

A newsletter on the biology and control of sea lice distributed free to researchers, aquaculture and fisheries industry, educators, consultants, and management authorities.

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4th International Conference on Sea Lice

28th-30th June 1998, Trinity College, Dublin, Ireland

Theme

The 3rd international conference held in Amsterdam in 1998 focused on sea lice biology. This meeting will thus focus on applied aspects of lice control.

Offers of papers are invited on:

- current and new chemotherapeutants
- progress and future options for vaccines
- progress in the use of cleaner-fish
- Integrated Lice Management strategies
- lice population dynamics, including production, dispersal, transmission between farms and between farms and wild fish.

Deadlines

Submission of abstracts	26 th February 1999
Draft programme	31 st March 1999
Pre-registration	30 th April 1999

Accommodation

A limited number of rooms has been booked in good quality accommodation in Trinity College, Dublin. This is the most convenient place to stay for the conference, is in the city centre and is half the price of hotels and guesthouses. When these rooms are full, delegates will have to make their own arrangements for accommodation. Rooms will only be reserved for named persons on payment of costs.

Standard single room £30 per person

Ensuite single room £38 per person

Ensuite twin room (2 beds) £34 per person

*Breakfast Continental £3; Full £6

*All rooms have access to a kitchen if people want to make their own breakfast.

Abstract Submission

Offers of papers must be submitted by 26th February 1999. Final versions of abstracts are required by 31st March 1999. All people presenting papers must pre-pay their registration fee.

Standard guidelines for the presentation of posters and talks and chairing sessions are available at

www.ecoserve.ie/conferences/guideline

Conference website:

<http://www.ecoserve.ie/projects/sealice/meetings.html>

Wrasse – do they transfer diseases to salmon?

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INTRODUCTION

Being in close contact with salmon in netpens, feeding partly from their mucus layer or on lice filled with salmon blood, as well as on the carcasses of dead salmon, wrasse would be likely to contract pathogens present in the salmon population. Given the wrasses ability to escape from salmon pens, diseases could be spread to wild wrasse populations, or to new salmon farms with subsequent capture of escaped wrasse.

Likewise the possibility of introducing new pathogens to salmon farming, by stocking wild wrasse with an unknown history of disease, has been a concern of the salmon farming industry. In some areas this has hindered the commercial use of wrasse as delousers.

This article summarizes the results from a three-year project on wrasse health, including screening of wild wrasse populations, the role of wrasse as a vector for diseases, and the prevention and treatment of diseases in wrasse. The goldsinny (*Ctenolabrus rupestris*) was chosen as a model, as it is the species most frequently used as a delouser in salmon farms.

DISEASES OF WILD WRASSE

A goldsinny population from the western part of Norway was sampled every second month from February to November. Simultaneously fish from the same wild population that had been transferred to a salmon farm was sampled. For each population and sample date 30 fish were examined immediately after transfer to the laboratory, and another 30 were put into a latent carrier test. The goldsinny was screened for presence of bacterial diseases, IPN-virus and parasites.

Virus

Kidney samples from wild or transferred goldsinny gave no cytopathic effect on CHSE-cells. The CHSE-cells, however, will only sustain growth of a limited number of viruses, so the presence of “new” viruses in goldsinny can not be ruled out by this screening. There is no evidence from the literature that wild wrasse carry viruses, but experiments have shown that goldsinny are susceptible to IPNV (Gibson and Sommerville, 1996).

Bacteria

Examination of freshly caught goldsinny from the wild revealed no external or internal signs of bacterial diseases, and pathogenic bacteria could not be isolated from the kidney. After the Latent Carrier test the picture was completely altered. In one particular sample a maximum of 33 % of the goldsinny were found to have covert infections of an atypical *Aeromonas salmonicida* (June-96), while the common incidence was 6-10%.

Parasites

Only parasites with a direct life cycle, which might be transferred from wrasse to salmon without intermediate hosts, would pose a potential problem in salmon farming. In this study the most common parasites were trichodinids on the gills of the goldsinny. The trichodinids did not cause any pathogenicity, even in the most heavily infected goldsinny, and seemed to be species specific for wrasse. The screening of the parasite fauna was done as a M.Sc. project, and performed by Mrs Aina Solberg (Dept. of Fisheries and Marine Biology, University of Bergen).

WRASSE AS A POSSIBLE VECTOR OF DISEASES

Infectious Salmon Anemia (ISA)

This viral disease causes mortality and clinical signs of disease mainly in farmed Atlantic salmon (*Salmo salar*), but sea trout (*Salmo trutta*) (Nylund and Jacobsen, 1995), rainbow trout (*Oncorhynchus mykiss*) (Nylund et al., 1997) and herring (*Clupea harengus*) (Nylund, unpublished) have proved to be asymptomatic carriers with the ability to transfer ISA to healthy salmon. To either confirm or rule out the wrasse as a possible carrier of ISA a thorough transmission experiment was carried out.

Blood from salmon positive for ISA, from natural outbreaks and from earlier transmission trials, was used for infection. There were 6 experimental groups:

2 x 30 goldsinny injected with ISA;

2 x 30 goldsinny cohabiting with 5 ISA-injected salmon;

2 x 30 salmon cohabiting with 5 ISA-injected goldsinny;

30 goldsinny injected with HBSS (negative control);

30 untreated salmon kept with 5 untreated goldsinny (negative control);

30 salmon injected with ISA (positive control).

From all treatment groups, and from goldsinny negative control, five fish were taken out for examination every fifth day from day five until day forty after infection. Moribund fish were taken out for examination on a daily basis. All fish were examined externally and internally for clinical signs of disease. Blood samples were taken for determination of hematocrit. Tissue samples from several organs was fixed for examination in light and electron microscope, and frozen for later immunohistology. From the ISA-injected goldsinny blood and tissue was frozen for later re-infection experiments with salmon.

While mortality started on day 17 and ceased on day 28 (90% mortality) in the ISA injected salmon, there were no mortality in the goldsinny injected with ISA, in goldsinny cohabiting with injected salmon, or in salmon cohabiting with injected goldsinny. Neither were there any clinical signs of disease or drop in hematocrit in these groups. Samples of tissue processed for light microscopy or for immunohistology did not show any signs of tissue damage, or positive reaction for the presence of ISA Virus.

In the re-infection experiment blood and tissue taken from the ISA-injected goldsinny (day 5, 10, 15, 20, 25, 30, 35 and 40) was prepared and intraperitoneal injected into eight groups of healthy salmon. There were no mortality in any groups of salmon, neither clinical signs of disease or drop in hematocrit in salmon sampled from these groups. In a positive control group of salmon the mortality reached 100 %.

The conclusion from the experiments must be that it is highly unlikely that goldsinny will be able to transfer ISA to or between salmon groups under natural conditions. The virus does not seem to be able to establish an infection in goldsinny, and through the cohabitation trials the role of goldsinny as a possible passive vector seems to be ruled out.

At present all material from the experimental groups, frozen and stored in liquid nitrogen, are being screened by the use of PCR, to examine clearance rate and possible traces of ISA- virus in the samples.

Atypical and classical furunculosis

As wild wrasse may carry an atypical variant of *Aeromonas salmonicida* it is of great importance to find out if this bacteria may be transmitted to, and cause disease in, salmon. Earlier work have demonstrated that wrasse are susceptible to classical furunculosis from salmon, both in laboratory experiments (Bricknell et al., 1996) and in a farming situation (Hjeltnes et al., 1992). In a laboratory experiment, groups of 2 x 30 goldsinny wrasse and Atlantic salmon were intraperitoneally injected with "high" (10^7 CFU/fish) and "low" (10^5 CFU/fish) doses of *Aeromonas salmonicida* subsp. *salmonicida* from salmon or atypical *Aeromonas salmonicida* from goldsinny.

In salmon injected with a "low" dose of *Aeromonas salmonicida* subsp. *salmonicida* mortality started at day three and reached 100 % within day eight post-injection. In the salmon groups injected with the atypical variant there was no mortality, and sequential examination of fish showed no signs of disease. The experiment gave no indications that the atypical furunculosis from wrasse could be transmitted to salmon, which corresponds to the findings of Costello et al. (1994).

In the goldsinny groups injected with "high doses" the mortalities for both isolates reached about 80 % within 15 days. In the while in the "low dose" groups mortalities were a bit higher in the atypical group (45 %) than in the classical group (35 %). When given an intraperitoneal injection goldsinny seems almost equally susceptible to classical furunculosis from salmon as to atypical furunculosis from wrasse. This implies that under farming situations with classical furunculosis present in the salmon population the use of goldsinny as cleaner fish should be avoided, because of the risk of mortalities in the wrasse and spreading the disease through escaped wrasse.

Prevention and treatment of atypical furunculosis in wrasse

Vaccine trials

Preliminary trials with vaccination of freshly caught goldsinny in April-May demonstrated the problems with vaccinating a carrier population. The stress of handling was sufficient to cause an outbreak of atypical furunculosis in the goldsinny, and from 400 fish ip injected with an commercial oil-based triple-vaccine only 50% survived the five-week long immunization period.

A following challenge with atypical and classical furunculosis proved to be rather inconclusive.

In a later experiment goldsinny were vaccinated in December with an oil-based trial vaccine made of formaldehyde-killed atypical *Aeromonas salmonicida* bacteria. As goldsinny are scarcely available in early spring, when the salmon smolts are put to sea, trials with winter-storage of goldsinny have been conducted. Simultaneous vaccination would give several advantages with the possibility of disease outbreaks being lower during the winter months, lower social interactions between the goldsinny, and a much longer immunization period (5-6 months) compensating for a slower immune reaction caused by low water temperatures.

The winter-vaccination experiment gave promising results as mortalities in vaccinated group receiving subsequent handling-stress was significantly lower than in unvaccinated groups. Challenge experiments with ip injection of atypical *Aeromonas salmonicida* however failed to demonstrate any effect of vaccination, but this method for challenge may be unsuitable.

Treatment with antibiotics

Given the high mortality caused by stress-induced outbreaks of atypical furunculosis and the difficulties in vaccinating the fish, a more applicable approach to reduce mortality could be treatment with antibiotics. An experiment using three different antibiotics to treat a natural outbreak of atypical furunculosis was therefore conducted in the laboratory. Three antibiotics were chosen on the basis of sensitivity studies of the bacteria isolate.

Treatment was commenced when mortality caused by atypical furunculosis started. For each treatment 2x55 fish was used. Fish in two groups were ip. injected with 0.5 ml Tribissen [®]vet. (400 mg/ml Sulfadiazine – 80 mg/ml Trimethoprim), and two with 0.5 ml Aquacycline [®]vet. (50 mg/ml Oxytetracycline). Two groups were bath treated with Flumequine (0.5 g/l) for three hours, and two groups kept as control. Dead and moribund fish were registered daily.

At the termination of the experiment, 28 days after treatment, the cumulative mortality was 47.5 % both in control groups and Tribissen injected groups. In the Flumequine treated groups mortality reached 34% while in the Aquacyclin-treated groups mortality was only 14%.

It will not be possible to administer chemotherapeutics to wild-caught goldsinny via the oral route, but even though ip. injection is quite labor-intensive it will reduce the amount of antibiotics used and thereby spare both costs and environment. A commercial fishfarm with 100,000 smolts using 5,000 goldsinny (1: 20) will need 250 ml Aquacycline [®]vet., or 12.5 g Oxytetracycline. Further investigation will probably show that the dose could be further reduced.

CONCLUSIONS

The screening of a goldsinny population from the West Coast of Norway did not reveal any pathogens that should pose an threat to salmon farming, neither were the goldsinny able to transmit ISA or atypical furunculosis to salmon. The main problem seems to be the mortality in the goldsinny, caused by stress-induced outbreaks of atypical furunculosis, after transfer to netpens. This disease may be treated efficaciously by injection of Oxytetracycline. Vaccination of goldsinny is difficult when the population contains carriers with covert infections, but vaccination combined with winter-storage has given promising results.

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Summary of the Irish sea trout problem

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This article was circulated on the sealice e-mail discussion group in August 1998

In reply to those requests for information on the sea trout collapse in the west of Ireland and whether sea lice were the cause of the collapse, it was clear from the uninformed statements and questions that have appeared recently on e-mail that it is necessary to restate the problem and where it has occurred. There is a substantial body of published reports and papers which are referenced at the end.

Because of the marginal existence of the species, there has been increasing evidence during the past two decades of a slow decline in some stocks and this was largely attributed to poaching with fine mesh monofilament and a range of environmental problems such as: field drainage, stream drainage and maintenance fertilization of the hillsides, afforestation and more recently hillside erosion, due to overgrazing by sheep (Whelan, 1992).

Whelan (1991, 1992, 1993) and Poole *et al.* (1996), described the appearance of a more serious decline which appeared in many fisheries along the western seaboard in 1986 which, by 1989, resulted in a population collapse in most mid-western sea trout fisheries. Subsequent research programmes (Anon 1990, 1992, 1993, 1994) confirmed that the declining rod catches reflected an actual spawning stock collapse, approximately 90-98% reduction in ova deposition rates in one catchment studied.

The major collapse occurred in 1989 when, tragically, there was little sea trout research taking place and only some anecdotal information is available on the sequence of events which took place during the May/June period of 1989. However, the following details are known:

- In May large numbers of post-smolts and some mending kelts appeared in the estuaries of the Delphi and Erriff systems.
- Many of these fish were heavily infested with lice and photographic evidence is available showing the level of lice damage to the skin and fins of the more seriously affected fish.
- In some fisheries, appreciable numbers of very thin adult fish appeared during the

angling season and the majority of these displayed poor gonadal development.

In 1990 the Salmon Research Agency co-ordinated a broadly based research programme which, it was hoped, would identify the extent of the problem and define a possible cause or causes. The results of this 'STAG' programme, implicating sea lice as the major component of the collapse, are summarised in Whelan (1992). During the following two years the research programme concentrated on five principal areas:

- Monitoring of sea trout survival in a range of fisheries
- Further investigations into the role of sea lice
- A physiological profile of sea trout smolts to study their state of fitness when entering saltwater
- Disease monitoring
- The development of practical sea trout enhancement strategies

In 1991 the Department of the Marine established a Sea Trout Working Group and the results of the sea trout research programme were examined by this group at the end of each year (Anon, 1991, 1992, 1993, 1994). The "sea trout problem" in the Irish context was defined as the following:

- the early return of smolts
- severe infestations of juvenile (chalmus) stages of lice, *Lepeophtheirus salmonis*.
- the presence of larger badly emaciated fish
- a severe reduction in spawning stock, across all age classes.

The following points from the research programmes are worth summarising:

- The most severe collapse in sea trout stock levels occurred in the area from Clew Bay in the north to Galway Bay in the south.
- Of the 60+ rivers sampled around the coast of Ireland between 1991 and 1996, no exception has been found to the observation that the sea trout problem, as defined above, has been recorded only in areas where salmon farming was taking place.

- No evidence of a disease was found which was consistent with the stock collapse. A range of internal parasites were identified but none that provided an explanation for the widespread collapse of stocks (Molloy, Holland & Poole 1993; Anon. 1991).
- There was no evidence of sea trout feeding regularly in the vicinity of cages, where it was claimed pollack and coalfish were eating the fish, or that sea trout smolts were straying into salmon cages.
- From the stomachs of the sea fish caught, while sampling for sea trout, there was no evidence of reduced food availability at sea or a lack of specific food items (e.g. sandeels). The collapse in the elver (young eel) stocks and predation by seals were also discounted.
- While acid flushes or chronic acidification may be contributory factors to sea trout problems in some catchments, there is no direct evidence to identify a causal link.
- A number of man-made freshwater environmental changes have taken place and these undoubtedly affect stocks in specific catchments. The sea trout stock collapse, however, cannot be attributed either individually or collectively to these changes.
- No global failure of osmoregulatory ability of sea trout, which could explain the premature return of sea trout smolts to rivers, was identified.

The only consistent factors to emerge from the research carried out to date are the early return of both smolts and kelts to the estuaries in early to late May and the presence of intensive infestations of juvenile salmon lice (Anon. 1991, 1993a, 1993b, 1994; Tully & Whelan 1993, Tully *et al.* 1993a, Tully *et al.* 1993b). The sea trout problem, as defined above, has only been observed in areas adjacent to intensive salmon farming. The problem is therefore geographically distinct and any valid hypothesis must be able to account for this fact.

Environmental factors have often been promoted as having been involved but results to date, particularly the high survival rates of stocked parr, would indicate that it is a marine based mortality of trout and no common factor, or suite of factors, have been identified as having caused the sea trout stock collapses in the west of Ireland. The "building of dams, roads, gravel digging, silage etc" (Kvenseth, Caligus 20/7/98) do not have any connection with the current sea trout situation in the west of Ireland.

In the latter half of the 1980's, farm salmon production in the bays of the mid-west of Ireland expanded to an unprecedented extent. Sea lice levels rose during this period and as a consequence juvenile lice production soared. No observed data exist for juvenile lice production during this period but extrapolation from the lice production figures indicates the massive release of larvae which took place at this time. It has also been shown that increasing sea temperatures in the late 1980's were directly linked with faster generation times in the louse life cycle (Tully & Whelan, 1993).

Two vital pieces of evidence have been shown; the sea trout smolts, and adults where present, are consistently infested by juvenile lice and that in the mid-west of Ireland during 1991, 95% of the total nauplius larval production of *Lepeophtheirus salmonis*, the louse causing the problem, was of fish farm origin. It has also been shown that sea trout were infested with juvenile lice within two to three weeks of migrating to sea and that morphological and physiological impact of the lice on the trout was sufficient to cause mortality. In the past number of years, correlations have also been found between both abundance and intensity of lice on sea trout with distance from neighbouring fish farms. While these correlations are by their very nature relatively crude, they have provided the impetus for further detailed in-bay research into the mechanisms governing sea lice infestation from both salmon farms and wild sources.

In 1996 the Salmon Research Agency attended the ICES Working Group in Edinburgh and the main conclusions of this group were as follows:

- Highest numbers of lice on wild sea trout post-smolts in Ireland, Scotland and Norway occur in salmon farming zones and comparable levels of infestation have not been recorded outside farming areas (also note ref. Tingley *et al.* 1997, ICES J. Mar. Sci.).
- The phenomenon of sea lice related early returning sea trout post-smolts and related stock collapses has not been recorded in England and Wales.
- In Norway, sea trout post-smolts do not return early except where they are infested with sea lice. These infestations are dominated by juvenile stages, as also observed in Scotland and Ireland.
- It is now known that salmon lice cause stress, altered behaviour, severe pathology and

mortality to host fish such as sea trout, salmon and char.

- Considering the direct effect of lice infestation on early returns of sea trout post-smolts, a study in Norway concluded that salmon lice significantly shorten sea trout's sea water residence time.
- Data relating to the proximity of fish farms and the lice infestations in sea trout from Scotland indicate that a similar correlation to Ireland may have been present in 1994 - the only year considered in detail by the ICES group.
- The data suggest that lice emanating from fish farms may transfer to wild trout populations but this has as yet not been quantified.
- The extent and mechanism of larval dispersion is unknown.
- The scarcity of wild salmonids inshore in west coast Scottish and Irish areas in February to April reduces the possibility that the spring pulse of larval lice was derived from wild sea going salmonids present at or before this time.

The commissioned report examining the 1992 - 1996 sea trout sampling programme, undertaken by Dr Ian Cowx, identified a number of perceived and actual inaccuracies in the programme. These were fully addressed in the 1997 programme. The inaccuracies identified were found to have not significantly altered either the database or the conclusions drawn from it and the 1997 modified programme completely corroborated the 1992-1996 findings.

Hopefully this description of the current status of our knowledge regarding the sea trout population collapses in the west of Ireland will help to inform those looking for such information.

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Sea lice management methods in Scotland

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This paper was presented at the workshop on sea lice control on fish farms in Trondheim, November 1997.

Introduction

This paper examines:

- (a) sea lice infestation patterns on farms in Scotland investigating whether the source of infection is external or is generated from within the farms;
- (b) factors governing infestation cycles and the pattern of infection;
- (c) methods to prevent and treat sea lice and
- (d) the choice of medicine, the timing of the treatment and how frequently the fish should be treated.

Internal or external infection patterns?

Smolts (1992 year class) stocked on a production farm in west Scotland with one sea winter production fish already present (1991 year class) were rapidly infected with *Lepeophtheirus salmonis* and copepodids were found on the newly stocked fish within 3 days (Fig. 1). Up to 8 mobile *L. salmonis* were recorded 4 weeks after stocking and the fish were treated with Aquagard (dichlorvos) at regular intervals through the first summer. In the following year the farm was fallowed for several weeks and this subsequent year class remained relatively uninfested with lice through the first year and only one treatment with Aquagard was required during this period. In many farms where fallowing is applied, lice treatment is not required for up to 15 months following transfer to sea and this treatment can be then solely for *Caligus elongatus* rather than *L. salmonis*. This was also the conclusion from an intensive study of four Scottish salmon farms that established that recruitment of lice was initially slow following fallowing and emanated from wild fish (Bron et al., 1993). Thereafter the build up of lice was largely internally generated within the farm itself.

The pattern of infestation with *Caligus* follows a well established direct route of transfer from wild fish from late June onwards (Fig. 2) and therefore fallowing has little effect on controlling this species. *Caligus* numbers on salmon often decline naturally with the onset of colder weather in November or an influx of freshwater. The recruitment of *Caligus* varies greatly between

sites and it is difficult to conclude whether *Caligus* are an increasing problem. Annual fluctuations in settlement of *Caligus* on salmon were evident on a farm in Loch Sunart over four year classes (Fig 2). Treatment with Aquagard-Novartis (dichlorvos 50% w/v) is normally very effective in removing *Caligus*, and there is no indication of reduced sensitivity to this compound.

In farms that have been fallowed the recruitment of lice in late spring in the second year is a critical period in sea lice control (Fig. 3). In this example there was an initial infestation with *Caligus* and this declined naturally without treatment. In week 16 of the second year numbers of chalimi of *L. salmonis* increased rapidly followed by a rise in weeks 18 to 20 of mobile *L. salmonis* to an average of 12 per fish. At this point fish were treated with Aquagard. One further treatment was required at the beginning of August. The increase in lice numbers on fish was also not gradual but logarithmic. Several factors may be involved in this rapid increase in sea lice infestation in weeks 16-20, including increasing day length, rising water temperatures and increasing salinity (allowing greater larval survival). In addition, copepodids may be less viable in winter due to smaller egg size and a reduced nutrient reserve, although larger numbers of smaller eggs are produced. In late spring fewer larger eggs are produced, and larger eggs may give more viable copepodids (Ritchie et al., 1993).

Estuarine plankton are adapted to prevent wash out including mechanisms for vertical movement in seawater. Nauplii and copepodids of sea lice are likely to behave in the same way as other zooplankton. Bron et al. (1993) indicated the average survival time of copepodids at 10°C as 7 days but it could be as much as 21 days in a farm situation in a confined bay area. Two tides each day, each with flow and ebb movements, provides four opportunities per day for copepodids to pass through a farm. Over a week this is 28 occasions, and over 3 weeks 84 opportunities. Together with high egg production this can explain the rapid increase in lice numbers from a relatively small number of gravid lice per fish.

Lice control methods in Scotland

On many farms integrated pest control management is being followed and this may involve management agreements between companies in certain sea loch areas.

1. Fallowing of farms

A management agreement between three companies operating in Loch Sunart included specifying a fallow period, on stocking a single year class, and on exchanging information on the health of the fish. Prior to this, in the 1989 year class, lice infested fish rapidly following stocking and remained high through the production cycle (Fig. 4). The first treatment with Aquagard was in September of the first year and a total of 22 treatments was required in this year class. In 1991 when a fallow period of 8 weeks was used, numbers of *L. salmonis* were low through the first year with only *Caligus* present in any numbers and not sufficiently high to require treatment. It was 15 months before the first treatment was required. Fallowing was therefore very effective with a 50% reduction in the number of treatments compared with the 1991 year class. The option to fallow may not be available to small companies who have a limited number of farms or only one farm and where fish of various sizes are required for harvest.

2. Wrasse

In 1994 a questionnaire was sent to fish farming companies in Scotland asking about their use of wrasse (Treasurer, 1996a). Wrasse were stocked widely with the smolt input, 150,000 wrasse in 1994 representing 33% of farms and 39% of fish put to sea that year. Wrasse have been effective in the first year of the production cycle where wrasse have been treated carefully and hides have

been used to give protection in cages. On one farm used as an example (Fig. 5) smolts were stocked with larger fish, as this was a broodstock site. In 1994 smolts were treated with Aquagard on three occasions but no treatment was required in 1995 after wrasse were stocked on a group of 8 cages.

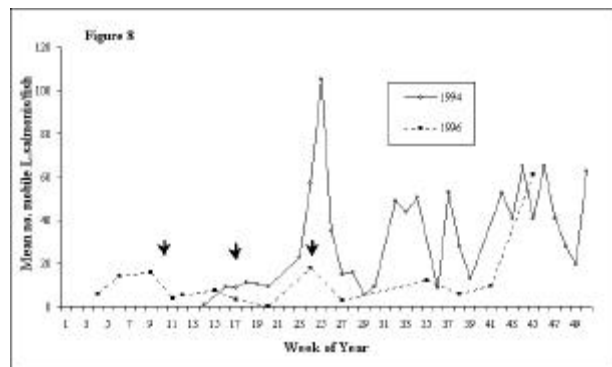
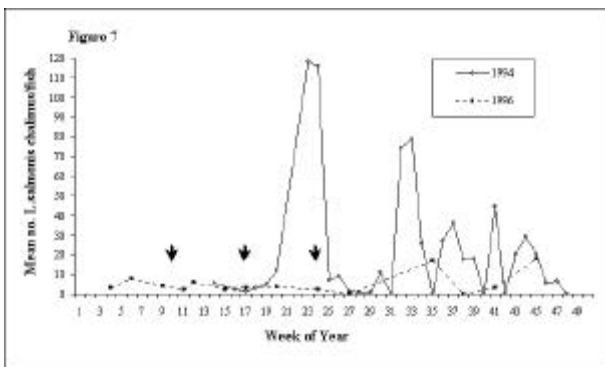
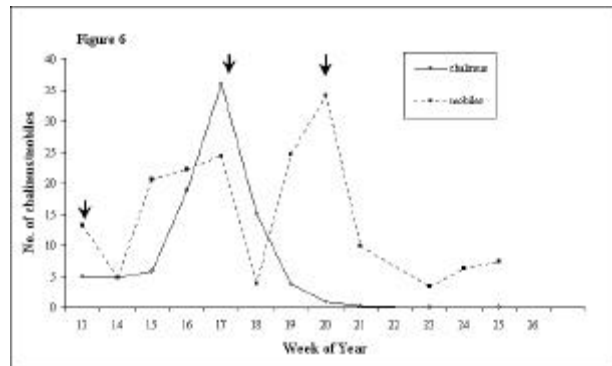
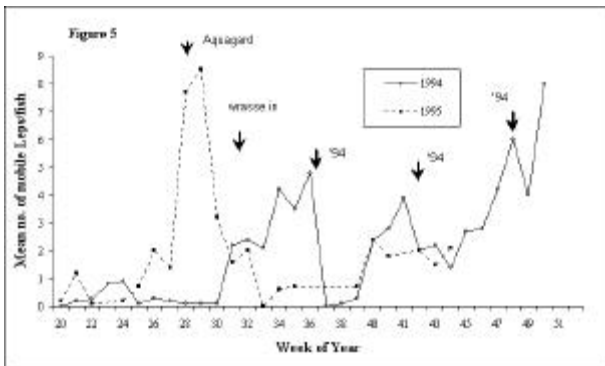
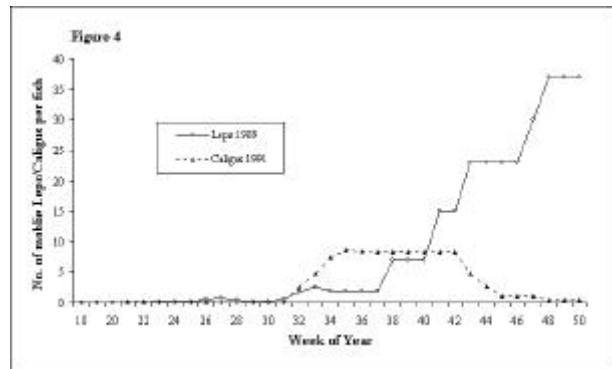
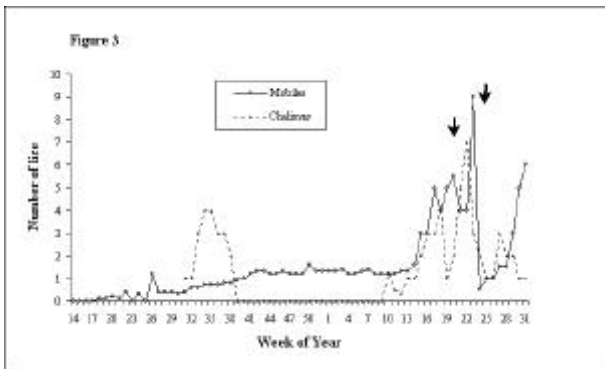
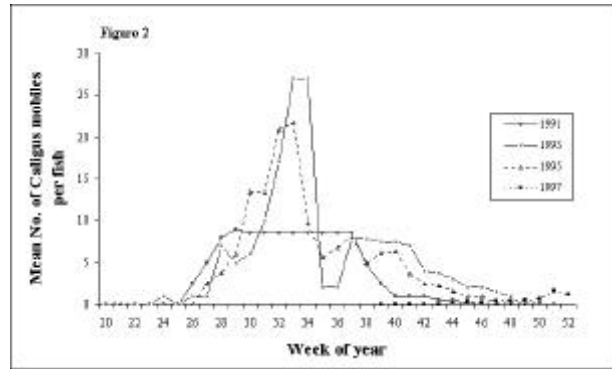
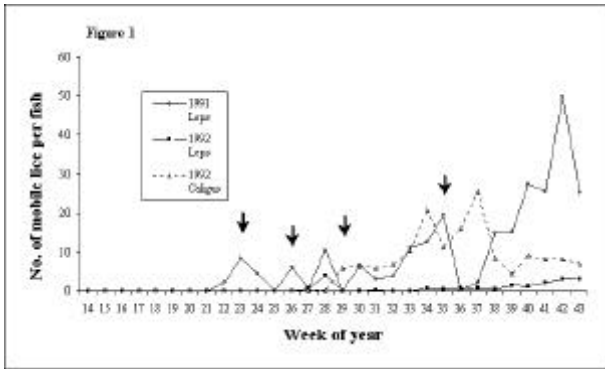
Wrasse have been found to be less effective in the second year of the production cycle. I have carried out a trials with larger corkwing wrasse on 2 cages but with little effect. An alternative would be to try ballan wrasse as good results using ballan have been reported from Norway. Ballan are relatively uncommon in Scotland (Treasurer, 1996b), about 1% of the catch, and culture of ballan would be required.

Part of the ineffectiveness of wrasse in the second year is the disappearance of wrasse over the first winter. Special hides have been developed by Martin Sayer of the Dunstaffnage Marine laboratory, Oban providing a buffer to sudden changes in salinity and temperature. These have been trialled on farms but with no conclusive results; although survival of wrasse improved, they continued to be lost from the cages. Wrasse were not found dead and therefore it was assumed that they have escaped through the net.

Another problem has been the occurrence of an atypical furunculosis, *Aeromonas salmonicida*, in wrasse following capture, transfer and stocking in cages. Wrasse should be vaccinated although the induction period is too short and there would have to be a simultaneous treatment with antibiotic.

3. Treatment with medicines

There are only three licensed medicines for treatment of salmon infested with sea lice in Scotland. Dichlorvos (Aquagard-Novartis) as 1 ppm active is applied as a bath treatment with the cage enclosed with a tarpaulin. The discharge of this medicine is regulated by the Scottish Environmental Protection Agency and the volume of dichlorvos that can be discharged has been reduced in many cases in line with the Paris Convention 1974 for the protection of the North Sea and North east Atlantic. This has a requirement to reduce the use of various toxic and persistent chemicals including dichlorvos. Therefore discharge consent may only be available to treat a farm once per annum. Also many lice populations are resistant to the use of



LEGEND FOR FIGURES

Fig. 1. Comparison of numbers of mobile *L. salmonis* in 1991 on a farm in west Scotland with mixed year classes with 1992 after fallowing (single year class). Arrows indicate dates of treatment in 1991. Time is shown as the weeks of the year (i.e. 1-52 from January to December).

Fig. 2. Mean numbers of mobile *Caligus elongatus* in the first year of the production cycle in 1991, 1993, 1995 and 1997

Fig. 3. A typical pattern of infestation with *L. salmonis* showing the increase in lice numbers in the second year. The reduction in numbers corresponds to 2 treatments with Aquagard.

Fig. 4. Comparison of numbers of mobile *L. salmonis* in 1989 when there was no management agreement with 1991 when the sea loch system was fallowed.

Fig. 5. Comparison of numbers of *L. salmonis* in 1995 when wrasse were stocked with 1994.

Fig. 6. An example of the efficacy of hydrogen peroxide as a treatment for sea lice in spring of the second year of the production cycle. Arrows indicate treatment dates.

Fig. 7. A comparison of chalimus numbers in 1996 on a farm in west Scotland following 3 winter treatments (treatment dates indicated with an arrow) with 1994 when this policy was not applied.

Fig. 8. A comparison of numbers of mobile *L. salmonis* following winter treatments (compare Fig. 7).

this organophosphate, particularly at lower water temperatures, and treatments can be ineffective (Jones *et al.* 1992). Azamethiphos (Salmosan, Novartis) has recently been granted a marketing authorisation and discharge consents have been obtained for a few farms.

The third medicine is hydrogen peroxide, supplied as Paramove by Solvay Interlox and Salartect by Brenntag. This is also applied as a bath treatment and can be very effective (Fig. 6). Although up to 80% of lice recovered from treated cages were active after an hour (Treasurer & Grant, 1997), there have been no reported cases of significant resettlement on salmon. The main problem with hydrogen peroxide is toxicity at water temperatures in excess of 14°C. In addition, chalimi are unaffected, effectiveness against mobile lice may not be complete, and egg bearing females are more difficult to remove.

These medicines are both applied as a bath treatment and there can be variations in enclosed volume compared with target volume. When the tarpaulin has not been filled adequately a higher more toxic concentration is achieved and with a large fill the target concentration is not attained, giving an ineffective treatment. Bath applications are labour intensive, may stress fish, and licensed medicines do not kill the larval stages. Furthermore, the appetite of fish is frequently affected by treatment and fish are starved on the day before and during treatment.

Alternative treatments

Within the terms of the Medicines Act 1968, any substance intended to be used as a veterinary

medicine has to have a marketing authorisation in the U.K. Applications for a marketing authorisation are submitted to the Veterinary Medicines Directorate (VMD) and are assessed on the quality, efficacy and safety of the product. The VMD is advised by the independent Veterinary Products Committee. Obtaining a marketing authorisation can be very time consuming and expensive process, e.g. azamethiphos took 6 years from the beginning of the Animal Test Certificate (ATC) trials.

Un-licensed medicines can be prescribed by a veterinarian where treatment is necessary on welfare grounds and where all licensed alternatives are considered as being ineffective. The veterinarian makes a series of decisions termed the 'cascade principle'.

In addition, the medicine has to be granted a discharge consent by the Scottish Environmental Protection Agency (SEPA). Under section 23 of the Water Act 1989 fish farms are classified as trade premises and any wastes are classified as trade effluent and require a discharge consent. An application for a consent has to be made for each individual farm and depending on the size of the farm extensive hydrographic data are required to predict the scale of discharge that can be made without breaching short term Environmental Quality Standards. An application for a discharge consent is advertised in the local press.

Following extensive laboratory and field trials and environmental impact studies, SEPA gave a limited issue of restrictive consents for ivermectin for a trial period. Efficacy has been good but there have been political issues in marketing these fish.

Cypermethrin (Excis, Grampian Pharmaceuticals) has been trialled under an Animal Test Certificate and this medicine will shortly receive a marketing authorisation. The product is very effective against mobile and to a lesser extent larval stages. Discharge consents will also need to be obtained.

No in-feed treatment is licensed (but see ivermectin), although three possibilities have been used in limited trials under ATC. Onions and garlic have been tried in bags and in feed but were ineffective. Neither have light lures demonstrated efficacy.

The development of a successful vaccine is not imminent. While immune stimulants have given good laboratory results (Simon Wadsworth, pers. comm.), they have not been found to be effective in farm conditions (pers. obs.).

Immediate assistance would be the provision of other more effective medicines but at present the most effective use of current medicines must be considered, particularly hydrogen peroxide. This involves strategic or winter treatments; treating fish when sea lice numbers are low and stable at the beginning of the year. Ritchie et al. (1993) showed that many small eggs are produced at this time and survival of copepodids is poor because of a low nutrient reserve. In an example from Loch Sunart fish were treated with hydrogen peroxide on 3 occasions from March at approximately 6 weekly intervals, weeks 10, 17 and 23 (Fig. 7). This had the effect of reducing the spring increase in sea lice numbers. A comparison is made of the 1993 with the 1995 year class in the second year of the production cycle. Chalimus numbers in 1996 were significantly less (ANOVA on log transformed data, $P < 0.05$), 5.5 on average compared with 21.8 in 1994 (Fig. 7). Numbers of mobile *L. salmonis* were also less, 13.4 weekly average for the second year compared with 31.1 in 1994 (Fig 8). The number of treatments in the second year was reduced by up to 46%, the length of time between treatments was extended, damage to fish was reduced, there were fewer mortalities and improved fish quality (Wadsworth *et al.*, 1998).

This policy and procedure should be allied to coordinating treatments between farms in a prescribed area and followed up with subsequent treatments based on a lice surveillance system. The availability of more effective medicines will enhance the success of this initiative. Recently a

national strategy was launched by the Scottish Salmon Growers Association to coordinate planned sealice treatments throughout designated areas in spring to coincide with the time of year when copepodid survival has been shown to be lowest (Wadsworth *et al.*, 1998). The results of the strategy have not been published but have been reported to be favourable and further improvement will be possible if more effective medicines such as cypermethrin are more widely available.

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Vaccine against salmon lice

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Summary of a project funded under the EC FAIR Research programme: AIR2-CT93-1079

The immune system of fish, as in human, reacts against invading foreign substances. Faced with a disease, the immune system will try to eliminate the infectious agent or substance, for example infectious bacteria, as soon as it has been identified. However, the infection may be too advanced by the time the immune system is fully reacting. Vaccines can accelerate this process. During vaccination, specific portions of the infectious agent (antigens) are injected to stimulate a specific reaction of the immune system (build up of antibodies) to prevent recurrence of the disease. The risk of infection is limited, as only antigens and not the disease agent are injected. During future infections, the immune system will react quicker to the already known disease and consequently improve the chances of survival of the animal.

This common method of vaccination can not be developed against lice as only the exoskeleton and mouth parts of the lice are in contact with the fish. The immune system does not recognise any foreign substances in the blood stream and the active defence mechanisms are not being triggered. However, lice feed on skin and mucus of salmon and thereby take blood meals. As the antibody, which recognise the target, and the white cells, which destroy it, are present in the blood, it was suggested that fish might fight against lice externally through the action of their blood's defence mechanisms ingested by the lice. Indeed, if the immune system is prepared to react against gut cells of lice, it will be triggered within the lice gut and against it. Therefore, lice could be eradicated by the action of the fish immune system following a blood meal. Such vaccination techniques have been used to fight bloodsucker parasites of cows and sheep.

The partners of this project managed to design several vaccines aimed to be used as described above. However, tests on salmon challenged with lice showed only a limited efficacy of the vaccination. Several reasons may explain this poor success. Firstly, lice, unlike bloodsuckers, only ingest a limited amount of blood. Secondly, there is still room for some improvements of the vaccine. Nevertheless, this new approach for treatment of parasites in fish is of great interest and research efforts are being continued to improve the present vaccine. Further development may be expected in a near future.

Cloning and characterisation of *Lepeophtheirus salmonis* microsatellite genetic elements as useful tools for the study of sea lice ecology.

Brief description of project

A two-year research project funded under the Operational Programme for Fisheries (1994-1999) and administered by the Marine Institute (Dublin) seeks to develop DNA profiling techniques and examine their usefulness in improving our knowledge of the ecology of the sea louse *Lepeophtheirus salmonis*. The method being developed is based on examining repetitive DNA elements termed microsatellites, and is used in conjunction with the polymerase chain reaction (PCR) allowing the genetic profile of individual sea-lice to be determined. This type of DNA fingerprinting has proved useful in the research of other species including areas such as identity testing, pedigree analysis, disease diagnosis, and population genetics. Once described, the DNA profiling tools will be tested and assessed for their ability to detect genetic variation in sea-lice recovered from both farmed and wild fish. The research aim is to describe the genetic variation within identified single populations of *L. salmonis* and also between different populations of *L. salmonis*.

The work is being conducted by Dr Richard Powell (Department of Microbiology) and Dr Sam Martin, (National Diagnostics Centre, BioResearch Ireland) of the National University of Ireland, Galway. They are currently at the half-way mark, and have cloned and determined the DNA sequence of forty sea-lice microsatellites, and developed ten microsatellite-PCR assays. The final year of the project will now be spent examining whether these new DNA profiling tests have the potential to provide new information on the monitoring and movement of sea-lice populations.

Semiochemicals for sea lice control

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Semiochemicals are naturally occurring chemicals which communicate information to living organisms. Some of these compounds have been exploited in order to regulate insect behaviour. For example, sex pheromones are used to lure, trap and disrupt the behaviour of some moth pests¹ and the compounds that attract some veterinary pests to their mammalian hosts have also been used in traps². Such approaches now form important options for the design of effective pest management strategies.

The theory, methodologies and technologies that have given rise to such strategies are now being applied to the problem of *Lepeophtheirus salmonis*. We are in the process of identifying the semiochemicals which attract salmon lice to their hosts and male lice to their mates*. It has long been suggested that parasitic copepods use fish-derived odours, at least in part, to identify their hosts^{3,4} and preliminary work has shown that lice do have a behavioural response to these stimuli⁵. The successful identification of such compounds will allow us to investigate the possibilities of designing lice traps or of creating disruptive techniques for use in fish farms.

Currently, our research focuses on host-finding behaviour by adult lice. Significant numbers of lice transfer between hosts in sea cages, and host-finding may be important in the reattachment of lice dislodged from their hosts, and for the redistribution of males searching for unmated females⁶. It may also prove possible to encourage lice to leave their host given sufficiently strong alternative attractants.

In this initial phase, the project centres on the design and use of simple flow chambers allowing different stimuli, present in host-conditioned seawater, to be proffered to lice. The copepods are monitored for the presence or absence of behavioural responses. Using a digital tracking system, the relative strength of these responses can be assessed by measuring the speed and direction of movement. Other assays, which allow the lice to exhibit preference for one stimulus over another, are used to gauge whether a stimulus is an attractant. By making a choice of odours available to the lice, we can discern which are the more effective.

As a result of these studies, we now have unequivocal evidence that male and female salmon lice exhibit behavioural responses to a variety of fish-derived stimuli, and that the molecules involved are quite stable in seawater. These responses are directional and kinetic, and provide the first evidence that *L. salmonis* exhibits a positive rheotaxis to fish-conditioned water.

Once we have established which semiochemical sources elicit the greatest attractant response, we will extract the organic components of these from the water and use electrophysiological techniques to record the sensory responses of lice to these compounds. The aim of this is to show a clear relationship between the chemical cue, the stimulation of the chemoreceptors and the triggering of host-finding behaviour. At this point we can embark on detailed studies of the particular molecules eliciting this chain of events. It is these we hope to investigate for their potential in trapping and disruption techniques.

*Link Aquaculture (SAL 11). Aberdeen University - AJ Mordue, AW Pike, W Mordue; Nottingham University - I Duce; IACR-Rothamsted - JA Pickett, L Wadhams. Funded by Natural Environment Research Council, the Scottish Salmon Growers Association and the Shetland Salmon Farmers Association. In collaboration with Marine-Harvest Mc Connell and Landcatch UK.

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Aqua TT – European Aquaculture Network

Aqua TT is a European Network of co-operative Universities and Industries involved in the aquaculture sector with the following main aim:

"To support the strategic goals of the aquaculture industry by facilitating collaborative university/industry action in education, training, technology transfer, research and development."

Aqua TT was founded in 1992 under the EU COMETT programme as the University Enterprise Training Partnership (UETP) for the European aquaculture industry. The initial proposal arose from the identification of a clear need to systematize, coordinate and develop the training requirements of the industry through a single body.

The company achieves this specific remit by supporting its members, through participation in a number of EU programmes such as COMETT, LINGUA, FORCE, TEMPUS, FAIR, LEONARDO DA VINCI, SOCRATES and the DGXIV PESCA initiative. Activities include:

- Transnational exchanges of staff from company to company or between companies and universities ·
- Development and delivery of short courses in advanced technologies ·
- International exchanges of students and recent graduates ·
- Industry, higher and vocational education surveys and training needs analysis ·
- Dissemination of information and results from EU RTD programmes ·
- Development of training materials and methods · Telematic training solutions

Currently AquaTT runs a successful network of almost 600 members throughout the European aquaculture sector, including industry bodies, trade and training associations, research institutes, governmental laboratories and development agencies. To date it has secured over 2.6 million ECU in funding for the European aquaculture sector.

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AQUAFLOW- European Network for the dissemination of Aquaculture RTD information

The European Aquaculture Society (EAS), Aqua TT and the Federation of European Aquaculture Producers (FEAP) are jointly promoting a new EU funded (FAIR-CT97-3837) project.

Known as AQUAFLOW, the project aims to establish a wider and more rapid circulation of information concerning the results and progress of EU funded (and, eventually, relevant non-EU funded) programmes for research, technological development and demonstration (RTD) in aquaculture. The target is the potential end user in Europe and will include farmers, technicians, vets and other professional people who are active within the aquaculture sector.

The project works in a simple manner- each month a number of single-page sheets will be prepared. These technical sheets will provide a concise summary of the research project, together with the main findings and conclusions. The sheets will then be widely distributed, reaching aquaculture interests across Europe. In addition a series of workshops are planned over the 3 year period, the first being scheduled for "Aquaculture Europe" to be held in Bordeaux, France 7-10 October 1998.

Aquaflow will also collect feedback from the small and medium aquaculture enterprises (SMEs) to be able to identify further the needs for aquaculture research & technology and associate information services as well as being able to respond to problems and bottlenecks encountered in the project.

Further information on the project available from:
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Report on the 1998 sealice conference in Amsterdam

About 70 persons attended the sealice sessions at the Fourth International Crustacean Congress, July 20-24, Amsterdam. Delegates were from industry (43%) universities (41%), government (14%) and non-governmental (2%) organisations. Many of these papers have been submitted for publication and are currently undergoing peer review. The proceedings will be published in the journal Contributions to Zoology (formerly Bijdragen tot de Dierkunde). The following papers were presented at the sealice workshop sessions. Note that the titles and authorships of papers submitted for publication in the proceedings do not necessarily match those presented at the conference.

- Banks, B.A., A.P. Shinn, J.E. Bron & C. Sommerville. The use of RAPDs 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.
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- 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., A.P. Shinn & C. Sommerville. Ultrastructure of the cuticle of the chalimus larva of the salmon louse *Lepeophtheirus salmonis* (Krøyer, 1837) (Copepoda: Caligidae).
- Bron, J.E., A.P. Shinn & C. Sommerville. A description of moulting in the chalimus larva of the salmon louse *Lepeophtheirus salmonis* (Krøyer, 1837) (Copepoda: Caligidae).
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- Costello, M.J. & A.W. Pike. Towards a quantification of salmon lice population dynamics and infestation potential.
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- Jackson, D., S. Deady, D. Hassett & Y. Leahy. Population dynamics of sea lice on wild sea trout post smoults.
- Jackson, D., S. Deady, D. Hassett & Y. Leahy. *Caligus elongatus* Nordmann as parasites of farmed salmon in Ireland.
- Jackson, D., D. Hassett, S. Deady & Y. Leahy. *Lepeophtheirus salmonis* (Krøyer) (Copepoda: Caligidae) on farmed salmon.
- McAndrew, K., R. Wootten & C. Sommerville. Survival and egg production of *Lepeophtheirus salmonis* in experimental infections of Atlantic salmon (*Salmo salar*).
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Events Calendar

Aquaculture America '99.

January 27-30, 1999, Tampa Convention Center, Tampa, Florida, USA.
E-mail: worldaqua@aol.com

Fifth Central American Symposium on Aquaculture.

March 3-5, 1999, Centro Social Hondureno Arabe, San Pedro Sula, Honduras.
E-mail: worldaqua@aol.com

World Aquaculture '99

The Annual International Conference and Exposition of the World Aquaculture Society. Sydney, Australia, 26 April - 2 May 1999.
Conference Homepage:
<http://ag.ansc.purdue.edu/aquanic/was/was.html>

7th International Conference On Copepoda,

Curitiba, Brazil, from 25 to 31 July 1999
Conference Website:
<http://www.ufpr.br/eventos/icoc>
E-mail: copepoda@cem.ufpr.br

4th International Conference on SeaLice

Dublin, 28-30 June 1998
E-mail: mcostello@ecoserve.ie
Website: www.ecoserve.ie/projects/sealice

17th International Conference of the World Association for the Advancement of

Veterinary Parasitology, Copenhagen, 5-19 August 1999.
E-mail waavp99@ics.dk
Web site www.waavp99.kvl.dk

Best current strategies for the control of lice on salmon farms

This document arose from the discussions at the Trondheim workshop on sea lice control on fish farms, as part of the EU Concerted Action on "Lice control in Fish Farms", under the FAIR programme, and was drafted by Kjell Maroni, KPMG Management Consulting, Flatanger, Norway

The following report is made as a pointed list, and not as an in depth advice. This is done as a consequence of the fast development of new methods for lice treatment, and also is the most correct picture from the discussions in Trondheim.

Prevention of infestation

- Use single generations sites, or if not possible, fallow at least one month between generations.
- Avoid sites found to have persistently high lice levels.
- Use cleaner-fish (wrasse) if possible.

These precautionary methods will also reduce the transfer of other diseases within and between farms.

Monitoring

- Monitoring is important, you do not know when to treat if you don't monitor lice.
- Motivation for lice sampling is important - teaching about lice and "standard protocol for lice sampling" is necessary.
- Use monitoring results to get information about the population structure and infection system (sporadic or continuous).
- Exchange counting results between farms in the same area (to know when and where infection is coming).
- The initiatives of EwosAS and Skretting (Nutreco) in distributing laminated A4 colour guides (in Norwegian) to farms for lice identification was praised.

Action level

- The action level will depend on time of year. Low numbers must be attained especially in the spring. The most important goal must be

to avoid maturing females (keep the numbers below 1 per fish, preferably zero!).

- A winter treatment (November - February), coordinated among farmers in the same region, has given very promising results (see article by Treasurer in this issue).
- It is important to document past experience at a farm so as future staff can consider this in planning further treatments.

Treatment

The preferred method will always be the biological method, using cleaner-fish (wrasse). The advantage is that they clean the fish continuously, and pick off the lice with egg strings first. The disadvantage is their low activity at low temperatures (< 6 °C), and the method is only partly developed for big salmon (> 2 kg). However, Ballan wrasse seem very promising on such big fish (see Kvenseth article, Caligus, Issue 2). It is necessary to avoid heavily fouled nets, because the wrasse will feed on the fouling rather than the lice. It is also possible to capture lice released when moving or grading fish.

Chemical treatment can be used if preventive methods or cleaner-fish do not do the job. The application of chemotherapeutants by spray or dip when grading is effective and uses and releases less chemicals. It was agreed that in-feed methods seem very promising, but documentation and practical results are still scarce. For example the time between dose and effect on lice and relative impacts on chalimus, mobile and egg production is unclear.

Chemical methods should be chosen so that the life cycle of the lice is broken. Bath methods effective against juveniles should be chosen when treating early in the life of the salmon, while methods killing the adult lice only can be used when it is near slaughtering time.

- Short term methods: Chemical treatment (bath, in-feed).

- Long term methods: Cleaner-fish (wrasse) and husbandry methods.

Authorities

It is important to have cooperation between the fish farmers and the authorities. The authorities should go for a preventive strategy, and help the salmon farming industry to quantify benefits from lice control (economic, less lice pressure on wild fish, market image).

It is felt that some countries (apart from Norway) have an over-protective strategy when it comes to legislation of new treatment methods. This can result in resistance problems, and also leaves the farmers fewer methods to use under different conditions. The authorities must use their “law-power” to force fish farmers who do not follow the agreed (co-ordinated) treatments in a region. Both “carrot” and “stick” are necessary!

Regulations

Most chemotherapeutants used against lice have been developed for other animals so considerable information already exists on their risk to staff

and the consumer. However there is inadequate co-ordination between different regulations for chemotherapeutants both within and between countries, including the EU and EEA countries. Products may be licensed for use but not permitted to be released into the sea or may not have maximum residue limits established for salmon meat going to market.

Future Research

Farmers need to have the methods and best advice on how to treat lice now. The priority for action here is to improve management and co-ordination of regulations. A longer term view identified novel areas of research which may produce more effective treatments. This includes research into how lice find their host, if it is possible to upset the digestive system of lice (e.g. through a vaccine), and to improve techniques for the use of different species of cleaner-fish to control lice. Another priority is for more sophisticated and quantitative models of lice population dynamics including their host location behaviour and hydrographic conditions.

New delousing compound, ALPHA MAXTMvet, from ALPHARMA successfully in use in Norway.

Pelle Kvenseth reports the following news on a new lice control compound, from talking to Alpharma, fish vets and farmers.

ALPHARMA has under general exemption from licensing, been given permission to sell a newly developed delousing compound in Norway. ALPHARMA has been working with the development and testing of this new formula for the last four years. The new compound is a pyrethroid and is sold under the trade name ALPHA MAXTMvet. As with all other treatment on farmed fish in Norway, both treatment and medicine must be prescribed by a veterinarian. Before permission is given by the Norwegian Medicine Control Authorities (SLK), corresponding to VMD in Great Britain, for a new delousing compound, it has to be extensively tested. Many tests are necessary to establish concentrations, effect on treated fish, effect on different life-stages of lice and effect on non target organisms and effect on the environment.

The active ingredient in ALPHA MAX is deltamethrin. The method of treatment is the traditional use of closed tarpaulin to surround the infected fish in a ‘bath’. Treatment concentration is 3 ppb during 30 minutes in closed tarpaulin. The withdrawal period before slaughtering is 3 days. The treatment is reported to be effective against all stages of sealice, both sessile and mobile, and has become very popular, especially in Western Norway and Trøndelag. According to veterinarians and farmers, ALPHA MAX is an efficacious treatment, and it has largely replaced other bath treatments in several regions.

Internet e-mail discussion group for lice biology and control

The Caligus listserver is an e-mail discussion group which was set up to enable people interested in lice biology and control to provide and request information from others in the group. The group relies on people voluntarily sending and replying to 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 signature in the message.

To leave the list, send the message "SIGNOFF CALIGUS" to <listserv@listserv.heia.ie>.

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.

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 back issues 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. Contact: Mr Chris Emblow (cemblow@ecoserve.ie).

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 Rathfarnham Rd, Terenure, Dublin 6W, Ireland; or any of the project's partners.

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