathogens is being increasingly recognized. The effect of climatic factors on host-parasite population dynamics is particularly evident in northern latitudes where the occurrence and transmission of parasites are strongly regulated by seasonality-driven changes in environmental temperatures. Shortened winter periods would increase the growth potential of many parasite populations. This paper focuses on the ways in which climate warming could affect the life history dynamics of the directly transmitted crustacean ectoparasite *Argulus coregoni* and the complex life cycle trematode *Diplostomum spathaceum*, which frequently cause problems in northern fish farming. Increased problems for fish farming are predicted in terms of increased infection pressure from these parasites. This would increase problems associated with infections and increase the use of expensive management protocols with high environmental impact.

Hakalahti, T. (teihaka@bytl.jyu.fi), Karvonen, A., Valtonen, E.T. (2006). Climate warming and disease risks in temperate regions - *Argulus coregoni* and *Diplostomum spathaceum* as case studies. *Journal of Helminthology*, 80: 93-98.

6. Slice® residues in rainbow trout

This study examined the depletion of emamectin B1a in the edible tissues of rainbow trout at two temperatures following in-feed treatment with Slice®. Fish approaching market size were held in tanks supplied with seawater at 6°C (cold water) or 15°C (warm water). At each temperature the medicated group was offered feed containing emamectin benzoate at a nominal dose rate of 50µg /kg fish/day for 7 days, and a control group was offered unmedicated feed. In the cold water experiment, emamectin B1a residues ranged from 82 ng/g at 1 day post-treatment to 14 ng/g at 77 days post-treatment. In the warm water study, residue concentrations ranged from 65 ng/g at 6 h post-treatment to 1.6 ng/g at 49 days post-treatment. In the cold water study, residues in skin and muscle were also determined separately; concentrations in skin were approximately 1.8

times higher than in muscle. Measured residue levels ranged widely and no detectable residues were found in at least a few individual fish at all time points. This high variability was considered to be due to differences in the consumption of medicated feed within the experimental populations. Depletion of emamectin was faster at 15°C than at 6°C. In both studies the depletion curve showed a small secondary peak at around 90 degree-days which is consistent with recirculation of the compound from a body store.

Roy, W.J. (w.j.roy@stir.ac.uk), Gillan, N., Crouch, L., Parker, R., Rodger, H., Endris, R. (2006). Depletion of emamectin residues following oral administration to rainbow trout, *Oncorhynchus mykiss*. *Aquaculture*, 259: 6-16.

7. Probiotics work in trout

Two bacteria (*Carnobacterium maltaromaticum* B26 and *C. divergens* B33) isolated from the intestines of healthy rainbow trout were selected as potential probiotics. Feed supplemented with B26 or B33 dosed at >10⁷ cells/g feed conferred protection to rainbow trout against challenges with virulent cultures of *Aeromonas salmonicida* and *Yersinia ruckeri*. Moreover, both cultures persisted in the gut for up to 3 weeks after administration. The cultures enhanced the cellular and humoral immune responses. Specifically, fish fed with B26 demonstrated significantly increased phagocytic activity of the head kidney macrophages, whereas the B33 led to significant increases in respiratory burst and serum lysozyme activity. Also, the gut mucosal lysozyme activity for fish fed with both cultures was statistically higher than the controls.

Kim, D.H., Austin, B. (b.austin@hw.ac.uk) (2006). Innate immune responses in rainbow trout (*Oncorhynchus mykiss*, Walbaum) induced by probiotics. *Fish & Shellfish Immunology*, 21: 513-524.

8. Immunostimulants improve disease resistance in carp

Common carp held in ponds were fed with chitin, chitosan and levamisole dietary supplements for a period of 90 days to determine the effects on growth, the immune response and resistance to an *Aeromonas hydrophila* challenge. All supplements enhanced fish growth compared to fish fed a non-supplemented diet. The highest growth was recorded in the chitosan fed fish, followed by levamisole and chitin. Dietary supplementation of chitin, chitosan and levamisole significantly

affected lysozyme and neutrophil activity. When the treated fish were challenged with *A. hydrophila*, survival was significantly higher in chitosan fed fishes, followed by levamisole and chitin. The results indicate that dietary intake of chitosan enhances the innate immune system and survivability of common carp in ponds.

Gopalakannan, A., Arul, V. (varul18@yahoo.com) (2006). Immunomodulatory effects of dietary intake of chitin, chitosan and levamisole on the immune system of *Cyprinus carpio* and control of *Aeromonas hydrophila* infection in ponds. *Aquaculture*, 255: 179-187.

9. Assessing vaccination strategies

Atlantic salmon and sea bass were used as representative aquaculture species in a mathematical model to evaluate the impact of disease risk, vaccine efficacy, and market price on the value of vaccination as a management tool. This innovative and interactive spreadsheet-based model was designed to help define the risk ranges that may be encountered in a variety of intensive or extensive aquaculture systems that are vulnerable to infectious diseases. To make the risk assessments for aquaculture practical, data were generated with expected estimates of worst case, best case, and "most probable" disease impact scenarios. As an integrated system, the combination of formulae described is capable of rapidly estimating and comparing the economic value created by vaccines of different cost and potency. A key concept of this new model of disease risk is the influence of the principle of alternative cost (or opportunity cost) and its importance in understanding the true economic effect of decisions regarding health management. For example, selecting a vaccine of low cost and moderately low efficacy may actually reduce profitability and operational efficiency compared to a much higher cost vaccine that provides only moderately higher levels of protection. Calculated savings from an economically justified vaccination program should combine the value of increased survival, reduced antibiotic use, fewer compensatory fish and reduced carcass removal/disposal costs.

Thorarinnsson, R., Powell, D.B. (davidp@profishent.com) (2006). Effects of disease risk, vaccine efficacy, and market price on the economics of fish vaccination. *Aquaculture*, 256: 42-49.

10. Side-effects of vaccination

In August 1998, 3000 Atlantic salmon parr were divided into 7 groups. A group was vaccinated every 6 wk until March of the following year, with one group held as an unvaccinated control. All fish were transferred to seawater in May 1999 and slaughtered in February 2000. Temperature, fish size and photoperiod at vaccination, and the time between vaccination and sea transfer thus varied between groups. Growth was reduced in all vaccinated groups for 1 to 2 months following vaccination. Intra-abdominal lesions developed faster, and stabilised at a higher level, in the groups vaccinated early at the highest temperature and the smallest fish size. Growth in seawater was influenced by the time of vaccination: at the end of the experiment the group vaccinated last (in March) was the heaviest of the vaccinated groups (4.0 kg) and the group vaccinated first (in August) was smallest (3.2 kg). There was a correlation between adhesion, condition factor and number of weeks from vaccination to sea transfer. The August vaccinated group had the highest condition factor, and this group also displayed the highest incidence of deformed vertebra. The experiment shows that side effects of vaccination can be significantly reduced when planning the vaccination strategy, by taking environmental factors and fish biology into consideration.

Berg, A. (arne.berg@imr.no), Rodseth, O.M., Tangeras, A. & Hansen, T. (2006). Time of vaccination influences development of adhesions, growth and spinal deformities in Atlantic salmon *Salmo salar*. *Diseases of Aquatic Organisms*, 69: 239-248.

11. Stocking density practices of UK trout farms

Despite the perceived increase in the likelihood for poor welfare at higher densities, there is a lack of information on actual practices and the factors affecting stocking density on commercial farms. This article collates such information from the UK trout production industry from a voluntary self-reporting postal questionnaire. The response rate achieved was 30%, allowing representation of 88 individual farms, which were conservatively estimated to represent 48% of the total UK production of rainbow trout in 2000. The responses indicate that fish size is an important factor in the selection of density, smaller fish almost universally being reared at lower densities. Stocking density practices

differed markedly between individual farms with maximum densities varying from <20 to >80 kg/m³. Stocking density was linked to type of production, with farms producing fish for the table market operating at higher densities than farms rearing fish for the restocking/fisheries market. Most farms surveyed (81%) used additional means to add oxygen to the water; oxygenation was more prevalent on table farms, whilst aeration was prevalent on restocking/fisheries farms. There is recognition within the industry that excessive densities can cause welfare problems, although individual responses indicated that water quality (oxygen level and water replacement) was perceived to be more significant than density per se.

North, B.P. (bpn2@stir.ac.uk), Ellis, T., Turnbull, J.F., Davis, J., Bromage, N.R. (2006). Stocking density practices of commercial UK rainbow trout farms. *Aquaculture*, 259: 260-267

12. A tank study of effects of density on trout

The welfare of farmed fish is a subject of increasing interest and one of the principal areas of concern is stocking density. In this study juvenile rainbow trout were held in 1.8 m³ flow-through tanks at densities of 10, 40, and 80 kg/m³ for 9 months. Welfare was assessed by measuring a range of population (mortality, growth, size variation, FCR), individual morphometric (mass, fin condition, condition factor) and physiological (haematocrit, plasma cortisol, lysozyme activity) indicators. Stocking density did not affect growth or mortality, but the fish held at 10 kg/m³ had a significantly lower condition factor and an increased size variation at the end of the study. Plasma cortisol levels were also greater at 10 kg/m³ on 5 of the monthly sample points. Stocking density affected fin condition, with the 40 and 80 kg/m³ treatments resulting in fish with significantly smaller fins than the 10 kg/m³ treatment. Principal components analysis was used to produce objective welfare scores representing coherence that existed between the simultaneously measured individual welfare indicators. The resulting principal components identified a trend for high levels of cortisol and lower lysozyme activity in the 10 kg/m³. The PCA also identified a group of fish common to all treatments that had good dorsal and caudal fin scores, but low condition factor. This may have represented individuals that had adopted

a non-competitive feeding strategy. The experiment demonstrated that stocking densities of 80 kg/m³ did not produce consistent effects on mean growth rate, or physiological indicators of welfare. Nevertheless, fin erosion increased with increasing density, although the cause of the erosion remains unclear. The evidence for stronger dominance hierarchies in the 10 kg/m³ treatment, indicate that low as well as high stocking densities have the potential to adversely affect trout welfare.

North, B.P. (bpn2@stir.ac.uk), Turnbull, J.F., Ellis, T., Porter, M.J., Migaud, H., Bron, J., Bromage, N.R. (2006). The impact of stocking density on the welfare of rainbow trout (*Oncorhynchus mykiss*). *Aquaculture*, 255: 466-479.

13. Fin erosion on UK trout farms

In this study 949 trout were sampled from 38 rearing units on 10 commercial farms growing rainbow trout for the table market in the UK. A fin index was calculated for each of the rayed fins by dividing fin length by the length of the fish. There was a large range in the indices of all fins. With the exception of the dorsal fin, all the indices were higher for small fish (<30 g) than for large fish (>100 g), but the magnitude of the difference was greater for some fins than others. When compared to the fins of feral fish, the pectoral and dorsal fins appeared to be most eroded and the damage to these fins was evident even in the small fish. Erosion of the caudal, anal and ventral (≡ pelvic) fins was more prominent in the larger fish. Variations in the fin indices of the caudal, anal and ventral fins suggested that there was little variation between rearing units on the same farm, but that there was significant variation between individual fish within the same rearing unit, and between fish on different farms.

St-Hilaire, S., Ellis, T., Cooke, A., North, B.P., Turnbull, J.F., Knowles, T., Kestin, S. (2006). Fin erosion on rainbow trout on commercial trout farms in the United Kingdom. *Veterinary Record*, 59: 446-451.

14. Low levels of ammonia increase disease susceptibility

Ammonia criteria are established using data from standardized toxicity tests involving healthy animals. Both intrinsic and extrinsic environmental changes affect the immune system, but few toxicity studies consider the overall impact on this system and potential changes in resistance to infection. To investigate the effects of subacute levels of ammonia on

physiological and immunological systems of fish, juvenile Chinook salmon were maintained in seawater (10°C, pH 7.8) and exposed to two concentrations of ammonia (2.5 and 10 mg/L total nitrogen). Both test levels resulted in increased internal levels of ammonia in the fish. Neither treatment level affected feeding rates. Over a period of 10 days, effects were observed in both treatments on white blood cell counts, respiratory burst activity, plasma lysozyme activity, and plasma glucose concentration. Fish previously exposed to subacute levels of ammonia were more susceptible to an experimental infection with *Vibrio anguillarum*. The findings of this study indicate that a more thorough investigation into the effects of environmental ammonia on fish should be undertaken.

Ackerman, P.A., Wicks, B.J., Iwama, G.K., Randall, D.J. (bhrand@cityu.edu.hk) (2006). Low levels of environmental ammonia increase susceptibility to disease in Chinook salmon smolts. *Physiological and Biochemical Zoology*, 79: 695-707.

15. Oxygen consumption during transport

Live transport of adult salmon from sea cages to processing plants is now common practice, but little documentation exists on fish welfare during such transport. This study examined the metabolic rate of adult Atlantic salmon during transport from a sea farm off the west coast of Vancouver Island, Canada, on board a state-of-the-art wellboat. Monitoring the oxygen concentrations of the water entering and leaving the wells showed that oxygen uptake by the fish halved (>8 to <4 mg O₂/min/kg) within the first 20 min of the vessel being underway. During the fourth hour of transport, oxygen uptake averaged 3.1 mg O₂/min/kg, a value comparable to routine oxygen uptake values. These results suggest that adult Atlantic salmon quickly recovered from the stress of loading. This conclusion was corroborated by visual observations of the fish in the wells, as the fish faced the water flow and ventilated lightly while slowly cycling their position in a schooling behavior during the 11-h journey. Thus, the transport conditions on the wellboat appeared to promote good fish welfare during the journey from the farm to the processing plant.

Farrell, A.P.T. (farrellt@interchange.ubc.ca) (2006). Bulk oxygen uptake measured with over 60,000 kg of adult salmon during live-haul transportation at sea. *Aquaculture*, 254: 646-652.

16. Transport stress in common carp

Stress responses and changes in biochemical and haematological indices were investigated in common carp during long-distance truck transportation. Transportation for 12 hours caused an increase in blood ammonia level, mean corpuscular volume, metamyelocytes and band neutrophils, and a significant decrease in Cl⁻, lactate, ALT and ALP levels. The values of LDH, AST, CK and haematocrit were also significantly influenced by the transportation, but no time-dependent relation was found. However, there was no effect of transportation on the levels of cortisol, glucose and total protein, and the values of erythrocyte count, haemoglobin, mean corpuscular haemoglobin concentration and leukocyte counts. These results show that pre-transport fish manipulation (hauling, netting, handling, loading) was an important stressor for the common carp studied, but the long-distance transportation itself was relatively benign.

Dobsikova, R. (dobsikovar@vfu.cz), Svobodova, Z., Blahova, J., Modra, H., Velisek, J. (2006). Stress response to long distance transportation of common carp (*Cyprinus carpio* L.). *Acta Veterinaria Brno*, 75: 437-448.

17. New non-pathogen disease in trout

This paper provides the first description of a spontaneous glycogen-storage disease in a lower vertebrate. Affected farmed rainbow trout experienced increased mortality from 60 days post-startfeeding and displayed clinical signs of heart failure with abnormal behaviour, exophthalmia, distended abdomen and ventral skin petechiation. Necropsy revealed alterations in cardiac shape with distended atria and rounded ventricles. Microscopically, the compact wall of the ventricle was absent, uneven or thinner than normal. The cardiac myocytes contained extensive amounts of glycogen in cytoplasmic vacuoles. Associated lesions included conspicuous subepicardial and myocardial vascularization, epicardial thickening and necrosis of the ventricular compactum/spongiosum interphase. The lesions in cardiac myocytes had a striking resemblance to glycogenosis type II (Pompe disease), a rare autosomal recessive lysosomal storage disease in humans. This condition was more severe and

mortality was higher in a parallel group of fish treated with 17 α -methyltestosterone to produce all-female progeny, indicating that the hormone treatment aggravated the condition resulting in earlier and more severe manifestation of the disease in this group.

Torud, B. (brit@fiskehelsa.no), Taksdal, T., Dale, O.B., Kvellestad, A., Poppe, T.T. (2006). Myocardial glycogen storage disease in farmed rainbow trout, *Oncorhynchus mykiss* (Walbaum). *Journal of Fish Diseases*, 29: 535-540.

18. Spine deformities

Fusion of vertebrae characterises many types of spinal deformities in farmed Atlantic salmon and other bony fish. Little is known about development and progress of the condition, knowledge that is required for prevention and control of spine malformations. This paper describes the development and progress of the disease in farmed Atlantic salmon. Vertebrae fusion was observed to develop both prior to and after smoltification; early and late fusion stages were detected in pre-smolts and in fish 12 months after seawater transfer. The process involves transformation of intervertebral notochord tissue into cartilage, shape alterations of vertebral body endplates, mineralisation of the intervertebral cartilage, and finally replacement of intervertebral cartilage by bone. Two fused vertebrae can develop into a centre of severe malformation through the continuous amalgamation of neighbouring vertebrae. Alternatively, animals have the capacity to contain the problem through reshaping and remodelling of two fused vertebral bodies into a single, regularly structured and jointed vertebra. Successfully reshaped vertebrae apparently do not inflict further spine malformations. It is demonstrated for the first time that the onset of vertebrae fusion does not inevitably lead to fish with deformed vertebral columns. Defining conditions that favour repair and prevent the spread of vertebrae fusion is a future task that could make a significant contribution to the control of spine deformities in farmed salmon.

Witten, P.E. (eckhard.witten@akvaforsk.no), Obach, A., Huyseune, A., Baeverfjord, G. (2006). Vertebrae fusion in Atlantic salmon (*Salmo salar*): development, aggravation and pathways of containment. *Aquaculture*, 258: 164-172.

19. Lighting improves growth and feed efficiency in trout

This study examined whether photoperiod techniques could be successfully transferred to commercial freshwater rainbow trout farming practices, with the key aim being to enhance winter grow-out and production in "open/uncovered systems". Commercial field trials conducted over a 3-year period showed that exposure of different developmental stages of rainbow trout to periods of constant light from autumn to spring appeared to enhance growth rates and could improve feed conversion. Furthermore, exposure to higher light intensities appeared to promote greater growth and feeding efficiency in all stages of production. The importance of even light distribution in the culture system rather than a critical light intensity was also evident. The outcome of artificial light regimes has been the ability to increase growth rates by up to 25%, alter stock-out times, and reduce production time by as much as 2 months.

Taylor, J.F. (jft2@stir.ac.uk), North, B.P., Porter, M.J.R., Bromage, N.R., Migaud, H. (2006). Photoperiod can be used to enhance growth and improve feeding efficiency in farmed rainbow trout, *Oncorhynchus mykiss*. *Aquaculture*, 256: 216-234.

20. Trial of new floating tank system

Rainbow trout were produced in an inland saline water body using a newly developed culture technology known as the Semi-Intensive Floating Tank System (SIFTS). Between June and September when average daily water temperatures ranged from 12 to 18°C, the trout grew from 83 to 697 g over 111 days (specific growth rate: 1.91%/day) with an FCR of 0.97. The SIFTS significantly reduced nutrient input into the pond by removing settleable wastes as a thick sludge with a dry matter content of 5-10%. The release of soluble nutrients into the pond resulted in blooms of macro- and micro-algae which caused large and potentially lethal diurnal fluctuations in dissolved oxygen within the pond; however, comparatively stable levels of dissolved oxygen were maintained within each SIFTS through the use of air lift pumps.

Partridge, G.J. (gavin.partridge@challengertafe.wa.edu.au), Sarre, G.A., Ginbey, B.M., Kay, G.D., Jenkins, G.I. (2006). Finfish production in a static, inland saline water body using a Semi-Intensive Floating Tank System (SIFTS). *Aquacultural Engineering*, 35: 109-121.

21. Water quality during reuse

Water quality criteria for aquaculture systems typical address parameters such as temperature, dissolved oxygen, total gas pressure, ammonia and nitrite. Many of the published criteria are derived for environmental protection of a wide range of species and life stages. These criteria may not be appropriate for a single species and life stage, especially in commercial applications. The value of a given water quality criterion may depend strongly upon the species, size, and culture objectives. In water reuse systems, fine solids, refractory organics, surface-active compounds, metals, and nitrate may become important. The limiting factors in very high intensity reuse systems are not entirely understood at this time. Development of more relevant water quality criteria for reuse systems will require production-scale trials. Separate water quality criteria for biofilter operation are also needed.

Colt, J. (2006). Water quality requirements for reuse systems. *Aquacultural Engineering*, 34: 143-156.

22. Field challenge proves useful in examining the genetics of disease resistance

A total of 77124 Atlantic salmon post-smolts, representing 197 full-sib families produced by 149 males and 197 females, were transferred to three separate seawater sites and experienced a field challenge from Infectious Pancreatic Necrosis Virus (IPNV). The first IPN mortality was observed 45 days after transfer, and the duration of the epidemic varied between 37 and 92 days among sites. The overall mortality rate was 10.8%, with only small differences between sites (10.3% to 11.9%). Mortalities were traced to their parental families by PIT (Passive Integrated Transponder) tag records and DNA genotyping. Full-sib family mean incidence of mortality was calculated for each family on each site. Genetic correlations among sites were all substantial (between 0.71 and 0.78) indicating that a substantial component of the genetic variation displayed within sites was common to all. Heritabilities were found to be moderate to strong, and ranged between 0.24 and 0.81, with a pooled estimate of 0.43, greater than is typically associated with disease traits. The results show that field challenges can yield very good genetic information on family differences in resistance, especially when replicated over

sites, which may then be developed for use in selection for breeding strains of Atlantic salmon with greater resistance to IPN.

Guy, D.R. (drguy@swim-back.com), BISHOP, S.C., Brotherstone, S., Hamilton, A., Roberts, R.J., McAndrew, B.J., Woolliams, J.A. (2006). Analysis of the incidence of infectious pancreatic necrosis mortality in pedigreed Atlantic salmon, *Salmo salar* L., populations. *Journal of Fish Diseases*, 29: 637-647.

23. Selective breeding for stress responsiveness 1

This study reports the growth rates of two lines of rainbow trout selectively bred for a divergent plasma cortisol responsiveness to a confinement stressor (high-responders, HR; low-responders, LR). Growth was evaluated over two generations (F1, F2), both when reared separately and when reared in co-culture. There was no difference in growth between the lines when reared separately. However, when reared in co-culture, the LR line significantly out-performed the HR line in both the F1 and F2 generations. It is likely that these results are related to the divergent behavioural attributes that characterise the HR and LR lines, rather than any differences in physiology. The growth disparity between the lines in co-culture may be linked to the greater degree of competitiveness/aggressiveness exhibited by fish of the LR line, or to another as yet unidentified divergent behavioural trait. The implications of these results for the exploitation of the LR line in aquaculture are discussed.

Pottinger, T.G. (tgp@ceh.ac.uk) (2006). Context dependent differences in growth of two rainbow trout (*Oncorhynchus mykiss*) lines selected for divergent stress responsiveness. *Aquaculture*, 256: 140-147.

24. Selective breeding for stress responsiveness 2

Two lines of rainbow trout, selected for different cortisol response to stress (low, LR; high, HR) and a non-selected control group (C), were subjected to crowded (100 kg/m³) and uncrowded (20 kg/m³) conditions for 4 weeks. Weight gain, specific growth rate, feed intake and feed efficiency of LR fish were better than those of HR fish under both rearing densities. Also, LR values were higher than the C group, with the exception of weight gain and feed intake under crowded conditions. Haematocrit and haemoglobin increase was significantly

pronounced in the HR group when crowded, showing higher values than LR and C fish. Plasma glucose was increased significantly by crowding in HR fish. At both rearing conditions, plasma glucose levels were higher and glycogen levels were lower in the HR fish compared with the LR group. Based on the differences between the HR and LR lines for some secondary stress-response indicators and growth features, selective breeding for higher stress tolerance seems to be an effective strategy for improving rainbow trout performance under certain aquaculture conditions.

Trenzado, C. (ctrenzad@ugr.es), Morales, A.E., de la Higuera, M. (2006). Physiological effects of crowding in rainbow trout, *Oncorhynchus mykiss*, selected for low and high stress responsiveness. *Aquaculture*, 258: 583-593.

25. Mating ratios in selective breeding programmes

This study examined the rates of genetic gain and inbreeding in various breeding designs of rainbow trout with different mating ratios. Analyses showed that the rate of genetic gain can be improved by as much as 20% by changing the mating ratio of sires to dams from 1M:3F (traditional nested design) to 3M:5F (factorial mating). This enhancement in genetic gain is mainly due to an increase in the intensity of selection of females. The rates of inbreeding appear to be higher for factorial than for nested designs, although, at the same rate of inbreeding, factorial designs present equal or higher rates of genetic gain compared to nested designs.

Martinez, V. (vmartine@uchile.cl), Kause, A., Mantysaari, E., Maki-Tanila, A. (2006). The use of alternative breeding schemes to enhance genetic improvement in rainbow trout (*Oncorhynchus mykiss*): I. One-stage selection. *Aquaculture*, 254: 182-194.

26. Selective breeding of brown trout

A line of brown trout has been selected for longer body length for five generations, and a parallel control unselected line been maintained as well. This study assessed whether the selection for growth was associated with changes in feeding behaviour under ad libitum conditions. The feeding hierarchy and the regularity of intake at the individual level were assessed (using an X-radiographic technique) in groups of mixed and separate lines. Individual food intake was higher in the selected fish than in the control fish of a comparable weight.

Feeding ranks were highly variable in both lines; however, a feeding hierarchy was present in all groups. The fish which ate the smallest proportion of the food were those displaying the largest day-to-day variations in feed intake. Mixing of the two lines did not affect the overall variability in food intake or growth. Altogether these results show that the increase in feed intake provoked by selection for growth is not accompanied by a more unequal share of food. This study demonstrates that increased feeding competition between individuals is not an inevitable consequence of growth selection.

Boujard, T. (boujard@paris.inra.fr), Cuvier, A., Geurden, I., Labbe, L., Mambrini, M. (2006). Selection for growth and feeding hierarchy in brown trout. *Applied Animal Behaviour Science*, 99: 344-356.

27. Feeding pattern in trout

Fish fed using demand feeders often display highly variable feeding activity across days. In order to quantify this pattern, data from 10 groups of self-feeding rainbow trout were examined for repeating patterns using time series analysis. The number of bites on a self-feeding trigger were recorded and summarised on both an hourly and daily basis. Significant peaks in trigger-biting activity occurred in the morning and evening at lights on and lights off. It is suggested that this activity pattern corresponds to an evolutionary trade-off between predation risk and feed availability. Across days, peaks in trigger-biting activity are significantly higher every second day. A possible explanation for this pattern is the time required for gastric evacuation and the return of appetite.

Bailey, J. (jbailey@genesis.mun.ca), Alanara, A. (2006). Mapping the demand-feeding pattern of hatchery-reared rainbow trout, *Oncorhynchus mykiss* (Walbaum). *Aquaculture*, 254: 355-360.

28. Astaxanthin improves reproductive performance

This study investigated the effects of dietary astaxanthin supplementation on reproductive characteristics of rainbow trout. Five groups of female broodstock were fed diets containing either 0.07, 12, 33, 65 or 93 mg astaxanthin/kg, and two groups of male broodstock were fed 0.07 and 33 mg astaxanthin/kg, for 6 months in an artificial photoperiod system until sexual maturation. The eggs from each group of female broodstock were fertilized with homogenized sperm of four males from

each group of males. The females produced eggs with astaxanthin concentrations ranging from 2 to 30 mg/kg. Dietary astaxanthin supplementation had positive effects on rate of fertilization, percentage of eyed and hatched eggs, and mortality of eyed eggs. A difference in fertilization rate was found between male groups. The astaxanthin content in the eggs was correlated to fertilization rate, eyed-egg percentage and percentage hatch. It was concluded that dietary supplements of astaxanthin are required for optimum reproduction in rainbow trout.

Ahmadi, M.R., Bazayr, A.A., Safi, S., Ytrestoyl, T., Bjerkgeng, B. (bjorn.bjerkgeng@akvaforsk.no) (2006). Effects of dietary astaxanthin supplementation on reproductive characteristics of rainbow trout (*Oncorhynchus mykiss*). *Journal of Applied Ichthyology*, 22: 388-394.

29. Hydrogen peroxide as an anti-microbial

Reduction of the bacterial load in live prey is paramount to achieving efficient microbiological control during larval fish rearing. Several methods have been tested using physical and chemical disinfection procedures: chemicals are difficult to deal with because of the frequent problems encountered when disposing of their residual products and because of the sensitivity of the live prey. Hydrogen peroxide is a disinfectant that has been used for a long time in other fields of research and decomposes into non-toxic products. However, it has not been used in aquaculture until recent years. This study assessed the effects of a hydrogen peroxide-based product, Ox-Aquaculture®, on live feeds and their associated microbial population. Exposure of rotifers for 15 min to 40 mg/L Ox-Aquaculture®, resulted in 80% rotifer survival and a 90% reduction of bacteria. Exposure of *Artemia* nauplii for 5 min to 8000 mg/L resulted in 90% *Artemia* survival and a 95% reduction in bacteria. No differences in the fatty acid composition of the live prey or oxidation of polyunsaturated fatty acids were detected after disinfection with hydrogen peroxide. A short time exposure and easy removal of the product from the treated live prey make hydrogen peroxide an interesting disinfectant for application in aquaculture.

Giménez, G., Padrós, F., Roque, A., Estévez, A., Furones, D. (2006). Bacterial load reduction of live prey for fish larval feeding using Ox-Aquaculture®. *Aquaculture Research*, 37: 1130-1138.

30. Dietary substitution of fish meal with krill meal

This study examined the inclusion of krill meal in salmon diets. A total of six isoprotein and isolipid diets were prepared substituting from 0 to 100% of fish meal protein (0-68% of diet by dry weight) with Antarctic krill meal. The feed produced from high inclusion levels of krill meal had a lower ability to absorb lipid during vacuum coating than fish meal. Amino acid and fatty acid compositions of the diets were similar. During the 140 day feeding experiment salmon grew from 500 g to 1500-1800 g. Moderate amounts of krill meal (20-60% of krill protein) in the diets increased growth during the first 71 days compared to the fish meal control, while no growth difference was observed during the last 69 days of feeding. The difference in growth may partially be explained by a feed-attractant function of the krill meal. Muscle dry weight and lipid concentrations were unaffected by the diet. Feed conversion rate increased with high levels of krill meal in the diets, indicating that the fish compensated by eating more to maintain growth. The apparent digestibility coefficients of dry matter and protein were not influenced by diet, but both faecal moisture and lipid had a tendency to increase at the highest inclusion level. This may be related to chitin in the krill diets decreasing lipid absorption and inducing diarrhoea. Chitin was not utilized to any major extent. Welfare parameters such as blood haemoglobin, red blood cell counts, plasma protein, cholesterol, triacylglycerols and glucose levels were unaffected by diets. Clinical indicators of cellular damage (alanine aminotransferase and aspartate aminotransferase) similarly indicated no diet-induced tissue damage.

Olsen, R.E. (rolf.erik.olsen@imr.no), Suontama, J., Langmyhr, E., Mundheim, H., Ringo, E., Melle, W., Malde, M.K., Hemre, G.I. (2006). The replacement of fish meal with Antarctic krill, *Euphausia superba* in diets for Atlantic salmon, *Salmo salar*. *Aquaculture Nutrition*, 12: 280-290.

31. Yeast supplement improves trout survival and growth

This study evaluated the addition of a yeast culture food supplement (DVAqua from Diamond V. Mills, Cedar Rapids, IA, USA) to rainbow trout feed. Two trials were run consecutively, starting with initial feeding, and were replicated over 2 years. The yeast culture

was added to commercial trout starter at levels of 0.125 and 0.25 g/kg. The inclusion of DVAqua yeast culture significantly increased trout survival and growth through the first 4 weeks of feeding, with continued benefits for the next 4 weeks.

Barnes, M.E. (mike.barnes@state.sd.us), Durben, D.J., Reeves, S.G., Sanders, R. (2006). Dietary yeast culture supplementation improves initial rearing of McConaughy strain rainbow trout. *Aquaculture Nutrition*, 12: 388-394.

32. UK study of trout taints

Earthy-musty taints have been reported in edible fish around the world. While this has no adverse health effects on either the consumer or the fish, it does have a profound effect on consumer acceptance and marketability. Earthy-musty taints have been reported in farmed rainbow trout in the UK but little was known about the source of the problem. In this study it was found that geosmin (GSM) was the main compound associated with the seasonal occurrence of earthy taints in UK farmed trout. GSM production occurred upstream in rivers supplying water to fish farms and was at its highest concentration (25 ng/L) during the warmer summer months. Fish tainted with GSM above the sensory threshold (0.9 µg/Kg) were typically found to have between 1.0 and 3.0 µg GSM/ Kg fish, with a maximum observed level of 7.2 µg/Kg. Levels of 2-methylisoborneol were negligible in terms of its potential to cause taint. In a river-fed northern UK farm the seasonal build up of an epilithic *Oscillatoria* sp. was linked to tainting episodes. Rivers supplying tainted farms were classified as being eutrophic and had very low N/P ratios. Temperature and phosphate levels were positively correlated with levels of GSM in inflow waters.

Robertson, R.F., Hammond, A., Jauncey, K., Beveridge, M.C.M., Lawton, L.A. (L.Lawton@rgu.ac.uk) (2006). An investigation into the occurrence of geosmin responsible for earthy-musty taints in UK farmed rainbow trout, *Onchorhynchus mykiss*. *Aquaculture*, 259: 153-163.

33. French study of trout taints

This paper presents the results of a study on off-flavour problems in four French rainbow trout farms. Detection of odorous compounds by gas chromatography-mass spectrometry showed that significant concentrations of geosmin (up to 18 µg/Kg in fat) are found in trout. The sensory evaluation, the presence/absence of geosmin in the flesh, and the identification of

off-flavour compound producers, implicate the cyanobacterium *Microcoleus* in the appearance of earthy/musty off-flavours. The presence of *Microcoleus* is linked to the deterioration of water quality during the water recirculation period. Correlations between chemical and sensory detection in the flesh indicate that the taste evaluation enables the differentiation of the four categories "non-tainted", "slightly-tainted", "tainted" and "strongly-tainted". However, the average concentrations of geosmin found for these different intensities are relatively limited, from 0.2 to 4.9 µg/Kg. Finally, recommendations are made to allow a more effective control of off-flavour occurrences.

Robin, J. (jrobin@isara.fr), Cravedi, J.P., Hillenweck, A., Deshayes, C., Vallod, D. (2006). Off flavor characterization and origin in French trout farming. *Aquaculture*, 260: 128-138.

34. Retrieving omega-3 fatty acids from salmonid offal 1

This study examined the fatty acid (FA) composition of visceral oil extracted from farmed Atlantic salmon viscera. Seventeen FA were identified in the extracted visceral oil, with percentages of saturated, monounsaturated, and polyunsaturated FA being 32, 36 and 32%, respectively. Compared with other fish oils, oil from farmed Atlantic salmon had much higher EPA (1.64 g/100 g) and DHA (1.47 g/100 g) contents. The FA profile of the salmon visceral oil was similar to that of the salmon fillet. Thus, salmon visceral oil could be a replacement for the oil obtained from edible salmon fillet and used in functional foods or feeds requiring a high level of omega-3 FA. Production of visceral oil would enable the industry to add value to processing waste.

Sun, T. (tingsun@lsu.edu), Xu, Z.M., Prinyawiwatkul, W. (2006). FA composition of the oil extracted from farmed Atlantic salmon (*Salmo salar* L.) viscera. *Journal of the American Oil Chemists Society*, 83: 615-619.

35. Retrieving omega-3 fatty acids from salmonid offal 2

This study examined the stability of omega-3 fatty acids in rainbow trout offal, kept on ice for up to 14 days and then frozen at -20 °C for one month. The offal consisted of 15% protein and about 20% lipids, with n-3 polyunsaturated fatty acids (n-3 PUFA) accounting for 20% of the fatty acids. No losses of long-chain n-3 PUFA in the offal during storage were detected. Rainbow

trout offal is a valuable - rich and stable - source of n-3 PUFA.

Kolakowska, A. (akolakowska@tz.ar.szczecin.pl), Domiszewski, Z., Kozłowski, D., Gajowniczek, M. (2006). Effects of rainbow trout freshness on n-3 polyunsaturated fatty acids in fish offal. *European Journal of Lipid Science & Technology*, 108: 723-729.

36. Slaughter methods and blood in fillets

Over the last few years blood spots in fresh and smoked Atlantic salmon fillets have become a concern to the industry. At present there are no appropriate methods to assess the number and severity of blood spots and residual blood in the fillets. In this work the main objective was to study the effects of slaughter procedure on residual blood in the fillet as measured by the number of blood spots and amount of haemoglobin. The haemoglobin method was well suited for measuring the quantity of blood in the fillet. The amount of residual blood was influenced by anaesthetisation and killing procedures. Fish that were chilled alive and CO₂/O₂ anaesthetised then directly gutted had less residual blood in the fillet, than fish slaughtered by the standard industrial procedure of gill cutting and bleeding before gutting. Use of CO₂/O₂ anaesthesia on live-chilled fish, killed by gill cutting, reduced muscle pH, but did reduce residual blood compared to live-chilled fish not anaesthetised, killed by gill cutting. In terms of fish welfare, CO₂/O₂ anaesthesia is not recommended as it creates vigorous activity among the fish before full anaesthesia is reached. The blood coagulation time was strongly influenced by temperature. At low temperatures, as in live-chilling, the blood coagulation time is prolonged keeping the blood fluid for up to 1 hour and possibly increasing bleeding.

Olsen, S.H. (stein.olsen@nfh.uit.no), Sorensen, N.K., Stonno, S.K., Elvevoll, E.O. (2006). Effect of slaughter methods on blood spotting and residual blood in fillets of Atlantic salmon (*Salmo salar*). *Aquaculture*, 258: 462-469.

37. Concentration of sludge from microscreen filters

As environmental regulations become more stringent, environmentally sound waste management and disposal practices are increasingly more important in all types of

aquaculture. In many recirculation systems, microscreen filters are used to remove and concentrate the suspended solids from the process water, because they require minimal labour and floor space and can treat large flow rates of water with little head loss. These microscreen filters generate a separate solids waste stream that can be further concentrated to reduce the quantity and improve the quality of discharge water. This study evaluated a Belt Filter System (Hydrotech Model HBF537-1H, from Waste Management Technologies Inc., Baton Rouge, LA, USA) for rapid thickening of sludge from the backwash water of a microscreen filter. The system was tested using the backwash effluent of a microscreen filter that treated water discharged from several large-scale recirculating aquaculture production systems growing Arctic char and trout. The system was tested using only alum as the coagulant aid, using only commercially available polymers as the flocculation aid, and the two coagulation/flocculation aids in combination. Alum alone was moderately efficient in removing solids (82%), but was very efficient in sequestering reactive phosphorus (96%). Several polymers used alone and at relatively low dosages were very effective in removing suspended solids (average removal rate 96%). At the optimum combined dosage of alum and polymer, the Inclined Belt Filter System increased the dry matter content of the sludge to approximately 13% solids, and reduced both the suspended solids and reactive phosphorus concentration of the effluent by 95 and 80%, respectively. The combination of coagulation/flocculation aids and the inclined belt filter show excellent potential to greatly reduce the volume of solids generated, and significantly reduce the concentration of suspended solids and phosphorus in discharged effluents. By eliminating the need for settling tanks or ponds, the leaching of nutrients (phosphorus, nitrogen) is minimized and the dewatered sludge is in a form for easy transport, storage, or disposal.

Ebeling, J.M. (j.ebeling@freshwaterinstitute.org), Welsh, C.F., Rishel, K.L. (2006). Performance evaluation of an inclined belt filter using coagulation/flocculation aids for the removal of suspended solids and phosphorus from microscreen backwash effluent. *Aquacultural Engineering*, 35: 61-77

38. Bacteriophages to control furunculosis

Fish aquaculture faces important losses as a result of bacterial resistance to antibiotics. Bacteriophages have proved to be a useful alternative therapy in other domains, but remain to be tested with fish. This study examined the potential of a bacteriophage to control *Aeromonas salmonicida* in brook trout. When bacteriophage was introduced, populations of *A. salmonicida* declined by a factor of 1 million in 3 d. Addition of the bacteriophage delayed the onset of furunculosis in brook trout by 7 d. The results suggest that bacteriophage could be successful in preventive programs on fish farms.

Imbeault, S., Parent, S., Lagace, M., UHLAND, C.F., BLAIS, J.F. (blaisjf@inrs-ete.quebec.ca). (2006). Using bacteriophages to prevent furunculosis caused by *Aeromonas salmonicida* in farmed brook trout. *Journal of Aquatic Animal Health*, 18: 203-214.

39. New EU draft regulations

The current veterinary legislature on aquaculture was developed 20 years ago when the European Union consisted of only 12 member states. It was created in order to protect the then basic field of activity of this sector, which was the culturing of salmonids (trout and salmon) and oysters. Currently, this law requires updating to reflect the wide scope of activity within the aquaculture sector and species now found in the enlarged Union. It should also include significant developments in this branch and the experience gained through the last 15 years of implementing the existing law and scientific progress in this discipline. EU regulations should also be updated to conform to international agreements and norms (e.g. WTO/SPS and OIE). The proposed new regulations submitted to the Council will abolish the present laws (Council directives 91/67/EEC, 93/53/EEC and 95/70/EC) and replace them

with a new directive on health requirements for aquatic animals and products thereof, and on the prevention and control of certain diseases in these animals. This will facilitate higher flexibility and give operational responsibility to the Member States, thus enabling effective disease prevention through initiating decision-making at a local or regional level.

Poplawski, K. (k.poplaw@wp.pl), Szarek, J., Wojtacka, J., Babinska, I. (2006). New regulations of the European Union on aquatic animals - a draft of the European Council directive. *Medycyna Weterynaryjna*, 62: 1123-1126.

40. Hatchery rearing affects salmonid brains

Recent studies suggest that hatchery-reared fish can have smaller brain-to-body size ratios than wild fish. It is unclear, however, whether these differences are due to artificial selection or instead reflect differences in rearing environment during development. This study explored how rearing conditions influence the development of two forebrain structures (the olfactory bulb and the telencephalon) in juvenile Chinook salmon spawned from wild-caught adults. The sizes of the forebrain structures of fish reared in a conventional hatchery, an enriched NATURES hatchery, and in a wild stream were compared. All fish were size-matched and from the same genetic cohort. The relative volumes of the olfactory bulb and telencephalon were significantly larger in wild fish compared to hatchery-reared fish, and there were no differences between fish reared in enriched and conventional hatchery treatments.

KIHSLINGER, R.L. (rlkihslinger@hotmail.com), LEMA, S.C., NEVITT, G.A. (2006). Environmental rearing conditions produce forebrain differences in wild Chinook salmon *Oncorhynchus tshawytsch*. *Comparative Biochemistry & Physiology A-Molecular & Integrative Physiology*, 145: 145-151.



Finfish in the Press

New home for CEFAS

A NEW multi-million pound laboratory complex is being planned at Lowestoft in Suffolk for CEFAS. DEFRA's minister for science John Rooker announced the move in a written statement to parliament on 20 June and added that CEFAS will remain in the public sector.

He said the aim is to complete the relocation by 2009, helping to guarantee the long-term future of the laboratory which leads research into the marine environment and fish stocks.

CEFAS will now work on more detailed funding and planning arrangements to

replace existing sites at Lowestoft and Burnham-on-Crouch in Essex, which are not suitable for future needs. The CEFAS laboratory at Weymouth in Dorset is not affected and will remain open.

Mr Rooker said that while CEFAS will remain in the public sector, he will consider giving it a status allowing more flexibility to meet customer needs as it continues to win more business from other clients, both public and private.

However, no change in status will be considered until work on the laboratory complex is sufficiently under way.

Fishing News, 26 June 2006

Keeping fish up all night

A LITTLE caffeine is good for the growth and food utilisation in gilthead seabream (*Sparus aurata*) but too much seems to cause irritation to the gastrointestinal tract as well as other side effects, according to Fotini Kokou and a team of other researchers at the University of Crete in Greece.

Five different diets containing 0.0, 0.1, 1.0, 2.0 and 5.0g caffeine/kg of diet were given to five groups of fish with three replicates per treatment, with the feed containing 50% protein and 15% fat on a dry weight basis.

In each 50 litre tank, 11 randomly distributed fish (around 20g initial weight) were stocked. Water temperature ranged between 13 and 18°C.

During this 115 day experiment, fish were hand-fed to apparent satiation twice a day, with the average weight per tank was assessed every 20 days by weighing fish individually.

The seabream which were given a small amount of caffeine (0.1g) showed the highest weight gain and the second best FCR. However, the fish that were at the high end of the caffeine scale (5.0) showed the least weight gain and the poorest FCR.

According to Kokou, results showed that a caffeine dose of over 2g/kg of feed negatively affected growth, FCR and food consumption. Unlike with humans who need that morning cup of coffee to get the brain moving in the morning, caffeine did not seem to enhance seabream brain activity.

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*Fish Farming International,
July 2006*

Biomarkers set to detect stress/quality

AN ITALIAN research team has established suitable and reliable biomarkers to detect the stress and quality in European seabass

(*Dicentrarchus labrax* L), says team leader M V Cangialosi of the Dipartimento di Biologia Animale in Palermo, Sicily.

Fish farming is an important commercial practice in Italy that makes up 14% of Europe's aquaculture production. Although fish farming offers socio-economic benefits, the impact of industrial activity on environment and vice versa can have an impact which needs to be investigated, according to Cangialosi.

"The aim of the research is to study the influence of facility locations and the surround environment on the welfare of European

seabass by identifying those biological responses able to be used as suitable tools in standardised protocols," says Cangialosi.

Specimens were collected from three fish farms in western Sicily with different tanks and cages.

Several parameters were investigated: detoxification enzymes activity belonging to the P450 system such as EROD, BaPMO and GSH content in the liver; and AchE activity in the brain and white dorsal muscle. In addition, the gonads were examined.

Highest EROD activity were measured in fish reared in tanks and in in-shore cages, while no differences in BaPMO activity were observed. Again, higher values of GSH were found in

specimens reared in tanks and in in-shore cages as well.

Both testosterone and E2 show a clear correlation with maturity stages and GSI values. No differences in brain and the muscle AchE activities were observed among the three farms.

The highest TL content was observed in fish from a tank, while the highest PL was observed in fish from an offshore cage.

Gonad histology showed highest percentage of myxozoa parasites in fish from a harbour cage while fish from a tank showed the presence of intersex.

According to Cangialosi, the set of data shows that facility location (in-shore and offshore) and farm typology (tanks and cages) might affect the

health of farmed fish and have an impact on their responses to stress.

In fact, the results suggest that LSI, EROD activity, GSH, GSI, hormone levels and gonad histology may represent the most suitable and reliable biomarkers of stress in farmed European seabass, he says.

Because of this, these biomarkers could be recommended for use in protocols for fish welfare and quality for future certification.

These biomarkers could be used as a diagnostic instrument because they indicate the health state, and as a prognostic tool by identifying potential damages or abnormalities in farmed populations and repercussions on consumers' health.

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Fish Farming International, July 2006

Seabass and bream with 'better taste'

A TURKISH hatchery and farming company, which has been very active in developing new species for the Mediterranean region, has set its sights on growing European seabass (*Dicentrarchus labrax*) and gilthead seabream (*Sparus aurata*) that tastes as good as wild.

According to Haluk Tuncer, president of Akuvatur Mediterranean Seafoods, the development stage will probably take at least a year longer to perfect but in the end, the company will have seabass and bream which will taste superior to any other farmed seabass and bream on the market.

"With chicken, for the most part the richest person to the poorest eats the same chicken, it looks the same, it tastes the same, and everyone seems willing to accept this same idea for seabass and bream," says Tuncer.

"But in France there are certain superior tasting species of chicken which are grown for the upper market. I want to do the same for seabass and bream. I want to develop a whole new concept of how consumers look at these two fish."

Tuncer does not want to go into details at this



Dr Haluk Tuncer of Akuvatur Mediterranean Seafoods in Turkey believes if you produce a quality product, you should label it so consumers know where it comes from

stage of development but he will say that Akuvatur is primarily experimenting with different feeds to try to get the wild taste.

"At our stand in Brussels this year I mentioned this idea to people and they laughed, but I'm a patient man, I know I'll get it right," he says.

Already he is used to sceptics. When Akuvatur was founded and it decided to undertake a tightly schedule programme to develop 'new' farmed species – and markets – there were many doubters. At last year's Brussels' European Seafood Exposition Akuvatur displayed three new fish; this year the company displayed seven.

"We said Akuvatur was going to develop these new species and we did.

It will be the same for seabass and bream."

Akuvatur does not claim a 100% success rate in developing new species and says that for those it has selected, it rejected many, many more.

"We did quite a bit of work with red seabream (*Pagrus pagrus*) but in the end we decided to abandon this fish as one to be developed, we just couldn't get the colour right," says Tuncer. "In a land based farm where we could control all aspects, we could do it but not with a sea cage."

However, with a similar fish, the red banded seabream (*Pagrus auriga*), Akuvatur has not had the same problems and this fish is proving to be very popular in the Portuguese and Spanish

markets, says Tuncer.

Product identity

One of the biggest challenges Haluk Tuncer sees in marketing seafood – not only for Akuvatur but for all fish growers – is getting buyers to demand a brand name.

"If you are proud of your product, you should be proud of your name," he says, explaining why he tags Akuvatur's fish. "You want buyers and consumers to ask for your fish by name, how can they if your name isn't on the fish?"

Akuvatur uses a simple tag placed through the upper body of the fish which only takes seconds to put on. "A course it costs money to tag your fish, nothing is free, but what we see as costing very little brings back much more in return."

About 75% of Akuvatur's new species are sold in Europe, with the German-based MGB Metro Buying Group taking a significant amount. Italy and Greece also buy much of the company's seabass and bream. However, Tuncer doubts that much of this fish is marketed under the Akuvatur name.

He says that the company is going through a growth phase,

with improvements coming in its feed production. "Right now we make only a small amount, about 10 tonnes a day, so we want to make more."

With fishmeal prices continually going up with no let-up in sight, he believes that it is getting more and more important to have control of this part of production. "There was no anchovy catch in the Black Sea this year by Turkey's fleet, so fishmeal is going to be a real problem this year," he says.

He sees value-added as a direction seabass and bream producers will have to go.

"Production will continue to rise in the Mediterranean so producers will need to figure out new ways of selling their fish. They look at salmon and how it is marketed now with very little whole fish for sale at retail shops, so they see this as the direction to go," says Tuncer.

"However, seabream isn't salmon, the flavour is different and sauces designed for salmon won't necessarily work for seabass and bream. Seabream follows a different path and this is what we have to figure out."

Fish Farming International, July 2006

Interest in farming Australian species grows

RENOWNED for its firm white flesh, great taste and high yield, barramundi is proving an attractive species to fish farmers.

Deriving its name from the aboriginal word for large-sealed fish, the barramundi is one of northern Australia's most sought-after predatory game fish. Its flesh tastes similar to sea bass or Dover sole

and it tastes best when barbecued and served with a simple lemon and butter sauce.

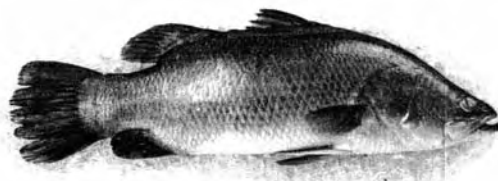
In April, New Forest Barramundi, the first barramundi to be produced in the UK, went on sale in Waitrose stores. It is currently retailing at a special price of £12.99 per kilo (usually £14.99 per kilo).

The brand is owned by the Aquabella Group plc which

invested several million pounds in converting a former pizza factory into a state-of-the-art fish farming facility located in the New Forest, just above the south coast near Lymington. The site houses 48 indoor tanks with an array of water treatment facilities; over three million litres of water are kept at a constant temperature of around 28°C.

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

In Ireland there have also been developments on the barramundi farming front. Based in Kilkenny, on the outskirts of Dundalk, Aqua Fresh Fish Ltd was founded in 2004 and has planning permission in place for a 600 tonne



Barramundi has a great taste and high yield

barramundi facility that would utilise recirculation technology.

The company has been working closely with the locally based Aquaculture Initiative and BIM for the past two years and was hoping to secure £1 million in grant aid from the National Development Plan fund and an Aquaculture Licence from the CZMD (Costal Zone Management Division) which operate under the control of the marine department.

However, the company received a bitter blow last month when Ireland's De-

partment of Marine announced over £1.3 million in grant aid for new aquaculture projects; Aqua Fresh Fish was not among the successful applicants.

A spokesperson for the company said that they were "bitterly disappointed" by the news. He said the project is one of the most innovative in the country.

The first phase of the project will cost in the region of £3 million and provide 9 jobs for the locality. It is expected that the facility will export over £1 million worth of product per annum for the first phase, with the potential to double this with the

planned expansion.

Meanwhile, thirteen thousand Australian barramundi fingerlings have arrived safely in the United States as part of expansion plans by Fremantle-based Cell Aquaculture Ltd.

The milestone means the U.S. production facilities, through joint venture partner Delta Aquaculture Services, are now operational.

Delta Aquaculture has identified a number of fish species for production in this facility which are in high demand by the restaurant and food service industry and specialty retail trade in the U.S.



Barramundi fingerlings

Fish Update, August 2006

Trout grouping calls for compensation scheme

THE disparity between Government support for the aquaculture sector compared with other agricultural food producers must be addressed. And it is time that the increasingly significant aquaculture sector is afforded the same level of support as other primary food producers, the British Trout Association (BTA) has said.

The BTA made the comments following the outbreak of Viral Haemorrhagic Septicaemia (VHS) - a notifiable disease which affects mainly farmed rainbow trout, and can cause significant mortality - in the Yorkshire Ouse area. This is the first outbreak of VHS recorded in mainland Great Britain, although there was an outbreak of the marine form of the disease in farmed turbot on the Isle of Gigha in 1994.

High risk

In a statement, the BTA said the VHS outbreak highlights the high risk nature of trout farming and the vulnerability of the industry. It said it remains "deeply concerned" at the absence of any Government compensation scheme on the compulsory slaughter of fish stocks.

Furthermore, the association said it fears this perpetuates an unnecessary and additional increased risk of non-reporting of suspected disease outbreaks and consequently of disease spread.

It is calling for immediate Government assistance for any farms which suffer financial loss as a direct result of observing Government disease control measures.

Fish Farmer, July/August 2006

BKD confirmed on Devon and Dorset trout farms

THE presence of Bacterial Kidney Disease (BKD) has been confirmed in trout farms in Devon and Dorset.

Defra has issued an Order under the Diseases of Fish Act 1937, prohibiting all movements of fish to and from the infected fish farm and fishery.

The disease was found in trout samples during routine fish health-monitoring visits to the farms. Fish Health Inspectors have been examining the source of the outbreak and investigations are ongoing.

Whilst the disease is considered serious and notifiable under EU law, it is not widespread in Great Britain and occurs only sporadically. BKD has no implications for human health.

Fish Farmer, July/August 2006

Fish Farmer, July/August 2006

More innovation needed, says EC's head of aquaculture

IN his closing remarks at the end of AQUA 2006, Professor Constantin Vamvakas, head of the European Commission's aquaculture unit said the event had been a "truly global forum" for the aquaculture community.

"As underlined in the 2002 Commission communication on 'A strategy for the sustainable development of European aquaculture', the European Commission recognises the importance of aquaculture: it guarantees a constant supply of affordable fish and shellfish, thus reducing the EU trade deficit in fisheries products," Prof. Vamvakas said. "It creates new economic opportunities, employment and effective use of local resources. In the near future European aquaculture must attain the status of a stable industry, creating long term employment, while assuring the availability to consumers of products that are healthy, safe and of good quality, as well as ensuring an environmentally sound industry and high animal health and welfare standards."

Prof. Vamvakas said the new European Fisheries Fund (EFF), which is due to replace the FIFG next year, has a strong focus on aquaculture and is consistent with the Commission strategy for the sustainable development of aquaculture.

He added that aquaculture research has been identified by the Commission as a key component of the European Aquaculture Strategy.

"We need more innovation in aquaculture. We want a strong European research effort in the aquaculture sector and, more generally, in the marine sciences."

Irish invest €13.3m in industry projects

GRANT AID of €13.3 million has been announced in Ireland for aquaculture projects under the Aquaculture Development Measure of the National Development Plan (NDP) 2000-2006, supporting overall investment of around €29 million.

A total of 41 private projects – 28 for shellfish and 13 for finfish operations – and three public projects benefit from the aid.

“These projects cover a wide range of activities such as development of new species, expansion and modernisation of salmon and trout farms, together with expansion of shellfish farm facilities,” said the announcement, made by John Browne, minister of state at the Department of Communications, Marine and Natural Resources.

Minister Browne stressed the importance of diversifying into new species and investing in new technologies, which “will underpin future growth

in Irish aquaculture and ensure it remains an important source of employment opportunities in our peripheral coastal communities”.

Included in the announcement is €2 million allocated to seven projects under the Technical Environment Support Programme (TESP) aimed at “achieving significant improvements in the environmental impact of the marine based salmonid sector, through improved levels of production efficiency”.

The TESP is a one-off initiative, with grant aid of up to 65% of eligible expenditure on qualifying projects; 35% of this amount will be sourced from the Financial Instrument for Fisheries Guidance in the Aquaculture Development Measure of the NDP 2000-2006 and up to 30% will be funded from the exchequer allocation of the development agencies. Maximum public funding is limited to €2m.

■ www.dcmnr.gov.ie

Fish Farming International, August 2006

Cod farmer scoops award

SHETLAND organic cod farmers Johnson Seafarms has become the first winner of the marine section of the new UK Crown Estate Business Awards.

The company's managing director, Karol Rzepkowski, was presented with the trophy by Crown Estate managing director Roger Bright in London.

Rzepkowski said: “Some of the aspects of the award were for the environmental attitude we take in the company.”

Judges said that for over two

decades Johnson's farmed salmon has been recognised as premium grade. It was among the first in the world to produce farmed cod on a commercial scale.

Its pioneering strategy aims to make all Johnson Seafarms' produce organic, including mussels and sea trout. The company has done much to raise the profile of marine fish farming in a positive manner, through the development of a unique brand.

Judges were particularly impressed with how the company, in the middle of very difficult trading conditions, managed to raise £21 million (about US\$39 million) of private equity funding to diversify from salmon farming into farming organic cod.

The company maintains a strong focus on sustainability, the environment, fish welfare and invests significant sums in research and development for the future, judges added.

Fish Farming International, August 2006

THE EUROPEAN Food Safety Authority (EFSA) has launched a major public consultation exercise, which will include fish farms, to forge a common European Union method for assessing the environmental risks posed by fish feed.

EFSA is not happy that in the EU “no specific environmental risk assessment guidance exists for the aquatic compartment”.

Feed safety consultation begins

It wants new common analysis methods to cover additives and other substances used in feeds and consider how best to measure their impact.

EFSA's feed scientific panel, FEEDAP, will later draft guidelines on these assessments, which, it said, “will be used as a basis when assessing the environmental

risk associated with the use of feed additives”.

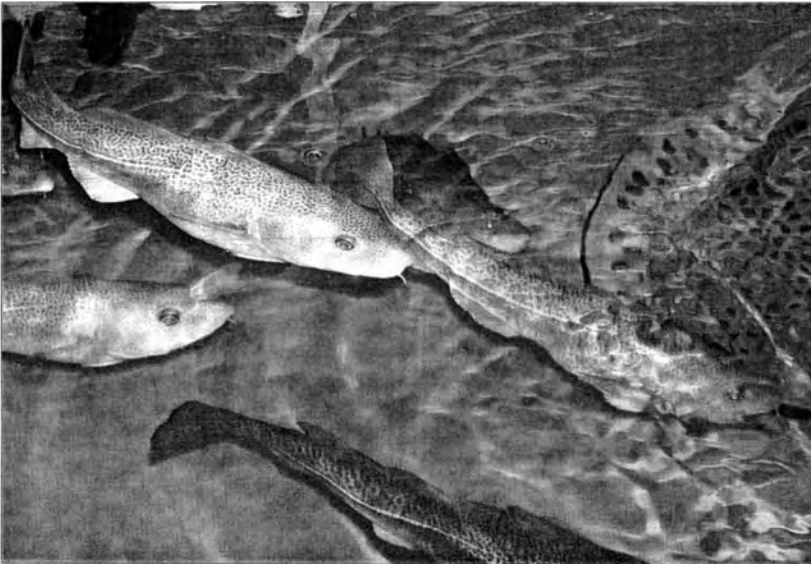
In a consultation report it says: “In general, approval of an additive for use in fish feed is granted irrespective of the type of aquaculture systems in use in the EU.”

As a result, specific pre-marketing authorisation models have not been developed,

although environmental risk assessment models have been developed nationally, for instance in Scotland, Greece and Norway

EFSA wants to develop a general system “based on a generic worst case scenario, which is applicable for different types of aquaculture and covers all kinds of environmental conditions and lower-tier approaches”.

Fish Farming International, August 2006



Cod programme on schedule at breeding centre

Some 20 litres of eggs were produced by the first generation of breeding cod. Two to three days after delivery, the eggs hatched into larvae, and in the spring they became fry that will grow up faster than the previous generation.

Ova were selected from the cod families showing the best weight and disease resistance properties, explains Hansen. "We use a classical breeding model in which we mate one female with one male broodfish, obtain the eggs from this family and incubate and hatch them," he says. "They are then

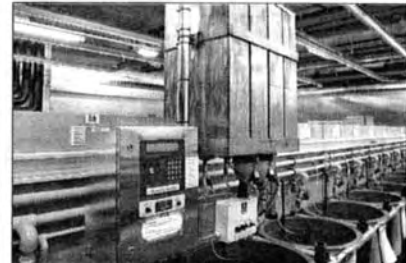
transferred to start-feeding. "The hatchery is made of many small units so we can keep the families separated from each other until they reach five to ten grammes. They are then individually tagged with a PIT [passive integrated transmitter] tag and put together.

"When the fish reach about 190g or so we transfer them to the sea cages where they all get the same treatment, the same feed, etc, and we compare growth between the different families after a year, two years and three years."

A new computerised fish registering system makes it easier to follow individual cod among thousands of the fish. A chip with a radio transmitter sends signals with the fish's ID. Later, when the cod is weighed and measured (at regular intervals), the system receives the radio signals and quickly discovers which fish is being weighed. Weight is also registered automatically.

Thanks to these tags the researchers can secure identification of each cod, fast and efficiently.

Researchers depend on



(Clockwise from left) Ivan Burkow: 'Our goal is increased innovation through interaction among industry, research and public authorities'; Exhausted cod broodstock just after spawning, now starting to eat and regain weight; Production chief Gyvind J Hansen with Rita Saether, head of information; This Storvik feeding robot runs on rails above the rearing tanks and can dispense both live and dry feed

many types of information. In addition to the cod's development, there is information on origin, genetic data, feeding and vaccination – all from the same place.

The programme will eventually include several hundred thousand cod, and Fiskeriforskning researchers will be able to analyse all information together, making it easier to discover which individuals are best suited for breeding.

"As well as determining which families are the best for growth, we also test for disease resistance," says Hansen.

there should be a 13% improvement per generation," says Hansen. "Each generation takes three years, and we produce a new generation each year."

Some of the cod families now going through the system are "incredibly large" for their age, according to Hansen. "I have never seen such large juveniles."

He says that the large number of families being selected and reared as part of the national breeding programme will prevent inbreeding in the future. And although it costs a lot to run a breeding programme, it should result in a huge pay-off for the Norwegian cod farming industry.

There is now much more interest in growing cod in Norway than a few years ago. "The salmon industry is making so much money that it has money to invest and try out cod," says Hansen. "So hopefully there will be a substantial cod farming industry in a few years time."

"Diversification of the Norwegian aquaculture portfolio is very important to stabilise the economy and to enable further investments to be made to develop the industry."

Fish Farming International, September 2006

Project aims to cut deformities

A NEW EU-funded collective research project – FineFish – has been launched to generate practical knowledge on how to reduce the incidence of deformities in major European farmed finfish species.

The results will be applied to the hatchery sector.

FineFish has as its main aim improved sustainability of European fish farming through better control of malformations – but in particular, it seeks to combine available information on the causal relation of deformities between species, so as to obtain new results faster and with higher precision.

Available scientific knowledge and practical

experience on the causes of deformities in young fish led to the identification of the following focus areas:

- Identify optimal rearing temperatures for early life stages of the major European farmed species, given as a table specifying “lethal and teratogenic temperatures” for different stages of life

- Identify nutritional components influencing the incidence of malformations, concentrating on bone mineralisation and muscle growth as affected by dietary components in starter diets and in fast growing juveniles

- Identify abiotic factors of tank environment that influence the incidence and development of

malformations, including tank hydrodynamics as well as gas supplementation

The species to be investigated by the project are Atlantic salmon, cod, rainbow trout, seabass and seabream, thus covering the main commercial sectors in European fish farming that depend on hatcheries.

Coordinated by Feap (Federation of European Aquaculture Producers), this three-year project combines hands-on experience and scientific know-how, joining ten top European hatcheries with scientists specialising in fish development, for a long-range study on the health of young fish.

Hatcheries from around

Europe are included as SME partners within the project.

FineFish was established as a response to conclusions made in the Profet workshops (organised by Feap, the European Aquaculture Society and AquaTT), specifically one that looked to assess the situation in European hatcheries.

During that meeting, held in Bordeaux, France, in 2004, hatchery managers from across Europe reported high levels of skeletal, backbone and gill malformations in fingerlings.

Such deformities represent a major source of financial losses for both SME hatcheries and

producers due to the loss of production efficiency and quality aspects. Thus, finding ways to reduce or prevent malformations was identified as one of the major research tasks for European aquaculture.

Knowledge generated by strategies to avoid malformations will be summarised as guidelines for use in best practice hatchery operating manuals. Such manuals will provide clear recommendations for the improvement of operations within the hatcheries concerned.

Besides the manuals, a classification handbook for deformity identification will be prepared – helping the operators to identify and determine malformations early.

A special monitoring programme is to be developed to establish benchmarks for the measurement of improvements; this programme may be enlarged to include other hatcheries at a later stage in the project.

Feap is responsible for ensuring that the new strategies developed by the project are transferred to SMEs in the EU via workshops, training programmes and other dissemination means.

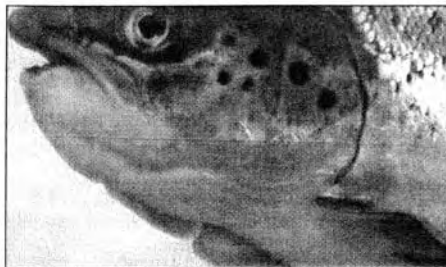
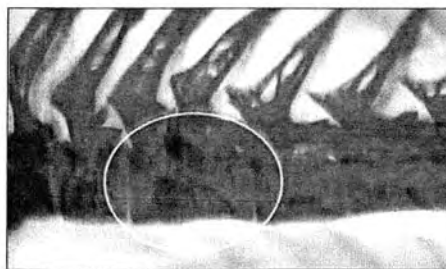
■ www.finefish.info

Project research and technology partners:

Participant	Country
Akvaforsk	Norway
Royal Veterinary College	UK
UMR NuAGe,	
INRA-IFREMER-Univ Bordeaux I	France
Centro de Ciencias do	
Mar do Algarve	Portugal
Israel Oceanographic and	
Limnological Research, National	
Centre for Marine Research	Israel
Hellenic Centre for Marine Research	Greece
Institut Francais de Recherche	
pour l'Exploitation de la Mer	France
University of Patras	Greece

SME hatcheries:

Participant	Country
Profunda AS	Norway
Ferme Marine de Douhet SA	France
AquaSearch Ova	Denmark
Viveiro Vila Nova SA	Portugal
Tinamenor	Spain
Bolaks AS	Norway
Viviers de France	France
Brow Well Fisheries Ltd	UK
Andromeda SA	Greece
Panittica Pugliese Spa	Italy



Examples of deformities: Fusion of vertebrae in juvenile cod (top), where bones have been stained with Alizarine Red to display the bone structure; and malformed jaws in Atlantic salmon

Photos: Akvaforsk

Fish Farming International, September 2006

Tags help work on fish welfare

'SMARTTAGS' are being used as fish welfare indicators by Norwegian scientists in a sub-project of the EU-funded SEAFODplus programme to measure how the total effect of the farming environment affects the welfare of free-swimming fish in aquaculture.

The project was described at by Dr Gyvind Aas-Hansen of Fiskeriforskning, the Norwegian institute of fisheries and aquaculture research, at the recent SEAFODplus conference in Tronso.

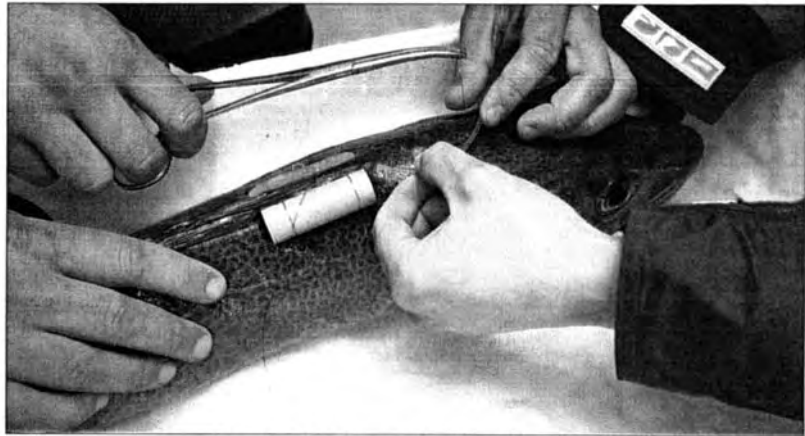
Fiskeriforskning is prominent in its work to promote the farmed fish welfare, and the possibility of documenting their wellbeing is becoming more important with

increased emphasis on animal welfare, Aas-Hansen said in his presentation, prepared with colleague Borge Damsgård.

Traditionally, the wellbeing of farmed fish has been measured by a few factors, such as fish density in a cage, oxygen levels in the water, and the amount of waste products. But this does not take into account how the sum of all the factors affects the fish.

Under the SEAFODplus sub-project, called 'Ethical', this new concept has been developed to measure how the whole farming environment affects fish welfare.

Fiskeriforskning has so far successfully tested SmartTags on cod, and the technology is also



A SmartTag being attached to an anaesthetised cod (Photo: Frank Gregersen, Fiskeriforskning)



Gyvind Aas-Hansen described the project to the recent SEAFODplus conference

being used in France on seabass.

A SmartTag measures how often and how much the pressure changes in the mouth, and with that the breath, of the fish. Audio signals are sent from the tag to an underwater microphone, which forwards it to a computer program that calculates breathing activity.

Breathing pattern is a welfare indicator because it shows not only general stress, fear and pain, but also:

- Hypoxia, hypercapnea (elevated CO2 levels) and water pH
- Toxic or sub-toxic levels of metabolites and xenobiotics in feed and water

- Parasite infection, disease and anaemia

Transmitters on fish have been used for many years, for example to map where they swim. But measuring wellbeing is a new use. The Fiskeriforskning team envisages that in future, farmers will use these SmartTags, fitted to a certain number of their stock, to monitor their fish. Abnormal breathing will indicate something is wrong, so steps can be taken to remedy the situation.

Aas-Hansen describes this as the "canary cod" principle – alluding to the caged birds once regularly used in coal mining to test for carbon monoxide.

The SmartTag prototypes, developed by the Trondheim company Thelma, are 46mm long, 16mm in diameter and weigh 6g. They are attached externally on the back of anaesthetised fish, a thin, water-filled tube being sutured inside the mouth and connected to the tag for pressure measurements.

Results so far suggest that the SmartTag is a promising candidate as a welfare indicator, says Aas-Hansen. It may also function as an early warning system and be used to optimise production systems, he adds. But further development and validation is needed before full-scale use.

Fish Farming International, September 2006

Salmon bonemeal used in cod diets?

SALMON bonemeal is being considered as a new ingredient in farmed cod diets, with the capacity to both reduce feed costs and increase growth.

The new ingredient is being developed in Bergen by Fiskeriforskning, Norway's institute of fisheries and aquaculture.

"Most of the research in this area has been focusing on vegetable alternatives, but we also wanted to look at alternative marine ingredients such as by-products from the seafood industry," said Jogeir Toppe, who is studying the improved utilisation of phosphorous from marine ingredients.

"Cod has a different digestive system to salmon. In the wild, cod can eat crabs, sea urchins, bivalves, etc, with a relatively high mineral [ash] content comparable to fish bones.

"Species with a similar diet could probably also benefit from diets with

increased levels of fish bones."

Researchers, who have also been looking at the use of blue whiting bones, noticed that farmed cod had a better appetite when mineral-rich salmon bones were added to their feed – and that the fish grew faster.

"Fish that received 20% treated salmon bonemeal in the feed grew 10% faster than fish that received regular feed," said Toppe.

When more than 20% of salmon bonemeal was added it was found that the feed factor increased. But scientists believe that if untreated salmon bones, which still have fish meat attached, are used it will be possible to increase the bone content to as much as 40% without the feed factor increasing.

Toppe estimates that feed costs for cod could be reduced by 12% using meal made from untreated salmon bones. In 2005, 11,000 tonnes of farmed cod was produced in Norway requiring around 13,000

tonnes of feed, and by 2010 production is estimated to reach 100,000 tonnes.

Untreated salmon bones are a by-product of salmon farming and the volume of salmon bones from the Norwegian industry is large enough to ensure stable supplies of this bonemeal – particularly if more of the salmon is processed domestically.

Salmon bonemeal could therefore potentially save the industry several million kroner a year.

Currently the same factories produce feed for both salmon and cod, but introducing salmon bones into a feed production line – which will be used for salmon feed at a later date – is not allowed under current regulations.

"If the demand for cod feed increases significantly, the feed industry has indicated that it would become economically interesting to build a separate line for cod," said Toppe.

However, this would



require new legislation in Norway. "At the moment using bones from farmed salmon as feed for farmed cod is not allowed, but

new legislation is underway and it is expected that by the end of 2006 it will be passed," said Toppe.

Salmon bonemeal can cut feed costs and boost growth in farmed cod, according to Norwegian research

Fish Farming International, September 2006

Halibut and crab show promise on Europe's menus

EXECUTIVE chef Kjetil Gundersen at the Culinary Institute of Norway believes that new farmed seafood products from Norway have a bright future in the European market.

During May's SEAFOODplus conference in Tromsø, Gundersen demonstrated how easy it is to use Norwegian farmed white halibut for simple – and tasty – meals.

The chef uses a lot of halibut at the Culinary Institute, much of it farmed. He finds that halibut is becoming increasingly common on menus in restaurants, both in Norway and in Europe.

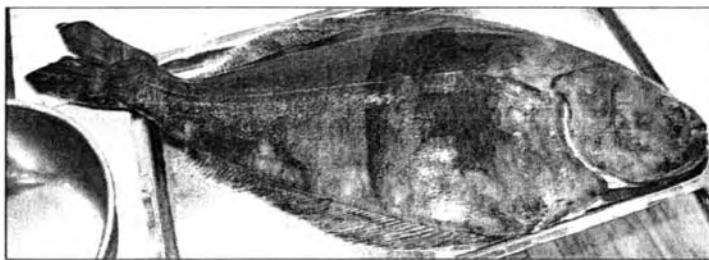
Norwegian farmed white halibut, one of the best flatfish, is versatile and easy to

work with, according to Gundersen. Known for its whiteness and firmness, the thick, firm fillet is suitable for creative cooking, and its qualities complement and enhance the taste and colours of other ingredients.

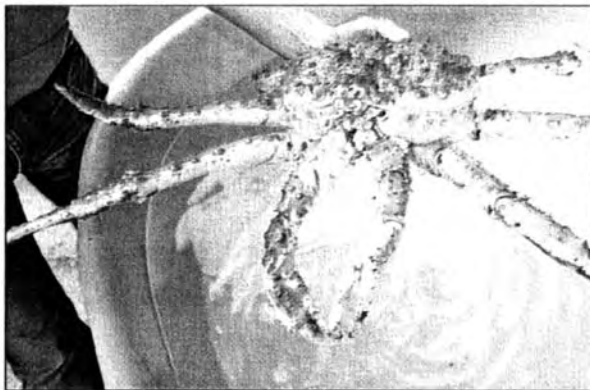
The consistency of Norwegian white halibut resembles that of meat and will satisfy guests with a larger appetite, says Gundersen.

Available year-round, Norwegian farmed white halibut are typically harvested when they are three-four years old and between two and seven kilogrammes.

Other promising species include king crab, which will be a main ingredient at the eleventh international gastronomy contest, Bocuse



A farmed Norwegian white halibut before preparation by chef Kjetil Gundersen



Left: Norway has an advantage as a supplier of king crab to the European market

d'Or, in Lyon, France, next January. Gundersen believes that this can pave the way for the giant crab in the European market.

"The Norwegian king crab is incredibly good to work with and can be prepared in a variety of ways," he says.

Jens Østli at Fiskeriforskning – Norway's institute of fisheries and aquaculture research – believes the king crab has market potential and has the qualifications

needed to succeed.

"The king crab achieves a high price and is already established as gourmet food on the European continent," he says. "Exports of the North American varieties Alaska king crab and Alaska snow crab to Europe opened this market many years ago, and we can take advantage of this."

"Norway also has a competitive advantage as a supplier in that we are closer to the market and can supply fresh

products."

Fiskeriforskning is collaborating with the company ContRace in Vardø, northeast Norway, in the culture of king crabs. Work includes studying space and feed requirements, as well as how large the crabs grow using different diets.

ContRace's production falls into two categories: intensive feeding of commercially caught adult king crabs, and rearing them from egg, via larvae, to adults.

Fish Farming International, September 2006

Sturgeon production increases to satisfy demand for caviar

By Christina Reid

WITH many sturgeon stocks around the world seriously depleted, an increasing emphasis is being placed on sturgeon farming.

In addition to being viable businesses, many sturgeon farms now function as genetic reserves for dwindling species, as well as reducing the fishing pressures on wild stocks by satisfying consumer demand.

Caviar, the renowned gourmet delicacy, is the unfertilised roe of sturgeon and paddlefish, a very ancient group of fish that occur in coastal and inland waters of 25 countries in Europe, Asia and North America.

There are 27 species of sturgeon and paddlefish, among them the Beluga *Huso huso*, which can live for 100 years and can weigh more than two tonnes. It produces the most valuable caviar, the sought-after beluga.



Celebrity chefs in France are backing the campaign

Historically, the Caspian Sea by the former USSR and Iran was the main area for sturgeon. With the break-up of the USSR, over fishing, habitat loss and pollution have led to a dramatic decline in sturgeon populations in the Caspian Sea. By 1998, the decline was so pronounced that an international committee known as CITES (Convention on International Trade of Endangered Species of Flora and Fauna) indicated that without international action, there was an imminent threat of extinction of sturgeon from the Caspian Sea. This action led to tight regulation and control of the international trade of all caviar from all species worldwide.

In July of this year, the European Union implemented new comprehensive caviar labelling requirements, the first of their

kind in the world. These requirements are an important element in combating illegal trade, one of the key factors affecting healthy sturgeon populations. According to the Commission, between 2000 and 2005, authorities seized over 12 tons of illegal caviar in the EU.

Backed by French celebrity chefs, ocean conservation organisation Seaweb will be launching its caviar labelling campaign in Paris on September 14.

French sturgeon farmers believe they have found the solution to the sustainability issue – Russian caviar produced in northern France.

The country's largest caviar farm is located in Saint-Genis-de-Saintonge in the French district of Charente-Maritime. Eight tons of caviar were produced last year by the Sturgeon Company, which was founded in 1995. Its eggs are produced from farm-raised Siberian sturgeons.

Prior to establishing the Sturgeon Company, the Boucher family began with a trout farm, which turned out to be unprofitable. Then the family joined forces with the British marine biologist Alan Jones, a specialist who had gained experience with gillthead sea bream, bass, and turbot.

With a potential of four to five million eggs available for breeding, the French company is the largest of its kind worldwide. Male and female sturgeons have to be two or even three years old before their gender can be clearly identified with ultrasound. Being a virtually useless feeder, the male sturgeons are immediately shipped to fish retailers while the females need another five to six years before they are sexually mature. After their eggs are extracted, their meat – either fresh, frozen or smoked – will be sold or will be used to produce sturgeon soup.

France's caviar output could soon reach 30 tons, a respectable market share considering that the Caspian Sea was only allowed to export some 100 tons in 2004.

Each kilogram of French caviar costs between €1,150 and €1,350, whereas Russian or Iranian caviar costs between €1,500 and €4,000 per kilo.

White sturgeon

Another pioneer in the farming of white sturgeon is Marine Harvest, which has been farming the species in the Sacramento Valley of California since the early 1980s. White sturgeon is one of two species of sturgeon native to the west coast of North America, and one of seven species of sturgeon found in North America.

Male sturgeon are harvested for their meat when they weigh



Farm raised Siberian sturgeons

about 10kg. Females that are selected for caviar production remain in the fish farm an additional 5–7 years before they mature and the caviar can be harvested.

White sturgeon meat is a nutritious delicacy and is available as whole fish, bullets, skin-on fillets, skinless fillets and hot and cold smoked sturgeon.

Israel has long been a leading innovator in agriculture and aquaculture. Now after more than a decade of research and development done by Caviar Galilee, a subsidiary of Dan Fish Farms, in cooperation with Israel's Ministry of Agriculture and Rural Development, aquaculturists can now speed up the rate at which farmed sturgeon mature and have nearly halved the time in which the fish produce ova (eggs). It used to take between 10 and 14 years to produce ova, but this time period has been cut to seven to eight years.

According to company biologist Avshalom Hurvitz, the changing nature of the caviar industry, caused by the shortage of sturgeon, prompted the launch of the programme in 1994 to produce sturgeon and caviar.

As sturgeon do not exist naturally in Israel, Caviar Galilee imported a number of young Russian sturgeon (*Acipenser gueldenstaedtii*) and white sturgeon (*Acipenser transmontanus*) from Russia.

The sturgeon are grown in outdoor ponds where the water is turned over twice a day, and the dissolved oxygen content of the water is between five and nine parts per million.

Fish Update, September 2006

Over two thirds of trout sector attend conference

■ Key themes addressed at annual event

THE recent VHS outbreak in North Yorkshire and, in the absence of statutory compensation, alternative measures for financial assistance to the industry, were key themes at this year's British Trout Association conference.

The conference and AGM took place on August 16 and 17 at Lechlade and Bushyleaze Trout Fishery in Gloucestershire, with representatives accounting for over 70% of UK trout production in attendance.

David Mullin (Veterinary Exotic Diseases, Research & Official Controls Division, Defra) and Barry Hill (Fish Health Inspectorate, Cefas), reviewed the history, control and management of the VHS outbreak in addition to providing wider information on the implications of the new Fish Health Directive.

Government policy towards disease management is one of risk based assessment although both speakers were keen to emphasise government commitment to allow trade to continue wherever it



Nick Read (right) presents Jonathan Jowett with the award

is safe to do so.

The practicalities of the testing and monitoring programme undertaken by Cefas during the VHS outbreak were also explained, attention being drawn to the sampling of some 7050 fish at an estimated cost of £500,000.

A lively open discussion followed with a number of those present taking the opportunity to pose frank questions and ask for clarification of Defra policy. A number of issues emerged including the treatment of fish processing waste and the disease risks posed by fish imports and movements.

The absence of statutory compensation for the compulsory slaughter of fish stocks led the meeting to agree the establish-

ment of a cross-industry working group to develop plans for a trout industry hardship fund, most likely self financed by industry and with the potential for government pump-priming funding. There was unanimous support from the meeting for such a development.

Robert Hughes and Paul Morris of Skretting gave a thought provoking overview of challenges facing the industry with regard to price increases for fish meal and oil. A cross comparison of feed content and price differential for feeds containing alternative sources of protein, animal fats and vegetable oils at differing combinations was presented. The reaction of retailers and of consumers to such

alternative feeds remains open to question.

The final business of the day was the presentation of the Peter Jones Memorial Award. The award, for outstanding service to the trout aquaculture industry, was presented by BTA Chairman Nick Read to Jonathan Jowett of Brow Well Fisheries, North Yorkshire. Having given over 20 years service to the industry Jonathan has been a key player during the recent VHS outbreak, raising the profile of the industry and the problems that, particularly small, independent, trout farmers face.

See *Sector must not become complacent, says trout association* – page 34.

Fish Update, September 2006

Focus on sustainable production of cod fry

A TRANSNATIONAL project is aiming to establish a sustainable production of cod fry to promote successful cod farming in northern regions of Europe.

Sustainable Development of Cod Farming, or NorthCod for short, is a three year transnational project financed by the EU regional Northern Periphery Programme.

The northern periphery countries of Iceland, Norway and Scotland, along with Russia, aim to establish a sustain-

able production of cod fry to promote successful cod farming in northern areas. NorthCod's goal is to address a number of problems that face cod hatcheries and ongrowers in becoming commercially viable. That includes finding better methods for cod broodstock management, control of egg and fry quality and control of sexual maturation.

These problems will be addressed through identification and application of best existing practices across the indus-

try in the North, applied research in specific issues and production of a best practice manual for hatcheries.

Joint projects, exchange of information and co-operation between participating hatcheries, R&D institutions and other collaborators concerning common issues and problems will contribute to the successful and sustainable development of cod production in hatcheries.

During the first year of the project, data on production technology, rearing environ-

ment and larval samples was collected. These data offer a good insight into today's practices in commercial hatchery productions. Data on growth and deformities have been extracted from larval samples using image analysis, although, some methodical obstacles must be addressed when comparing the collected samples. For example, does the fixation of larvae in formaldehyde create artefacts that could be misinterpreted as deformities? An experiment is being con-

ducted to compare live and fixed larvae to see if this is the case, and results will be available later in 2006.

By January 2006, larvae had been sampled from three different productions at three participating hatcheries. Preliminary data show very interesting and significant differences in larval performance during the first 42 days after hatching. Another main finding so far is a generally high prevalence of deformities, already at very early stages.

A recent meeting of the

project partners concluded there is a great need for improvements in the juvenile production of cod. To optimise and improve production, standardisation and exchange of information, work on selected projects will continue.

It is expected that the collaboration in NorthCod, with links to other research institutions and cod producers, will significantly contribute to a more viable and efficient production of cod in Northern Europe.

Fish Update, September 2006

WALES could well become a world centre for sourcing aquaculture feed after the go-ahead was recently given to build a new 500,000 tonnes a year capacity mill to process polychaete worms farmed by Dragon Feeds of Aberavon.

Dragon Feeds has just started operations at a £3 million test facility, built with EU Objective One grant aid, which the Welsh company will use to develop and refine diets based on these marine worms for a wide range of aquaculture fish and shellfish species.

The company has already developed a 100% replacement maturation diet, claimed to be the only such feed on the market.

Its new, bigger mill will be based at Baglan Energy Park and is scheduled for completion by the end of next year. Company founder Tony Wilson tells FFI that it should be running at full capacity within around six years, by which time the enterprise expects to have a turnover of up to £300 million and employ up to 4000 people.

ENTER THE DRAGON!

new mill to make Wales a world centre for feed

Plans also envisage harvesting, processing and distribution infrastructure using dock facilities at Swansea.

Aquaculture interest in polychaete worms – Dragon Feeds' production is based on native ragworms (*Nereis virens*) – has increased exponentially in recent years. Indeed, Dragon Feeds, which began farming the animals in 1998 mainly for the sport fishing trade, has been swamped with requests for trial samples from various aquaculture sectors received at recent trade exhibitions around the world.

Farming feed has obvious environmental benefits, as

well as financial, given the increasing cost of traditional raw materials for aquafeed. Dragon Feeds has already proven that up to 30 tonnes a hectare can be grown successfully – possibly even 50 tonnes/ha.

Tony Smith explains that the company has already sold live, fresh and frozen polychaetes to shrimp hatcheries. "We decided that the best way to service that market would be with a processed broodstock feed made from polychaetes," he said, pointing out that Dragon Feeds' new shrimp maturation diet does not require any other supplements.

"Our early trials show that *Penaeus vannamei* mature and spawn on this diet. Other trials are taking place around the world. Because it's such a nutritious processed feed – with less leaching – you don't need to use as much of it as you do with other maturation feeds."

Dragon Feeds carry out what it calls 'cold processing' to preserve the worms' nutritional quality. "This means our temperatures never go above 80degC," said Smith. "We put the worms into the feeds as a puree, as a wet product, mixed with the dry ingredients. We also put fishmeal, mussels and squid meal in there, so it has a

good strong fishy odour. It's a huge attractant.

"It's a 3mm dry pellet, packaged in 5kg, aluminium foiled, nitro-flushed packs in a plastic bucket with measuring cup and with a shelflife at room temperature of 12 months. Shrimp are messy eaters, but when they drop our pellets, they pick them up again because they remain very stable in the water."

Dragon Feeds produces the worms in about seven months, egg to harvest. "We grow through the spring, summer and autumn, and harvest in the winter," explained Smith.

"The average harvest size is about 7g, about 150mm long. They're detritus feeders: they feed on whatever settles to the floor of the ocean."

The company grows the worms in 100 x 10m raceways, and has some production in The Netherlands in 500 x 15m raceways.

Fish Farming International, September 2006

Marine ingredients have 'essential components'

NORWAY'S fisheries and aquaculture research body Fiskeriforskning is working on new sustainable feed resources and the impact of nitrogen extractives in rainbow trout.

Presenting the work at the recent SEAFOODplus conference in Tromsø, Dr Anders Aksnes described the institute's objective of developing feed based on an optimal use of existing and alternative marine feed raw materials.

Aksnes, whose presentation was prepared with Ellinor Helland of feed company BioMar, pointed to the current focus on increasing the use of plant resources in feed, and also in removing anti-nutrients.

But Fiskeriforskning is looking at marine resources because, says Aksnes, they possess something essential for fish growth, and it is trying to identify, then maximise them – or find alternatives.

Aksnes and colleagues are analysing ingredients, focussing on water-soluble nitrogen compounds with potential health-promoting effects. The focus is on free amino acids, taurine, anserine/carnosine, nucleotides, polyamines, peptides and glutamine.

With BioMar, they chose 40 ingredients and analysed these for 30 different components.

Nucleotides are chemical compounds said to be very important in stressed situations: disease, quick growth, young individuals with poorly developed intestinal and immune systems, vegetarian diets.

To illustrate their effect, Aksnes showed pictures of intestines of fish fed on diets with and without nucleotides; with nucleotides, intestines and intestinal walls were in much better condition and had a much higher surface area.

Marine sources such as fishmeal, fish hydrolysate and calanus have a much higher level of free nucleotides than vegetable protein, he said.

Another component, taurine, has been found to

be important in osmo-regulation/transport and in immune stimulation.

Various biological effects include blood pressure, heart rhythm, neuronal activity, learning, feed intake and sperm mobility.

Taurine levels in vegetable protein sources are very low, or totally absent, while in marine ingredients (and also some animals and chicken meals) there is a much higher level of taurine, said Aksnes.

Anserine is another component. It acts as a buffer and influences a range of characteristics from energy metabolism through immune stimulation to ageing. Again, anserine is present mainly in marine and animal products.

Fiskeriforskning ran a trial on rainbow trout to show how these components affect growth, digestibility and retention, feed intake and feed efficiency, health (immune stimulation), and the health-promoting compounds in fillets.

One diet contained high vegetable protein – a 66% mixture of soya, corn and wheat – and a very low level of fishmeal (8%). Another was a moderate diet containing 47% vegetable protein and 26% fishmeal.

The high vegetable protein diet was found to increase fish weight – from 150 to about 200g – in 12 weeks, but the 26% fishmeal diet gave much greater weight gain, about 300g. The latter's FCR was also much lower (less than 1.0) than the vegetable diet (>1.5).

Daily feed intake during the first ten days was more or less equal for all the diets tested (including a couple of fish hydrolysate diets), indicating that taste is not an issue and that the differences in feed intake thereafter were due to some growth-promoting effect.

Aksnes' conclusion is that the better performance of marine ingredients is due to some essential small components in marine ingredients and not due to better taste.

Fish Farming International, September 2006

Soil Association gives full backing to organic aquaculture

FOLLOWING eight years developing the most rigorous aquaculture standards and assessing every aspect of UK farmed fish production, the Soil Association has taken the highly significant step of giving its full backing to organic aquaculture.

Although the Soil Association's aquaculture standards have had full organic status from the Government's Advisory Committee on Organic Standards (ACOS) since 1998, the Association's own governing body has demanded improvements above this baseline, and far greater clarity on the potential impacts of fish farming. To encourage this process, the standards had been held in 'interim' status by the Soil Association's trustees. The removal of this 'interim' qualification reflects the results of three years' intensive work by the Association's aquaculture team. Following field visits, seminars, and detailed briefing by staff, a set of new, radically-improved standards was approved by Council in July.

Responsible

Soil Association Scotland Director Hugh Raven hailed this crucial step-forward in organic aquaculture: "The Soil Association has followed a responsible and pragmatic path to bringing aquaculture fully into the organic fold. It would have been a dereliction of duty to ignore this hugely important food sector - and one with the potential to vastly reduce the unsustainable exploitation of wild fisheries.

"But fish farming has been highly controversial - as is any food production system that puts profit before principles and good practice.

"As with land-based organic farming, the Soil Association's aim is to achieve the most sustainable production for aquaculture. Our new standards represent carefully targeted key improvements on their 'interim' predecessors. We are delighted Council recognises the progress we've made by unanimously granting them full approval."

The Soil Association will now embark on a major programme of continuing work to develop the standards further - focusing on priorities such as sustainable fish feeds, moving away from potentially polluting veterinary treatments, and farming multiple species of fish, seaweed and crustaceans to minimise nutrient losses - replicating the diversity of cropping and species found on land-based organic farms.

*Fish Farmer,
September/October 2006*

Carp sector urged to help fight KHv

THE Environment Agency is asking for the carp sector's co-operation in dealing with the outbreak of Koi Herpes Virus (KHv). The appeal comes following speculation in the angling press and in Internet chat rooms about this year's serious outbreak of the disease, and the actions taken by the agency.

There have been 12 confirmed cases of KHv disease - which only affects carp, including Koi carp - this year in stillwater fisheries in England.

The Environment Agency says while it will not issue any fish movement consents from these affected fisheries into any other water, it has no powers to prevent the movement of fish from these affected sites on to fish farms. It also has no power to close affected fisheries, although it advises them to do so.

The Agency does not routinely screen for KHv when consenting carp introductions.

Unless the carp are clinically diseased it is very difficult to detect. If fish are showing clinical symptoms then they would automatically fail a health check.

In order to contain the outbreak and to try to trace the source or sources of it, the Agency says it needs the full co-operation of the fish suppliers, the affected fishery owners and of the many others that could potentially be affected if the outbreak escalates.

"Naming fishery owners and suppliers will do nothing but hamper our efforts, by discouraging the reporting of fish mortalities," Adrian Taylor, Fisheries Policy and Process Manager said.

As a precaution the agency is advising all fishery owners to put routine disinfection measures in place to protect against this and other fish diseases. Advice on disinfection can be found at: <http://www.environment-agency.gov.uk>



A healthy common carp

Fish Farmer, September/October 2006

Trout sector urged to remain vigilant

By CHRISTINA REID

TROUT farmers in Yorkshire have been urged to remain vigilant in the wake of the VHS outbreak. Farmers in the area received a last minute reprieve after changes in movement restrictions came just in time to prevent large-scale slaughtering of stock.

The sector had feared that around nine million fish would have to be culled after restrictions were imposed following an outbreak of viral haemorrhagic septicaemia (VHS).

However, Defra announced on August 10 that it had redefined the area subject to movement restrictions after taking advice from the National Control Centre, based at the Centre for Environment, Fisheries and Aquaculture Science.

The immediate effect of the redefinition was to permit all fish farming businesses situated in the catchments of the rivers Derwent, Rye, Wharfe, Aire, Calder, Don and Rother to move live fish to other parts of Great Britain.

The movement restrictions will, however, remain on the catchment area of the River Ouse from its sources to the Normal Tidal Limit at Naburn Lock, and will apply to all fish farming and processing businesses on the catchments of the Rivers Nidd, Ure, Swale as well as the River Ouse.

Safeguard

To provide extra safeguard, a buffer zone with heightened surveillance has been established between this redefined River Ouse catchment and the river areas no longer subject to specific movement restrictions. Movement restrictions will also apply within this buffer zone.

Defra said investigations into the outbreak indicate only a low risk of spread of VHS from the redefined restricted area to the remainder of Great Britain.

A spokesman for the British Trout Association told *Fish Farmer* that the association is hopeful that further tests will prove negative.

"Obviously we've been very lucky. The situation could have been a lot worse," he said. "The risk is still there, monitoring is still going on and this will continue for two to four years.

"It's been good news to date and we've been very lucky but we mustn't be complacent."

He added that the BTA will continue to push for a trout industry hardship fund. At the moment there is no Government compensation scheme on the compulsory slaughter of fish stocks. However, Defra has said officials are looking at the possibility of some assistance in the form of "pump priming" for a hardship fund.

The farm where the outbreak of VHS occurred lost eight tonnes of trout - valued at around £100,000.

Fish Farmer, September/October 2006

New astaxanthin product developed in Israel

SOME 100 kilometres of water-filled tubing in the Arava Desert, in southern Israel, is home to some many trillions of microscopic (*Haematococcus pluviialis*) algae. This green microalga is the richest known source of the naturally occurring astaxanthin molecule, the most abundant carotenoid in the freshwater and marine worlds, and perhaps the next superfood for mankind. Astaxanthin is found naturally in wild-harvested seafoods and has thus been present in the human diet for a very long time. It is responsible for the pink and red pigmentation in seafoods such as wild trout and salmon, red sea bream, lobster, and shrimp. It is also found in caviar.

For aquaculture, the newly developed natural astaxanthin product holds a particular importance

for trout and salmon farming, says Dr Amir Drory, head of research and development, and Efrat Kat, head of sales and marketing, at Algatex in Israel. The rich pink colouring found in wild-harvested trout and salmon is attractive (and thus important) to consumers. Additives to reproduce this pink flush are a vital component of trout and salmon feed when these fish are farm-produced. Presently, the majority of astaxanthin used in the trout and salmon feed industry is created in laboratories. But, as food health concerns in the consumer market place continue to push the animal feed industry towards natural components, astaxanthin from the *Haematococcus pluviialis* algae could be important to the 'healthy' future of these aquaculture products.

Fish Farmer, September/October 2006

Sturgeon farming techniques progress

ISRAEL has long been a leading innovator in agriculture and aquaculture. Now after more than a decade of research and development done by Caviar Galilee, a subsidiary of Dan Fish Farms, in cooperation with Israel's Ministry of Agriculture and Rural Development, aquaculturists can speed up the rate at which farmed sturgeon mature and have nearly halved the time in which the fish produce ova (eggs). It used to take between 10 and 14 years to produce ova, but this time period has been cut to seven to eight years.

"The research began about 12 years ago. Our idea was to produce sturgeon artificially in fish ponds," Prof Dan Levanon, the ministry's chief scientist, told David Brinn of ISRAEL21c.

Dan Fish Farms is owned by Kibbutz Dan, situated close to the Lebanese border in the north of Israel. It specialises in developing new fish species for aquaculture, in addition to developing vaccines and fish feeds, and assimilating biotechnology products in aquaculture.

According to company biologist Avshalom Hurvitz, the changing nature of the caviar industry, caused by the shortage of sturgeon, prompted the launch of the programme in 1994 to produce sturgeon and caviar.

As sturgeon do not exist naturally in Israel, Caviar Galilee imported a number of young Russian sturgeon (*Acipenser gueldenstaedtii*) and white sturgeon (*Acipenser transmontanus*) from Russia.



Dr Andrew Payne of CEFAS (UK) with a sturgeon from the Caspian Sea

Fish Farmer, September/October 2006

Can haddock culture meet gaps in wild supply?

By Jim Treasurer,
Research Manager, Ardtoe Marine Laboratory

A RECENT article in *FISHupdate* (July 2006) indicated that fish processors have a problem in seasonal supply and predictability of haddock from the North Sea. While the supply of haddock has been more available compared with cod, recent changes in the fishery indicate that future supply of haddock may be less secure. Also, haddock landings generally in the North Atlantic have declined in the last 40 years with the species classified as vulnerable (International Union for Conservation of Nature and Natural Resources, 2002).

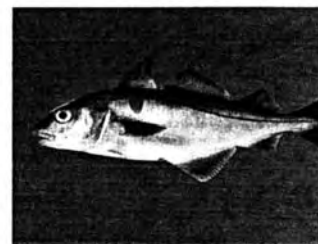
Haddock have been farmed by Heritage Salmon in Canada and also in a demonstration

project in the UK and these experiences have shown that haddock culture is technically possible. This is encouraging and, although cod farming has attracted most recent interest in marine species farming, further diversification of coldwater marine farming would be welcome.

While rearing of haddock is technically feasible, further improvement is required in hatchery techniques and diet with reduced lipid and low energy formulations required. Current growth rates in cultured haddock are uncompetitive compared with cod. This could be addressed to some extent by selective breeding of fish and in improvements to the diet,

and through better understanding of the periodicity and regularity of feeding. Farmed haddock can also be a substitute for premium wild line caught fish of high quality, primarily from Iceland, and especially when fishermen are on holiday or the quota is exhausted.

What are the prospects for haddock farming? The price of wild haddock in the UK following the strong 1999 year class currently makes the economics of farming difficult. However, the rapidly changing status of wild fish may make haddock culture economically viable in the future and it would further aquaculture diversification of cold temperate species.



Fuller diversification of coldwater marine farming would be welcome

Fish Farmer, September/October 2006

Shetland investment for cod and mussels

SHETLAND Islands Council have backed almost £1 million (US\$1.88 million) in investment into the islands' aquaculture industry, helping to create a new era of growing cod and processing mussels.

The SIC's executive committee approved a £750,000 (\$1.4 million) stake in the cod hatchery run by Nufish Ltd, in Sandwick, to be purchased by public investment agency Shetland Development Trust (SDT).

The committee also supported a council grant of almost £100,000 (\$188,000) into mussel firm Demlane Ltd, which is promising to create 24 jobs and safeguard a further nine as part of a large development plan.

The Nufish investment follows a £300,000 (\$565,000) loan SDT made to the hatchery's parent company Johnson Seafarms in May to fit out a processing factory in Scalloway.

Johnson Seafarms, which is a world leader in growing organic cod, won a Soil Association award recently and was judged supreme winner of the Scottish Food and Drink Awards earlier this year. It is already

supplying major supermarket chains across the country, including Tesco and Sainsbury's.

SIC economic spokesman Drew Ratter said the trust's new stake, which must still be approved by the full council, represents 8% of the total value of the company, estimated at around £9.5 million (\$18.8 million).

"The rest of the money has been inward investment developing this industry and providing employment in Shetland," Ratter said. Nufish employs 14 people in Sandwick who supply Johnsons with 600,000 codlings a year to grow in sites all around the isles.

"This is a new industry for Shetland so there are risks involved in developing it, but having observed the progress made by the company so far we think this is the kind of risk we ought to take on."

Demlane was set up in 1995 by Jim and Joy Tait, but last summer it was sold to Isle of Shuna plc, based near Oban with offices in London, which had extensive background in mussel farming.

Fish Farming International, October 2006

KHv dominates meeting agenda

KOI Herpes Virus (KHv) dominated the agenda at the recent Coarse Fish Meeting held in Hampshire by Sparsholt College and Aquatic Consultancy.

More than 40 coarse fish farmers and other industry members attended the meeting, which started on the evening of September 6 with Shaun Leonard and Viv Shears giving a guided tour of the Sparsholt College fish facilities including the National Aquatics Training Centre, trout hatchery and fishing lake. The tour was followed by a barbecue sponsored by Skretting, giving the participants a chance to relax and discuss issues affecting the industry at leisure and long into the night.

The next day started with Fish Vet, Dr Fiona Macdonald giving an overview of fish disease and discussing the herpes virus group and in particular the current knowledge of KHv. This talk was followed by Dr Pat Smith from Schering Plough who described the evolution of fish vaccines and current research in prevention

of disease, including KHv and vaccine delivery. Both talks provoked a barrage of questions. A team from the Environment Agency, National Fisheries Laboratory, Brampton then gave a practical demonstration of fish dissection for fish submitted for Section 30 Movement consent.

Following lunch, Mike Heylin of the Specialist Angler's Alliance provided the buyer's perspective of the industry, a thought-provoking insight into the demand for fish from the anglers and fishing clubs. Trout and carp feed or barley as suitable carp diets were the topics covered by Jon Handley of Skretting, including a bit of chemistry to keep the audience on the ball.

It emerged the best diets for carp are those formulated for this species, particularly for many who regularly supplementary feed carp with barley through the winter. Nigel Hewlett of the Environment Agency rounded off the day's presentations with an update on KHv which resulted in a lengthy question and answer session.

Following the meeting, some participants took the opportunity for some coarse and trout fishing or to pop a few clay pigeons.

The success of the meeting has encouraged the organisers to make this an annual event and Sparsholt College will be hosting another Coarse Fish Meeting from September 5-6 2007.



Over 40 fish farmers attended the meeting

Fish Farming International, October 2006

Virus hits farmed cod

NODAVIRUS has been detected for the first time in cod in Norway, according to the Norwegian research Fiskeriforskning.

Earlier in August, the Norwegian National Veterinary Institute and the Norwegian Food Safety Authority reported that the nodavirus, which has previously affected both halibut and turbot fry in Norway, has been detected for the first time in Norwegian farmed cod.

The virus can cause the disease viral nervous necrosis (VNN) in the fish that becomes infected. The result can be reduced appetite and high mortality.

Together with Saskia Mennen and others, senior scientist Ann-Inger Sommer has spent several years studying infection by nodavirus in halibut, spotted wolffish and cod.

Sommer says that in the cod, as in the other fish species, the fry are most vulnerable to the disease after infection through the water.

Tests have shown that the smallest cod fry became sick after infection with a nodavirus from Norwegian farmed cod. During the two-month test period, 56% of the cod fry that weighed 0.5g died when infected via the water.

Conversely, the larger fry that weighed 5g did not die of infection via the water. In this group, 35% died of VNN when they were infected through injection of the virus into the fish.

The last tests also show that when the temperature in the water rises, there is a pronounced increase in mortality in the fish that are infected with the virus.

Fry weighing 5g that were infected by injection of the virus suffered 60% mortality in water that was kept at around 15 deg C. In cooler water, the mortality rate was much lower.

"The tests show that the infected cod is far more likely to die of the nodavirus if the water temperature rises", says Sommer.

So, what can be done to prevent this virus from becoming a big problem for cod farming?

The research results at Fiskeriforskning are the beginning of a challenge model for the disease VNN in cod, on a level with the model scientists at the Institute have created for the viral disease IPN in salmon.

For example, such a challenge model can help the scientists create a vaccine

against VNN in cod. It can also be used in the cod breeding programme to select the cod families that are hereditarily most resistant to the disease.

"When complete, the model will also help us learn how the cod thrives best in farming conditions. A fish that thrives also has a better immune defence," says Sommer.

The research is financed by the Research Council of Norway, Innovation Norway and Fiskeriforskning.

Fish Farming International, October 2006

Fish farmer vows not to be beaten by animal activists

■ Company will continue to produce halibut despite major setback

By Christina Reid

THE fish farm at the centre of what is believed to be an animal rights attack has vowed to carry on farming halibut despite suffering what has been described as "a major setback".

Around 15,000 fish were released into the open water and £500,000 worth of damage was caused during the overnight raid on September 13 at Kames Marine Fish Farm, by Kilmelford, near Oban. Since then thousands of halibut have washed up dead on the shores.

Anonymous

The break-in, which an anonymous internet article alleged is linked to members of the Animal Liberation Front, left staff at Kames "shocked and totally dismayed".

"These fish haven't been liberated at all," Kames' Stuart Cannon told *FISHupdate*. "We need to emphasise that these are farmed fish and like any other farmed animal, they need care and attention. That's what we've given them for the last four or five years and to expect them to be thrown out



Thousands of halibut have washed up dead on the shores

into the wilderness and the deep ocean and look after themselves, fend for themselves and protect themselves against predators is ludicrous. This is why we're having hundreds and I would think probably by now thousands turning up on the beach."

While he doesn't know why his farm was targeted, Mr Cannon said he is slightly concerned that the animal activists may be targeting new species.

"What have they gained? They have gained absolutely nothing," he continued. "The poor beasts. They've suffered far more than a humane stunner to go to market—their eyes pecked out by gulls, seals attacking them. They will

have suffered."

Mr Cannon said Strathclyde Police has been treating the crime very seriously. Describing the activists as "serious vandals", he urged fish farmers to increase security around their sites by installing CCTV and employing night watchmen if they can afford to.

"I would say don't show people around your farms other than bona fide visitors," he added. "Because we're so close to the road we get quite a few tourists. I just don't know how many of those were bona fide tourists now, sad as it is."

Mr Cannon said his biggest concern was letting his customers down. He and his staff are now doing everything in

their power to ensure that business continues as usual.

"We're a very resilient company, we're well diversified and we intend to continue producing halibut in a sustainable manner, using a welfare-friendly method, to continue supplying fish to our customers in Scotland and the UK."

The attack has reportedly been condemned by animal rights group Compassion in World Farming and by the anti-aquaculture groups Salmon Farm Protest Group and Pure Salmon.

Strathclyde Police has said its enquiries are ongoing. Anyone with information is asked to contact Oban Police Office on 01631 510500 or Crimestoppers on 0800 555 111.

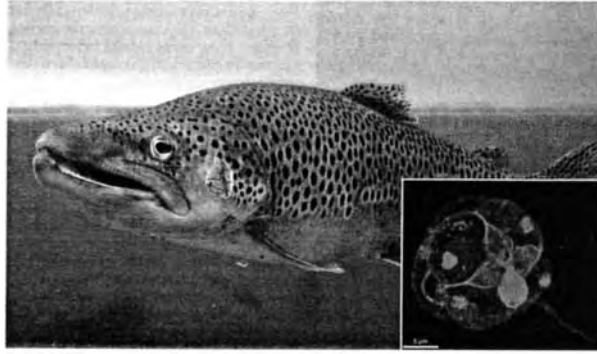
Fish Farming International, October 2006

Vaccine could play key role in PKD control

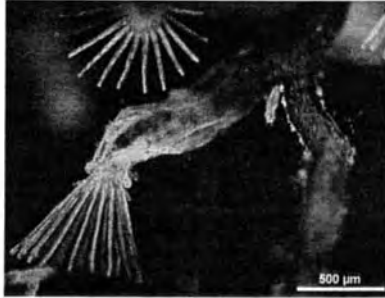
PROLIFERATIVE kidney disease (PKD) is an economically significant parasitic condition, costing the UK trout industry over £2.5 million per annum. Although primarily regarded as affecting first season rainbow trout, other salmonids can become infected during freshwater stages with varying levels of severity. The name PKD was first devised in 1974, although reports of a similar syndrome affecting trout date back at least 50 years previously. The disease is endemic in large areas of Europe and North America, but has not been recognised in the Southern hemisphere to date. Water temperature has a profound effect upon the progress of the disease, with high levels of mortality seen on endemic farms during the summer months.

For many years the causative agent responsible was unidentified. In 1999, however, this was shown to be a myxozoan parasite (named *Tetracapsuloides bryosalmonae*) that developed within freshwater bryozoans (invertebrates known colloquially as "moss animals"), releasing 20 µm spores that could infect salmonids by entry through the skin and gills. Typically, on affected farms, most if not all stock exposed to infected water develop the disease. However, mortality levels vary from 20-100% depending upon secondary factors, such as temperature, stress levels and the presence of other diseases. Those fish that recover from clinical disease display resistance to future challenge with the pathogen: this being crucially important in the development of a prospective vaccine.

As with many other parasitic diseases, there are currently no licensed prevention or treatment protocols for PKD. Previously, the use of malachite green in salmonid husbandry



Above: Male brown trout: a possible target for *T. bryosalmonae*



Insert: Confocal microscopy representation of a *T. bryosalmonae* spore

Left: Part of a bryozoan colony of *Fredericella sultana*, an alternate host for *T. bryosalmonae*

seemed to mitigate the severity of the disease, but its withdrawal has led to farmers employing alternative management systems with limited success. The Institute of Aquaculture (IoA) has played a pivotal role in PKD research for the last 25 years, liaising closely with partners within the UK and the rest of the world during that time.

A NERC funded research project within the Aquatic Vaccine Unit of the IoA focused on the laboratory culture of bryozoans alongside development of control methods. The establishment of an invertebrate laboratory culture system allowed in depth study of the development of the parasite within this host, including the use of confocal microscopy to determine the 3D structure of the infective spore. It was established that exposure to a single spore of *T. bryosalmonae* was sufficient to lead to full-blown PKD in rainbow trout, thus explaining the high morbidity levels witnessed on farms. Drug trials were conducted using in-feed medications and experimental vaccine preparations developed from infected bryozoan material, but neither was found to be sufficiently effective to justify commercial refinement.

A current vaccine development project funded by Defra and Schering-Plough Aquaculture aims to overcome some of the shortcomings encountered using conventional technology. A protective component of the parasite has been identified and purified. Using its DNA sequence, large quantities of the antigen could be produced and used for the vaccination of fish. The prospective vaccine would play a key role in the control of this highly damaging disease on farms and limiting the spread in wild populations of native salmonids.

Fish Update, October 2006

Farming almost equals caught

NEARLY half the fish consumed as food worldwide are raised on fish farms rather than caught in the wild, says a new report from FAO.

The *State of World Aquaculture 2006* was presented to delegates from more than 50 countries attending the biennial meeting of the FAO Sub-Committee on Aquaculture in New Delhi.

While in 1980 just 9% of the fish consumed by human beings came from aquaculture, today 43% does, the report shows.

But levels of captures of fish in the wild have remained roughly stable since the mid-1980s, hovering around 90-95 million tonnes annually. There is little chance of any significant increases in catches beyond these levels, FAO says.

"Catches in the wild are still high, but they have levelled

off, probably for good," explains Rohana Subasinghe of FAO's Fisheries Department and Secretary of the Sub-Committee on Aquaculture.

This levelling off, coupled with a growing world population and increasing per capita demand for fish, spells trouble.

FAO's report estimates that an additional 40 million tonnes of aquatic food will be required by 2030 - just to maintain current levels of consumption.

"Aquaculture could cover the gap between supply and demand, but there are also many forces which could pull production in the opposite direction, making it difficult for the industry to grow substantially enough to meet demand in the decades to come," the report notes.

Aquaculture has been experiencing a boom since the mid-

1980s, sustaining a growth rate of around 8% per year. Today it continues to expand in almost all world regions, with the notable exception of sub-Saharan Africa.

But FAO is concerned that momentum could taper off if governments and development agencies don't adjust their policies to respond to emerging challenges that threaten to dampen the sector's future growth.

One serious bottleneck, says FAO, is the lack of investment capital for producers in the developing world. Another is a shortage of land and freshwater for use in aquaculture. Rising energy costs also pose a problem, and environmental impacts and questions of product safety continue to require attention.

The agency's report also points to doubts regarding future supplies of fishmeal and

oil, used to feed carnivorous cultured species, such as salmon, grouper and seabream.

Since 1985, world production of fishmeal and fish oil has stabilised at 6 to 7 million tonnes and one million tonnes, respectively.

While the vast bulk of fishmeal is used for livestock feed, chiefly by the poultry sector, aquaculture now accounts for 35% of the world's fishmeal supply. So as aquaculture's fishmeal needs grow, competition with terrestrial livestock for a limited resource will intensify, with ramifications for both price and availability.

Key to resolving the dilemma will be continued progress in improving the efficiency of feed formulations - reducing the amount of fishmeal they contain - and coming up with adequate vegetable-based additives.

Fish Farming International, October 2006

Fish disease science receives boost

CHANGES that will help the Environment Agency better understand and respond to fish diseases have been announced.

After a comprehensive review of the Environment Agency's role in fish health, resources currently allocated to fish stocking health checks will – from April next year – be diverted into expanding and improving scientific education, testing and response to the threat of disease and parasites.

"The Environment Agency plays a vital role in controlling fish diseases by regulating fish stocking consents and investigating fish kills caused by disease," said Fisheries Policy Manager Adrian Taylor.

"At the moment we undertake only one third of all fish health checks – which form part of stocking consents – with the majority conducted by approved fish health consultants.

"By offering this final third to the private sector, we can redi-

rect our scientific resources into increasing our knowledge of fish disease, developing the best possible testing procedures and improving the quality and range of fish mortality investigations.

"There will be no reduction in the level of protection given to our fisheries. The need for a health check in support of fish introductions to high risk waters will remain – the only change will be who does the health checks."

From April 1 next year, all fish stocking health checks from suppliers (Section 30 introductions) will be conducted by independent fish health consultants. The Environment Agency will be working to make sure that they are adequately prepared to take on these additional 200 health checks each year.

The Environment Agency is responsible for regulating the movements of fish to inland waters within England and Wales.

Fish Update, November 2006

Vaccines must be developed for new farmed species



New species could increase risk of disease

THE rise in new species being farmed along the Norwegian coast is increasing the danger for spreading disease, according to Norwegian research institute Fiskeriforskning.

With shorter distances between each farm, due to spatial constraints, the spreading of bacterial and viral diseases is a possibility, researchers say.

In collaboration with the Norwegian College of Fishery Science, Fiskeriforskning has now tested this possibility on salmon, cod and halibut.

"We still do not know much about which diseases the new farmed species can catch, but we do know that several known bacteria and viruses can cause disease in many different fish species", says Senior Scientist Vera Lund.

"We have now studied this in a tank system designed especially for these studies at

Tromsø Aquaculture Research Station. Here, we can inflict a bacterial or viral disease on one type of fish in a central tank.

Disease

From this tank, different quantities of infected waste water can be transferred to tanks with other species to see whether these are susceptible to the disease," she explained.

The system has been tested by transmitting classical vibriosis from salmon to cod. Forty to sixty per cent mortality has been registered in the tanks with cod, depending on how much infected water was transferred, according to the research.

"Atypical furunculosis is a problem in halibut farming and an increasing problem in cod farms. Our tests showed that wastewater from a tank containing halibut with atypical furunculosis, transmitted the dis-

ease to cod in neighbouring tanks. The cod had a more chronic form of the disease than that which we had observed with other challenge models.

"Since neither cod nor halibut are vaccinated against atypical furunculosis, it is also possible that cod can infect halibut in a nearby farm. In addition, we do not know for certain whether salmon that are vaccinated against typical furunculosis are protected against all variants of the atypical furunculosis bacteria that are found in the environment."

The researchers say it is important that effective vaccines for new farmed species are developed before the disease problems become too serious. The challenge model proves the possibility for spreading, but does not say anything about the distances to which the disease can spread.

Fish Farming International, November 2006

First fish from halibut farm

JOHN Goodlad's Shetland Halibut Company, which was one of the farms delegates had a chance to visit, has just harvested its first fish. The three kilo male halibut, which are being marketed and distributed by Framgard, are destined mainly for the restaurant trade.

Goodlad's halibut farm on the west side of Shetland is a small operation that is tagged onto his nearby organic salmon farm. This helps to keep the venture viable in what is still very much an industry in its infancy.

However, he sees the future potential for growth in halibut farming as being good.

"Halibut occupies a niche market and this is a big advantage - certainly for the time being," said Goodlad. "There is no problem in getting a good price for the product and the market has tremendous potential for growth."

Despite the predictions of a bright future, John maintains that there are still important problems to overcome. A particular difficulty is the high price

of juveniles - currently £6 or £7 (\$11.22-13.10) each - which combined with the long grow-on time of around four years, means there is a huge initial investment just to get the venture off the ground, especially since mortality until harvest can be in the region of 20 to 25%.

Another major problem is the annual maturation of male halibut, which means they don't feed from October to January, resulting in a very poor food conversion ratio. The only way around this problem is to try and grade out and market the smaller male halibut before they mature - as Goodlad is doing at the moment.

"Halibut farming remains an enormous risk. There are still only a small number of halibut farmers and this means that there is not a huge flow of information preventing people from making the same mistakes. It is important that we communicate as much as we can," Goodlad said.

"The ideal scenario would be to receive all juvenile fish at a kilo each



and have all-female populations at a price of around £5 (\$9.35) each. That is a great challenge for hatcheries, but if this could be achieved, then the industry would be poised for take-off and would be a very attractive prospect for investors."

His fish, which are held in steel square cages, are hand-fed to demand. The taut net at the bottom of the four-metre deep cage has a mesh diameter just large enough to allow the

feed pellets to lie and not drop through to the seabed.

The expected annual harvest in a couple of year's time will be around 200 tonnes and John anticipates that it will probably stay at this level for a few years thereafter.

"The venture is not big enough as a stand-alone operation but it works very well operating in tandem with our salmon farm by keeping costs down," said Goodlad.



Above and top: John Goodlad of Shetland Halibut at his farm

Fish Farming International, November 2006

Tastier fish goal of EU project

A NEW EU-funded project will help European fish farms produce tastier freshwater fish and become more competitive on the world market.

Over-fishing means that many of the world's fish stocks are being depleted, even as the world's fish consumption is on the rise. Aquaculture offers an alternative to extracting fish from free-living stocks. However, there are question marks

over the environmental impacts of fish farms and how healthy and tasty fish-farmed fish are.

The SustainAqua project, which will receive €2.5 million in funds under FP6, aims to address these problems for the freshwater fish farming sector.

"The project should show how fish farmers in Europe can produce fish more economically and at the same

time improve their image by using more environmentally friendly production methods," said Ina Küddelsmann, project manager at the Technology-Transfer Centre (ttz) in Bremerhaven in Germany.

The 24 project partners' plan is to improve the competitiveness of the sector by looking into the culture of different and new types of fish; the commercialisation of by-products and the

technical optimisation of the facilities.

Case studies in Poland, Hungary, Denmark, the Netherlands and Switzerland will provide researchers a representative sample of European aquaculture systems for trout, carp, catfish, eel and tilapia.

A central aspect of all five case studies will be the efficient provision of nutrients to the fish; all too often nutrients

build up in the cages in the form of waste products, leading to the pollution of the river or lake where the fish farm is situated. The researchers plan to look into the possibility of converting this waste product into biomass, which could either be sold for use in other industries.

The taste of the final product is also addressed in the project; this is strongly influenced by the food fed to the

fish and the conditions in which they are kept.

"We want to show that there is a direct connection between flavour, high quality and sustainable breeding conditions," said Werner Młodzianowski, director of ttz-Bremerhaven.

Finally, the project partners will develop training materials to help the aquaculture industry apply the project's findings and, ultimately, become more competitive.

Fish Farming International, November 2006

Time running out to find CO₂ replacement

ALTERNATIVES to slaughtering salmon with carbon dioxide (CO₂) are being studied by the Norwegian research group Fiskeriforskning to come up with a viable solution before the gas is soon banned.

Ever since salmon farming became a considerable food production industry in the late 1970s, CO₂ has been used as an anaesthetic before bleeding and killing the fish. But this method involves stress for the fish.

"The salmon actually tries to jump out of the tank that has been added CO₂," says senior scientist Kjell Midling at Fiskeriforskning.

Authorities in Norway and elsewhere are concerned about the welfare of the fish, both while it is at the fish farm, and when it is going to be slaughtered and sent out in the market. Good fish welfare also results in better quality of the finished product.

Officials are issuing a new slaughterhouse

regulation, and it will soon be illegal to use CO₂ as an anaesthetic in Norway. This means that most of the approved salmon slaughterhouses in Norway – which together slaughter around 600 million kilos of salmon annually – are facing extensive changes in production.

"The transition from CO₂ anaesthesia will perhaps become the greatest challenge for the Norwegian aquaculture industry in 2007," says Midling.

Scientists at Fiskeriforskning are well

under way with a project to evaluate three Norwegian methods that use electricity instead of CO₂ to anaesthetise the salmon before slaughter.

However, the results show that there is still a way to go before electrical anaesthesia satisfies the requirements for instantaneous anaesthetisation while simultaneously resulting in a salmon with the best possible quality.

"The evaluations at the slaughterhouses showed that fish that were killed

using high voltage had severe muscle contractions, many had their spines broken, and there was blood in the fillets."

At too low of voltage, the salmon was not anaesthetised but, rather, very stressed and exhausted. This goes against the requirements for instantaneous anaesthetisation and merciful killing, in addition to resulting in a poorer quality fish.

Fiskeriforskning is now testing equipment that anaesthetises the fish by a hard blow to its head. At the Tromsø Aquaculture Research Station in Skulgambukt, an Australian system will also be tested.

"The principle behind the new system is that the fish swims into a canal where it is rendered unconscious by a machine that gives it a quick blow to the head," says Midling.

Previous studies show that after using CO₂ on the fish, it only takes about two hours from the time of killing until rigor mortis sets in. When the fish is stunned by a blow to the head, it can take considerably longer before this happens, and this gives the fillet manufacturers more time to process the raw materials.

The studies will be completed later this year. They are financed by the Fishery and Aquaculture Industry Research Fund as a part of the programme 'Action Plan Salmon'. The research is a collaboration between Fiskeriforskning and the National Veterinary Institute.

Fish Farming International, November 2006

Future of marine farming outlined

THIS year's British Marine Finfish Association (BMFA) conference in Shetland has been hailed as the best ever, with an excellent turnout of delegates. Interest was further spurred by a series of fact-finding trips to cod and halibut farms, and a cod processing plant.

Opening the event, BMFA chairman Alastair Barge took the opportunity to praise recently retired BMFA secretary Jim Buchanan, who had been a stalwart of the association for many years.



John Goodlad of Shetland Halibut

Richard Slaski, the new secretary, told delegates that marine finfish farming was not an easy industry and still faced a steep learning curve in terms of biology and production systems. A major challenge was to try and attract significant outside investment so as to help the industry grow.

"We are probably 15 years behind the salmon sector, but consumers are hungry for our products and the future is looking good," he said.

Speakers included Mike Thomson of Marine Harvest who focused on farming of new species in Norway, John Goodlad of Shetland Halibut, who

provided an overview of marine finfish farming in Shetland, and Lesley McEvoy of Johnson Seafarms (JSF) who outlined plans for a major £1.7m expansion at its Nufish hatchery in the south of Shetland.

Other speakers included Alan Bourhill of JSF, who said key areas of research over the coming years will be on production technology, health management strategies, maturation and processing technology. Dr Graeme Dear, managing director of Skretting UK&I, discussed feed sustainability and Karen Galloway, marketing manager of Seafish, discussed seafood and health.

Fish Farmer, November/December 2006

Bacterial protein meal may reduce the need for fish meal

BACTERIAL protein meal (BPM) shows great potential as a raw ingredient in fish feed and it has characteristics that could make the aquaculture industry less reliant on fish meal, an Akvaforsk researcher has concluded.

Certain bacteria use methane gas as a carbon and energy source.

This characteristic has been used to produce a protein-rich bacterial meal (BioProtein®) grown on natural gas from the North Sea. Turid Synnøve Aas investigated the use of BPM as a protein source in feed for salmon, rainbow trout and halibut. She compared BPM with fish

meal and documented different tolerance levels for BPM in the three fish species. Based on growth rate, feed intake and feed utilisation, BPM appeared to be an excellent protein source in salmon feed when the feed contained up to 36 per cent of this product. Growth rate and feed utilisation in salmon was greater when the amount of BPM in the feed increased, even though the digestibility of nutrients decreased. Satisfactory results were also achieved in rainbow trout given feed containing up to 27 per cent BPM. For halibut, however, it appeared that the product should only be used at moderate levels (nine per cent).

Fish Farmer, November/December 2006

Seaweed diets tested on rainbow trout

OVER the past 10 years the aquaculture industry has witnessed a rapid expansion of intensive fed aquaculture throughout the world, with an annual growth of 10 per cent: fishmeal and fish oil are key dietary components for farmed fish.

Increasing use of fish for human consumption, along with a decline in availability and increasing costs of fishmeal, has created a need for alternate sources for the fish-farming industry. This is because the current practice is not sustainable.

With the present trend set to continue, an urgent need has arisen to use alternative and sustainable feed ingredients. The biochemical composition of marine macroalgae has received limited attention; nevertheless several studies have demonstrated that marine algae can be used as a partial replacement for many ingredients in fish feed, such as proteins, oils, vitamin and mineral mixes, binders, antibiotics, antioxidants and



There is an urgent need for alternative feed ingredients



15-20% seaweed supplementation in the feed is feasible

colourants.

The Irish Seaweed Centre has run trials in which several seaweed diets were tested on rainbow trout with good results, indicating that 15-20 per cent seaweed supplementation in the feed is feasible. The centre has now applied for a large-scale project using different fine-tuned seaweed diets for salmon farming.

Discharge of nutrients and low-quality water from finfish and shellfish rearing in land based cultivation systems is a major concern everywhere. Marine algae are able to act as bio-filters and remove many of these pollutants from the (discharge) waters. The principle is to direct effluent water from rearing ponds into tanks, where unattached seaweeds are maintained in

permanent motion, using aeration. This allows for the production of value added seaweed species as sources of cosmetics, pharmaceutical, fine chemicals, biomedicines, food and animal feed, while producing a clean wastewater effluent.

The idea is to couple these systems with finfish hatcheries, producing high protein seaweed that can be used as feed ingredient in the fish feed. The Irish Seaweed Centre has finished an EU Aquareg funded project with Norway on the use of these biofilter-systems and has developed a system using two seaweeds to be used year round.

In collaboration with Carna laboratories, a dedicated state-of-the-art field research station, the centre is particularly focusing on:

- The use of seaweeds as partial fish feed replacement for the fed aquaculture industry;
- The use of seaweed-biofilters to elevate waste water discharge problems from land based aquaculture systems;
- Integrated aquaculture (fish-mussels-seaweed) to increase carrying capacity of bays;
- Nutritional analysis of commercial and edible seaweeds;
- Green tides, environmental impact and cause; and
- The use of wet seaweed biomass for energy (Bio-diesel and butanol).

For further information please email the Manager, Dr Stefan Kraan at Stefan.kraan@nuigalway.ie.

Fish Farmer, November/December 2006

New rules on health of farmed fish welcomed

MARKOS Kyprianou, European Commissioner for Health and Consumer Protection, has welcomed the adoption of a new Directive on the health of farmed fish and shellfish and disease control in the aquaculture sector.

The Directive, which was proposed by the Commission last year, was adopted at October's Agriculture Council.

It aims to improve the health of aquaculture animals in the EU by upgrading the current legislation and introducing a series of new measures, including more emphasis on disease prevention at each point in the production chain.

Boost

In setting down clear-cut and harmonised EU rules, the new legislation should also help to boost competitiveness in the EU aquaculture sector, which has a production value of some 2.6 million euros a year, and facilitate increased trade in fishery products.

Markos Kyprianou, Commissioner for Health and Consumer Protection, said: "I am very pleased that Member States have given such strong backing to this Directive, which has also been received input from the European Parliament and a wide spectrum of stakeholders. The new legislation will help to shape the future of Europe's aquaculture sector, which is worth millions of euros each year. It will also ensure that consumers can remain confident in the safety and wholesomeness of seafood farmed in the EU."

Update

The new Council Directive responds to the need to update current animal health legislation for farmed fish and shellfish, taking into

account developments in the aquaculture sector, as well as international experience and scientific knowledge. A major aim of the proposal is to provide for better disease prevention by applying stronger controls throughout the production chain. Pre-empting and preventing diseases, rather than just treating them when they occur, should reduce economic losses and minimise restrictions on trade.

The Directive also seeks to ensure that disease-free fish farms are protected from the introduction of pathogens, and that no new diseases affecting aquaculture animals enter the EU.

Greater flexibility in the application of EU rules on the health of aquaculture animals is provided through the Directive. While the new legislation sets firm required standards when it comes to the health of farmed fish and shellfish, there is no fixed approach laid down for achieving these standards. This allows for the possibility of local or regional approaches to be taken in preventing and containing diseases, while Member States will be responsible for ensuring proper implementation and controls. National control and eradication plans for aquatic diseases will have to be drawn up, as will contingency plans for possible disease outbreaks. The Directive adopted will enable financial contributions from the European Fisheries Fund to be made for the eradication of aquaculture disease. This funding will support Member States and aquaculture operators when they need to implement compulsory disease eradication measures, which can range from culling stock, to movement bans, to long-term programmes to eliminate a less threatening disease.

For more information, see: http://ec.europa.eu/food/animal/liveanimals/aquaculture/index_en.htm

Fish Farmer, November/December 2006

Aquafeed conference to be held in Netherlands

FEED issues, including fishmeal replacement, new technology and the requirements of emerging species, are to be discussed at a major industry conference next year.

Aquafeed Horizons will take place alongside Victam 2007, in Utrecht, the Netherlands from May 9-10, 2007, and will provide feed companies and their suppliers with important insights into the needs of aquaculture and the possibilities offered by



Feed issues will be discussed at conference, next year

advances in aquafeed technology and formulation.

Presentations will fall under one of three main themes: 'Markets and Trends', 'Feed Processing Technology' and 'Feed Formulation'.

'Markets and Trends' will provide an

overview of world and European aquaculture and present insights into hot aquafeed markets, emerging species, farming technologies and market drivers.

The 'Feed Processing Technology' session will present the latest concepts in feed processing and new equipment for the production of aquatic feeds, while the 'Feed Formulation' session will focus on new ingredients, formulation concepts and applied nutritional science for aquatic species.

Major theme

The interaction between ingredients and processing will be a major theme of the technical sessions. Presentations by Fiskeriforskning, Akvaforsk and industry presenters will examine the impact of ingredients on processing and vice versa.

Fishmeal replacement is of course a major issue for the industry and this session will include updates on some of the newest protein sources available for aquatic diets. Scientists from Fiskeriforskning's Department of Aquafeed Development and Marine Processing, Bergen, Norway, will join internationally acclaimed experts from the industry to examine the latest concepts in feed development for aquatic species.

Aquafeed Horizons is organised by Aquafeed.com and Fiskeriforskning, the Norwegian Institute of Fisheries and Aquaculture Research.

Fish Farmer, November/December 2006

New species is promising but risky

THE future looks bright for halibut, according to a Shetland-based fish farmer. However, communication between the few people farming the species is essential if the risk is to be mitigated.

John Goodlad's Shetland Halibut Company has just harvested its first fish. The three kilo male halibut, which are being marketed and distributed by Framgard, are destined mainly for the restaurant trade. John's halibut farm is a small operation that is tagged onto his nearby organic salmon farm. This helps to keep the venture viable in what is still very much an industry in its infancy.

Potential

However, John sees the future potential for growth in halibut farming as being good.

"There is no problem in getting a good price for the product and the market has tremendous potential for growth. The main halibut market in Europe at the moment is in Norway and if the Norwegians are eating more of this fish than anyone else, then this indicates an enormous potential in the UK, France and Germany with their much higher populations.

"However, it is important that producers don't compete needlessly with each other." Despite the predictions of a bright future, John maintains that there are still important problems to overcome. A particular difficulty is the high price of juveniles - currently £6 or £7 each - which, combined with the long grow-on time of around four years, means there is a huge initial investment just to get the venture off the ground, especially since mortality until harvest can be in the region of 20 to 25 per cent.

Another major problem is the annual maturation of male halibut, which means they don't feed from October to January, resulting in a very poor food conversion ratio. The only way around this problem is to try and grade out and market the smaller male halibut before they mature - as John is doing at the moment.

"Halibut farming remains an enormous risk. There are still only a small number of halibut farmers and this means that there is not a huge flow of information preventing people from making the same mistakes. It is important that we communicate as much as we can," says John.

Fish Farmer, November/December 2006

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:-
ASFFW, Area 5E,
3-8 Whitehall Place, London, SW1A 2HH
(Tel. 020 7270 8825) (Fax. 020 7270 8827)

Grant Aid:-
Marine Fisheries Agency, Area 6D,
3-8 Whitehall Place, London SW1A 2HH
(Tel. 0207 270 8041) (Fax. 0207 270 8019)

Research and Development
Programmes:-
Fish Health and Shellfish Health R&D
Programme Manager
Area 6C, 3-8 Whitehall Place, London
SW1A 2HH
(Tel: 0207 270 8770) (Fax: 0207 270 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

Advice is also available via the *eFishBusiness*
web site (<http://www.efishbusiness.co.uk>). This
site has information on all the controls that
apply to the import or movements of live fish,
both nationally and internationally, together
with supporting information, including detailed
descriptions of the most serious fish diseases
and lists of disease-free (approved) areas. All
relevant application, registration and notification
forms can be downloaded from the site.

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)
(Fax. 0131 472 4083)
www.britishtrout.co.uk

The Coarse Fish Farmers & Traders Association
Chairman: Bernice Brewster; Tel: 01622 815255;
Email: BerniceACS@aol.com
Secretary: Ian Welby; Tel: 01664 859433;
Email: bluroof@ntlworld.com

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,
Rowanbank, 7 Atholl Gardens,
Dunkeld, Perthshire PH8 0AY
Tel:/Fax: 01350 727484
www.frmltd.com

USEFUL PUBLICATIONS

Previous issues of *Finfish News* and *Trout News* are available online (<http://www.cefas.co.uk>).

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

The following publications are available on the eFishBusiness Website (<http://www.efishbusiness.co.uk/news>)

- Import of live coldwater fish from third countries: frequently asked questions
- Controls on the keeping or release of non-native crayfish in England and Wales
- Information note on Koi Herpesvirus
- Koi Herpesvirus (KHV)
- Infectious Salmon Anaemia (ISA)
- Infectious Haematopoietic Necrosis (IHN)
- Viral Haemorrhagic Septicaemia (VHS)
- Spring Viraemia of Carp (SVC)
- Gyrodactylosis
- Bacterial Kidney Disease (BKD)
- Furunculosis in salmon
- Lactococcosis
- Category 2 parasites
- Information on various species of non-native fish
- Scientific references on various diseases of fish

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

Available on the Environment Agency website (<http://www.environment-agency.gov.uk/subjects/fish>)

- Protecting your fishery from cormorants
- Cormorants, the facts
- Goosanders and mergansers, the facts
- Coarse fish biology and management
- The construction and renovation of stillwater coarse fisheries
- De-oxygenation
- Desilting stillwaters
- Environments for Fish
- Stocking fish - a guide for fishery owners and anglers



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