

Caligus

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Issue 4 (April 1998)

A newsletter on the biology and control of sea lice for researchers, aquaculture and fisheries industry, educators, consultants, and management authorities

This fourth issue of *Caligus* includes:

- More information on the 1998 international symposium on sea lice biology in Amsterdam including the list of presentations and posters
- more papers and abstracts from the Trondheim workshop:
 - Developments in sea lice management in Irish salmon farming
 - Sea lice infections in Chile
 - The Marine Harvest McConnell surveillance system for sea lice infesting farmed Atlantic salmon
- information on previous research projects on biological control (cleaner-fish, vaccines) funded by the European Commission
- the updated mailing list of persons interested in sea lice biology and control.

1998 INTERNATIONAL CONFERENCE ON SEA LICE BIOLOGY

Recent advances in the study of the biology of Sea Lice will be the subject of a THREE DAY CONFERENCE to be held in Amsterdam from 22nd to 24th JULY 1998. Following the very successful formula of the first Sea Lice workshop held in Paris in 1992, the AMSTERDAM meeting will take place during the Fourth World and Third European Crustacean Congresses - hosted by the University of Amsterdam. The dates of the main congress are 20th to 24th July. This will enable Sea Lice meeting participants to experience sea lice research within its wider context, to interact with the top crustacean specialists world-wide, and to hear about research in important related topics - such as shellfish aquaculture and fisheries. The proceedings will be peer-reviewed and published after the meeting. The Crustacean Congress has plenary sessions each morning so contributed sessions will take place in the afternoons. The sea lice sessions will be held from Wednesday 22nd to Friday 24th of July.

SEA LICE CONFERENCE SESSIONS

Wednesday 22nd July pm: Sea Lice and Fish Parasitic Crustacea
 Thursday 23rd July pm: Sea Lice Biology
 Friday 24th July am: Plenary session
 Sea Lice Workshop Speaker: Mr Gordon Rae, Scottish Salmon Growers Association
 Friday 24th July pm: Sea Lice Biology
 There will also be Poster Sessions during the period 22nd to 24th.

REGISTRATION:

REMINDER for all those planning to attend the conference in Amsterdam:
 Remember to register by the end of April since the late registration supplement will be payable after 1st May
 Address for all correspondence concerning registration to:
 Conference Office, Universiteit van Amsterdam, Spui 21, 1012 WX Amsterdam, The Netherlands.
 Tel: +31-20-525-4791; Fax: +31-20-525-4799

The Sea Lice conference is being organised by Dr Geoff Boxshall on behalf of the partners in the EU Concerted Action on "Lice Control in Fish Farms" under the FAIR programme. If you have any questions or problems concerning the Amsterdam meeting please contact: Geoff Boxshall: E-mail: G.Boxshall@nhm.ac.uk; Fax: +44-171-938-9158

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Developments in sea lice management in Irish salmon farming

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Introduction

Progress to date in the management of sea lice infestations in Irish farmed salmon is very encouraging. It is the result of the efforts of the industry to fully implement the recommendations of the Sea Trout Working Group, the Sea Trout Task Force and the Sea Trout Monitoring and Advisory Group. There are a number of key elements in the management of lice numbers. These are: Monitoring of lice levels; Husbandry Practices; Single Bay Management; and Treatments.

Monitoring

Monitoring is carried out in line with the recommendations of the Sea Trout Monitoring and Advisory Group. This requires fourteen samples to be taken each year from each year class of fish at every farm site in the country. Two per month during the months of March, April and May and one per month for February, June, July, August, September, October, November and December-January. Each sample consists of a sample of thirty fish, from a standard cage and a sample, also of thirty fish, from a cage selected at random. All mobile lice of each species are recorded from the fish examined.

The results of the monitoring programme allow for an accurate assessment of infestation parameters at all sites. This information is a pre-requisite for any targeted management strategy.

Husbandry Practices

Changes in husbandry practices have centred on reducing lateral and vertical transmission of disease and parasites within stocks. Most fish are now produced on a cycle of fourteen to eighteen months in the sea. Two sea-winter fish are no longer a feature of the industry, except in

a very limited way and for the early part of the spring. Equally single generation sites are now standard practice with separate sites being used to hold smolts and growers. These latter not only assist in reducing lice infestation they show reduced incidence of disease, lower mortality rates and better production figures.

Lower stocking densities are being used than was the practice in the past. Current stocking densities are of the order of 10 kilos per metre cubed. These have contributed to the overall health status of the fish, probably by reducing stress levels, and are thus indirectly contributing to improved lice control. This improved health status has been reflected in an increased production in terms of kilos produced per smolt.

Food conversion ratios (FCR's) have dropped from figures of approximately two to one to (i.e. an FCR of 2) five or six years ago to a position today where FCR's of 0.9 to 1.2 are the norm. This means that the amount of food fed to produce a tonne of fish has almost halved.

The net effect of all the above changes is that for a given annual production tonnage: -

1. The number of fish in the water at the production site is approximately half what it was in 1990.
2. The biomass of fish in the water at the production site is some two thirds of what it would have been in 1990
3. The amount of food used over the production cycle in the sea is approximately 50% of what would have been used in 1990

This has resulted in a substantial reduction in the biological impact of a given production tonnage and has substantially altered the parameters upon which carrying capacity models were calculated in the past. In the context of sea lice infestation and the question of salmon farms being potential reservoirs for these parasites it has significantly reduced the standing stock of

salmonid hosts for a given production tonnage. Not only have the mean number of lice per fish dropped but the numbers of individual fish in the water has also dropped. In real terms this means that the real decrease in lice loads on Irish salmon farms is in fact greater than that suggested by the decrease in mean numbers of lice per fish alone.

Single Bay Management

There are essentially four strands to single bay management. These are; information exchange, a code of practise for salmon farms, fallowing and agreements on stocking and disease management. The information exchange involves both a structure for the exchange of relevant information between farms operating in a bay and the exchange of information between the farms and the local fishery interests. The code of practice covers such issues as single generation sites, synchronisation of lice treatments and harvesting methodologies. The fallowing element is essentially the implementation of the recommendations of the Whitaker (1994) report and involves fallowing of all sites annually. The aim of Single Bay Management is to have all sites in the bay managed according to a common strategy for the common good.

During 1995 Single Bay Management (SBM) plans were prepared for the majority of bays. Agreements were put in place in many of the key bays including Lough Swilly, Mulroy Bay, Ballinakill Bay, Bertrabuoy Bay, Kilkieran Bay and Greatmans Bay. Subsequently plans have been put in place in Killary Harbour, Kenmare and Bantry and draft plans are in preparation for Donegal Bay and Clew Bay. There are a number of obstacles to the full implementation of SBM. The chief of these are the availability of fallowing sites and the difficulty of getting production cycles synchronised on adjacent farms. The latter difficulty can only be overcome through extensive discussions and a series of stepwise changes in production cycles to bring farms into line without compromising the viability of individual farms.

Treatments

The final and often crucial element in any lice control strategy is the availability of suitable treatments. The difficulties and deficits in regard to treatments within the Irish industry have long been identified (Jackson and Costello, 1992). To ensure efficient control and avoid the dangers of developing resistance a suite of licensed effective treatments is required. Two distinct types of treatment are required.

For routine maintenance of low lice levels throughout the year an oral treatment is essential. Only an oral treatment can be applied synchronously to large numbers of cages and on adjacent sites and thus avoid cross infection. Suitable treatments should ideally have good efficacy against juvenile lice and a short withdrawal period.

In order to treat acute problems and/or special batches of fish and effective bath treatment is required. This should ideally have a high efficacy against all stages of lice and be immediately effective. As this latter treatment type is likely to be used under less than ideal conditions it should also have a good therapeutic margin. Bath treatments are necessary where a speedy reduction in lice numbers is required. They are also the only route of administration when fish are not feeding. Suitable bath treatments, which are effective and simple to administer, are an essential part of any lice control strategy with the objective of maintaining near zero lice levels in all farmed fish.

References

- Jackson, D. & Costello, M. J. 1991. Dichlorvos and alternative sealice treatments. In: De Pauw, N. & Joyce, J. (eds), *Aquaculture and the environment*. European Aquaculture Society special publication No.16, Ghent, pp. 215-221.
- Whitaker 1994. Report of the Sea Trout Task Force, Department of Marine, Dublin.

Sealice Infections in Chile

Geoffrey Boxshall

Natural History Museum, London

After three weeks on a field expedition to collect free-living copepods in southern Chile (Region XI) Geoff Boxshall had the opportunity (courtesy of the British Council) to visit the salmonid farming region around Puerto Montt (Region X), to meet Chilean scientists involved in studying the local species of sealice.

Farming of salmonids has increased dramatically in Chile during the 1980s and 1990s. Production is currently about 200,000 tones per annum. The species farmed include rainbow trout (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*) and Atlantic salmon (*Salmo salar*). Unlike the situation on the Northern Hemisphere, there are no natural populations of these salmonids. However, major storms in the early 1990s released an estimated 3 million farmed salmonids which now form a substantial semi-wild population. These escapees are currently the subject of detailed dietary and behavioural studies and it appears that they tend to feed around the netpens, constituting a population of potential reservoir hosts for caligids and other parasites.

The first caligid recorded for cultured salmonids (coho salmon) in Chile was identified as *Caligus teres* Wilson by Reyes and Bravo in 1983. Gonzalez & Carvajal (1994) reported infestations of coho salmon and sea trout with *Caligus flexispina* Lewis for the first time in 1994. They found *C. flexispina* in the Bahia Metri to the southeast of Puerto Montt and *C. teres* on coho salmon in the vicinity of Castro and Calbuco (in the internal sea of Chiloe). Prevalence was in the order of 10 to 13%. Sea trout from Calbuco were more heavily infested (prevalence 43-50%) than those from the Metri region (26%). Even higher prevalence levels were achieved experimentally by Gonzalez, Carvajal & Medina (1997) in a study of the comparative susceptibility of coho salmon and sea trout to infestation by crustacean ectoparasites. Gonzalez and Carvajal (personal communication) regard *C. flexispina* as the main problem in salmonid culture, although coho salmon can also suffer from a high prevalence

of the cymothoid isopod *Ceratothoa gaudichaudii* (Milne Edwards).

Fernandez & Villalba (1986) produced a key to species of *Caligus* found in Chile that is used by the majority of researchers there to identify species. Completed but unpublished studies by Laura Gonzalez and Prof. Juan Carvajal (Universidad de Los Lagos) have concentrated on identifying the natural hosts of *Caligus teres* and *C. flexispina* in the region of Puerto Montt. These two species have successfully transferred to salmonids from distantly related fish hosts and there is the possibility that yet more local caligids, including *Lepeophtheirus* species, might also transfer at some point in the future.

Little is known of the biology of *Caligus flexispina*, although work in progress at Universidade de Los Lagos is aimed at determining development rates of the various life cycle stages. The information is necessary for targeted lice control. At present control is predominantly by means of imported organophosphates and it appears that little research was carried out in advance to determine optimum treatment times.

Chile has an enormous coastline and there is a very marked dependence on natural marine products. Ecological impact studies for salmonid culture are necessary and being carried out by researchers at the Universidade Austral de Chile (Puerto Montt campus). The same group led by Dr Doris Soto and Fernando Jara are interested in identifying local fishes which exhibit cleaning behaviour similar to that of wrasse, since there are no obvious labrids in the local fauna.

The names and addresses of interested Chilean scientists have been added to the Caligus database and some of their recent papers have been added to our sealice bibliography.

P.S. If you go to Chile you must try the giant barnacles (*Megabalanus psittacus*), they are truly delicious served hot. I am less keen on sea urchin gonads and I would urge caution before eating "pure" (seasquirts)

The Marine Harvest McConnell surveillance system for sea lice infesting farmed Atlantic salmon

Jim Treasurer and Andrew Grant

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A surveillance system which has been developed in Marine Harvest McConnell since 1989 is described here which has permitted lice numbers to be controlled, but with difficulty because of the restricted range of safe and effective licensed medicines.

The source of infestation following the introduction of smolts on a fallowed site is largely from wild fish, but once a louse population is established, the infestation is propagated within the farm. Lice have a high reproductive output: one female can produce up to six batches of 150-300 eggs at summer temperatures. A monitoring system will aim to trigger intervention at a point which prevents significant shedding of eggs. The system must be sufficiently sensitive to provide reliable data but not so time consuming as to be impracticable on farms.

1. Selection of cages for sampling

This depends on the layout of cages on the farm. Where cages are arranged in groups (pontoons), ten fish are counted from each group (five fish sampled from each of two cages). Lice numbers are frequently higher on fish in the end cages of the group and an end pen is therefore selected; a second pen is chosen having visibly the highest lice burden. The count is repeated from two cages on each cage group. On farms with larger groupings of cages, counts are carried out on three cages from each group, one at each end and one cage in the middle. The designation of some specific pens to count regularly gives continuity in counts and permits assessment of changing trends in lice numbers.

2. How often should counts be done?

At least weekly in summer as sea lice development is rapid at temperatures over 10°C, for example 5 days through the 4 chalimus stages at 15°C. Counts may be less frequent in winter but counting lice weekly helps to establish and reinforce the routine.

3. Sampling fish

Care must be taken to sample fish which carry 'typical' numbers of lice. Moribund, small and unhealthy fish swim more slowly and have more lice, as do maturing fish and these should be excluded provided they do not constitute the majority of the population. Fish are placed in an anaesthetic bath to ease handling. Lice may be dislodged in the anaesthetic bath during handling; these are added to the overall total lice count for the cage.

4. Recording

A basic count differentiates fixed larval (chalimus) from mobile lice stages and distinguishes between the two lice species, *Lepeophtheirus salmonis* and *Caligus elongatus*. However, more detailed information such as whether mobile lice are juvenile (pre-adult) or adult or have egg strands is more useful. An example of the level of detail recorded is shown in Table 1. At one time in the development of this system, chalimus stages were differentiated as stages I/II and III/IV. However accurate counts on live fish by farm staff, in often inclement weather and overcast conditions proved difficult and a total count of both *Lepeophtheirus* and *Caligus* chalimi was found more practicable, particularly when handling larger fish. Our experience and that of others has shown that counts on anaesthetised fish under field conditions, regularly underestimates chalimus numbers by up to 50% when compared with fish sacrificed at sea and examined under artificial light with a magnifying glass onshore. As a routine therefore field counts of total chalimus are adjusted by a multiplier of two to compensate for this error.

Caligus are counted in the same way as *Lepeophtheirus* but males and females of both pre-adult and adult stages are combined as a total mobile count. The criterion for treatment for *Caligus* is still dependent on lice numbers but generally the threshold for *Caligus* is higher since this species is, on the whole, less damaging and better tolerated by fish.

5. Appraisal of louse count system

The system described here has been developed for routine louse monitoring purposes and does not claim the robustness of more detailed statistical tests which are required to determine efficacy of medicines. The scheme is intended to be as basic as possible for use on farms and the absolute count of lice numbers per fish and

the proportion of different developmental stages present is regarded as a more useful indicator of the need to treat fish.

The lice monitoring system by itself cannot control sea lice numbers, but does give a sound basis for planning the timing of treatments to interrupt the reproductive cycle always provided that effective medicines are available.

Table 1 : Marine Harvest McConnell – weekly sea lice counts

Site:

Date:

Group:

Pen:

Counted by:

Temperature:

Fish No.	Gravids	Other Adult F	Adult M	Pre-adult M & F	Total Adults	Chalimus	Caligus Mobiles
1							
2							
3							
4							
5							
Totals					Total of Means	x2=	
Means							

Previous research projects on sealice control funded by the European Commission

Project Name	Development of a louse vaccine for salmon culture	Development of a vaccine to protect farmed Atlantic salmon from lice infestation	Vaccine to protect Atlantic salmon against lice
Duration	November 1993 to October 1996	May 1989 to April 1991	May 1992 to April 1993
Contract No.	AIR2-CT93-1079	FAR AQ.1.258	FAR AQ.3.786
Coordinator	Dr. Alan L. S. Munro, SOAFD, Marine Laboratory, Victoria Road, PO Box 101, Aberdeen AB9 8DB, UK		
Partners	University College Cork, Aberdeen University and Stirling University		

CONCLUSIONS FROM THE PROJECT: 'CLEANER-FISH TECHNOLOGY: PARASITE CONTROL, ALTERNATIVE TO PESTICIDES, AND CREATING A NEW FISHERY'

This two year project was completed in March 1993 and funded under the EC Fisheries and Aquaculture Research (FAR) programme (contract AQ-2-502). It was conducted by M. J. Costello (co-ordinator), W. Darwall, S. Lysaght and O. Tully (Trinity College, University of Dublin), J. Fives and S. Deady (University College Galway), A. Pike (University of Aberdeen), S. Papoutsoglou (Agricultural University of Athens), and J. Menezes and M. A. Ramos (Instituto Nacional de Investigacao das Pescas, Lisbon), with assistance from their colleagues and students and involved collaboration with several fish farms in Ireland and Shetland.

The cleaner-fish, corkwing (*Crenilabrus melops*) and goldsinny (*Ctenolabrus rupestris*) wrasse, effectively controlled sea-lice (*Lepeophtheirus salmonis*) on Atlantic salmon (*Salmo salar*) under commercial conditions in three farms in Ireland. Cleaner-fish were more effective than the pesticide nuvan, and as effective as ivermectin, in controlling lice abundance. Reported failures of wrasse to control sea-lice were invariably due to wrasse escaping from cages with greater than 15 mm square mesh. Trials were limited to salmon in their first year at sea. Most wrasse had escaped after a year in the cages. Some increases in lice numbers in autumn were attributed to decreasing wrasse activity at reduced sea temperature and wrasse escapement.

In aquaria, recently captured rockcook (*Centrolabrus exoletus*) wrasse were twice as effective as goldsinny in cleaning lice from salmon. However, no significant differences in lice abundance occurred between male-only corkwing, female-only corkwing, mixed-sex corkwing, and goldsinny in commercial scale trials. Aquarium experiments showed rockcook and goldsinny cleaned both mobile and chalimus stages of lice, and the smaller of the two lice species infesting salmon, *Caligus elongatus*. Data from one commercial trial also suggested cleaning of chalimus. Diet analyses of wrasse from aquaria and cages indicated that a small proportion of wrasse (20-40%) removed most (80%) of the lice.

Ectoparasites have only occasionally been a problem in southern European finfish culture. The most frequent species of sea-lice on sea-bass (*Dicentrarchus labrax*), *Caligus minimus*, was found to concentrate in the host buccal cavity, where it would probably be inaccessible to cleaner-fish. There are generally more cleaner-fish in warmer waters; if skin parasites become a problem in finfish culture then such cleaners may be an effective control method.

Aquarium and field observations show markedly reduced foraging and general activity in wrasse below 10°C. The fishery, and perhaps

cleaning activity, is thus limited to warmer months (May to October in Ireland). Wrasse fishing does not damage habitats or other marine life and the by-catch is released unharmed. A collapsible wrasse trap has been designed and is recommended, but standard shrimp pots and fyke nets can also be used. The fishery is unlikely to affect the sustainability of wrasse populations as it is localised, and requires only ≥ 10 cm wrasse (and most have bred once by this size). Local reductions in numbers of ≥ 10 cm wrasse are likely and recruitment to these size groups (from growth and immigration) will be critical for fisheries.

A literature review of wrasse diseases and parasites was completed, and 376 corkwing, 271 goldsinny and 54 rockcook were screened by veterinarians; a further 50, 50 and 30 (respectively) were analysed in detail for metazoan and protozoan parasites. No parasites, bacteria or viruses of known pathogenic concern to salmonids were recorded. Four wrasse had an atypical *Aeromonas salmonicida* which was not pathogenic to salmon.

Wrasse are cheaper and more effective than nuvan in lice control on first sea-year salmon. Effectiveness on second sea-year salmon remains to be shown although several Norwegian and UK farms claim positive results. The current limitations on cleaner-fish technology are: (1) availability of wild stocks near some farms; (2) absence fishery from March to May which exposes salmon to lice for two months; (3) sustainability supply ≥ 10 cm wrasse from local populations; (4) concerns over transmission wrasse diseases and parasites to salmon.

Disease-free certified wrasse culture may overcome these limitations. Additional research is also required to reduce wrasse escapement, improve understanding of factors affecting cleaning activity (e.g. presence hides, alternative food, social status, salmon aggression), and predict the transmission potential of wrasse (and other wild fish associated with farm cages) diseases and parasites to salmon.

List of persons interested in the biology and/or control of sea lice on fish farms.

Please send corrections and new entries to Ms. J Dowse (jdowse@ecoserve.ie)

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Internet e-mail discussion group for lice biology and control

An e-mail discussion group has been established to enable people interested in lice biology and control to provide and request information to others in the group. All persons who have already submitted their e-mails to this project will automatically be included in the group. The group relies on people voluntarily sending and replying to messages. Sending an e-mail to <CALIGUS@listserv.heia.ie> will send the message to all subscribers to the group. If you wish to reply to such a message consider whether it is more appropriate to send it back to everybody, or only to the individual who sent the message. The latter may avoid annoying others with irrelevant messages.

To join the group (a) send an email to <listserv@listserv.heia.ie>, (b) leave the 'subject' line blank, and (c) type in the following command in the main part of the email message: "SUBSCRIBE CALIGUS first-name surname". Do not include your email address in the message as this will be automatically recorded. To leave the list, send the message "SIGNOFF CALIGUS" to <listserv@listserv.heia.ie>.

Sealice Web site

A World Wide Web site has been established at <http://www.ecoserve.ie/projects/sealice> to host the Concerted Action Homepage. The information available at the site includes the html format of the project newsletter CALIGUS, details of workshops and conferences, the register of persons interested in lice biology and control, a bibliography of sealice literature as well as contact details and an outline of the project. The site is routinely updated to incorporate new additions to the register of researchers and bibliography. Links to the site are welcomed. Please contact Mr Chris Emblow (cemblow@ecoserve.ie) to arrange links.

Contributions

Information on current and completed research projects, viewpoints, letters and publications are all welcomed for this newsletter. Please send details to Ms J. Dowse, EcoServe, 17 Rathfarnham Road, Terenure, Dublin 6W, Ireland (e-mail: jdowse@ecoserve.ie)

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The project is co-ordinated by Dr Mark J. Costello (EcoServe, Dublin) in partnership with Dr Geoffrey A. Boxshall (Natural History Museum, London), Mr Kjell Maroni (KPMG, Lauvnes), Mr Per Gunnar Kvenseth (Norsk Hydro a/s), and Dr Carmel Mothersill (Dublin Institute of Technology). Enquires about the project should be sent to: mcostello@ecoserve.ie; Dr M. J. Costello, Ecological Consultancy Services Ltd, 17

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List of contributions for sealice conference in Amsterdam

ORAL CONTRIBUTIONS (20 Titles)

- Banks, B.A. & C. Sommerville. Enrichment of microsatellites from the ectoparasite *Lepeophtheirus salmonis* (Krøyer) genome using biotinylated oligonucleotide sequences.
- Bell, S., J.E. Bron & C. Sommerville. Distribution of exocrine glands in *Lepeophtheirus salmonis* (Krøyer, 1837) and *Caligus elongatus* Nordmann, 1832.
- Boxaspen, K. & T. Næss. Development of eggs and planktonic (early life) stages of salmon lice (*Lepeophtheirus salmonis*) at low temperatures.
- Braidwood, J.C. The use of *Crangon crangon* to investigate the potential environmental impact of excis sea lice treatment.
- Bron, J.E., G. Wainwright, R.P. Smullen, C. Sommerville, R. The cuticle and ecdysis in larval stages of *Lepeophtheirus salmonis* (Krøyer, 1837) (Copepoda, Caligidae).
- Costello, M.J. & A. Pike. Towards a quantification of salmon lice population dynamics and infestation potential.
- Dawson, L.J., A.W. Pike, D.F. Houlihan & A.H. McVicar. Effects of Sea Lice, *Lepeophtheirus salmonis*, on Sea Trout, *Salmo trutta*, at different times after seawater transfer.
- El-Rashidy, H & G. Boxshall. Coevolution of the parasitic copepods of the family Ergasilidae (Poecilostomatoida) and host fishes of the family Mugilidae.
- Firth, K.J., S.C. Johnson & N.W. Ross. Investigation on the role of skin mucus proteases of atlantic salmon during *Lepeophtheirus salmonis* infestation.
- Hull, M.Q., A.W. Pike, A.J. Mordue & G.H. Rae. Should I stay or should I go? New on- and off-host parasite data having implications for inter-host transfer of *Lepeophtheirus salmonis*.
- Jackson, D. (1) Population dynamics of sea lice on wild sea trout post smoults.
- Jackson, D. (2) Population dynamics of *Lepeophtheirus salmonis* Krøyer (Copepoda: Caligidae) on farmed salmon.
- Jackson, D. (3) *Caligus elongatus* (Nordmann) as parasites of farmed salmonids in Ireland.
- McAndrew, K., R. Wootten & C. Sommerville. Survival and egg production of *Lepeophtheirus salmonis* in experimental infections of Atlantic salmon (*Salmo salar*).
- Nordhagen, J.R. P.A. Heuch & T.A. Schram. Size as indicator of origin of salmon lice *Lepeophtheirus salmonis* (Copepoda: Caligidae).
- Roth, M. The availability and use of chemtherapeutic sea lice control products.
- Shinn, A.P., D.J. Gray, J.E. Bron & C. Sommerville. Elemental analysis of Scottish populations of the ectoparasitic copepod *Lepeophtheirus salmonis* (Krøyer, 1837).
- Tully, O., P. Gargan, W.R. Poole & K.F. Whelan. Spatial and temporal variation in Sea Lice infestation of Sea Trout in Ireland (1990-1997).
- Tully, O., W.R. Poole & K.F. Whelan. Temporal variability in physiological conditions of Sea Trout in the marine environment: Implications for the impact of Sea Lice on host survival.

POSTER CONTRIBUTIONS (7 Titles)

- Banks, B.A., A.P. Shinn, J.E. Bron & C. Sommerville. The use of RAPD's to establish the interspecific relationships of the ectoparasitic Caligid, *Lepeophtheirus salmonis* (Krøyer, 1837) in Scotland.
- Bashirullah, A.K. Non-interactive coexistence of two parasitic copepods of *Caranx hippos* in eastern Venezuela.
- Grimnes, A., B. Finstad & P.J. Jakobsen. Salmon lice: Comparative study on two host species.
- Haji Hamin, H.L., J.E. Bron, A.P. Shinn & C. Sommerville. The occurrence of blood reeding in *Lepeophtheirus salmonis* (Krøyer, 1837).
- Schram, T.A.Hooks. Holdfasts of egg string in parasitic copepods.
- Shinn, A.P., B.A. Banks, J.E. Bron & C. Sommerville. Comparison of 18S, ITS and cytochrome oxidase sequences obtained from *L. salmonis* derived from wild and farmed salmonids in Scotland.
- Treasurer, J.W., A. Grant & P.J. Davis. Physical constraints of bath treatment of Atlantic salmon (*Salmo salar*) infested with sea lice (Copepoda: Caligidae)