salmon lice *Lepeophtheirus salmonis*." *BMC Genomics* **2014,** *15* 200.

2. Sutherland, B.J.G.; Hansen, K.; Jantzen, J.R.; Koop, B.F.; Smith, C.R.; "Divergent immunity and energetic programs in the gills of migratory and resident *Oncorhynchus mykiss*." *Molecular Ecology* **2014**, *23 (8)*, 1952-1964.

3. Sahlmann, C.; Sutherland, B.J.G.; Kortner, T.M.; Koop, B.F.; Krogdahl, A.; Bakke, A.M.; "Early response of gene expression in the distal intestine of Atlantic salmon (*Salmo salar L.*) during the development of soybean meal induced enteritis." *Fish & Shellfish Immunology* **2013** *34*, 599-609.

4. Sutherland, B.J.G.; Jantzen, S.G.; Yasuike, M.; Sanderson, D.S.; Koop, B.F.; Jones, S.R.M.; "Transcriptomics of coping strategies in free-swimming *Lepeophtheirus salmonis* (Copepoda) larvae responding to abiotic stress." *Molecular Ecology* **2012** *21*, 6000-6014.

5. Jantzen, S.G.*; Sutherland, B.J.G.*; Minkley, D.R.; Koop, B.F.; "GO Trimming: Systematically reducing redundancy in large Gene Ontology datasets." *BMC Research Notes* **2011**, *4*, 267.

6. Pavey, S.A.; Sutherland, B.J.G.; Leong, J.; Robb, A.; von Schalburg, K.; Hamon, T.; Koop, B.; Nielsen, J.; "Ecological transcriptomics of lake-type and riverine sockeye salmon (*Oncorhynchus nerka*)." *BMC Ecology* **2011,** *11*, 31.

7. Sutherland, B.J.G.; Jantzen S.G.; Sanderson, D.S.; Koop, B.F.; Jones, S.R.M.; "Differentiating size-dependent responses of juvenile pink salmon (*Oncorhynchus gorbuscha*) to sea lice (*Lepeophtheirus salmonis*) infections." *Comparative Biochemistry and Physiology D-Genomics & Proteomics* **2011**, *6*, 213-223.

University of Victoria | Graduate Studies

PROGRAMME

The Final Oral Examination
for the Degree of

DOCTOR OF PHILOSOPHY
(Department of Biology)

Ben Sutherland

2008 Thompson Rivers University BSc (*hons*)

"Comparative Responses of Salmon to Sea Lice *Lepeophtheirus salmonis* Infections, and Lice Responses to Chemical and Environmental Stressors"

Thursday, April 24, 2014
10:30am
Harry Hickman Building, room 120

Supervisory Committee:
Dr. Ben F. Koop, Department of Biology, UVic (Supervisor)
Dr. Simon R. M. Jones, Department of Biology, UVic (Member)
Dr. Steve J. Perlman, Department of Biology, UVic (Member)
Dr. Terry W. Pearson, Department of Biochemistry and Microbiology, UVic (Outside Member)

External Examiner:
Dr. Patricia M. Schulte, Department of Zoology, University of British Columbia

Chair of Oral Examination:
Dr. Lisa Gould, Department of Anthropology, UVic

Abstract

Systems biology methods can provide novel insight into the response of an organism to a suboptimal environment, an infection, or a xenobiotic. Expansion of our genomics knowledge base for salmon and salmon lice has enabled investigations into several important areas of this host-parasite interaction. Some of these areas include comparing responses of different salmon species or life stages to lice infections, characterizing the influence of environmental conditions on lice stress, and identifying mechanisms underlying the emergence of resistance to important parasiticidal chemicals. In this work, global gene expression analyses are combined with phenotypic and physiological responses of salmon or salmon lice *Lepeophtheirus salmonis* to further understand these topics that are important for sustainable aquaculture development and wild salmon conservation. The profiling of the responses of juvenile pink salmon of different size classes to salmon lice infection was the first large-scale transcriptome profiling reported of a Pacific salmon (pink salmon *Oncorhynchus gorbuscha*) to a salmon lice infection, and identified gene expression signatures specific to the most susceptible life stage. A co-habitation infection study of three size-matched species of Pacific and Atlantic salmon allowed for the profiling of physiological and transcriptomic responses at the local and systemic levels. Through salmon lice transcriptomics, the responses to temperature and salinity perturbations were compared, and coping strategies as well candidate marker genes were related to specific levels of abiotic stressors. Additionally, the emergence of resistance to the important parasiticide, emamectin benzoate in multiple populations of *L. salmonis* globally has provided a system for the identification of potential polygenic mechanisms related to drug resistance. These approaches have improved our understanding of the host-parasite interaction of salmon and salmon lice, and will continue to inform ongoing investigations of this ecologically and economically important interaction.

Awards, Scholarships, Fellowships

2012 Alexander Graham Bell Canadian Graduate Scholarship (NSERC)
2012 UVic President's Research Scholarship
2011 Bob Wright Graduate Scholarship
2011 Maureen De Burgh Memorial Scholarship
2011 B&C Food Distributors Graduate Scholarship
2010 Best Poster, Ecol. and Evol. Ethology of Fishes (SFU)
2008 W. Gordon Fields Memorial Fellowship
2008 Graduate Fellowship, University of Victoria

Presentations

1. Koop, B.F.; Sutherland B.J.G.*; "Genomics in lice and salmon (GiLS) project provides new tools and mechanisms for understanding louse biology." World Aquaculture, Nashville, Tenn., USA. Feb. 2013. (oral).
2. Sutherland, B.J.G.*; Koczka, K.W.; Jones, S.R.M.; Koop, B.F.; "Early responses of three salmonid species to *Lepeophtheirus salmonis* (Copepoda) infections." 1st International Conference for Integrative Salmonid Biology. Oslo, Norway. June 2012. (oral).
3. Sutherland, B.J.G.*; Koczka, K.W.; Jones, S.R.M.; Koop, B.F.; "Stressed lice and refractory responses: Host-parasite transcriptomics." 9th International Sea Lice Conference. Bergen, Norway. May 2012. (oral).

Publications

1. Sutherland, B.J.G.; Koczka, K.W.; Yasuike, M.; Jantzen, S.G.; Yazawa, R.; Koop, B.F.; Jones, S.R.M.; "Comparative transcriptomics of Atlantic *Salmo salar*, chum *Oncorhynchus keta* and pink salmon *O. gorbuscha* during infections with