

NEA(08)3

**Report of the Second Meeting of the
Working Group on *Gyrodactylus salaris* in the
North-East Atlantic Commission area**

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1. The second meeting of the Working Group on *G.salaris* in the North-East Atlantic Commission area was held in Oslo, Norway, during 10-12 October 2007 under the Chairmanship of Mr Stian Johnsen (Norway). Representatives of the European Union (Finland and UK (England and Wales, Northern Ireland and Scotland)), Norway, NASCO's accredited NGO's, the World Organisation for Animal Health and the ICES Working Group on the Pathology and Diseases of Marine Organisms attended the meeting. The lack of participation by some NEAC Parties and EU Member States is a concern to the Working Group. The report of the meeting is attached.
2. The Working Group reviewed information on:
 - monitoring programmes for the parasite and information on its distribution;
 - the measures being taken to prevent the spread of the parasite and to eradicate it where it has been introduced;
 - initiatives being taken to increase awareness of the parasite;
 - the results of cost-benefit analyses in relation to the introduction and eradication of the parasite;
 - on-going and planned research and research requirements in relation to *G.salaris*;
 - other fish health issues of relevance to wild Atlantic salmon (because of time constraints there was only a brief exchange of information in relation to Proliferative Kidney Disease (PKD) and Anisakis infestations of salmon.
3. The Group noted that the host-parasite relationship between *G.salaris* and Atlantic salmon is complicated because of the existence of both pathogenic and non-pathogenic strains of the parasite, because the resistance of Atlantic salmon to the parasite varies, and because environmental conditions such as water quality can have a significant impact on the relationship. Nonetheless, given the potentially devastating impact of the parasite on wild stocks the Group concluded that Additional Guarantees under the EU Fish Health Directive should continue to be based only on the presence or absence of the parasite rather than trying to distinguish between pathogenic and non-pathogenic strains.
4. The Group endorsed the recommendations contained in the NEAC's 'Road Map', (document (NEA(04)13 as amended)) and believes that there should be urgency about their implementation by the NEAC Parties because the risks posed by the parasite have not been diminished in any way. These recommendations are in relation to:
 - the need for strengthened national and regional legislation and measures to prevent the further spread of the parasite;
 - revisions to international guidelines;

- research, in particular with regard to differentiation of harmful and non-harmful forms of the parasite and the effects of environmental factors, and with regard to improved coordination of research
5. The Working Group recommends as follows:
- that the NEAC seeks reports on progress in developing contingency plans for *G.salaris* from those countries that did not attend the Working Group meeting and that those countries without plans be encouraged to develop them as a matter of urgency;
 - that the NEAC Parties and the Secretariat make representations to the European Commission seeking the continued availability of all Additional Guarantees as originally adopted, in perpetuity after 2009;
 - that information on *G.salaris* be made available on the NASCO website when it is revised, with appropriate links;
 - that a scientific Working Group be established, that would report back to the *G.salaris* Working Group, to facilitate exchange of scientific information; to make recommendations on standardised methods; e.g. on monitoring; to identify and recommend areas where collaborative research across government laboratories requires funding; and to identify sources of funding.
 - that the NEAC decides when the Group should next meet and encourage further participation in any future meetings.
6. The NEAC is asked to consider these recommendations and decide on appropriate action.

Secretary
Edinburgh
9 April 2008

GSWG(07)19

Report of the Second Meeting of the Working Group on Gyrodactylus salaris in the North-East Atlantic Commission Area

**Clarion Collection Savoy Hotel, Universitetsgaten 11, Oslo, Norway
10-12 October 2007**

1. Opening of the Meeting

- 1.1 The Chairman of the Working Group, Mr Stian Johnsen (Norway), opened the meeting and welcomed participants to Oslo. He particularly welcomed representatives of the World Organization for Animal Health (OIE), the ICES Working Group on the Pathology and Diseases of Marine Organisms (WGPDMO) and NASCO's accredited NGOs.
- 1.2 The Secretary of NASCO, Dr Malcolm Windsor, added his welcome and briefly described the structure and functions of NASCO. He indicated that the Group's report, including any recommendations, would be presented to NASCO's North-East Atlantic Commission (NEAC) for consideration at its Annual Meeting in June 2008. He noted that NASCO's role was to conserve and restore the Atlantic salmon and that this objective should guide the work of the Group in developing its recommendations.
- 1.3 A list of participants is contained in Annex 1.

2. Adoption of the Agenda

- 2.1 The Working Group adopted its agenda, GSWG(07)18 (Annex 2), after amending Item 9 to 'Other fish health issues of relevance to wild Atlantic salmon'.

3. Consideration of the Terms of Reference

- 3.1 The Working Group considered its Terms of Reference (ToR), as contained in the 'Road Map', GSWG(07)3, agreed by NASCO's North-East Atlantic Commission in 2004 for taking forward the recommendations developed by a previous workshop in relation to *G. salaris*.
- 3.2 The Working Group considered that it did not have the socio-economic expertise available to it to undertake cost-benefit analyses as proposed in its ToR but nonetheless agreed that it would be useful, as at the Group's first meeting, to exchange information on such analyses where these had been undertaken by the Parties and their relevant jurisdictions.
- 3.3 The Working Group decided that, if time permitted, under Agenda item 9 it would briefly discuss progress in managing interactions between sea lice and wild Atlantic salmon but recognised that this topic was also being addressed by the NASCO/North Atlantic salmon farming industry Liaison Group and through the Parties' implementation plans and reporting arrangements. It would also review information

on Proliferative Kidney Disease (PKD) and Anisakis made available by the ICES WGPDMO.

4. Monitoring programmes for, and the distribution of, *G. salaris*

- 4.1 Reports on *G. salaris* sampling in UK (Scotland) in 2006, GSWG(07)5 (Annex 3) and 2007, GSWG(07)6 (Annex 4) and GSWG(07)7 (Annex 5), were presented. All salmon and trout farms are visited annually and 50% are sampled (30 fish per sample). Farms holding broodstock are visited twice each year. The 55 defined river catchments (covering the 380 salmon rivers) are sampled once every five years. In summary, this monitoring indicated that while gyrodactylids (*G. derjavini* and *G. truttae*) had been recorded during sampling programmes for farmed and wild fish, no *G. salaris* had been recorded. Information was also made available to the Working Group on the diagnostic methods used for *Gyrodactylus* species in Scotland, GSWG(07)8 (Annex 6).
- 4.2 The representatives of the UK (England and Wales) reported that in 2006/2007 monitoring for the parasite had occurred at 37 sites that had been sampled up to three times each. While gyrodactylids had been found at 14 sites, *G. salaris* was not recorded and England and Wales remain free of this parasite. *G. derjavini* was found at 7 sites on a mixture of Atlantic salmon, brown trout and rainbow trout. *G. truttae* was found on brown trout and *G. thymalli* was found on grayling.
- 4.3 The representative of the UK (Northern Ireland) reported that in 2006/2007 monitoring for the parasite had occurred at fish farms but *G. salaris* had not been found. In addition, sampling takes place in 12 rivers each year under a rolling programme in which all of the 27 rivers are sampled approximately once every three years. *G. salaris* had not been identified using microscopic inspection of skin scrapes and fin tissue.
- 4.4 The representative of Finland tabled a report on monitoring for *G. salaris*, GSWG(07)13 (Annex 7). In accordance with an agreement with Norway, 150 wild salmon parr are sampled annually from the rivers Teno and Näätämö. There is no aquaculture in these catchments. *G. salaris* has not been recorded. Sampling in two other watercourses draining into the Barents Sea, and at two fish farms in one of these watercourses, was also conducted but *Gyrodactylus* spp were not recorded. There was no sampling in a third river draining into the Barents Sea. There is no official monitoring for *G. salaris* in rivers draining into the Baltic and White Seas.
- 4.5 The representative of Norway reported that in 2006, more than 3,000 salmon from 94 rivers had been examined for *G. salaris*, together with approximately 1,800 fish, both rainbow trout and salmon, from fish farms, GSWG(07)14 (Annex 8). However, for 2007 the sampling programme had been restructured into a risk-based programme in which 108 rivers are monitored annually, with at least 30 fish being sampled from each river and with examination of the whole fish, not just their fins. In larger rivers, larger samples are examined. In fish farms only the fins are examined but sample sizes are at least 60 fish for rainbow trout and 30 fish in the case of salmon. Two other monitoring programmes are undertaken. In rivers where there has been an eradication programme, samples are collected at 1 - 2 km intervals along the river and the monitoring continues for a period of at least five years to confirm the successful eradication of the parasite. In rivers where the parasite has appeared for the first time

or where the parasite has reappeared after treatment, sampling of 60 fish is undertaken. The representative of Norway tabled a document on monitoring and research in relation to *G. salaris* in Fennoscandia, Denmark and Russia, GSWG(07)4 (Annex 9). This paper noted that nine different haplotypes of *G. salaris* have been identified and that the pathogenicity of the parasite appears to vary both within and among haplotypes. However, the host-parasite interaction is further complicated because there are also different types of Atlantic salmon with varying resistance to the parasite and environmental conditions such as water quality may have a significant impact on the relationship between the parasite and its host.

- 4.6 The Working Group recognised that there might be a situation where a non-pathogenic strain of *G. salaris* was introduced into a country or region that was previously free of the parasite. This could affect that country or region's disease status with regard to *G. salaris* which could increase the risk of pathogenic strains being introduced through movements of live fish, with consequences for wild Atlantic salmon. Nonetheless, the Group believes that in order to safeguard wild salmon stocks, Additional Guarantees should continue to be based on the presence or absence of *G. salaris* rather than trying to differentiate between pathogenic and non-pathogenic strains, since its pathogenicity may be influenced by the environment and the salmon population concerned. Further research into the pathogenicity of *G. salaris* is required.
- 4.7 At its first meeting the Working Group had agreed that it should seek an exchange of information on *G. salaris* monitoring and research from the ICES WGPDMO and the EC Fish Disease Reference Laboratory and, accordingly, the NASCO Secretariat had invited both organizations to be represented at the meeting to facilitate this exchange. ICES had agreed that a Norwegian representative to the WGPDMO, Dr Tor Atle Mo, would participate in the NASCO Working Group meeting, and that the Chairman of the NASCO Working Group would be invited to attend the next ICES WGPDMO meeting. Dr Mo indicated that the ICES WGPDMO had not had much focus on *G. salaris* as it is a freshwater parasite and is being dealt with in other fora. He indicated that he had contacted members of the ICES WGPDMO seeking information on: *G. salaris* monitoring and research; information on *G. salaris* from countries without wild Atlantic salmon; and topics for possible workshops and seminars. He summarised the information provided for those countries not represented. He indicated that there was no monitoring programme for *G. salaris* in the southern Baltic area of Russia but there may be sampling programmes in northern parts of the country. Information from Ireland indicated that under EC Decision 2004/453, Ireland has been granted an Additional Guarantee of freedom from the parasite and, in accordance with the conditions associated with this guarantee, monitoring of rivers is carried out annually and both microscopic and molecular methods of identification of gyrodactylids are used. *G. salaris* has not been found. Canada had reported that there is no evidence that *G. salaris* occurs in Canada but a research programme has commenced to develop diagnostic markers under the National Aquatic Animal Health Programme. It is anticipated that a database on the Canadian, and perhaps North American, species of gyrodactylids will be developed. It is thought unlikely that there is a monitoring programme for *G. salaris* in the USA.
- 4.8 The Working Group discussed standards for monitoring programmes, which are vitally important in mapping the distribution of the parasite and in support of

Additional Guarantees. The Group noted that the 'Road Map' contained some important guidance with regard to monitoring programmes, as follows:

- the geographic distribution of *G. salaris* should be established with a view to minimising its spread to uninfected catchments. To this end, existing monitoring programmes should be retained and expanded as necessary. Standardised targeted monitoring methods in watercourses, lakes and in rivers should be introduced;
- surveillance programmes should include all potential host species. On farms with both salmon and rainbow trout both populations should be tested. Higher sample sizes will be required for rainbow trout because the prevalence of the parasite is expected to be lower;
- diagnosis of *G. salaris* by morphology should be confirmed by the use of molecular techniques. Criteria for diagnosis should be based on the OIE Manual of Diagnostic Tests for Aquatic Animals;
- countries with shared catchments should cooperate in monitoring programmes.

- 4.9 The Working Group noted that principles concerning monitoring have been developed by OIE and are contained in the Aquatic Animal Health Code, 2007 and the Manual of Diagnostic Tests for Aquatic Animals, 2006 (the general principles are in section 1 of these documents and principles specific to *G. salaris* in section 2.1.14). With regard to standardised targeted monitoring methods the Working Group has recommended establishing a Scientific Working Group whose Terms of Reference include facilitating cooperation on issues including monitoring approaches (see paragraph 8.5 below).

5. Measures to prevent the spread of the parasite and to eradicate it where it has been introduced

(a) national and regional initiatives, including progress in developing contingency plans

- 5.1 At its first meeting the Working Group had considered that, consistent with the 'Road Map', it is essential that each Party and relevant jurisdiction should have a contingency plan to deal with an outbreak of *G. salaris*. While it was recognised that these plans would need to be tailored to the situation in each country, the Working Group had developed guidelines for establishing contingency plans for the treatment, containment and eradication of *G. salaris*.
- 5.2 A document, GSWG(07)9 (Annex 10), was tabled detailing the measures taken to prevent the spread of *G. salaris* in UK (Scotland). *G. salaris* is exotic to Scotland but it is considered that there is a risk of its introduction as a result of both the trade in fish eggs and via leisure pursuits. Importation of live salmonids from areas of lower health status with respect to *G. salaris*, is prohibited into Great Britain, although importation of disinfected eggs is permitted. A contingency plan has been developed and contains sections on disease response assumptions; command and control; structures and responsibilities of government headquarters; field operations; communications; and resources. In February 2007, a table-top exercise was conducted in cooperation with officials from England and Wales and Norway to test the robustness of the plan. A number of revisions had been proposed in the light of this testing. Initiatives are underway to highlight the risks of importing the parasite through publicity at airports and ferry and sea ports.

- 5.3 The representative of Finland indicated that no contingency plan had been developed for the rivers draining into the Barents Sea and there were no plans to develop such a plan in the near future.
- 5.4 The representatives of the UK (England and Wales) indicated that a *G. salaris* group had been established involving scientists from Scotland, Northern Ireland and England and Wales in order to develop common approaches to diagnostic screening and for conducting surveillance in the event of the introduction of *G. salaris*. Furthermore, existing databases on fish movements are not well integrated and this aspect is also being addressed. They indicated that the contingency plan for England is being reviewed and there are separate, but parallel, plans for Wales and Northern Ireland. The DEFRA plan represents the strategic approach while the CEFAS and the Environment Agency elements of the contingency plan deal with strategies to be followed by the national control centre (CEFAS) and by the Environment Agency for combating an outbreak. Consideration of the legislative powers is underway. In addition, the information leaflets about *G. salaris* are being revised. The representative of the UK (Northern Ireland) indicated that the revised contingency plan is at the consultation stage and more details of the treatment method to be used are required.
- 5.5 A report on the eradication programme in Norway was presented (see GSWG(07)14, Annex 8). In 2007, a total of NOK49 million (approximately £4.5 million) had been allocated to the eradication programme, an increase from NOK30 million in 2006. A total of 46 rivers have been infected with the parasite but, of these, 15 have been treated and confirmed free of the parasite and 10 rivers have been treated but are still being monitored to confirm their freedom from the parasite. A further 10 rivers have been treated but the parasite has returned. Eleven rivers have not been treated. When rivers are treated, the salmon stock is maintained in a living gene bank and then parr are stocked back into the river following treatment. It was noted that in Norway, where barriers are erected to facilitate treatment, there is a need to take measures to conserve sea trout stocks but there are no species above barriers that would be a reservoir for the parasite. This may not be the case in other countries, making the eradication programme more complicated and expensive. It was further noted that in Norway the stretch of rivers accessible to anadromous salmonids was perhaps 10-15% of the catchment and that natural recolonisation of invertebrates could occur from areas above the treated zones. It was also stressed that a combination of both rotenone and acid aluminium was considered necessary since rotenone is needed in stagnant areas and very alkaline systems.
- 5.6 At its first meeting the Working Group had asked that the Russian delegation and the NASCO Secretariat cooperate in contacting the Government of Karelia to determine if the report of movements of live rainbow trout to Karelia, from sources in Finland that had not been confirmed to be free of the parasite, was correct, and to see what action could be taken to prevent the spread of the parasite with imports of rainbow trout. The Secretary indicated that in accordance with this request he had contacted the Head of the Russian Federation's delegation to NASCO regarding this matter. He indicated that the response from the Federal Veterinary Authority had confirmed that while there had been imports of live rainbow trout to Russia from Finland, all imports were under permit and all the regulatory requirements had been met. It had subsequently been decided that the Russian import requirements would be modified to

include specific provisions regarding the parasite *G. salaris*. The Working Group welcomed this information but requested that the Secretary seek further clarification from Russia on the existing regulatory requirements and the proposed new provisions concerning *G. salaris*.

- 5.7 At its first meeting the Working Group had recommended that NASCO's Parties and their relevant jurisdictions should: continue to develop methods for the use of chemical treatments which minimise any environmental impacts; establish whether the use of alternative or complementary methods to rotenone might be restricted or rejected under EU or other legislation; make available to the Working Group information on the effects of alternative or complementary methods; identify the means of ensuring continued experimental use of alternative or complementary methods to rotenone. The Working Group had been advised that an application for essential use derogation for rotenone under the so-called EU 'Biocides Directive' had been submitted by the Norwegian Government in March 2006. Furthermore, the private company VESO had submitted a dossier to the UK Health and Safety Executive, as the competent authority appointed by the Commission, for registration of rotenone in the positive list of the Directive. The representative of Norway advised the Working Group that a decision on the application for listing of rotenone was expected in 2008 or 2009 but that in the meantime continued use of rotenone is permitted within the EU and EEA. The Norwegian application for essential use derogation had been withdrawn. No new information was available on whether the use of acid aluminium might be restricted under EU or other legislation. In the event of a major demand for rotenone it was noted that there could be a delay of up to 18 months since the current supply can only meet the existing demand for the product.
- 5.8 The Working Group endorsed the recommendations in the 'Road Map' for strengthened national and regional legislation and measures to prevent the further spread of *G. salaris* and believes there should be urgency in their implementation by the Parties to the North-East Atlantic Commission of NASCO and their relevant jurisdictions because the risks posed by *G. salaris* have not diminished in any way. In particular, the Working Group noted that Iceland, Russia and a number of EU Member States (Ireland, France, Spain, Sweden, Germany) were not present at the meeting and that no reports had been submitted on progress in developing contingency plans in these countries. This is a concern to the Group, as is the fact that there is no plan for Finland. The Working Group recommends that this issue be considered further by the NEAC and that reports on progress in the development of these plans should be sought from the countries concerned and that those countries that do not have plans in place be encouraged to develop these as a matter of urgency.

(b) *international initiatives*

- 5.9 At the first meeting of the Working Group, a letter from the Head of the EU delegation to NASCO had been tabled that stated that the level of Community protection against the importation of *G. salaris* has not been diminished under the new draft EU Fish Health Directive. The Working Group had considered that that would only be the case if the Additional Guarantees were permanently adopted under the new Directive rather than being subject to review. The Working Group had, therefore, requested that the North-East Atlantic Commission of NASCO seek further clarification from the European Commission that the Additional Guarantees will be permanently adopted and not subject to review, so that the protection against import

of *G. salaris* is not diminished under the new Directive. The Secretary reported that at NASCO's 2006 Annual Meeting the representative of the European Union had stressed that the safeguards in place would be maintained and would be available to countries in the Community and the European Economic Area. However, the Working Group noted that the existing Additional Guarantees are scheduled to be reviewed in 2009. In the absence of listing of *G. salaris* under the Fish Health Directive, these Additional Guarantees are vital in safeguarding wild Atlantic salmon stocks from this highly damaging parasite and the Group strongly recommends that the Parties of the NEAC and the Secretariat of NASCO make representations to the European Commission seeking the continued availability of all Additional Guarantees, as originally adopted, in perpetuity after 2009. The Working Group noted that these Additional Guarantees could be used to prevent movements of live fish from a zone of lower *G. salaris* status into a higher status zone. Where trade is permissible, trade in disinfected gametes is, however, preferable to trade in live fish since the risks of spreading the parasite are less because for example of issues with certification, monitoring, and diagnostic tests (see paragraph 6.6). Commission Decision 2004/453/EC details the conditions that must be met to obtain area/country freedom from a specific disease. Annex 5 of this Decision also details the conditions to be met before status can be regained after a case of disease in a previously free area/country. The Working Group noted that the 'Road Map' recommends that the minimum approved zone size should be a river catchment not individual farms.

- 5.10 The Working Group noted that several countries had not been represented at the meeting and that for future meetings it might be useful to consider specifically inviting certain participants working on *G. salaris*, e.g. from Karelia and the Murmansk region, and to consider possible methods to fund such attendance. These participants should also be invited to participate in the Scientific Working Group meeting referred to in paragraph 8.5. The representative of Norway indicated that it is intended to hold joint meetings with Sweden and Finland to improve cooperation on measures to prevent the spread of the parasite.
- 5.11 The Working Group endorsed the recommendations in the 'Road Map' concerning revisions to international guidelines and believes that there should be urgency in their implementation by NEAC Parties of NASCO and their relevant jurisdictions because the risks posed by *G. salaris* have not diminished in any way.

6. Initiatives to increase awareness of the parasite

- 6.1 A report on initiatives to increase awareness of *G. salaris* in UK (Scotland) was presented, GSWG(07)10 (Annex 11). These initiatives include the 'Home and Dry Campaign', targeting anglers and the wider public through brochures and posters, articles in the angling press, the work of angling/fisheries organizations in keeping their members advised of the risks from introducing the parasite, and inclusion of information on *G. salaris* on the websites of VisitScotland (the national tourist board) and the Scottish Canoe Association. Consideration is being given to making all the information available on a single website. It was noted that there had been considerable focus on *G. salaris* in the Scottish Parliament at the time that the Aquaculture and Fisheries Bill was being debated.
- 6.2 The representative of Finland indicated that leaflets concerning *G. salaris* have continued to be distributed at places where licences to fish for salmon are sold and

there are also facilities to disinfect angling equipment at these places and along the main routes to the rivers. There had also been articles published in fishing journals to increase awareness of the damaging impacts of the parasite.

- 6.3 In UK (England and Wales) new leaflets are being produced on individual diseases, including a leaflet about *G. salaris*. Consideration is being given to a campaign in support of the Scottish campaign and a testing of the contingency plan.
- 6.4 In UK (Northern Ireland) leaflets on *G. salaris* continue to be made available with fishing licences and at ports and will be updated in the future.
- 6.5 In Norway, initiatives to increase public awareness have continued through distribution of leaflets and posters, particularly at disinfection stations, and information made available on the Food Safety Authority and Directorate for Nature Management websites. The leaflets are available in four languages.
- 6.6 The Working Group discussed potential mechanisms of spread of the parasite. Concern was expressed that canoeists may inadvertently transfer the parasite on their canoes. A risk assessment conducted in Norway suggested that such transmission was unlikely because even during an epidemic there is less than one parasite per ten cubic meters of water and they are distributed close to the river bottom. Nonetheless, the Working Group recognised that although the risk of transmission with movements of canoes may be low, as with the risk of transmission on fishing equipment, the consequences could be very severe. It would be consistent with the requirements on anglers if efforts were made to ensure that canoeists also take precautions to prevent the spread of the parasite. A requirement to disinfect canoes would increase awareness of the risks associated with spread of the parasite. The Group also noted that netting in infected rivers, both legal and illegal, might be a route of transmission. The risk assessment considered that movements of live fish posed a greater risk of spreading the parasite. In this regard it was recognised that as with any certification system, certification concerning disease-free status for *G. salaris* involves having a certain amount of faith in the authority issuing the certificate. It was noted that some consistency in certification and in diagnostic tests was desirable since at present different States have different approaches and interpretations of the requirements.
- 6.7 The Working Group felt that it would be useful if information on *G. salaris* was made available on the NASCO website, when it is revised, with links to other sources of information developed by the NEAC Parties and their relevant jurisdictions.
- 7. Cost-benefit analyses to support research, guarantees, policy decisions, publicity, etc.**
 - 7.1 In order to assess the effects of various possible actions in the event of Scottish waters being affected by *G. salaris*, the Scottish Government had commissioned a cost-benefit analysis entitled 'An Economic Evaluation of the Impacts of the Salmon Parasite *Gyrodactylus salaris* (Gs) should it be introduced to Scotland'. A summary of this analysis was presented, GSWG(07)11 (Annex 12). The study had concluded, *inter alia*, that:

- should the Scottish Government take no action to prevent the spread of *G. salaris*, a decrease in net Economic Value capitalised at £633 million could result from the complete loss of salmon angling;
- aquaculture is not as likely to be seriously affected;
- the probability of *G. salaris* entering the UK could be reduced considerably by the provision of disinfection stations at ports and by extensive publicity notifying of the danger of the parasite. A long-term reduction in the likelihood of transmission of 1% is all that would be necessary to justify these measures;
- for a small river (the Luce), eradication is likely to be preferred to containment and the cost-benefit ratio was estimated to be between 1.94 and 2.93 depending on the treatment method used. Containment was costed for a large, complex river system (the Spey). The cost of minimal exclusion was shown to be small (£175,000) but total exclusion would result in a loss of income of £1.75 million annually and the loss of 106 jobs in the area.

7.2 The Working Group noted that the cost-benefit analysis did not include the existence values of salmon which, although hard to estimate, could be very significant.

7.3 A report on a cost-benefit analysis in Norway was presented, GSWG(07)15 (Annex 13). This report assessed socio-economic costs assessed with three different levels of funding for the eradication programme. With the highest allocation of funds the eradication programme would be completed by 2018 at a total cost of NOK 373 million and a total loss of man-years of 4,173. Under the lowest allocation scenario, the eradication programme would take until 2032 and would cost NOK 630 million with a loss of 8,024 man years.

7.4 No cost-benefit analyses in relation to *G. salaris* were presented for Finland, UK (England and Wales) or UK (Northern Ireland). The Working Group recognised that such cost-benefit analyses are valuable in seeking funding for measures to prevent the further spread of the parasite and to eradicate it from areas where it has been introduced.

8. Ongoing and planned research concerning *G. salaris* and research requirements

8.1 At its first meeting, the Working Group had agreed that it would be useful if each Party of relevant jurisdiction provided a summary of the findings of research being conducted in relation to *G. salaris*. The Working Group noted the information provided in GSWG(07)4.

8.2 A report on ongoing and planned research at FRS in UK (Scotland) was presented. A major research focus has been to improve diagnostic methods and validate these among laboratories in Scotland, England and Wales and Northern Ireland. In addition more rapid diagnostic methods have been developed. Studies are also being considered into pathogenic and non-pathogenic forms of the parasite and have been undertaken into reasons for differences in the susceptibility of host species.

8.3 Reports on *G. salaris* research in Finland, GSWG(07)16 (Annex 14) and in Norway, GSWG(07)4 (Annex 9), were presented. In Finland, studies have shown that the parasite is killed rapidly when immersed in hot water (>35°C) and that this method might be an alternative to treatment with disinfectants such as Virkon S. In Norway, additional research is also being undertaken at the universities in Oslo and Tromsø

and at the National Veterinary Institute. The Directorate for Nature Management is also funding research into host-parasite interactions in infected rivers, on improved eradication methods and on the effects of eradication treatment on aquatic invertebrate fauna. UK (England and Wales) has also taken part in the FRS study referred to above (as is the case for UK (Northern Ireland)) but a number of additional projects are ongoing. For example, a project using GIS is being conducted to identify sites conducive to high *G. salaris* numbers during an epizootic. A mathematical modelling study on the spread of the parasite in relation to movements among trout farms has also been conducted. There are also ongoing studies to understand the factors influencing the transmission of the parasite and to optimise detection methods.

- 8.4 The Working Group endorsed the recommendations for research in the 'Road Map' and in the report of the first meeting of the Working Group. In particular, the need for research on differentiating harmful and non-harmful forms of the parasite, and the effects of environmental factors on pathogenicity, was stressed. The need for improved coordination of research in different organizations and countries, through regular meetings, was recognised. These aspects could be considered by the Scientific Working Group proposed in paragraph 8.5 below.
- 8.5 The Working Group noted that in some countries there may be difficulties in obtaining funding for scientific research and cooperation. A mechanism is needed to allow such cooperation on issues, including approaches to identification and monitoring, disinfection, cost benefit analyses, etc. The Working Group therefore recommends to the North-East Atlantic Commission that a Scientific Working Group be established to facilitate exchange of information among scientists working on *G. salaris*, with a view to developing information that could assist in policy decisions. The Working Group developed Terms of Reference for a Scientific Working Group GSWG(07)17 (Annex 15). This Scientific Working Group would report back to the *G. salaris* Working Group and one option would be for the scientific group to meet immediately prior to the next meeting of the Working Group.

9. Other fish health issues of relevance to wild Atlantic salmon

- 9.1 Under its Terms of Reference the Working Group is asked to consider other fish health issues of relevance to wild Atlantic salmon. At its first meeting the Working Group had agreed that it might review progress in managing interactions between sea lice and wild Atlantic salmon. However, the Group considered that it did not have either sufficient time or appropriate expertise available to review this topic which is being addressed in other fora.
- 9.2 The representative of ICES noted that at the last WGPDMO meeting there had been increased focus on Proliferative Kidney Disease (PKD) which is of great concern for wild salmonids in Europe. Studies in the River Aelva in northern Norway had indicated very high additional parr mortality (85%) in this river in 2002, 2003, 2004 and 2006. This additional mortality was most likely a result of PKD linked to environmental changes, possibly associated with hydro-power generation in the river or climate change. He noted that at the next WGPDMO meeting there will probably also be discussions on *Anisakis* infections observed in one-sea-winter Atlantic salmon in the UK and Iceland this year and which causes red vent syndrome. At this stage it is not known if the parasite affects survival or fecundity but there are also potential human health issues associated with such infestations.

10. Any other business

- 10.1 There was no other business.

11. Date and place of next meeting

- 11.1 The Working Group decided not to set a date and place for its next meeting but to seek the views of the North-East Atlantic Commission. The Working Group believes that if it is to have an effective exchange of information then it is important that all NEAC Parties and relevant jurisdictions participate in future meetings of the Group. The Working Group also agreed that the Secretariat should be requested to communicate the NEAC's decisions in relation to the recommendations in this report to members of the Working Group following the next Annual Meeting of NASCO.

12. Report of the meeting

- 12.1 The Working Group agreed a report of its meeting.

List of Participants

European Union

Ms Catherine Collins	FRS Marine Laboratory, Aberdeen, UK
Mr David Dunkley	Scottish Government Marine Directorate, Edinburgh, UK
Dr David Graham	AFBNI, Belfast, UK
Mr Robert Griffin	DARDNI, Belfast, UK
Mr Arthur Griffiths	Scottish Government Marine Directorate, Edinburgh, UK
Dr Perttu Koski	Finnish Food Safety Authority, Oulu, Finland
Mr Stefan Pietrzyk	DEFRA, London, UK
Dr Nick Taylor	CEFAS, Weymouth, UK

Norway

Mr Sturla Brørs	Directorate for Nature Management, Trondheim
Mr Paal-Erik Jensen	Norwegian Food Safety Authority, Brumunddal
Mr Bjorn-Ove Johnsen	Norwegian Institute for Nature Research, Trondheim
Mr Stian Johnsen (Chairman)	Norwegian Food Safety Authority, Brumunddal
Mr Jarle Steinkjer	Directorate for Nature Management, Trondheim

Representatives of other organizations

Prof. Tore Håstein	World Organisation for Animal Health (OIE)
Dr Tor Atle Mo	ICES Working Group on the Pathology and Diseases of Marine Organisms
Mr Finn Erlend Odegaard	Representative of NASCO's accredited NGOs

Secretariat

Dr Malcolm Windsor	Secretary
Dr Peter Hutchinson	Assistant Secretary

GSWG(07)18

**Second Meeting of the Working Group on Gyrodactylus salaris
in the North-East Atlantic Commission area**

**Clarion Collection Savoy Hotel, Universitetsgaten 11, Oslo, Norway
10-12 October 2007**

Agenda

1. Opening of the Meeting
2. Adoption of the Agenda
3. Consideration of the Terms of Reference
4. Monitoring programmes for, and the distribution of, G. salaris
5. Measures to prevent the spread of the parasite and to eradicate it where it has been introduced
 - (a) national and regional initiatives, including progress in developing contingency plans
 - (b) international initiatives
6. Initiatives to increase awareness of the parasite
7. Cost-benefit analyses to support research, guarantees, policy decisions, publicity, etc.
8. On-going and planned research concerning G. salaris and research requirements
9. Other fish health issues of relevance to wild Atlantic salmon
10. Any other business
11. Date and place of next meeting
12. Report of the meeting

**Working Group on *G. salaris*
in the North-East Atlantic Commission Area**

GSWG(07)5

***Gyrodactylus* sampling in Scotland 2006
(Tabled by EU (UK - Scotland))**

GSWG(07)5

Gyrodactylus sampling in Scotland 2006

Overview:

No *G. salaris* were identified

Total No. of cases: 124

No. of +ve cases: 14

No. of +ve farms: 12 (2 cases from same farm positive for *Gyrodactylus* parasites)

No. of +ve wild sites: 1

Total No. of fish examined: 2771 fish

Total No. of wild fish sampled: 19 sites, 374 fish

Total No. of Farmed fish examined: 94 sites (6 sites sampled twice and 1 site sampled thrice to give total of 102 farm cases), 2391 fish

Total No. of Fisheries/Estuaries sampled: 3 sites, 6 fish

Details:

Gyrodactylus sampling per fish species

Farmed fish for ≥ 30 fish per case:

Total number of farms sampled (≥ 30 fish per farm)	Number of farms positive for <i>Gyrodactylus</i> species	Species of <i>Gyrodactylus</i> identified
Atlantic salmon 48 (<i>Salmo salar</i>)	4	<i>G. derjavini</i>
Rainbow trout 16 (<i>Oncorhynchus mykiss</i>)	5	<i>G. derjavini</i>
Brown/Sea trout 6 (<i>Salmo trutta</i>)	1	<i>G. derjavini</i>
Artic Charr 1	0	
Total 71	Total 10	

Farmed fish <30 fish or mixed species:

Species	No. of cases	No. of fish sampled (in each case)	Positive or negative for <i>Gyrodactylus</i>
TRO/RTR	2	30	1 case +ve (<i>G. truttae</i>)
TRO/RTR	1	4	-ve
CHARR/SAL	2	30	1 case +ve (<i>G. derjavini</i>)
RTR	4	1	-ve
RTR	2	2	-ve
RTR	3	3	-ve
RTR	2	4	-ve
RTR	3	5	-ve
RTR	1	7	-ve
RTR	1	8	+ve (<i>G. derjavini</i>)
RTR	1	10	-ve
RTR	1	14	-ve
SAL	2	1	-ve
SAL	2	3	-ve
SAL	2	5	-ve
SAL	1	10	-ve
SAL/TRO	1	30	-ve
	Total 31	Total fish 261	

RTR: Rainbow Trout, TRO: Brown Trout/Sea Trout, SAL: salmon.

Wild fish

Species	No. of cases	No. of fish sampled (total)	Positive or negative for <i>Gyrodactylus</i>	Species of <i>Gyrodactylus</i> identified
SAL	5	92	-ve	
TRO/RTR	1	5	-ve	
TRO/SAL	7	210	1 case (30 fish sample) +ve*	PCR failed
RTR	3	6	-ve	
TRO	3	61	-ve	
	Total 19	Total fish 374		

RTR: Rainbow Trout, TRO: Brown Trout/Sea Trout, SAL: salmon.

*Two parasites found

Other samples received:

2 Fisheries cases: 2 fish, CARP, negative
3 fish, RTR, negative

1 Estuary case: 1 fish, SAL, negative

***Gyrodactylus* sampling per region from farmed fish**

≥30 fish per case (EC testing)

Region	Number of cases/Farms	Total number of cases positive for <i>Gyrodactylus</i> species
Highland	25	2
Western Isles	14	0
Dumfries & Galloway	7	2
Strathclyde	8 (7)	1
Shetland	5	1
Tayside	4	1
Orkney	3	2
Lothian	1	0
Grampian	0	0
Borders	3	0
Central	6	3

<30 fish per case (non-EC testing)

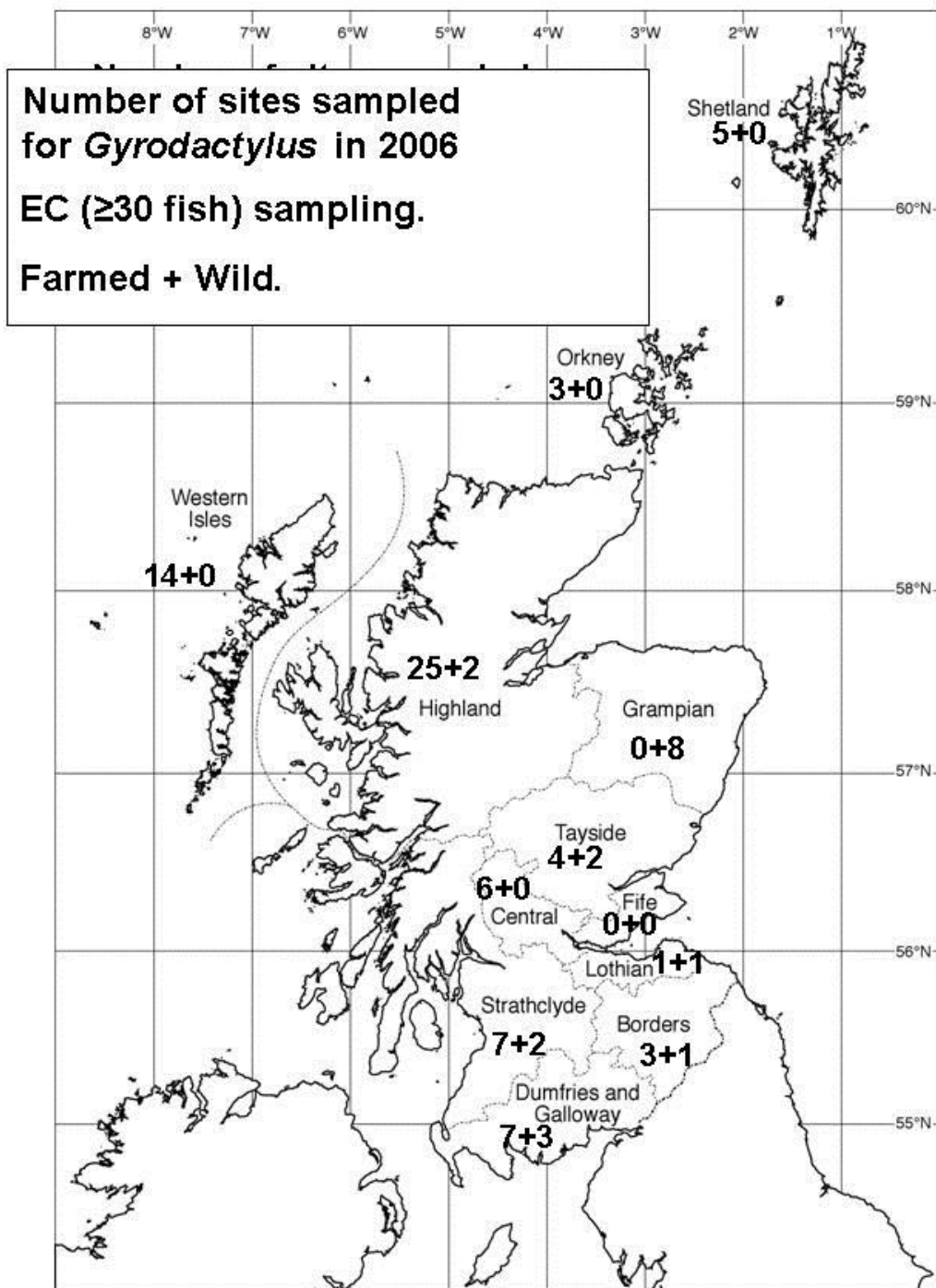
Region	Number of cases/farms	Total number of cases positive for <i>Gyrodactylus</i> species
Highland	4 (3)	0
Western Isles	3	0
Dumfries & Galloway	6 (4)	0
Strathclyde	6 (4)	1*
Shetland	0	0
Tayside	3 (2)	0
Orkney	0	0
Lothian	1	0
Grampian	1	0
Borders	0	0
Central	2 (1)	0

* Same farm as that found positive for ≥30 fish samples above.

***Gyrodactylus* sampling per region from wild fish**

Region	Number of sites sampled	Total number of cases positive for <i>Gyrodactylus</i> species
Highland	2	0
Western Isles	0	0
Dumfries & Galloway	3	0
Strathclyde	2	0
Shetland	0	0
Tayside	2	0
Orkney	0	0
Lothian	1	0
Grampian	8	1*
Borders	1	0
Central	0	0

*Two parasites found.



Annex 4

Working Group on *G. salaris* in the North-East Atlantic Commission Area

GSWG(07)6

***Gyrodactylus* sampling in Scotland January 2007 to August 2007
(Tabled by EU (UK - Scotland))**

GSWG(07)6

Gyrodactylus sampling in Scotland January 2007 to August 2007

Overview:

No *G. salaris* were identified

Total No. of cases: 66
No. of farm cases: 55
No. of wild cases: 11
Total No. of Fisheries/Estuaries sampled: 0 sites

Total No. of fish examined: 1582 fish
Total No. of farmed fish sampled: 1438 fish
Total No. of wild fish sampled: 144 fish
Total No. of Fisheries/Estuaries fish sampled: 0 fish

No. of +ve farm cases: 10
No. of +ve wild cases: 2

Details:

***Gyrodactylus* sampling per fish species**

Farmed fish for ≥30 fish per case:

Total number of farms sampled (≥30 fish per farm)	No. of fish sampled	Number of farms positive for <i>Gyrodactylus</i> species	Species of <i>Gyrodactylus</i> identified
Atlantic salmon 20 (<i>Salmo salar</i>)	600	2	<i>G. derjavini</i>
Rainbow trout 21 (<i>Oncorhynchus mykiss</i>)	630	4	<i>G. derjavini</i>
TRO 2	60	1	<i>G. derjavini</i>
Salmon/Charr 1	30	1	<i>G. derjavini</i>
SAL/TRO 1	30	0	<i>G. derjavini</i>
RTR/TRO 1	30	1	<i>G. derjavini</i>
Total 46	Total 1380	Total 9	

Farmed fish <30 fish:

Species	No. of farms/cases	No. of fish sampled (in each case)	Positive or negative for <i>Gyrodactylus</i>	Species of <i>Gyrodactylus</i> identified
RTR	1	5	-	
RTR	2	1	-	
RTR	1	10	-	
SAL	1	2	-	
SAL	1	4	-	
SAL	1	10	-	
SAL	1	20	+	<i>G. derjavini</i>
TRO	1	5	-	
	Total 9	Total fish 58	Total 1	

RTR: Rainbow Trout, TRO: Brown Trout/Sea Trout, SAL: salmon.

Wild fish <30 fish:

Species	No. of cases	No. of fish sampled (total)	Cases positive or negative for <i>Gyrodactylus</i>	Species of <i>Gyrodactylus</i> identified
SAL	7	52	1	<i>G. derjavini</i>
TRO	2	60	1	<i>G. derjavini</i>
SAL/BTR	1	30	0	
SAL/MIN	1	2	0	
	Total 11	Total 144	Total 2	

RTR: Rainbow Trout, TRO: Brown Trout/Sea Trout, SAL: salmon.

Other samples received:

1 Fisheries cases: 3 fish, RTR, negative

1 Estuary case: 1 fish, SAL, negative

Gyrodactylus* sampling per region from farmed fish*≥30 fish per case (EC testing)**

Region	Number of cases/Farms	Total number of cases positive for <i>Gyrodactylus</i> species
Highland	10	2
Western Isles	6	0
Dumfries & Galloway	5	2
Strathclyde	11	1
Shetland	3	1
Tayside	6	2
Orkney	1	1
Lothian	1	0
Grampian	0	-
Borders	1	0
Central	2	0

Parasite numbers: 4 to 30+

<30 fish per case (non-EC testing)

Region	Number of cases/Farms	Total number of cases positive for <i>Gyrodactylus</i> species
Highland	5	1
Western Isles	0	-
Dumfries & Galloway	0	-
Strathclyde	1	0
Shetland	0	-
Tayside	1	0
Orkney	0	-
Fife	1	0
Lothian	0	-
Grampian	0	-
Borders	1	0
Central	0	-

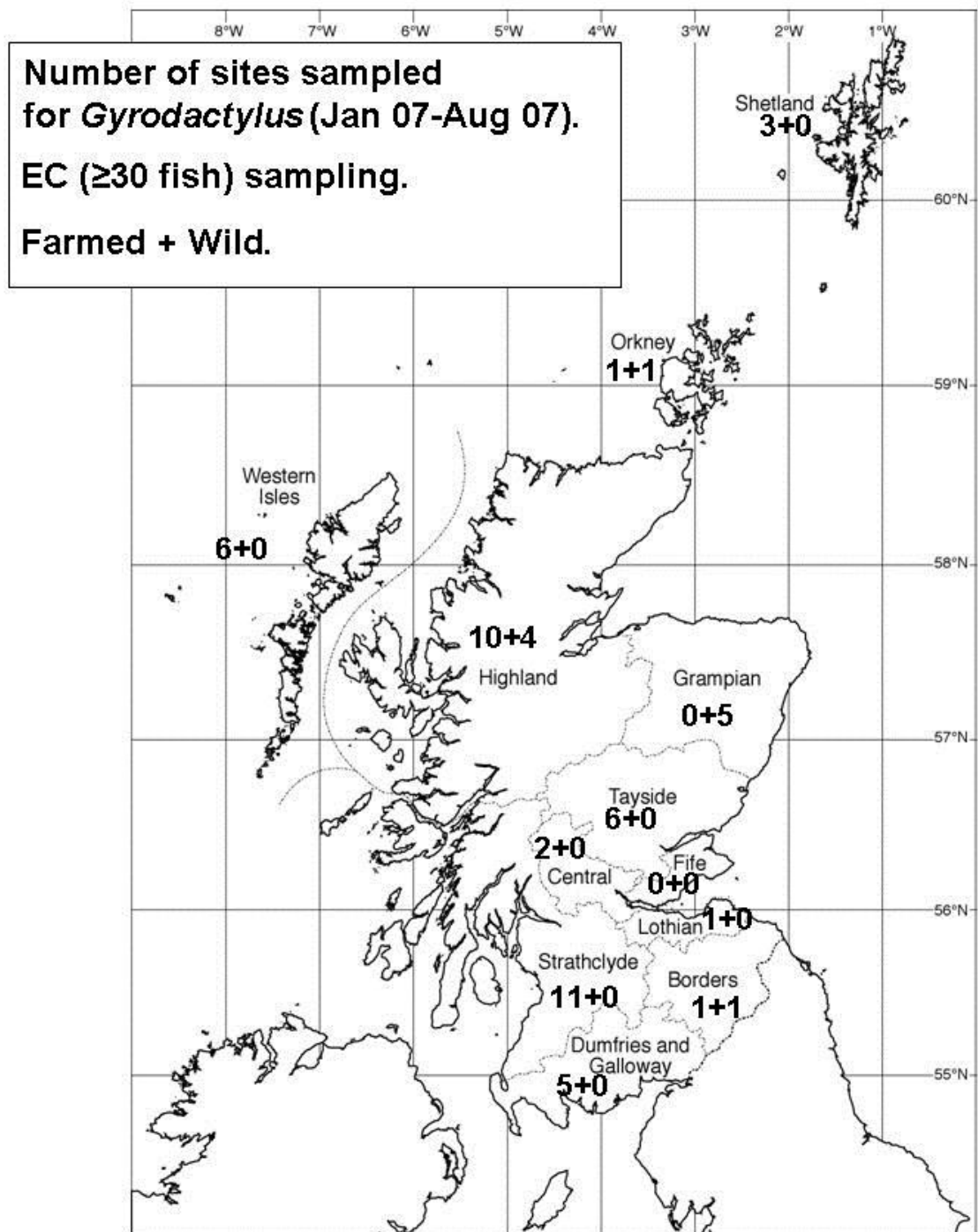
*One farm same as sampled for ≥ 30 fish samples above.

Parasite numbers: 6 individuals from the one infected case.

***Gyrodactylus* sampling per region from wild fish**

Region	Number of sites sampled	Total number of cases positive for <i>Gyrodactylus</i> species
Highland	4	0
Western Isles	0	-
Dumfries & Galloway	0	-
Strathclyde	0	-
Shetland	0	-
Tayside	0	-
Orkney	1	1
Fife	0	-
Lothian	0	-
Grampian	5	0
Borders	1	1
Central	0	-

Parasite numbers 3 and 26



Annex 5

**Working Group on *G. salaris*
in the North-East Atlantic Commission Area**

GSWG(07)7

***Gyrodactylus* sampling in Scotland 02/08/2006 to 16/08/2007
(Tabled by EU (UK - Scotland))**

GSWG(07)7

Gyrodactylus sampling in Scotland 02/08/2006 to 16/08/2007

Overview:

No *G. salaris* were identified

Total No. of cases: 129

No. of farm cases: 103

No. of wild cases: 24

Total No. of Fisheries/Estuaries sampled: 2 sites

Total No. of fish examined: 3006 fish

Total No. of farmed fish sampled: 2552 fish

Total No. of wild fish sampled: 450 fish

Total No. of Fisheries/Estuaries fish sampled: 4 fish

No. of +ve farm cases: 15

No. of +ve wild cases: 3

Details:

Gyrodactylus sampling per fish species

Farmed fish for ≥ 30 fish per case:

Total number of farms sampled (≥ 30 fish per farm)	No. of fish sampled	Number of farms positive for <i>Gyrodactylus</i> species	Species of <i>Gyrodactylus</i> identified
Atlantic salmon 45 (<i>Salmo salar</i>)	1350	5	<i>G. derjavini</i>
Rainbow trout 27(<i>Oncorhynchus mykiss</i>)	810	4	<i>G. derjavini</i>
TRO4	120	2	<i>G. derjavini</i>
Salmon/Charr 3	90	2	<i>G. derjavini</i>
SAL/TRO 1	30	0	
RTR/BTR 1	30	1	<i>G. derjavini</i>
Total 81	Total 2430	Total 14	

Farmed fish <30 fish:

Species	No. of farms/cases	No. of fish sampled (in each case)	Positive or negative for <i>Gyrodactylus</i>	Species of <i>Gyrodactylus</i> identified
RTR	4	5	-	
RTR	1	14	-	
RTR	1	7	-	
RTR	2	2	-	
RTR	3	1	-	
RTR	1	3	-	
RTR	1	4	-	
RTR	1	10	-	
SAL	1	2	-	
SAL	2	3	-	
SAL	1	4	-	
SAL	2	10	-	
SAL	1	20	+	<i>G. derjavini</i>
TRO	1	5	-	
	Total 22	Total fish 122	Total 1	

RTR: Rainbow Trout, TRO: Brown Trout/Sea Trout, SAL: salmon.

Wild fish

Species	No. of cases	No. of fish sampled (total)	Cases positive for <i>Gyrodactylus</i>	Species of <i>Gyrodactylus</i> identified
SAL	10	142	1	<i>G. derjavini</i>
TRO	4	120	1	<i>G. derjavini</i>
RTR	3	6	0	
SAL/TRO	6	180	1	<i>G. derjavini</i>
SAL/MIN	1	2	0	
	Total 24	Total 450	Total 3	

RTR: Rainbow Trout, TRO: Brown Trout/Sea Trout, SAL: salmon, MIN: minnow

Other samples received:

1 Fisheries cases: 3 fish, RTR, negative

1 Estuary case: 1 fish, SAL, negative

***Gyrodactylus* sampling per region from farmed fish**

≥30 fish per case (EC testing)

Region	Number of cases/Farms	Total number of cases positive for <i>Gyrodactylus</i> species
Highland	17	3
Western Isles	18	0
Dumfries & Galloway	7	2
Strathclyde	13	1
Shetland	6	2
Tayside	6	2
Orkney	3	2
Lothian	2	0
Grampian	0	-
Borders	2	0
Central	7	2

Parasite numbers: 4 to 30+

<30 fish per case (non-EC testing)

Region	Number of cases/Farms	Total number of cases positive for <i>Gyrodactylus</i> species
Highland	8(7)*	1
Western Isles	1	0
Dumfries & Galloway	3	0
Strathclyde	3	0
Shetland	0	-
Tayside	2	0
Orkney	0	-
Fife	1	0
Lothian	1	0
Grampian	1	0
Borders	1	0
Central	1	0

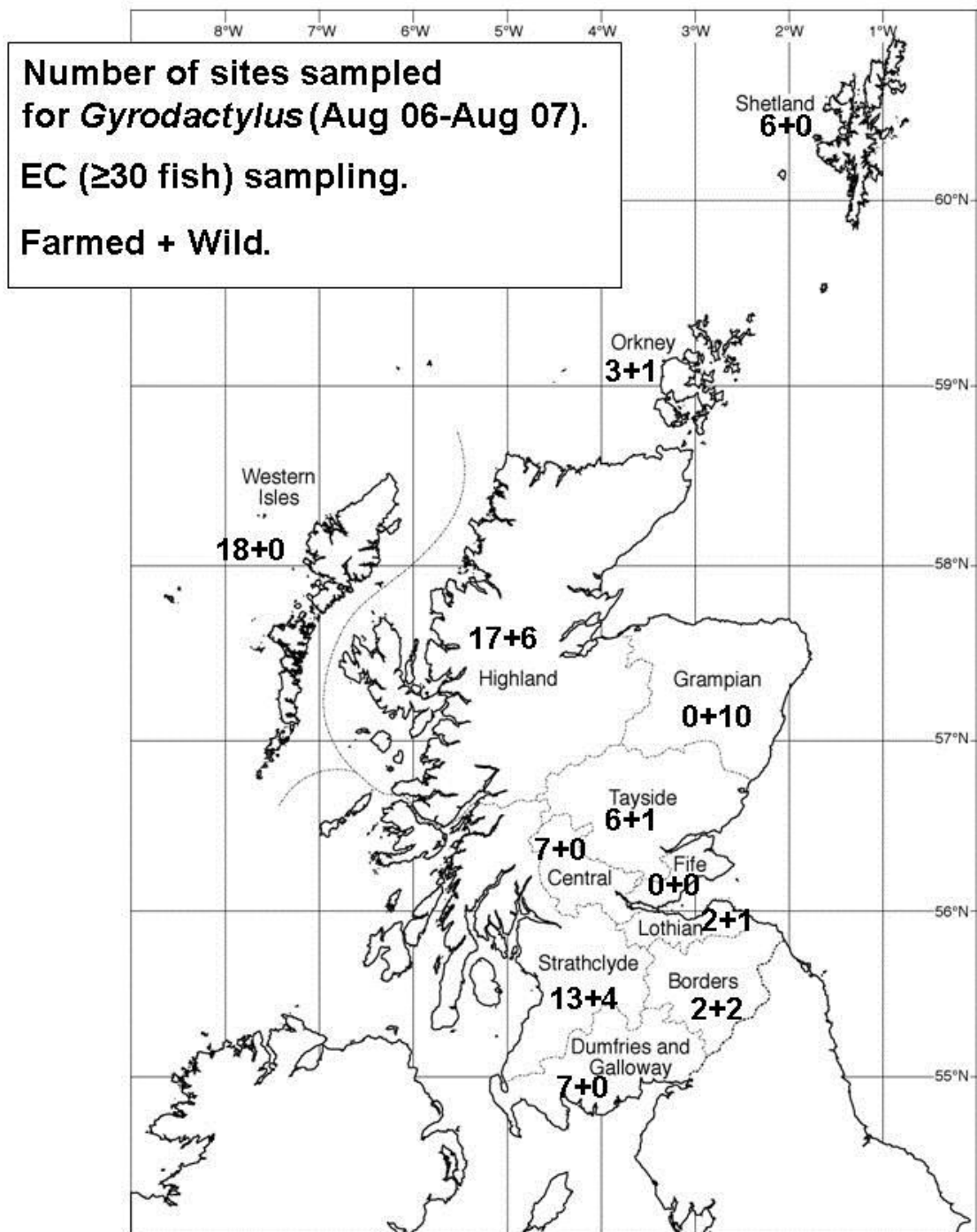
*One farm same as sampled for ≥30 fish samples above.

Parasite numbers: 6 individuals from the one infected case.

***Gyrodactylus* sampling per region from wild fish**

Region	Number of sites sampled	Total number of cases positive for <i>Gyrodactylus</i> species
Highland	6	0
Western Isles	0	-
Dumfries & Galloway	0	-
Strathclyde	4	1
Shetland	0	-
Tayside	1	-
Orkney	1	1
Fife	0	-
Lothian	1	0
Grampian	9 + estuary	0
Borders	2	1
Central	0	-

Parasite numbers 3-26



**Working Group on *G. salaris*
in the North-East Atlantic Commission Area**

GSWG(07)8

***Diagnostics of Gyrodactylus species at FRS Marine Lab Aberdeen
(Tabled by EU (UK - Scotland))***

GSWG(07)8

Diagnostics of Gyrodactylus species at FRS Marine Lab Aberdeen

Gyrodactylus spp. targeted:

Of the Gyrodactylidae described from salmonid hosts in Europe, *G. salaris* is of obvious concern. *G. derjavini* and *G. truttae* are common in Northern Europe and *G. thymalli* is of interest because of the great similarity to *G. salaris*, although *G. thymalli* has a different natural host; grayling, *Thymallus thymallus* (Platten *et al.*, 1994; Shinn *et al.*, 1995). Therefore monitoring for *G. salaris* in UK has concentrated on identification of these species and especially the discrimination of *G. salaris* from other types.

Overview of diagnostic method.

Gyrodactylus specimens are removed from fins and examined individually under the light microscope. They are identified to either "*G. salaris* type" or "not *G. salaris* type" based on morphological characteristics of their attachment organ. They are not identified to species level at this stage.

The specimens are then lysed individually in appropriate buffer to release their DNA and the DNA is used in a PCR reaction to amplify the internal spacer (ITS) region of the parasites ribosomal genes.

A Restriction Fragment Length Polymorphism (RFLP) analysis is then carried out using the restriction enzyme *Hae* III. The *Hae* III enzyme cuts the ITS PCR product everywhere a specific nucleotide sequence, recognised by the enzyme, is present. The fragment pattern obtained from the diagnostic samples following restriction with *Hae* III is compared with the pattern obtained from known gyrodactylid species (*G. salaris*, *G. derjavini* and *G. truttae*, the latter two of which are found on salmonids in Scotland). A diagnosis is made based on the pattern obtained.

Numbers Analysed:

In samples where less than 15 parasites have been found, all parasites are analysed.

In cases with more than 15 parasites, a minimum of 15 parasites and a maximum of 30 parasites are analysed. The number analysed in the latter case depends on being able to identify at least 10 parasites morphologically to "*G. salaris*" type/"not *G. salaris*" type.

Detailed diagnostic procedure:

Removal of parasites from fins:

- Tubes containing fins in 95% ethanol are received from the Fish Health Inspectors.
- The fins are removed from the tubes containing 95% ethanol and examined under a dissecting microscope for gyrodactylid parasites.
- Gyrodactylids are removed individually and placed in 70% ethanol.

Morphological diagnosis of parasites:

- Parasites are placed individually in a drop of water on microscope slides under coverslips and the morphological features (hooks, anchors and ventral bar) (Fig.1) of their attachment organ are examined under x400-x1000 magnification.

Note: Formaldehyde-fixed specimens and ammonium-picrate glycerin (Malmberg, 1957) are superior methods for preparing whole mounts of Gyrodactylus for microscopic examination. Neither of these methods is used routinely for Gyrodactylus in the Scottish reference laboratory, as the chemicals used interfere with molecular analysis, and molecular analysis is relatively more important for species identification at FRS.

- The shape and size of the morphological features are diagnostic for different species.
- The parasites are identified where possible into "not *G. salaris*" type specimens or "*G. salaris*" type specimens, based largely on the shape and size of the ventral bar and hooks, or "no I.D." in cases where the attachment organ is damaged or missing.

Note: Measurement and detailed analysis of the hard parts of the attachment organ increases the accuracy of this method of identification, but requires careful preparation of the specimen. Due to time restrictions, the Scottish laboratory frequently identifies the parasites to either "G. salaris type" or "not G. salaris type" based on morphological characteristics of their attachment organ. They are not identified to species level at this stage. Species identification by morphology alone is uncommon.

- Photos are taken of any unusual or ambiguous morphological features.
- The results of the morphological examination are recorded.
- The parasites are then removed from the slide and placed in lysis buffer to release their DNA

Molecular diagnosis of parasites:

Note: Since 1995, the Scottish laboratory has routinely carried out molecular analysis of Gyrodactylus specimens. Methods have been developed to analyse the genes and spacers of the ribosomal RNA gene array to discriminate G. salaris, G. derjavini and G. truttae (Cunningham et al., 1995a; b; Cunningham, 1997; Cunningham et al., 2001). Currently, PCR amplification of the internal transcribed spacer (ITS) followed by restriction fragment length polymorphism (RFLP) is used for species identification.

- The DNA of the parasite is used in a PCR reaction to amplify the internal spacer (ITS) region of the parasite's ribosomal genes.
- A subsample of the ITS PCR product is run on an agarose gel to confirm that amplification has taken place.
- The ITS PCR product is then digested with a restriction enzyme (*Hae* III) that cuts DNA at specific nucleotide sequences in the ITS product. Depending on the sequence of the ITS product, the enzyme will cut it in different places and different fragment sizes will be obtained. Differences in ITS sequence between *G. salaris* and gyrodactylid species such as *G. derjavini* and *G. truttae* will result in different fragment sizes for each species. The pattern (Restriction Fragment Length Polymorphism -RFLP) of fragment sizes is diagnostic for the species.
- The ITS fragments from diagnostic samples are run on an agarose gel alongside ITS fragments from known species (*G. salaris*, *G. derjavini* and *G. truttae*) (Fig.2).

- The pattern obtained for the diagnostic samples received from the Fish Health inspectors is then compared to the pattern from the known species and the sample specimens identified.
- The results of the molecular diagnosis are recorded and cross-checked with results from the molecular diagnosis.
- Any unusual results are followed up by sequencing the ITS, and then by sequencing the mitochondrial COI gene if necessary (Hansen et al., 2003; Lindenstrøm et al., 2003).
- Phylogenetic analysis is then carried out with COI sequence obtained, and other characterised COI sequences from the public sequence database. The parameters are as described in Hansen et al., (2003).
- The specimen is identified as *G. salaris* or *G. thymalli* depending on insertion into one of seven described clades: clades I-III are currently considered to represent *G. salaris*
Note: COI sequencing and phylogenetic analysis is necessary to separate *G. salaris* specimens from *G. thymalli* specimens.

Morphological Diagnosis:

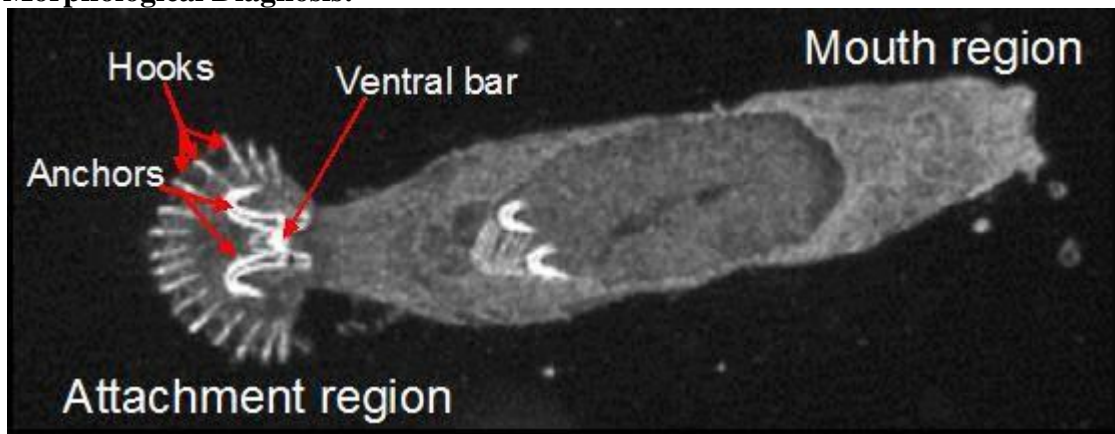


Figure 1: Picture taken from GyroDb: <http://www.gyrodb.net/>

Molecular Diagnosis:

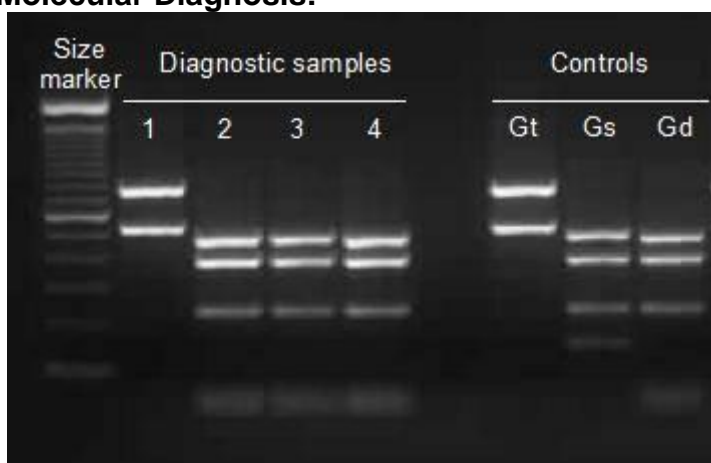


Figure 2: Agarose gel showing ITS PCR fragments after cutting with restriction enzyme *Hae* III. The control patterns are on the right: Gt; *G. truttae*, Gs; *G. salaris* and Gd; *G. derjavini*. The diagnostic samples on the left can be identified as (1)*G. truttae*, (2)*G. derjavini*, (3)*G. derjavini*, and (4)*G. derjavini* respectively.

Acknowledgements:

The author wishes to thank all involved in *Gyrodactylus* monitoring and identification at FRS for providing the data used in this paper.

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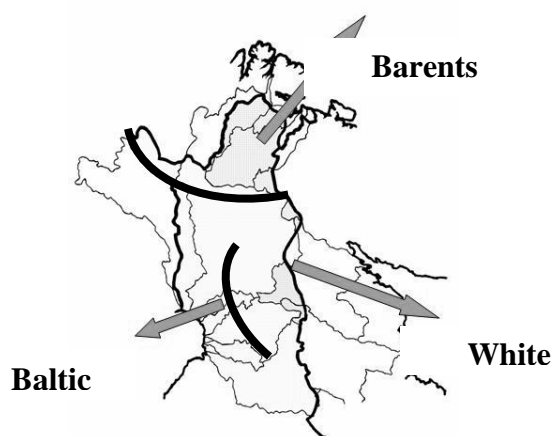
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**Working Group on *G. salaris*
in the North-East Atlantic Commission Area**

GSWG(07)13

***Monitoring of Gyrodactylus salaris in Finland in 2006-2007
(Tabled by EU - Finland)***

Monitoring of Gyrodactylus salaris in Finland in 2006-2007



The watersheds between the water catchment areas of the Barents Sea, White Sea and Baltic Sea are partly situated in the territory of Finland (see Fig. 1).

This report includes the results of the samples taken during January 1st 2006-June 30th 2007.

Figure 1: Three main water catchment areas in northern Finland.

Monitoring of the situation in the catchment areas running into the Barents Sea

In accordance with an agreement between Norway and Finland, 150 wild salmon parr per river are to be sampled from the Rivers Teno (Tana in Norwegian) and Nääämö (Neiden in Norwegian) each year. Examination of the samples from a particular river is performed in Finland and Norway in alternating years. There is no fish farming activity in these watercourses.

The number of the examined salmon parr were as follows: in 2006 163 in River Teno and 155 in River Nääämö. *G. salaris* has not been found in these examinations. The results for the year 2007 are not available, yet.

Wild fish of the three other water catchment areas running into the Barents Sea were examined as follows: River Paats 8 grayling in 2006, no samples in 2007. No samples have been taken from River Uutuan (River Munkelva in Norwegian). River Tuuloma 25 grayling in 2006, 15 grayling in 2007. All examinations mentioned in this paragraph have been negative for the presence of *Gyrodactylus* spp.

The two fish farms of the River Paats catchment area were examined with negative results in 2006 (number of fish examined: farm A 150 salmon; farm B 60 arctic charr). The results of the year 2007 are not ready, yet. In the rivers Uutuan and Tuuloma there is no fish farming activity on the territory of Finland.

Monitoring of the catchment areas running into the Baltic and White Seas

There is no regular official monitoring of *G. salaris* in these areas. On wild salmon *G. salaris* was found only in the river Tornio (border river between Finland and Sweden). For the first time for years *G. salaris* was also found from farmed salmon in one farm in 2006. This farm is situated along a river flowing into the Baltic Sea and farms Baltic salmon for stocking into the Baltic Sea. There was no mortality or clinical symptoms in association with the infection. Totally 5 salmon farms in 2006 and 6 salmon farms in 2007 were examined (sample size usually 60 fish/farm/year).

Rainbow trout farms are considered to be quite often infected with *G. salaris* in both these catchment areas. Only a few farms were, however, examined for the presence of *G. salaris* in 2006-2007. In 2006 only 3 rainbow trout farms (0 infected with *G. salaris*) and in 2007 10 farms (3 infected with *G. salaris*) were examined. In addition to *G. salaris* also *G. lavareti* was found at some farms. The examinations of farmed rainbow trout were performed in connection with research or live fish export certification. Usual sample size was 60 fish/farm/year.

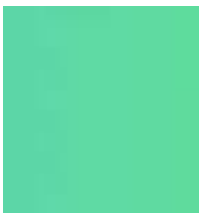
**Working Group on *G. salaris*
in the North-East Atlantic Commission Area**

GSWG(07)14

***The Surveillance and Control Programme for Gyrodactylus salaris in
Atlantic salmon and rainbow trout in Norway
(Tabled by Norway)***

The surveillance and control programme for *Gyrodactylus salaris* in Atlantic salmon and rainbow trout in Norway

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Introduction

In 2006, *Gyrodactylus salaris* was detected in two rivers. No commercial salmon farms were infected

During the period of 1975 to 2006, *Gyrodactylus salaris* has been detected in Atlantic salmon fingerlings/parr from 46 rivers, 13 hatcheries/farms with Atlantic salmon parr/smolt and 26 hatcheries/farms with rainbow trout (*Oncorhynchus mykiss*). The policy of the Norwegian Authorities is to eradicate *G. salaris* from infected rivers and farms. In farms, the procedure is to eliminate the hosts (salmon and rainbow trout). By doing so, the parasite is also eliminated because it does not have specialized free-living stages or intermediate hosts. In rivers, acidified aluminium sulphate is now the main chemical used to kill the parasite but not the fish host. By 31 December 2006, *G. salaris* was confirmed to be eradicated from 15 rivers and from all hatcheries/fish farms. The eradication has not been confirmed for nine additional rivers. The parasite is known to be present still in 22 additional rivers in Norway.

G. salaris is a notifiable (Group B) disease in Norway. It is listed as "Other significant disease" in the Office International des Epizooties (OIE). Surveillance of *G. salaris* has been performed in Norwegian salmon rivers since late 1970s (1, 2, 3, 4, 5). Surveillance is not performed in rivers or farms known to be infected unless measures for eradication of the parasite have just been carried out or other circumstances that justify the need for surveillance.

The Norwegian Food Safety Authority is responsible for sampling rivers and fish farms although County Environmental Departments and other institutions/companies are commissioned to do the actual sampling. The National Veterinary Institute in Oslo (the OIE reference laboratory for the disease) is responsible for examination of samples and taxonomical studies if *Gyrodactylus* is detected.

Aim

The surveillance programme aims to trace any spread of *Gyrodactylus salaris* to new river systems or fish farms (or to rivers and farms cleared of infection).

Materials and methods

At least 30 Atlantic salmon are sampled from each farm and river. In rivers fingerlings/parr/smolt are caught by means of electrical fishing gear. In some of the large rivers, sampling is done at different dates and at different sampling stations. Farmed fish are caught by net. The fish are killed and preserved in 96 % ethanol. The samples are sent to the National Veterinary Institute in Harstad where body surface and fins are examined by a magnifying microscope (10 - 15 times magnification). However, only fins (except adipose fin) are sampled and preserved for examination from fish >15 cm.

Results

Altogether, 3,082 specimens from 94 rivers and 1,862 specimens from 57 farms were examined in 2006 (Tables 1 and 2). *G. salaris* was detected in two rivers but no farms were infected.

Conclusion

G. salaris extended its range to river Ranelva while the river Hestdalselva had been rotenone treated in 2003 to eradicate the parasite.



Table 1. Rivers examined for *Gyrodactylus salaris* in 2006

County	No. of rivers	Species	No. of fish examined	Detections
Finnmark	7	Atlantic salmon	310	0
Troms	7	Atlantic salmon	236	0
Nordland	16	Atlantic salmon	496	2 ¹
Nord-Trøndelag	14	Atlantic salmon	423	0
Sør-Trøndelag	5	Atlantic salmon	170	0
Møre og Romsdal	15	Atlantic salmon	430	0
Sogn og Fjordane	10	Atlantic salmon	302	0
Hordaland	6	Atlantic salmon	217	0
Rogaland	1	Atlantic salmon	32	0
Vest-Agder	2	Atlantic salmon	61	0
Aust-Agder	1	Atlantic salmon	31	0
Telemark	1	Atlantic salmon	32	0
Vestfold	2	Atlantic salmon	121	0
Buskerud	1	Atlantic salmon	30	0
Akershus	2	Atlantic salmon	65	0
Oslo	3	Atlantic salmon	96	0
Østfold	1	Atlantic salmon	30	0
Total	94		3,082	2

¹ 1 new river and 1 reappearance after rotenone treatment.

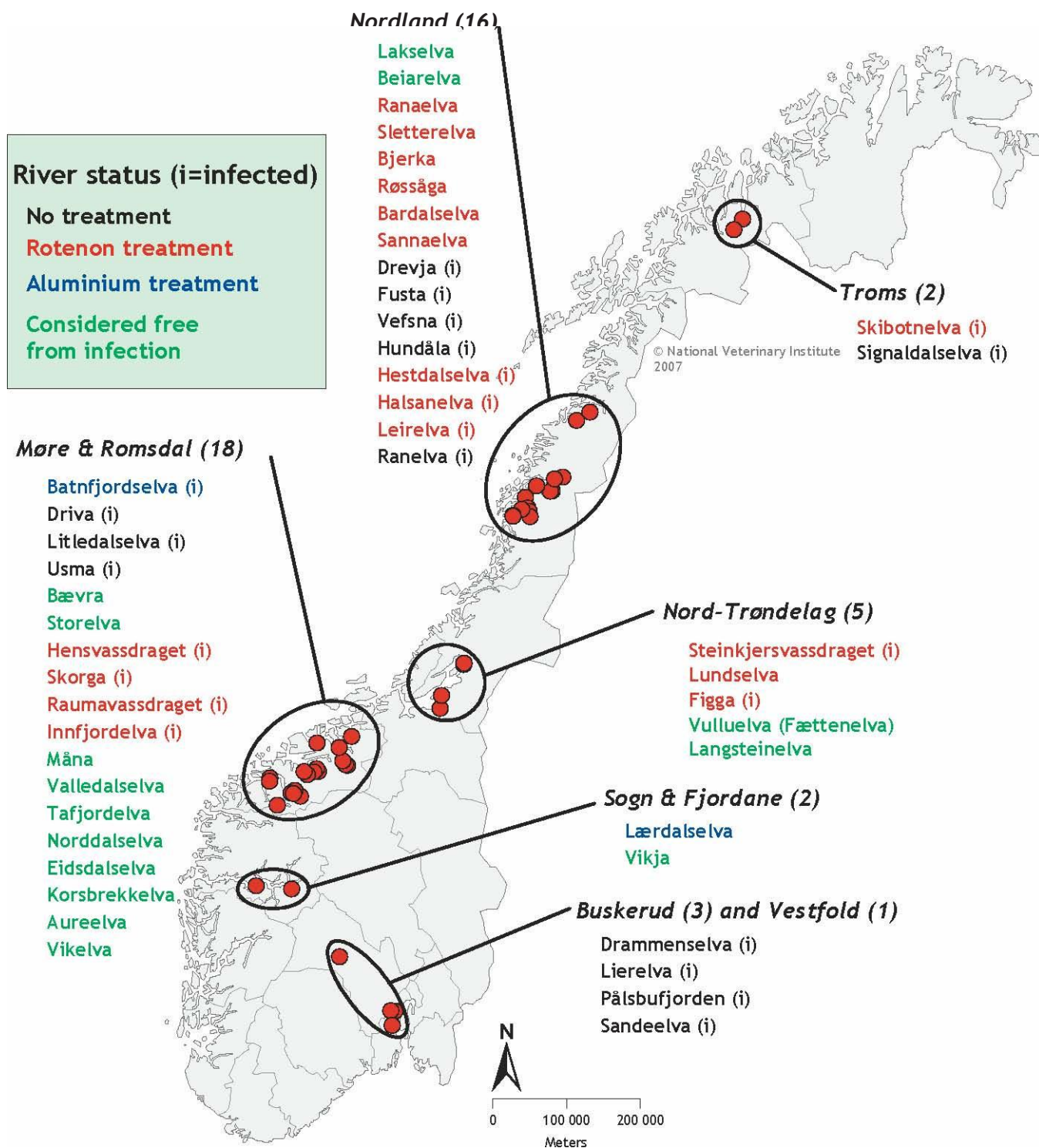
Table 2. Fish farms examined for *Gyrodactylus salaris* in 2006

County	No. of farms	Species	No. of fish examined	Detections
Troms	5	Atlantic salmon	150	0
Nordland	9	Atlantic salmon	270	0
Nord-Trøndelag	2	Atlantic salmon, rainbow trout	90	0
Sør-Trøndelag	4	Atlantic salmon, rainbow trout	150	0
Møre og Romsdal	10	Atlantic salmon, rainbow trout	330	0
Sogn og Fjordane	8	Atlantic salmon, rainbow trout	272	0
Hordaland	11	Atlantic salmon, rainbow trout	360	0
Rogaland	5	Atlantic salmon	150	0
Telemark	2	Atlantic salmon	60	0
Buskerud	1	Atlantic salmon	30	0
Total	57		1,862	0

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Gyrodactylus salaris detections 1975 -2006



**Working Group on *G. salaris*
in the North-East Atlantic Commission Area**

GSWG(07)4

***G. salaris in Fennoscandia, Denmark and Russia - monitoring and
research
(Tabled by Norway)***

GSWG(07)4

G. salaris in Fennoscandia, Denmark and Russia - monitoring and research

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Publications on *G. salaris* epidemics in Norwegian rivers (Johnsen 1978, Heggberget & Johnsen 1982, Johnsen & Jensen 1986, 1988, 1991, 1992) led to great interest and increased research on the *G. salaris* problems in Norway. Successively this increased interest for research also spread to Sweden, Finland, Denmark and Russia. The *Gyrodactylus* project at NINA initiated cooperation with Russian scientists during the 1990's, and this cooperation was successively extended to the other countries. In 2000 the cooperation was strengthened through the project "Host/parasite relationship between Atlantic salmon and *Gyrodactylus salaris* in Denmark, Finland, Norway, Russia and Sweden". The main objective of this project was to study annual and seasonal variations in the prevalence and intensity of *G. salaris* on Atlantic salmon in rivers in northern Europe with special reference to the immigration history of Atlantic salmon and *G. salaris*. Due to lack of financial support this project never "took off". But in spite of this, the cooperation is maintained and important research on *Gyrodactylus* goes on in the respective countries. This research has generated a lot of interesting results and in the following a summary of these results is presented.

Native range

Genetic studies of the host, Atlantic salmon, suggest a large-scale, geographic grouping which has relevance to understanding the host/parasite relationship. Baltic salmon constitute one of the three major groups of the species, the others being the west and east Atlantic groups (Ståhl 1987) or races (Cross *et al.* 1998). Nowadays, Baltic salmon as a whole forms one effectively isolated evolutionary unit of Atlantic salmon and differs clearly from Atlantic salmon of the rivers draining into the Atlantic Ocean and Barents Sea (Ståhl 1987, Koljonen 1989, Kazakov and Titov 1993, Nilsson *et al.* 2001).

Southern Baltic salmon from an inlet river to the Onega lake (Russia) (Shulman *et al.* 2000, 2005) and from the river Neva (Bakke *et al.* 1990) which is the outlet river from the Ladoga lake, showed a response against *G. salaris* while northern Baltic salmon showed an intermediate susceptibility against *G. salaris* (Dalgaard *et al.* 2003, 2004, Bakke *et al.* 2004, Lindenstrøm *et al.* 2006).

Based on these observations there are reasons to believe that the Lake Onega is confirmed to belong to the native range of *G. salaris*. Even though the relation between the host and the parasite in the rest of the Baltic is somewhat different from the situation in the Onega lake, *G. salaris* has been in the Baltic for so long that the whole Baltic area should probably be considered as the native range of *G. salaris* (Meinilä *et al.* 2004).

Alien distribution

History of introduction and geographical spread

Observations from the different countries indicate that *G. salaris* does not occur naturally in the Atlantic distribution area of the Atlantic salmon populations. It has been introduced in later years to rivers in Norway (1970's, Johnsen and Jensen 1986), to rivers on the Swedish west coast (1980's, Alenäs *et al.* 1998), and to a Russian river draining into the White Sea (1980's, Ieshko *et al.* 1995).

Pathways of introduction

G. salaris has been spread in the alien range mainly by anthropogenic movement of infected fish between hatcheries/fish farms, between hatcheries/fish farms and rivers and by migration of infected fish in rivers and in brackish water in fiords.

Denmark

In May 1972, *G. salaris* was recorded on *O. mykiss* in a Danish rainbow trout farm (in Køge) (Malmberg and Malmberg (1993). Later, Buchmann and Bresciani (1997) found *G. salaris* on rainbow trout and indicated the presence of an infection reservoir in spawners in Danish freshwater fish farms. *G. salaris* is present in most counties in Jutland on rainbow trout. This could seem quite problematic because a large stocking programme using salmon susceptible to the Norwegian type of *G. salaris* is in progress in Denmark. However, the Danish strain of the parasite shows very low pathogenicity to Scottish salmon and Danish salmon and high predilection for rainbow trout.

Russia

In Russia, the epidemic in the river Keret was caused by *G. salaris* transferred from lake Onega, as evidenced by exactly matching mitochondrial haplotypes (J. Lumme and A. Veselov pers. comm.).

In the river Pisto, Kuitozero Lake, Karelia, *G. salaris* was first observed in 2001. The parasite belong to the rainbow trout specific clade and was most probably introduced from upstream fish farms on the Finnish side of the border.

Sweden

In the first investigation carried out at the Swedish west coast in the year 1989, the parasite was found in a salmon hatchery in Laholm at the river Lagan and the same year on wild parr in the river Säreån (a tributary to the river Göta älv) (Malmberg and Malmberg 1991, Karlsson *et al.* 2003b). Since the first finding in 1989, the parasite has spread gradually (Malmberg and Malmberg 1991). It was found in the river Ätran in 1991 (Alenäs 1998). According to Alenäs *et al.* (1998) *G. salaris* might have been introduced to the river Ätran possibly about 1986. In 1997, more comprehensive investigations including almost all salmon rivers on the Swedish west coast from Skåne to the Norwegian border, were conducted, and *G. salaris* was found in 8 rivers. The river Stensån was probably infected later than 1994 since two earlier investigations showed no *G. salaris* (Malmberg 1998). At the end of 2002, 11 out of 23 wild salmon rivers on the west coast were infected (Karlsson *et al.* 2003b).

Hansen *et al.* (2003) elucidated the mitochondrial haplotypes of *G. salaris* in several rivers on the Swedish West coast. Interestingly, they observed different origins. In the rivers Ätran and Surtan, the mtDNA type was identical to the Norwegian “salmon killer” suggesting introduction from Bothnian Bay by fish transport. In the rivers Suseån and Stensån, the parasite was specific and most closely related to haplotype from Gauja, Latvia. This, as well as the fact that the salmon population in some of the rivers on the Swedish West coast carry a collection of Baltic mitochondrial haplotypes without any Atlantic mixture (Nilsson *et al.* 2001) lead Meinilä *et al.* (2004) to suggest that part of the Swedish West coast parasite population is native. The introduction of alien strains may have induced an observable epidemic.

Norway

Regional investigations of salmon parr (about 50,000) from a large number of rivers in Norway, show that *G. salaris* is not native in Norway. In 139 of the rivers more than 90 salmon parr have been investigated without finding the parasite. If the parasite had occurred with a prevalence of 5 % or more in one of these rivers, there is a 99 % probability that it would have been discovered (Johnsen *et al.* 1999a).

Four anthropogenic introductions of *G. salaris* into Norway along with infected salmonids from hatcheries around the Baltic Sea have been suggested (Johnsen *et al.* 1999a). *G. salaris* was found for the first time in Norway at Sunndalsøra hatchery in July 1975 (Tanum 1983, Malmberg 1989). In August the same year, *G. salaris* was found on salmon parr in the river Lakselva, northern Norway (Johnsen 1978). Later the parasite was discovered in a number of Norwegian rivers (Heggberget and Johnsen 1982, Johnsen and Jensen 1986, 1991, 1992) and the number of rivers where *G. salaris* has been found is now 46, of which 41 can be traced to three sources: 1) stocking of fish from infected hatcheries, 2) infected hatcheries situated by the rivers or 3) spread by migrating fish through brackish from infected rivers.

The colonization of rivers after parasite introduction has been rapid (1 - 3 years). For example in the large salmon river Vefsna the parasite was found in the lower parts in 1978. In 1980 it had spread throughout the entire watercourse. Data from other infected Norwegian rivers such as the Lakselva, Beiarelva, Ranaelva, Steinkjervassdraget, Rauma and Lærdalselva present a similar picture of a very rapid colonization (1 - 3 years) (Johnsen and Jensen 1988).

There are numerous examples of dispersal of *G. salaris* between rivers in fiord regions in Norway. The rivers within these regions are situated so close to each other that the occurrence of *G. salaris* in the neighbouring rivers may be explained as the result of spreading with fish through brackish water in the fiord area (Johnsen and Jensen 1986). This kind of spread has, however, been slower than the dispersal in rivers. For example infection of four new rivers in Romsdalsfiord took 13 years.

Alien status in region

G. salaris probably has its native range in the distribution area of the Baltic salmon, including the rivers draining into the Onega Lake, the Ladoga Lake and the Neva river which flows out of the Ladoga Lake. *G. salaris* is alien in the distribution area of the eastern Atlantic salmon population. It has been introduced in later years (1970s) to rivers

in Norway, to rivers on the Swedish west coast (1980s), and to the Russian river Keret draining into the White Sea (1980s).

Species identification and virulence

The directly transmitted viviparous gyrodactylids have high species richness but low morphological and biological diversity and many species are recorded from only a single host. The group has the widest host range of any monogenean family, being found on 19 orders of bony fish. However, individual species range from narrowly specific (71% of 402 described species recorded from a single host) to extremely catholic (*Gyrodactylus alviga* recorded from 16 hosts) (Bakke *et al.* 2002). The *Gyrodactylus* species are ectoparasitic, attacking various parts of the body of fishes (Bykowsky 1962).

According to Malmberg (1993), 21 different species of *Gyrodactylus* have been described from salmonids. He divided these into six groups and named one of the groups the *G. salaris*-group. This group consists of 10 *Gyrodactylus*-species which Malmberg further divided into three subgroups. *G. salaris* was placed in subgroup 1 together with the species *G. brachymystacis* Ergens 1978, *G. lenoki* Gussev 1953 and *G. asiaticus* Ergens 1978. These three *Gyrodactylus*-species which Malmberg considered to be the closest relatives to *G. salaris*, are all described from the host *Brachiomystax lenok*, which is a freshwater species within the family *Salmonidae* with its distribution in central Asia. On this background Malmberg argued that *G. salaris* has its origin in central Asia, and that it once spread westwards to the Baltic region.

By analyzing mitochondrial DNA sequences (Meinilä *et al.* 2002), *Gyrodactylus salaris* was divided into different evolutionary lineages or clades (Hansen *et al.* 2003, 2004, Meinilä *et al.* 2004). Five of the mtDNA clades were specific for grayling. The others were divided into nine haplotypes found on Atlantic salmon, Baltic salmon, Rainbow trout and Arctic charr (**table 2.1**).

Table 2.1. Haplotypes of *G. salaris*, clade, host fish and rivers and/or hatcheries/fish farms where it has been observed (after Hansen *et al.* 2003 og Meinilä *et al.* 2004).

Haplotype	Clade	Host fish	Observations
A	I	Atlantic salmon	River Røssåga, Vefsna, Byaelva, Ognå, Batnfjordelva, Driva, Litledalselva, Usma, Henselva, Innfjordelva, Rauma (No), Surtan, Ätran (Se)
B	I	Atlantic salmon, Baltic salmon, Arctic charr	River Signaldalselva, Skibotnelva, (No), Torneelv, Vindelelven (Se).
C	I	Atlantic salmon	River Susenån, Nissan, Fylleån, Genevadsån, Stensån (Se)
D	I	Baltic salmon	Hatchery at river Gauja (Latvia)
E	II, I*	Atlantic salmon	River Göta elv (Se)
Sal T Tornio	I	Baltic salmon	River Torneelv (Fi)
Sal Keret 2	I	Atlantic salmon	River Keret (Ru).
Sal Keret 1	I	Atlantic salmon	River Keret (Ru).
F	III	Rainbow trout, Atlantic salmon, Baltic salmon, Arctic charr.	Fish farm in lake Bullaren (Se), river Lærdalselva, Drammenselva, Lierelva (No), Hatcheries/fish farms in Finland, Sweden, Denmark, river Pistoja (Ru), lake Pålbufjorden (No).

*Hansen *et al.* (2003) place this haplotype in clade II, while Meinilä *et al.* (2004) include it in clade I.

The pathogenicity of *G. salaris* appears to vary and in the following we have made some comments on how this may vary both between and within haplotypes.

Haplotype A.

This is the most common haplotype found in Norwegian rivers. In most rivers it has turned out to be very pathogenic to the Atlantic salmon, but in the river Batnfjordelva the mortality was much lower compared to the other rivers (Johnsen *et al.* 1999). We do not know why.

On the west coast of Sweden this haplotype was found in the rivers Surtan and Ätran and the most marked reductions in parr density on the Swedish West coast appear to have occurred in the river Ätran. The survival of salmon parr in the river Högvadsån, which is a part of the river Ätran, has decreased steadily, and the average density of salmon parr has been reduced by about 90 % (Alenäs *et al.* 1998).

Haplotype B

Since this haplotype was found in the rivers Torneelv and Vindelelven, it may be "the original" *G. salaris* described from the Hölle laboratory by Malmberg (1957). It was also

found in the Norwegian rivers Skibotnelva and Signaldalselva (Hansen *et al.* 2003) and it was also carried by the Arctic charr in the river Signaldalselva (Robertsen *et al.* 2007a).

Haplotype C

This haplotype was found in several rivers on the west coast of Sweden. The impact of the parasite on salmon parr densities has varied markedly although baseline data on parr densities are limited. It was noted that these Swedish rivers vary in water quality and it is possible that there has been genetic mixing of Atlantic and Baltic salmon.

Haplotype D

This haplotype has so far only been found in a hatchery at river Gauja in Latvia.

Haplotype E

This haplotype was found in Sävån, which is a tributary to the river Göta elv. In the first investigation carried out at the Swedish west coast in the year 1989, the parasite was found in a salmon hatchery in Laholm at the river Lagan and the same year on wild parr in the river Sävån (a tributary to the river Götaälven) (Malmberg & Malmberg 1991, Karlsson *et al.* 2003b). However, since 1997 the parasite has not been found in this river despite eight surveys having been carried out and three different stations were used for collection of parr in 2001 and 2002 (Karlsson *et al.* 2003b).

Haplotype Sal T Tornio

This haplotype has only been found in the Finnish part of the River Torneelv.

Haplotype Sal Keret 2 and Haplotype Sal Keret 1

These haplotypes, both of which were found in the river Keret, matched exactly with the two different haplotypes found in the Lake Onega system, one in river Kusmha the other in river Lizhma (Jaakko Lumme pers. comm.).

Haplotype F

This haplotype was common in rainbow trout farms in Finland, Denmark and Sweden, but it was also found in some populations of salmon: in Lierelva, Drammenselva and Lærdalselva in Norway (Hansen *et al.* 2003) and in the Pistojoiki river (lake Kuitozero, Russian Karelia) where it was suggested to be introduced via rainbow trout farms (Meinilä *et al.* 2004). In the river Lærdalselva the mortality of salmon parr was very high (Johnsen *et al.* 1997) while in the rivers Drammenselva and Lierelva the mortality seemed to be slightly lower than in most other Norwegian rivers (Johnsen *et al.* 1999a).

A special variant of this haplotype with mutation both in the ITS and the COI subunits is found in Denmark. This special variant is not pathogenic to salmon from Scotland or Denmark (Kurt Buchmann pers. comm.).

Arctic charr are also infected with *G. salaris* in five salmon-free lakes in central south Norway (Robertsen *et al.* 2006, 2007b). This host seems to be able to support *G. salaris* in species-poor fish communities in the absence of Atlantic salmon or rainbow trout. Recent work by Robertsen *et al.* (2007a, b) has shown that the *G. salaris* strain isolated from charr in the lakes had the same mitochondrial haplotype as rainbow trout parasites isolated from Lake Bullaren, Sweden, but was non-virulent to salmon (Olstad *et al.* 2005).

However, the ITS of *G. salaris* from Arctic charr showed a difference of one nucleotide to that previously observed in *G. salaris* populations (Olstad *et al.* 2007).

In addition to the haplotypes mentioned here another haplotype was found in Lake Ladoga which was different from the two haplotypes found in Lake Onega (Jaakko Lumme pers. comm.).

Discussion

Gyrodactylid taxonomy utilizes three classes of characters: (i) morphology, especially the morphometry and shape of the attachment hooks and bars, have been most extensively used, (ii) genetics, molecular loci have been available since the mid-1990s, particularly the internally described spacers (ITS) and lately the mitochondrial cytochrome oxidase subunit 1 (CO1) which are sensitive indicators of gene pool boundaries; (iii) biology, especially host specificity, but also the micro- and macrohabitat preferred. However, there are several unanswered questions in relation to the definition of species boundaries and selection of species concept for gyrodactylids (Harris 2002-2003). One example is *G. thymalli* and *G. salaris* which are very similar based on morphometry and genetics. Traditionally *G. thymalli* and *G. salaris* have been considered as two different species. However, Malmberg (1989) pointed out that *G. thymalli* was morphologically very similar to *G. salaris*. Cunningham (1997) unexpectedly found identical sequences in the ITS (Internal transcribed spacer) of *G. salaris* from Atlantic salmon and *G. thymalli* from grayling and was unable to discriminate between these species by genetical methods (Cunningham *et al.* 1995). The relationship between these species are discussed in several articles (McHugh *et al.* 2000, Soleng & Bakke 2001, Bakke *et al.* 2002, Sterud *et al.* 2002, Zietara & Lumme 2002, Hansen *et al.* 2003, Meinilä *et al.* 2004). According to Hansen *et al.* (2007), the data strongly suggest conspecificity of *G. thymalli* and *G. salaris* (Hansen *et al.* 2003, Meinilä *et al.* 2004, Hansen *et al.* 2006). Currently there is no morphological or molecular marker available that can unambiguously discriminate the two species, and differences in host preference (Soleng & Bakke 2001, Bakke *et al.* 2002, Sterud *et al.* 2002), remain the main argument in favour of considering *G. thymalli* and *G. salaris* valid species (Hansen *et al.* 2006). Bakke *et al.* (2007) point out “that there is still a lack of knowledge and that this lack of knowledge is particularly apparent in relation to *G. salaris* in Norway; the precise relationships of the different forms which infect salmonids in Scandinavia, and which are evolving via a series of host shifts, remain obscure and elusive. There is a need to be very careful with nomenclature (which can be legally binding) in such a fluid situation, and we would highlight the potential of this system for evolutionary biologists with an interest in the role of host shifts. The reasons why *G. salaris* is so damaging, when the congener *G. thymalli* and some *G. salaris* strains are not, remain obscure, and much additional research is needed on the role of gyrodactylids as potential biotic invaders. In particular, we need to identify potential future pathogens, particularly of salmonids, to predict their likely impact. This has been given additional urgency by the recent report (You *et al.* 2006) that *G. brachymystacis* can establish pathogenic infections of rainbow trout in China, with the potential that this may also become a significant pest in aquaculture”.

Whatever the outcome of these taxonomic discussions might be, still the fishery authorities in the different countries must relate to the different effects of the different “types” of *G. salaris*/*G. thymalli*.

To further complicate the question, it is well known that different salmon stocks have different resistance against *G. salaris*. Experimentally, Bakke *et al.* (1990) showed that salmon from the river Neva which is the outlet river from Lake Ladoga, showed a response against *G. salaris*. The hatchery-reared Baltic Neva stock demonstrated both an innate and an acquired resistance towards *G. salaris*, in contrast to the highly susceptible, Norwegian Alta and Lone stocks (Bakke *et al.* 1990). It has also been noted that not all Baltic salmon stocks are resistant to the parasite. Northern Baltic salmon show an intermediate susceptibility against *G. salaris*. A study on the susceptibility of the Baltic salmon from the Swedish river Lule (Dalgaard *et al.* 2003) reports that this strain is susceptible to infection, but to a lesser extent than the Scottish salmon. Although the Lule salmon seems more susceptible to infection compared to previous reports on the Neva salmon, the results support the notion that Baltic salmon strains are generally more resistant than East Atlantic salmon (Dalgaard *et al.* 2003). The susceptibility of a Baltic salmon stock from the river Indalsälva, central Sweden to Norwegian *G. salaris* was experimentally tested and compared with previously obtained results on East Atlantic salmon (Lierelva, SE Norway). Contrary to expectation, the Baltic salmon appeared almost as susceptible as the Norwegian salmon parr (Bakke *et al.* 2004). Laboratory studies on the susceptibility of young salmon from the Mörrum River, Southern Sweden to infection with a Norwegian strain of *G. salaris* showed that the salmon exhibited intermediate susceptibility and low mortality (Dalgaard *et al.* 2004).

It is also well known that environmental factors like for example water quality may influence the relationship between the host and the parasite. For example on the west coast of Sweden the impact of the parasite on salmon parr densities has varied markedly although baseline data on parr densities are limited. The most marked reductions in parr density appear to have occurred in the river Ätran, although these were not as marked as reported in Norwegian rivers, whereas in other rivers there has been limited impact. It was noted that these Swedish rivers vary in water quality.

In summary the status of knowledge for the relationship between *Salmo salar* and *Gyrodactylus salaris* is:

- There are different types of *G. salaris* with different virulence towards the host
- There are different types of salmon with varying resistance towards the parasite
- Environmental conditions, for example water quality may have a significant impact on the relationship between host and parasite

Host-parasite interactions are therefore complicated and merit further research in the different countries involved.

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**Working Group on *G. salaris*
in the North-East Atlantic Commission Area**

GSWG(07)9

***Measures to prevent the spread of Gyrodactylus salaris and to eradicate it
where it has been introduced
(Tabled by EU (UK - Scotland))***

GSWG(07)9

Measures to prevent the spread of Gyrodactylus salaris and to eradicate it where it has been introduced

Actions taken in Scotland

1. Prevention

1.1 *Gyrodactylus salaris* is exotic to Scotland and it is highly improbable that the infection could enter the country by natural means because of the inability of the parasite to survive in full strength seawater. Significant risk is therefore associated with the actions of man both in the trade in fish and fish eggs and via leisure pursuits.

1.2 Commission Decision 2004/453/EC recognises that Great Britain has demonstrated freedom from *G. salaris* and maintains a surveillance programme to determine continued absence of the disease. The Decision therefore provides certain protective measures for GB with regard to *G. salaris* in salmonids.

1.3 The importation of live salmonids from areas of lower health status, with respect to *G. salaris*, is prohibited into Great Britain although importation of disinfected eggs is permitted from areas infected with *G. salaris*. NB Imports can occur from areas of a country that has *G. salaris* providing that the area from which stock are imported meets the requirements of Commission Decision 2004/453/EC.

1.4 Discussions are being held with airports, ferries and seaports, assisted by fishing and leisure organisations to identify the greatest points of risk where *G. salaris*, might enter Scotland. It is intended that an enhanced publicity campaign, by way of displaying posters, could be used to highlight the risks of anglers, canoeists and rafters inadvertently bringing *G. salaris* into Scotland on damp equipment.

1.5 The Association of Salmon Fishery Boards (ASFB) and the Rivers and Fishery Trusts for Scotland are working with individual Boards to discuss with fisheries proprietors the benefits of getting anglers to sign declarations that they have not been fishing abroad or have been and have subsequently disinfected their equipment. ASFB have written to all boards outlining what they should do to raise awareness of *G. salaris*, what preventative measures they should take and some advice on preparing a document that outlines the characteristics of the catchments that will be important in developing an eradication strategy. It is ASFBs intention to audit these actions annually.

1.6 The Scottish Aquaculture Industry produced a Code of Good Practice (CoGP) for fish farmers in 2005. This is not specific to *G. salaris* but does provide advice on sourcing brood stock and the disinfection of imported gametes or eggs into Scotland. The CoGP relies on the latest scientific information and developments from within the industry. The CoGP can be found at www.scottishsalmon.co.uk/dlDocs/CoGP.pdf

2. Contingency plans

2.1 A draft outline contingency plan to deal with an outbreak of *G. salaris* was produced in May 2002 but a more detailed plan was not developed at that time. Several events since 2002 have led to the production of a more detailed plan being published:-

- A workshop was held in 2005 to discuss the issues surrounding the possible introduction of *G. salaris* into Scotland. The workshop was attended by officials of several Government Agencies, representatives of the fishing industry and other commercial users of water and by officials from England, Ireland, and Norway. It was the unanimous view of the workshop that Government set up a Task Force to investigate and report on a range of issues surrounding *G. salaris* and to produce a contingency plan to deal with any future outbreak.
- Officials had been to Norway in 2004 to observe treatment of several rivers and to gain information on the whole process of dealing with *G. salaris*.
- The Aquaculture and Fisheries Act 2007 provides legal powers to enhance such controls as already existed i.e.:-
 - To eradicate *G. salaris*
 - To authorise or direct the removal of dead and moribund stock
 - To impose standstills on all waters and fish farms
 - To erect barriers and close fish passes
 - To have compulsory access
 - To clear fish farms if they contain a species on which *G. salaris* can reproduce
 - To order mandatory disinfection of recreational gear.
- The disastrous Foot and Mouth outbreak in 2001 had caused officials to rewrite the Scottish Foot and Mouth Contingency Plan in 2002 and to produce a new Scottish Communication strategy document. These two documents formed the template on which the current contingency plan for *G. salaris* was based.
- All of these events provided information and guidelines in developing a new detailed contingency plan to deal with any future outbreak of *G. salaris* if it ever occurs in Scotland

2.2 The remit of the Task Force was based on the outcomes of the workshop and was formalised in the following terms of reference:-

- Develop preventive measures home and abroad to exclude *G. salaris* from Scotland.
- Produce a contingency plan to contain and where possible eradicate the parasite should it be introduced to Scotland.
- Identify the personnel who would form the skeleton of a control organisation and the preparation and training they require such as secondment in Norway.
- Consider other options for intervention including employment of the Norwegian company VESO and recommend accordingly.

- Where control is impractical, to make recommendations for measures to minimise the spread of *G. salaris* and mitigate its impact on freshwater fish and the wider economy.
- Identify and develop proposals for new statutory controls, including necessary powers for compulsory slaughter of wild fish, prohibiting abstraction of water during a river treatment, provision of alternative water supplies for watering livestock and movements of live fish.
- Identify research needs for the identification of *G. salaris*, containment and control measures such as determining the efficacy of disinfectants and investigation of the chemistry of Scottish rivers in preparation for the use of aluminium sulphate.
- Investigate with representatives of Scottish smolt producers the question of the industry providing gene bank facilities for use in restocking rotenone treated rivers.

2.3 The Contingency plan (www.scottishexecutive.gov.uk/Topics/Fisheries/Fish-Shellfish/Gs) assumes that in the event of *G. salaris* being confirmed in Scotland the preferred option will be eradication but also details how an outbreak might be contained if eradication is deemed to be impractical. The plan contains the following sections:-

- Disease response assumptions
- Command and control
- Structures and responsibilities of government headquarters
- Field Operations
- Communications and
- Resources

These overall instructions are supported by 11 appendices that detail:-

- Summary of legislation affecting control of *Gyrodactylus salaris*
- Roles and Responsibilities of Scottish Government Departments, External Enforcement bodies and other Stakeholders
- Factors to be considered when deciding on whether to contain or eradicate disease
- Additional information on disease responses
- Communications issues and strategy
- Command and Control
- Composition and roles of national and local Stakeholder Groups
- Resources
- Gene banking and restoration
- Plans and projects—environmental consents
- Operations Manual

2.4 A table top exercise was carried out over two days in February 2007 to test the robustness of the plan that had been produced. Officials from Norway and England attended together with all the main departments from the Scottish Government, Enforcement Bodies, fishing, leisure and industrial users of water. The exercise took the form of a series of scenarios using previously assembled data and maps. Participants were divided into a series of groups comprising participants from a number of disciplines. The aim was to test whether the plan would work and where problems were identified to refer

them back to the Task Force for further consideration. The main issues that needed resolution can be summarised as follows:-

- Cross border legislative issues with England
- Serving of legal notices to prevent movements of fish etc
- Access to additional staff, call off arrangements and training issues
- Timing of treatment including possibility of early treatments to reduce disease load.
- Access to Rotenone
- Security issues re-water extraction details
- Scope of Scottish Ministers especially in relation to issues for which the UK Government has responsibility e.g. energy including Hydro-electric power
- Strategic Co-ordination Groups and Civil Contingencies Structures
- Amendments to Contingency Plan

The contingency plan was revised and a second edition published in April 2007. Some of the above issues are subject to ongoing review and resources necessary to tackle any outbreak are being sought.

2.5 Officials visited Norway again in August 2007 to observe an aluminium sulphate treatment and were able to obtain information that will be useful in developing training programmes and considering amendments to the contingency plan. The relationship built up with Norwegian officials has been very beneficial and is greatly appreciated.

**Working Group on *G. salaris*
in the North-East Atlantic Commission Area**

GSWG(07)10

***Initiatives to increase awareness of *Gyrodactylus salaris*
- actions taken in Scotland
(Tabled by EU (UK - Scotland))***

GSWG(07)10

Initiatives to increase awareness of Gyrodactylus salaris - actions taken in Scotland

In recent years there has been an increased awareness in Scotland about the dangers that *G. salaris* would pose to both the commercial salmon industry and to salmon anglers if Scottish waters were affected with this parasite. The discovery of *G.salaris* in Scotland would also have severe adverse effects on other users of water. These factors have led to a number of initiatives aimed at increasing public awareness of the parasite, the damage it could cause and ways to reduce the risk.

1. Home and Dry Campaign

The Scottish Government launched a campaign in February 2007 to heighten the awareness of *G.salaris* among anglers and the wider public and to point out the dangers of allowing the parasite into Scotland. The campaign was launched at four major salmon sites simultaneously and was led by a media interview given by Jack Charlton who as well as being a renowned international footballer is also a keen salmon angler.

The campaign featured a poster aimed at fishermen and water sports enthusiasts who have just returned from countries where *G.salaris* is known to exist or may be present and gives advice on precautions to be taken. There is also a leaflet giving details of what the parasite is, which countries are affected, how it could get into Scotland and precautions to take to keep it out of Scotland. Copies of the leaflet and poster have been circulated very widely among the fishing and water sports fraternity as well as hotels, estates and holiday companies who specialise in fishing and water leisure industries. The poster and the leaflet can be found at www.infoscotland.com/gsbug.

The campaign has been widely supported by the fishing and water sports industry. The initial print run of 30,000 copies was quickly used up and a second run was printed.

2. Interest in Fishing Press

Scottish and UK fishing press have published several articles on *G.salaris* and advantage has been taken by several organisations to produce articles to keep up the awareness.

3. Work of Angling/Fisheries Associations

All the angling and commercial fisheries interests were represented on the Task Force that produced the contingency plan and developed the “Home and Dry” campaign. They have been active in promoting the initiatives amongst their own members and in trying to increase public awareness. Two of the organisations led two of the media conferences associated with the campaign. The Association of Salmon Fishery Boards has written to all District Fishery Boards outlining actions that can be taken to enhance awareness and increase preventative measures. They intend to audit what District Fishery Boards do on an annual basis.

4. Visit Scotland

VisitScotland is Scotland's national tourist board which delivers a multi-channelled bookings and information service for visitors to Scotland. To achieve this, the company operates the National Booking and Information Centre where a team of trained advisors deals personally with telephone requests for information and bookings. VisitScotland provides online access to its information and accommodation availability to the 120 Tourist Information Centres networked across the country.

VisitScotland's website contains a section on *G. salaris*, in its advice on salmon fishing that gives advice to visiting anglers and those who have been fishing abroad. It contains information on the risk of introducing *G.salaris* and on preventative measures.

5. Scottish Canoe Association

The Scottish Canoe Association has produced a leaflet on *G salaris* that is specifically targeted at the actions of its members and gives advice on what action to take if they have taken canoes to areas known or thought to be affected with *G.salaris*.

**Working Group on *G. salaris*
in the North-East Atlantic Commission Area**

GSWG(07)11

***Cost-benefit analyses to support research, policy decisions, etc.
- actions taken in Scotland
(Tabled by EU (UK - Scotland))***

GSWG(07)11

Cost-benefit analyses to support research, policy decisions, etc. - actions taken in Scotland

In looking at the possibility of *G.salaris* affecting Scottish waters, officials were very aware of the multiple users of Scottish rivers and lochs. Any decision to impose containment or eradication measures on rivers and lochs is likely to have far reaching effects on a number of commercial and leisure activities and to involve up to 20 separate pieces of legislation.

There could be a major impact on any or all of the following depending on the catchment(s) affected:-

- Whisky distilling
- Hydroelectricity generation
- Public water supplies
- Water transfers
- Environmentally designated sites
- Commercial fishery sites
- Salmon anglers
- Leisure anglers
- Canoeing and rafting
- Hotel trade
- Local employment
- Suppliers of fishing equipment

In order to assess the effects of various possible actions in the event of Scottish waters being affected the Scottish Government commissioned a cost-benefit analyses entitled “An Economic Evaluation of the Impact of the Salmon Parasite *Gyrodactylus salaris* (Gs) Should it be Introduced into Scotland”. The analysis was carried out by the Institute of Aquaculture, University of Stirling and Caledonian Business School, Glasgow Caledonian University. It can be found at www.scotland.gov.uk/Topics/Fisheries/Fish-Shellfish/18610/GsEclmpSt

The cost-benefit analyses was commissioned by the Scottish Government to provide data that could be used to inform the development of strategies to be deployed if *G. salaris* were ever to be found in Scotland. The study assumed that the parasite will most likely spread by infected fish or by water movements or both. It also evaluated the possibility of parasite transfer on wet clothing, angling and boating equipment. A contingency plan exists for dealing with an outbreak of *G. salaris* in Scotland but no decisions have been taken by Scottish Ministers as which of several options might be used. The analyses thus looked at using rotenone and/ or aluminium sulphate in each of the eradication scenarios studied.

1. The Options

The economic benefits from successful policy initiatives to control *G. salaris* are the avoidance of the adverse economic consequences that would arise if no action were taken. To evaluate the expected economic benefits of any specific strategy, it is necessary to estimate the probability that the strategy will be successful. Factors such as the biology of the parasite, current practices within the aquaculture and fisheries sectors, and the likely response of

different stakeholders to possible policy measures have all been considered in the cost/benefit analysis.

Costs and benefits have been examined for the following policies:

1.1 Prevention

Measures that potentially reduce the probability of *G. salaris* entry.

1.2 Eradication

An eradication strategy might be possible if *G. salaris* reaches Scotland and infests a small river catchment (e.g. the River Luce in the south west). The strategy would have implementation costs, but would also generate Net Economic Value as the river recovers

1.3 Containment

If *G. salaris* infested a large river catchment (e.g. the Spey) and remained undetected until it had spread widely then eradication may not be feasible on economic, political and/or legal grounds. However, a strategy of containment to protect the rest of Scotland from infestation might be appropriate. Such a containment policy might be either limited (Minimal Exclusion), focusing only on the greatest risk of *G. salaris* transfer, or it could involve the Total Exclusion of the public from the water. The size of the infected catchment should not be used as a measure of whether or not eradication is feasible. If the parasite is detected early and/or it is possible to divide the catchment into smaller sectors eradication may still be an option.

1.4 Other Measures

Initiatives that cannot properly be described as containment or eradication measures but which are essentially complementary to these strategic approaches.

2. Summary of Analyses

2.1 Prevention

Two basic approaches to decreasing the probability of *G. salaris* infestation are disinfection at ports, and publicity to anglers, other water users and the general public. The total cost of these measures was estimated at £6m. This is small in comparison with both the Net Economic Value of £633m of keeping Scotland free of *G. salaris* and the protection of the 1,966 full time jobs that could be lost if *G. salaris* was detected in Scotland.

Thus, on the basis of the Net Economic Value alone, a long-term reduction in the likelihood of transmission of 1% is all that would be necessary to justify these measures.

2.2 Eradication: The River Luce case study

The Luce is a small river in South West Scotland with no aquaculture activity. A loss of 600 angler days would follow if it became infected, with a direct economic impact of £12,500 in lost local income. However, overall, there would be a positive economic impact because the cost of eradication is put at around £550,000, with a labour bill of £166,000. During the process of river treatment, enhanced local employment prospects and raised incomes would be expected before a return to the *status quo*.

The analyses looked at treatment with both Rotenone and aluminium sulphate. In both cases the analyses looked at the cost of treatment, the loss of rents and consumer surplus and the benefits from rents and consumer surplus after treatment plus the avoidance of containment costs once treatment was carried out.

The costs and loss of rents and consumer surplus when using rotenone was assessed at £0.77M. The benefits were assessed at £2.24M giving a Benefit/Cost ratio of 2.93 i.e. for every £1,000 spent in eradicating *G. salaris* there would be an estimated benefit of £2,930. When using aluminium sulphate the costs were estimated at £1.08M, the benefits at £2.11M and the Benefit/Cost ratio at 1.94. Either treatment thus shows a positive economic benefit over a strategy of containment.

2.3 Containment: The River Spey case study

The Spey is a large complex river system, providing habitats for a number of vulnerable species. Aquaculture in the area is almost wholly based on rainbow trout for recreational purposes.

Given that eradication regimes may not be feasible on economic, political, and/or legal grounds, the economic impact of *G. salaris* infection will depend on the containment policies pursued, together with the period taken for economic recovery and the re-employment of those who loose their jobs.

Two containment policies were examined:

- **Minimal Exclusion** where only transport of fish and ‘water’ are banned, and
- **Total Exclusion** where all activities (except water for cooling in distilleries) are banned.

Policies involving partial exclusions were not studied.

Minimal Exclusion incorporates a pass scheme to ensure disinfection of all boats and equipment when they leave the area, which, along with the ban on fish and water movement, should virtually eliminate the possibility of *G. salaris* transfer to another catchment. The scheme’s running cost was found to be surprisingly small in the order of £175,000 per annum. In addition, the Minimal Exclusion policy does generate some jobs in surveillance and in publicity.

Total Exclusion has a more dramatic effect because it stops all angling and water sports. It would also affect the attractiveness of the area for the one million tourists who visit the Cairngorm National Park and lower Spey each year. A conservative estimate of the effect, of the additional constraints, on the local area are over £1.75m in lost income together with a loss of 106 jobs. The impact on Scotland as a whole is much less because it is assumed that most users would simply shift their activities to somewhere else in Scotland.

The Net Economic Value lost to Scotland, in the event of widespread infection with *G. salaris*, is estimated at £633M. The Minimal Exclusion policy has a capitalised value of £5.8M so the policy would only need to reduce the risk of transmission of the parasite by 0.91% ($5.8\text{M}/633\text{M}$) to be justified on economic grounds. The Total Exclusion policy has a capitalised value of £41.1M and would need to reduce the risk of transmission by 6.5% ($41.1\text{M}/633\text{M}$) to be justified.

The data does not include the adverse effects that containment policies may have on other water users which maybe very considerably more than on salmon angling. Such costs may

justify the option of treatment if it minimises the adverse effects on whisky distilling, hydroelectricity generating and public water supplies.

2.4 Other Measures

The study looked at other measures that might be undertaken immediately, notably:

- Gene-banking and,
- Increased surveillance.

Gene-banking

The principal purpose of gene-banking is to enable re-establishment of natural populations native to specific rivers following successful eradication of *G. salaris*. Currently, there are no live fish gene-banks in the UK, and their establishment is both lengthy and costly.

A gene-bank accommodating a sample of 20 rivers would have a set-up cost of £16m, with a running cost of £1.2m per annum. This gives a total capitalised cost of £56m. There are 381 salmon rivers in Scotland, so the cost of comprehensive gene-banking would be prohibitive. In addition, the value of re-instating salmon quickly in a small river attracting very few anglers will also be low.

Surveillance in the current programme involves sampling 226 sites annually (215 salmon or rainbow trout farms, and 11 rivers on a rolling system of 55 sites over five years).

Surveillance has no economic value if the measures to keep the parasite out succeed. In the event of failure, a value is generated where surveillance limits the spread of *G. salaris* from one river to another. A value is generated if surveillance allows the parasite to be confined and then eradicated within a section of a river system. If increased surveillance and early detection prevented spread from, say, a small to a large river then the saving could be far more than the surveillance costs.

It is difficult to justify extra surveillance if the probability of *G. salaris* entry is very low after the suggested precautions have been taken. However, if *G. salaris* is detected in Scotland (or the UK), transmission probabilities will have increased, the Expected Value of surveillance will increase correspondingly, and additional surveillance might be economically justified. The value of surveillance may also be enhanced if it prevents the loss of other fish species that have a significant financial value.

3. Conclusions

The cost-benefit analyses concluded that:-

3.1 Should the Scottish Government take no action to prevent the spread of *G. salaris* in Scotland, a decrease in Net Economic Value, capitalised at £633m could result from the complete loss of salmon angling.

3.2 Aquaculture is not as likely to be seriously affected because of the incentive for, and ability of the commercial organisations involved to protect their stocks.

3.3 The probability of *G.salaris* entering the UK could be reduced considerably by the provision of disinfection stations at ports, and by extensive publicity identifying the danger of the parasite. The cost of these measures is put at a capitalised value of £6m.

3.4 On entry of *G.salaris* into a river system, the appropriate eradication/containment policy is wholly dependent upon the biological and physical characteristics of the river:

- For a small river, eradication is likely to be preferred to containment. If the salmon catch is relatively large, it is likely that, despite the increased cost, aluminium sulphate will be preferred to rotenone because salmon angling can be resumed more quickly.
- If the river system is large and complex, it is likely that eradication would prove to be economically and, perhaps, legally or politically, infeasible. Further economic analysis of a clearly defined eradication plan in a large system is necessary in order to identify the conditions necessary for eradication to become appropriate. This would need to include the adverse effects on other users of water and the risk that containment would not prevent the gradual spread of disease.

3.5 In the Spey case study on containment, transmission probabilities were identified as a key factor in selecting between Minimal and Total Exclusion strategies. Transmission probabilities are influenced by the number of water sports-persons and visitors. The Total Exclusion strategy becomes more economically attractive with fewer users.

3.6 Further information in three areas would be useful for policy formulation:

- Transmission probabilities and the factors affecting them,
- The relationship between river geography and the potential for *G.salaris* eradication,
- The uses made of rivers in Scotland.

Note

The financial data given in Section 2.2 above includes the capital cost of providing the equipment. Equipment for Rotenone treatment was estimated at £123,764 and for aluminium sulphate treatment at £508,840. These are capital costs for equipment that can be used again. Removing the cost of equipment from the data gives a benefit/cost ratio of 3.68 for rotenone and 4.25 for aluminium sulphate treatment.

**Working Group on *G. salaris*
in the North-East Atlantic Commission Area**

GSWG(07)15

***Cost-benefit analyses
(Tabled by Norway)***



Cost-benefit analyses

Jarle Steinkjer
Directorate for Nature Management



Cost-benefit analyses

Krokan, P.S. og Mørkved, O.J. 1994. Nytte-kostnadsanalyse av innsatsen for å bekjempe lakseparasitten *Gyrodactylus salaris* i perioden 1981-1998. Utredning for DN nr. 1994-4, 53 sider.

Mørkved, O.J. og Krokan, P.S. 2000a. Nytte-kostnadsanalyse av prosjektet rotenonbehandling av Steinkjervassdragene. Utredning for DN nr. 2000-3, 38 sider.

Mørkved, O.J. og Krokan, P.S. 2000b. Økonomisk analyse av villaksressursene i nasjonale laksevassdrag. Høgskolen i Nord-Trøndelag, Utredning nr. 24, 37 sider.

Navrud, S. 2001. Samfunnsøkonomisk nytteverdi av villaksressursene i nasjonale laksevassdrag: oppfølgingsstudie. Oslo Energi Konsult, 37 sider.





The general conclusion from an analysis estimated benefits and costs of the fight against *G. salaris* indicate that the project is very profitable for the society, and considerable more money can be used before the limit of profitability is exceeded

Krokan & Mørkved (1994). Nytte-kostnadsanalyse av innsatsen for å bekjempe lakseparasitten *Gyrodactylus salaris* i perioden 1981-1998. Direktoratet for naturforvaltning. Utredning for DN 1994-4: 1-53



In 2006 the Directorate for nature management calculated the total cost in connection with accomplishment of the *Gyrodactylus* program.

The total cost for the *Gyrodactylus* program depend on the annually allotment.





High annually allotment make it possible to purchase requisite equipment, building fish barriers and treat rivers within a short time period. This will result in quickly reduced expenditures for the gene bank, the total socio-economic loss will be reduced, local man-year will be secured, and the possibility of spreading of the parasite will be reduced.

Low annually allotment will lengthen the program period with considerable increase of the total cost and loss of man-year as result



Factors considered in the cost-benefit analyse

Eradication: The total cost of mapping, planning and chemical treatment of infested rivers in the different regions

Treatment strategy: 2 treatments in each region

Gene bank: We know the cost for each stock in the gene bank

Research: Constant, highest in the beginning of the period

Equipment: Estimated to 20 mill NOK

Management/unforeseen: 5% of the total budget

New infection/unsuccessful treatment: Each fifth year

Local economic consequences: Factors from NINA report 126 "Assessment of socio-economic value of aquaculture and sport angling for wild salmonids in north-western Europe" among others.

Loss of man-year: 3.3 man-year per 100 fish caught in the river





2	High annually allotment									
3										
4	Measure	2007	2008	2009	2010	2011	2012	2013	2014	2015
5	Gene bank	6000	6000	6000	5250	5250	4875	3375	2625	1500
6	Skibotn region	200	200	2000	15000	15000	500	500	500	500
7	Rana region	500	500	500						
8	Vefsna region	20000	20000	500	500	500	500	500		
9	Steinkjer region	15000	500	500	500	500	500			
10	Driva region	30000	500	500	500	2000	15000	15000	500	500
11	Romsdal region	1000	15000	15000	500	500	500	500	500	
12	Lærdal region	500	500	500	500	500				
13	Research	3000	3000	3000	2000	2000	2000	2000	500	500
14	Equipment	10000	10000	500	500	500	500	500		
15	New infection/unsuccessful tr.					10000	10000			
16	Management/unforeseen	4260	2760	1375	1238	1813	1694	1094	306	225
19	Sum	90460	58960	30375	26488	38563	36069	23469	4931	3225
20										
21	Local economic consequences	242000	242000	242000	226000	226000	175000	154000	103000	75000
22	Total sum	332460	300960	272375	252488	264563	211069	177469	107931	78225
23	Loss of man-year	552	552	552	516	516	399	352	235	175
24										



	Annually allotment		
	High*	Middle**	Low***
Treatment cost (mill USD)	56	67	90
End of the project year	2018	2024	2032
Total cost (treatment and socio-economic loss (mill USD)	373	473	630
Total loss of man-year	4173	5402	8024

* 13 mill USD the first three years, then gradual reduction

** 7 mill USD annually within the period

*** 4 mill USD annually within the period



**Working Group on *G. salaris*
in the North-East Atlantic Commission Area**

GSWG(07)16

***Research on Gyrodactylus salaris in Finland in 2006-2007
(Tabled by Finland)***

Research on Gyrodactylus salaris in Finland in 2006-2007

Scientific research on *Gyrodactylus salaris* during the recent years has mainly been performed at the University of Oulu, Department of Biology, by a group led by docent Jaakko Lumme. Their interest has been on the molecular ecology and evolution of the parasite.

At the Finnish Food Safety Authority Evira there is ongoing research on the epidemiology of *Gyrodactylus salaris* infection in the Baltic Sea salmon river Tornionjoki and on more applied subjects, disinfection of the fishing equipment and the method of monitoring the parasite at fish farms.

Publications in peer reviewed journals in 2006-7:

Ziętara, M. S., Kuusela, J. Veselov, A. and Lumme, J. (in press) Molecular faunistics of accidental infections of *Gyrodactylus* Nordmann, 1832 (Monogenea) parasitic on salmon *Salmo salar* L. and brown trout *Salmo trutta* L. in NW Russia (Monogenea, Platyhelminthes).

Systematic Parasitology in press

DOI: 10.1007/s11230-007-9121-7

Kuusela, J. Ziętara, M. S., and Lumme, J. (2007) Hybrid origin of Baltic salmon-specific parasite *Gyrodactylus salaris*: a model for speciation by host switch for hemiclinal organisms. **Molecular Ecology** in press

DOI: 10.1111/j.1365-294X.2007.03562.x

Rokicka, M., Lumme, J. and Ziętara, M. S. (2007). Identification of *Gyrodactylus* ectoparasites in Polish salmonid farms by PCR-RFLP of the nuclear ITS segment of ribosomal DNA (Monogenea: Gyrodactylidae). **Acta Parasitologica** 52: 185-195.

DOI: 10.2478/s11686-007-0032-1

Ziętara, M. S., Kuusela, J. and Lumme, J. (2006). Escape from an evolutionary dead-end: a triploid clone of *Gyrodactylus salaris* is able to revert to sex and switch host (Platyhelminthes, Monogenea, Gyrodactylidae). **Hereditas** 143, 86-92.

DOI: 10.1111/j.2006.0018-0661.01956.x.

**Working Group on *G. salaris*
in the North-East Atlantic Commission Area**

GSWG(07)17

***Subgroup recommendations to facilitate coordinated research and
monitoring***

Subgroup recommendations to facilitate coordinated research and monitoring

Discussions during the main Working Group meeting suggested that a common approach to *G. salaris* monitoring and control was required across member countries. The subgroup agreed that certain areas of work required standardisation between laboratories and that collaboration was required to do this. Such areas include (but are not restricted to): identification of the parasite, monitoring, defining which strains are classed as *G. salaris*, disinfection (how, what and when) and understanding pathogenicity.

One of the problems identified in achieving this was a lack of funding resources available to government research laboratories to conduct research in to *G. salaris*. To facilitate collaborations and exchange of information the subgroup proposed that the Working Group take the following recommendations forward to NASCO:

1. Set up a *G. salaris* scientific Working Group. This should be developed based around appropriate work streams and use the example of the tri-nations Pancreas Disease Working Group that is currently active. The Terms of Reference for the Group should be to:
 - a. facilitate the free exchange of information, especially unpublished or ‘grey’ literature between interested scientists from member countries;
 - b. make recommendations to NASCO as to standardised methods that could be adopted across member countries based on this information;
 - c. identify and recommend to NASCO areas where collaborative research across government laboratories requires funding.
2. That funding is made available to allow such a group to be set-up and run.
3. That NASCO identify funding sources suitable to facilitate the collaborative research requirements recommended by the *G. salaris* scientific Working Group.