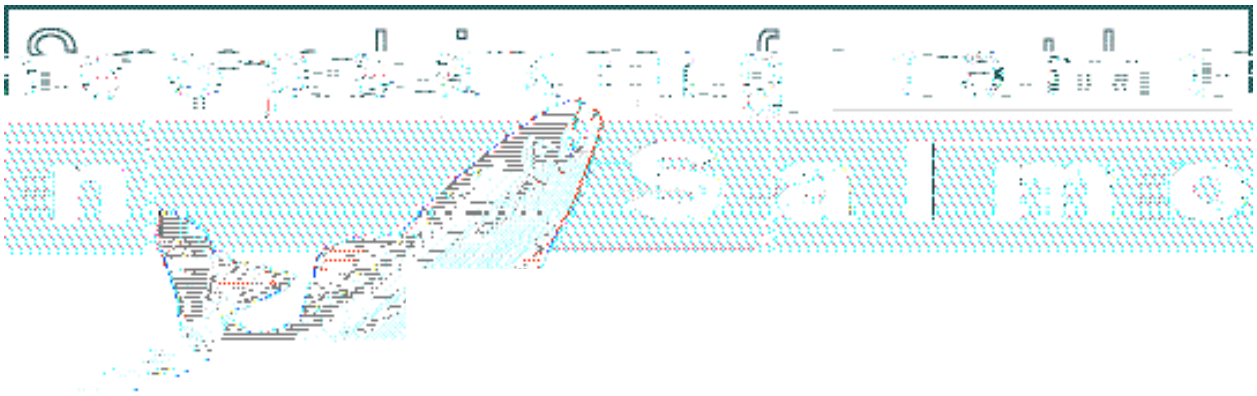

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Linking Science and Local Knowledge Node of the
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THE ROUNDTABLE PROCESS

Twenty-five scientists including those conducting research on sea lice and pink salmon in the Broughton Archipelago, or with extensive knowledge of salmonids and (or) sea lice, came together in a one-day Roundtable meeting and discussed the subject of sea lice and pink salmon in the Broughton Archipelago. Participation in the Roundtable was by invitation and the event took place on November 18, 2004. A list of participants is found on page 10.

In keeping with the spirit of a Roundtable discussion, with the exception of the opening presentation by an invited speaker from Scotland, there were no formal presentations; rather, as the day's discussions evolved, data and observations were shared when appropriate and relevant to the topic under discussion. The Roundtable was chaired by the Honorable John Fraser, Chair of the Pacific Fisheries Resource Conservation Council.

What follows is a summary of the discussions. This report does not represent a unanimous consensus of the participants.

Statement of Agreement

Based on the weight of evidence approach, participants generally agreed on the following statements as a reflection of their understanding of the impact and significance of sea lice for wild salmon in BC:

1. Salmon farms contribute sea lice to wild fish.
2. In Central British Columbia there are more sea lice (*Lepeophtheirus* spp) on juvenile wild fish near farms.
3. Sea lice can kill juvenile fish, even at low infestation levels. The lethal load varies with environmental conditions, fish size and cumulative stress. Limited evidence suggests that levels that appear to be lethal are found near fish farms.
4. The risk factors (e.g., geographic, channel morphology, salinity and temperature, presence of large and healthy runs, size of wild salmon population) contribute variability to sea lice incidence and lethality.
5. There is suggestive evidence of population impacts.
6. Raw data (temperature, salinity, stocking density, sea lice incidence, treatment regimens) from fish farms are crucial to research and management and we need to be able to verify those data.

The weight of evidence came primarily from the current knowledge of salmon and sea lice in Europe, Atlantic Canada and the Broughton Archipelago shared in the day's discussions.

"The ICES workshop in Europe concluded that in Europe where there are salmon farms there are more sea lice."

"Norway had (and still has) a problem with sea lice. Scotland and Ireland and then eastern Canada were also faced with a sea lice problem when salmon aquaculture was introduced. Now, on the west coast we have a problem. This is not magic. Sea lice kill salmon."

Invited presentation

Margaret McKibben, Biologist and Field Station Manager, Loch Shieldaig Field Station, Scottish Freshwater Research Services

Sea lice in Loch Torridon, Western Scotland: planktonic distribution, interactions with sea trout, larval transport modelling and the impacts of fish farms.

M.A. McKibben, P.A. Gillibrand, D.W. Hay, S. Murray & M.J. Penston.

Sea trout, *Salmo trutta*, numbers on the west coast of Scotland have fallen over the last thirty years. This decline has been linked to reduced survival in the marine phase. Lice infection may have a

Discussion following the presentation was centered on the apparent link between declines observed in sea trout returns with the introduction of salmon farming and cooperation of the salmon farming industry and the sharing of their information.

Although declines observed in sea trout numbers could be related to a number of factors including

poor marine survival, poor management or climate change, Margaret McKibben stated that most Europeans have accepted the link between the onset of farming and the decline in wild sea trout. Their results clearly demonstrate: planktonic sea lice levels are significantly higher near the farms, and; the pattern of planktonic sea lice dispersal from these regions throughout the loch.

With respect to the cooperation of the salmon farming industry, the AMAs are a voluntary process and to date have been very effective. Through the AMAs industry is working towards synchronized treatment and synchronized fallowing. *"The farms have started talking to one another (they never used to). They started communicating amongst themselves and then with government and the public."*

What follows is a summary of the collective knowledge and experience of the participants that was shared during the discussions of the Roundtable. Comments in quotation marks were made by participants unless designated otherwise.

WHAT WE KNOW ABOUT SEA LICE AND SALMON*

** " Research results are always 'suggestive', never conclusive. Fault can be found with any individual study, whether in the laboratory or field. It is the weight of evidence from several studies combined that is important, and lets one conclude that sea lice transfer from farm to wild fish."*

Effects of fallowing
Results of a recent study (North American Journal of Fisheries Management, in press) show that there was a significant drop in sea lice loads on juvenile wild salmon sampled near three of the farms in the Broughton Archipelago that were fallowed in 2003. In 2004 the lice loads on wild juvenile salmon sampled at these sites increased significantly and substantially when these same farms were not fallowed.

The nature of parasitic diseases – sea lice infections in juvenile salmon
• Stress
When animals are stressed, for example confined in a small area in high densities (such as in salmon net cages), they are more prone to parasitic infection. Sea lice outbreaks are therefore to be expected on salmon farms.

When animals that are already stressed (such as smolting juvenile wild salmon) encounter additional stresses such as infection with sea lice, the impact can be lethal. The more factors contributing to this cumulative stress the more debilitated the organism becomes and the greater the chance that it will die.

Even if individual fish survive the lice infections this does not mean that they do not suffer from long term impacts of parasitism. They may be compromised in some other way (e.g., reduced capacity to avoid predation or reduced reproductive capacity).

• Knowledge of sea lice species and life cycle and damage to host
Two genera of sea lice are found on juvenile pink salmon in British Columbia, *Caligus* and *Lepeophtheirus*. In the Broughton Archipelago infestation is primarily by *Lepeophtheirus*.

There are conflicting reports of physical damage to the skin of the juveniles. Some report no significant damage to the skin. Others have observed puncture holes. Puncture holes contribute to cumulative stress, especially in terms of osmoregulation in already challenged smolts. In comparing the susceptibility of Atlantic salmon juveniles with pink salmon juveniles a participant commented

"Atlantic salmon are like armoured cars and therefore you do not see lesions. Pink salmon are coming out at around 3 cm with hardly any scales and are virtually naked. You can see the holes easily."

In ensuing discussion, considerable interest was expressed in the use of this model to predict the population impact of sea lice infestation on adult pink salmon returns. Further discussion focused on the advantages of using corroborative evidence from abundance patterns of copepodid stage lice that could be found by direct sampling of copepodids in regions around the fish farms.

Incidence of sea lice in areas without farms
Results of a recent published study show that the Broughton Archipelago has higher sea lice levels than in adjacent regions in Central BC where there are no salmon farms. There is also evidence that sea lice occur more frequently in areas with fish farms. A participant noted that in Alaska, with no fish farms, sea lice have not been observed on juvenile salmon in significant numbers.

On the north coast of BC, an area currently without salmon farms, most of the sea lice observed on pink salmon are *Caligus* spp (early stages). *Lepeophtheirus* spp. are rare and infestation is of low intensity.

"There is a geographic pattern of smolt occurrence on the coast. That knowledge would benefit both aquaculture and the wild salmon. On the north coast applications for the first farms are under review. We have to get to the place where we acknowledge that there is a potential problem."

WHAT WE DO NOT KNOW AND NEED TO KNOW

During the course of the day's discussions participants identified a number of gaps in our knowledge of sea lice and pink salmon in the Broughton Archipelago.

Salmon farm data
Participants stressed that open access to all salmon farm data is an absolute requirement. Without this information we do not have a 'control' for other research findings. Some companies have been more forthcoming in sharing their data than others; however, what is needed is all raw data, as opposed to averages, for all relevant factors from all the industry participants including species, incidence, life stage and fecundity, and treatment regimens. Similar to the work described for Scotland, we need to be able to correlate the planktonic stages of sea lice and their distribution with location of farms and routes taken by outmigrating smolts.

Sea lice life cycle and species interaction and life cycle of Pacific salmon
We do not fully understand the life cycles of both genera of sea lice species, *Caligus* and *Lepeophtheirus*. We need to know the spatial (geographic and planktonic) and temporal distributions of each species. We also need to know about the life cycle of Pacific salmon (*Oncorhynchus*) compared with Atlantic salmon

(*Salmo*). For example, pink salmon have a two year life cycle – is one age class more vulnerable to parasitic infection than the other? Does the fact that there are multiple hosts affect the degree of infestation? It was felt that much of this information may be available in the literature – we need a comprehensive review of available information.

Effect of fallowing
There is compelling evidence from Scotland with respect to reduction in sea lice infestation of juvenile salmonids as the result of fallowing practices. There is only one published study showing similar effects for the Broughton Archipelago. We need long-term (e.g., five year) studies to examine the effects of fallowing on sea lice infestation of out-migrating juvenile Pacific salmon. To date only one partial fallowing has occurred in this area – in 2003, approximately half of the 27 farms were fallowed.

We need to know if the fallowing of one channel benefited the Broughton Archipelago as a whole.

Effect of salinity, temperature and other risk factors
The fjords of BC, where juvenile salmon emerge and outmigrate, are complex ecosystems. There is a high degree of inter-annual variation for a number of the abiotic and biotic factors that contribute to stress in the outmigrating juvenile fish. We need comprehensive information on these risk factors so as to predict which temporal, spatial and environmental factors are likely to be the most significant contributors to the susceptibility of juvenile fish to infection.

Long-term impacts on pink salmon populations in the Broughton Archipelago
We need to examine the transferability of data from the findings in Europe and Atlantic Canada to the Pacific with regard to population impacts of sea lice infestation.

"Sea lice have always affected wild salmon, but intensive farming has increased the size of the problem. It is now one of the biggest issues for salmon aquaculture in many areas of Scotland." Chapter 6, 6.88, Turning the Tide, T. Blundell, Royal Commission on Environmental Pollution's Report, December 7, 2004.

Two or three years of data are not sufficient to draw conclusions about the long-term effects of sea lice on pink salmon populations. There is much inter-annual variation. For example, the frequency of sea lice in a population can be dependent on environmental quality (e.g., if growth conditions are good then the load may not matter).

We need to approach the problem with laboratory studies and seek commitment for funding of long-term field studies. Studies such as those described by Rick Routledge and Alexandra Morton and Martin Krkosek should be given a high priority for financial support in 2005.

Planktonic distribution
We do not have sufficient information on louse planktonic distribution in the Broughton Archipelago. Plankton sampling was carried out in Summer 2003 and the results were not conclusive – there were very few lice and results were not correlated with sea lice abundance on farms. Plankton sampling was not conducted in 2004. Participants stressed that this information is important given the inter-annual variation. They stressed the need for future plankton distribution studies in the Broughton similar to those conducted in Loch Torridon in Scotland.

Sea lice treatment regimes
The ecological effects of the major therapeutant, SLICE, are unknown – this is still under review by Health Canada. Other approaches in controlling sea lice infections are worth pursuing. The use of immuno-stimulants as a prophylactic measure should be investigated.

Incidence of sea lice on wild fish and placement of salmon farms
We do not know if there are areas that have a natural abundance of sea lice. This information would assist in placement of farms in the future so that these areas could be avoided. Similarly there are areas that are critical to juvenile rearing which should be avoided. In addition, spatially there are areas that should be avoided (e.g., long narrow channels) in placement of new farms.

RECOMMENDATIONS FOR FUTURE RESEARCH

Participants stressed the **urgent** need for information and research plans. It is now December 2004 and the pink salmon will begin their out-migration in February or March 2005. The Chair advised participants to put aside the issue of available funding – if this information is critical, then the agencies should commit the funding for this research.

Participants identified the following specific research areas as being of high priority.

1. Study the impact of fallowing over at least a five year period. However, given the life cycle of the sea lice it may be difficult to begin these studies in 2005 unless immediate action i411p it maa24 0 0 -0.24 30 76g 0.24 0 0r aeiac stres 4 30 70a.24 0 it 175 212 Tm /l

RECOMMENDATIONS FOR MANAGEMENT ACTIONS

Again participants stressed the **urgency** of taking immediate action. In the absence of conclusive information about the impacts of sea lice on the pink salmon runs in the Broughton Archipelago the Precautionary Approach should be invoked in some form given the weight of evidence that exists. We should take heed of the European experience that indicates that regulations can substantially reduce the impacts of sea lice on wild salmon.

Industry Collaboration and Area Management Agreements
It is critical to immediately gain access to all existing data of the salmon farming industry in the Broughton Archipelago. The cooperation of the industry is key to ensuring the co-existence of a sustainable aquaculture industry and healthy wild salmon stocks.

Fallowing should be strongly considered as a management option for reducing infestation rates on the 2005 outmigrating salmon; a fallowing action plan should be developed immediately.

We should put in place in British Columbia a system of Area Management Agreements similar to those described for Scotland. Some measures that succeeded in the Scottish experience include selecting sites that have the least impact on wild salmon and synchronized treatment of sea lice (fallowing and baths) to avoid re-infection. No single approach to understanding the problems or implementing solutions will suffice so it is crucial for industry, communities and government to work collaboratively on these plans.

Independent review
There should be an immediate **independent** comprehensive review of all sea lice and salmon related research. This would address some of the discrepancies between the results described during the Roundtable discussions. The terms of reference for such a review are as follows:

1. Involve all stakeholders
2. Document the level of public concern
3. Review the state of knowledge of lice (define the species) in particular on the Broughton Archipelago and extrapolate from it to the Broughton situation. Tap into presently unavailable data.
4. Arrive at an assessment of the sea lice risk to Broughton farmed and wild fish.
5. Define management actions for immediate implementation to counter risk.
6. Define science/monitoring programs to document impacts of the management actions, and to provide necessary new knowledge.

Policy for salmon farm expansion
Plans are underway for expansion of salmon aquaculture in other 'virgin' areas of the BC coast. It is proposed that policy for new farms be amended to include the provision of monitoring prior to approval for licensing. Monitoring of a proposed farm site should commence one to two years prior to the commencement of farming and up to five years after the introduction of the farm.

Funding
Funding for research into the sea lice and pink salmon issue in the Broughton Archipelago should be of the highest priority.

Invited Participants

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Larry Dill, PhD, FRSC, Professor, Biological Sciences, Simon Fraser University

The Hon. John A. Fraser, P.C., O.C., O.B.C., C.D., Q.C, L.L.D. (Hon), Chair, Pacific Fisheries Resource Conservation Council

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Allen Gottesfeld, PhD, Head Scientist, Gitxsan and Wet'suwet'en Watershed Authorities

Brent Hargreaves, PhD, Research Scientist, Salmon Section, Fisheries and Oceans Canada

Blair Holtby, PhD, Head, Salmon Section, Fisheries and Oceans Canada, and Science Advisor, Pacific Fisheries Resource Conservation Council

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Margaret McKibben, MSc, Loch Shieldaig Fisheries Research Services Freshwater Laboratory, Western Scotland

Alexandra Morton, BSc. R.P.Bio, Raincoast Research

Craig Orr, PhD, Director, Watershed Watch Salmon Society

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Laurie Wood (observer), Program Coordinator, Continuing Studies in Science and Centre for Coastal Studies, Simon Fraser University

For information about other Speaking for the Salmon initiatives on sea lice and other topics visit our website at www.sfu.ca/cstudies/science/salmon.htm or contact us at

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Speaking for the Salmon Workshop Series

- A Community Workshop to Review Preliminary Results of 2003 Studies on Sea Lice and Salmon in the Broughton Archipelago Area of British Columbia, Jan 2004
- World Summit on Salmon, June 2003
- Summit of Scientists: Nutrients & Salmon Production, Nov 2002
- Summit of Scientists: Sea Lice, July 2002
- Aquaculture and the Protection of Wild Salmon Follow-up to March 2000, Oct 2001
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- Aquaculture and the Protection of Wild Salmon, March 2000
- Pacific Coast Salmon: Status of Stocks and Habitat, June 1999
- Thompson Steelhead: A resource in crisis?, Oct 1998
- Summit of Scientists on the Scientific Underpinning of the 1998 Management Decisions for Pacific Coho Salmon–Consensus report, June 1998
- Selective Harvesting, May 1998
- Speaking for the Salmon Inaugural meeting, Jan 1998