

STATE OF MAINE
BOARD OF ENVIRONMENTAL PROTECTION

IN THE MATTER OF

NORDIC AQUAFARMS, INC
Belfast and Northport
Waldo County, Maine

A-1146-71-A-N
L-28319-26-A-N
L-28319-TG-B-N
L-28319-4E-C-N
L-28319-L6-D-N
L-28319-TW-E-N
W-009200-6F-A-N

) APPLICATION FOR AIR EMISSION, SITE
) LOCATION OF DEVELOPMENT,
) NATURAL RESOURCES PROTECTION
) ACT, and MAINE POLLUTANT
) DISCHARGE ELIMINATION
) SYSTEM/WASTE DISCHARGE LICENSES
)
)
)
)
)

PRE-FILED REBUTTAL TESTIMONY OF DR. IAN BRICKNELL

1. On behalf of Nordic Aquafarms Inc (NAF) I am providing this testimony as a response to the pre-filed testimony of Brian Dixon PhD and Mr. Bill Bryden for the Northport Village Corporation and Upstream Watch. The purpose of this response is to address instances where the above referenced testimony differs substantially from the facts of the case and provide, to the best of my knowledge, a factually accurate response. My testimony focuses on the areas where I have expertise and direct knowledge of fish disease, fish disease transmission and fish vaccination. I have gained this expertise during a 5-decade long career as a research scientist in this field with numerous peer reviewed papers. A copy of my resume is at Addendum A.
2. The testimony of Professor Dixon expresses an opinion that NAF did not address several disease risks to Atlantic salmon and that steps need to be taken to mitigate the effect of disease in both the freshwater and marine phase of an Atlantic salmon's life cycle. By not addressing these risks, there is a potential point source for fish diseases from the NAF discharge.
3. This testimony rebuts these opinions as Professor Dixon has not considered the role that NAF's biosecurity plan will play in eliminating incoming pathogens or the vaccination program the fish will undergo as part of their routine husbandry. Prof. Dixon estimates that NAF will lose "34% of their stock to disease over the whole life cycle." This figure is taken from the research paper "More rapid and severe disease outbreaks for aquaculture at the tropics: implications for food security" (Leung and Bates, 2013).¹ The title of this paper deals predominantly with aquaculture in the tropic and concluded that

¹ LEUNG, T. L. F. & BATES, A. E. 2013. More rapid and severe disease outbreaks for aquaculture at the tropics: implications for food security. *Journal of Applied Ecology*, 50, 215-222.

“Disease at lower latitudes progresses more rapidly and results in higher cumulative mortality, in particular at early stages of development and in shellfish.” This is due to the warmer waters and more rapid disease replication at these lower latitudes. Although Maine has the most southerly salmon farm in the Northern Hemisphere, the unique environment found in the Gulf of Maine where winter temperatures hover around 32°F and summer temperatures are around 52°F are not directly comparable with other fish farms at the same latitude. Indeed, the NAF facility will be maintaining the fish within a very close temperature regime of 53-55°F by means of a cooling/heating system maintaining the fish environment independent of sea water temperature. On the Eastern Atlantic, Belfast’s latitude would be very similar to that of Marseille France at 43.2965° N, 5.3698° E with a sub-tropical climate where the average water temperatures are 55°F in winter and 79°F in summer. (Nordic Exhibit 33.) At these higher temperatures, disease progresses much more rapidly than on the cold waters of Maine. So although the latitudes are similar, it is not realistic to assume that the mortality rate of farmed fish in Belfast would be similar to other fish farms at that latitude as Atlantic salmon are not typically farmed that far south. It is only possible here due to the unique oceanography of the Gulf of Maine and that region of the Mediterranean Aquacultures a very fish species, predominantly turbot, (*Scophthalmus maximus* L.) that has very high larval mortality unlike Atlantic salmon (Bowden and Bricknell, 2013).²

4. Prof. Dixon gives two examples of pathogens that could infect salmon in the Gulf of Maine. Firstly, he cites infectious salmon anemia virus (ISAv) explaining that no filter is stringent enough to filter out viruses and hence it is a risk to the fish. While it is true that ISAv is small enough to pass through a 0.22 or 0.1 µm filter, infectious salmon anemia virus is very susceptible to ultraviolet light (UV) disinfection. The biosecurity plan submitted by NAF states “UV dosage of at least 250 mJ/cm² will be applied to all intake water and a dose of 300 mJ/cm² will be applied to all effluent. This dose is more than enough to inactivate any ISAv in the affluent water or in the effluent water as ISAv is very susceptible to UV.” A dose of about 8 mJ/cm² will render the virus inactive (Liltved et al., 2006). ISAv is very susceptible to UV as it has an RNA based genome which lacks the stability of DNA. Hence, an application of 31 and 38 times the lethal dose of UV to the incoming and outgoing water respectively will eliminate any risk from ISAv.
5. *Aeromonas salmonicida*, the causative agent of the fish disease furunculosis, is also presented as a risk by Prof. Dixon. This pathogen is common in all bodies of water and was a major disease risk to aquaculture fish until the mid 1990’s. The development of excellent vaccines during the early 1990’s has effectively eliminated this disease from aquaculture (Bricknell, 1995, Bricknell et al., 1997, Bricknell et al., 1999, Ferguson et al., 1998, O’Dowd et al., 1999, Vipond et al., 1998). Today all salmon smolts are routinely

² BOWDEN, T. J. & BRICKNELL, I. R. 2013. Management of finfish and shellfish larval health in aquaculture hatcheries. In: ALLAN, G. & BURNELL, G. (eds.) *Advances in Aquaculture Hatchery Technology*

vaccinated against *Aeromonas salmonicida* (and several other pathogens). *Aeromonas salmonicida* is a fish pathogen that is considered to be ubiquitous and is found on all 7 continents (Bernoth et al., 1997).³ *Aeromonas salmonicida* is a very common organism that is endemic in Maine and will, without doubt, be in the surface and receiving waters of the NAF facility in Belfast. As such, NAF's operation will not adversely impact the receiving waters. When vaccination is combined with NAF's proposed ultrafiltration and UV treatment, (which will trap this pathogen as they are caught in 0.22µm filters) (Bernoth et al., 1997) and combined with a dose of UV in the range of 250-300 mJ/cm² (Liltved et al., 1995), it is highly unlikely that NAF will experience an outbreak of *Aeromonas salmonicida*. Further, NAF's filtration and UV treatment will eliminate this pathogen from the discharge.

6. Prof Dixon, then goes on to discuss the decline in efficacy of UV systems. While they are correct that usage will decline by time, the 40% decline after one year is not unreasonable. This assumes that NAF will be replacing the UV bulbs on an annual basis. Even so, the relative amount of UV irradiating the affluent and effluent water would be 150 mJ/cm² and 180 mJ/cm². This is more than sufficient to inactivate ISAv (Lethal dose 8 mJ/cm²) and *Aeromonas salmonicida* (Lethal dose 3 mJ/cm² (Bernoth et al., 1997)) with a minimum safety factor of 19 and 50 respectively. Providing the ultrafiltration system is well maintained this should also continue to trap and remove bacterial pathogens efficiently.
7. I was surprised that Professor Dixon was concerned about the ozone disinfection system as post ozone treatment of water with UV effectively eliminates the formation of hypobromous acid and causes the formation of antimicrobial active residual oxidants that will also have short term disinfectant properties (Penru et al., 2013).⁴ As Penru points out in his manuscript (Penru et al., 2013) Ozone is safely and routinely used as a disinfectant for both freshwater and seawater in recirculating Aquaculture Systems with the appropriate use of UV after the water has been treated with Ozone.
8. Although there are examples of fish eggs introducing disease into fish farms the one Professor Dixon has cited refers to ISAv. This is interesting as there is very poor evidence of ISAv being transmitted vertically, that is from parent to offspring (Lyngstad et al., 2008, and Melville and Griffiths, 1999)⁵. This is probably why Prof Dixon chose a non-peer

³ BERNOTH, E. M., ELLIS, E. A., MIDTLYNG, P. J., OLIVIER, G. & SMITH, P. 1997. *Furunculosis. Multidisciplinary Fish Disease Research*, LONDON, Academic Press.

⁴ PENRU, Y., GUASTALLI, A. R., ESPLUGAS, S. & BAIG, S. 2013. Disinfection of Seawater: Application of UV and Ozone. *Ozone-Science & Engineering*, 35, 63-70.

⁵ LYGSTAD, T. M., JANSEN, P. A., SINDRE, H., JONASSEN, C. M., HJORTAAS, M. J., JOHNSEN, S. & BRUN, E. 2008. Epidemiological investigation of infectious salmon anaemia (ISA) outbreaks in Norway 2003-2005. *Preventive Veterinary Medicine*, 84, 213-227; MELVILLE, K. J. & GRIFFITHS, S. G. 1999. Absence of vertical transmission of infectious salmon anemia virus (ISAV) from individually infected Atlantic salmon *Salmo salar*. *Diseases of Aquatic Organisms*, 38, 231-234.

reviewed article to support his argument, citing a New York Times newspaper article (Barrionuevo, 2011, NVC/Upstream Exhibit D-1) as it is just as likely that ISAv was introduced into Chile by contaminated water or equipment, but not by the eggs themselves.

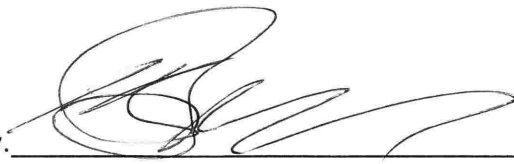
9. The testimony of Mr Bryden expresses an opinion that NAF did not address several disease risks to Atlantic salmon and that steps need to be taken to mitigate the effect of disease in both the freshwater and marine phase of an Atlantic salmon's life cycle. By not addressing these risks, Mr. Bryden claims there is a potential point source for fish diseases from the NAF discharge.
10. This testimony rebuts these opinions as Mr Bryden has not considered the role that NAF's biosecurity plan will play in eliminating incoming pathogens or the vaccination program the fish will undergo as part of their routine husbandry. Mr Bryden asserts that "Finfish virology is a new and expanding science. New viruses are constantly being discovered and techniques for monitoring are still being developed for many viruses." This statement is true of virology in general. There are many unknown viruses in the environment that will affect many organisms from simple single celled algae to simians. In a nutshell, science is a process of discovery, the more scientists look at an area more will be discovered. Be it fish viruses or the emerging SARS like virus that has been reported from China this week (Boseley, 2020). However, virulent viruses like the recent China example are very rare most newly discovered viruses have little pathogenicity and simply form part of the complex microbiome that is so important in maintain a healthy population of organisms (Brugman et al., 2018, Egerton et al., 2018, Legrand et al., Ross et al., 2019).
11. Mr Brydon states "All RAS Systems Have Disease Issues, but Especially Those Using Surface Water". This is a very sweeping statement there are many examples of very successful RAS systems where disease is not an issue in both Maine (The Center for Cooperative Research in Franklin Maine) and Canada (PEI Halibut in Prince Edward Island, Canada) as well as globally. Such as statement is a factorial error, which is very misleading.
12. The Statement following the disease issue refers to the importation of Non-Native fish and the Williamsburg Treaty. The USA (not Maine as is stated) is a signatory to the Williamsburg treaty. This treaty refers to the use of Pacific salmon (Pacific salmon species belong to the genus *Oncorhynchus*) not Atlantic salmon which is only one species (*Salmo salar* L.). However, Maine has its own legislation that requires native strains of Atlantic salmon to be farmed in open pen aquaculture- preventing the genetic contamination of wild Atlantic salmon with non-native stocks. In the section on the Import of Non-native fish. Mr Brydon goes on to say "Importing non-native fish often results in importing non-native viruses and other pathogens. Not all viruses are screened for in egg or smolt importation." Of course, this is true as many are innocuous and to assume otherwise would be an oxymoron. However, all pathogens that are considered exotic to the importing state or country are required to be tested for under the International OIE regulations (Anon, 2020). This is required both at the State and Federal level in the US.

13. "Lack of Fish Disease Control in the Food Supply System" Mr Brydon makes a very bold statement that the "USDA, etc are only concerned with human pathogens." This is simply nonsense; the USDA has a significant program on animal health including fish health.
14. "Lack of Antimicrobial Testing:" Mr Brydon's assertion that "The USA does not adequately test RAS produced fish for antimicrobial resistance..." seem to be erroneous as fish do not develop antimicrobial resistance.
15. "Lack of Effluent Screening" Mr Brydon again makes another sweeping statement "No government or independent monitoring of the effluent will be conducted for virus etc shedding." NAF's will be monitored under the same requirements as any other farm in Maine. Indeed, any issue with the effluent will probably be detected by the routine monitoring by the State of Maine's Department of Marine Resources shellfish sanitation and Management Program so to state that there is no government monitoring is erroneous.
16. Disinfection. The biosecurity plan submitted by NAF states "UV dosage of at least 250 mJ/cm² will be applied to all intake water and a dose of 300 mJ/cm² will be applied to all effluent." This dose is more than enough to inactivate any pathogenic viruses in the affluent water or in the effluent water as most pathogenic viruses are very susceptible to UV. A dose of about 8 mJ/cm² (Liltved et al., 2006) will render most viruses inactive. AS pathogenic viruses are very susceptible to UV an application of 31 and 38 times the lethal dose of UV to the incoming and outgoing water respectively will eliminate any risk from Pathogenic viruses. *Pathogenic bacteria*, are the causative agent of several fish disease furunculosis. These pathogens are common in all bodies of water and were a major disease risk to aquaculture fish until the mid 1990's. The development of excellent vaccines during the early 1990's has effectively eliminated this disease from aquaculture (Bricknell, 1995, Bricknell et al., 1997, Bricknell et al., 1999, Ferguson et al., 1998, O'Dowd et al., 1999, Vipond et al., 1998). Today all salmon smolts are routinely vaccinated against *Pathogenic bacteria*. Pathogenic bacteria of fish are a very common group of organism that are endemic in Maine and will, without doubt, be in the surface & receiving waters of the NAF facility in Belfast, as such NAFs operation will not adversely impact the receiving waters. When vaccination against *Pathogenic bacteria* is combined with NAF's proposed ultrafiltration and UV treatment, (which will trap this pathogen as they are caught in 0.22µm filters; Bernoth et al., 1997) combined with a dose of UV in the range of 250-300 mJ/cm² (Liltved et al., 1995), it is highly unlikely that NAF will experience an outbreak of *Pathogenic bacteria*. Furthermore, NAF's filtration and UV treatment will eliminate this pathogen from the discharge. Even if the bulbs were not replaced for a year, as discussed above, the relative amount of UV irradiating the affluent and effluent water would still be 150 mJ/cm² and 180 mJ/cm²--More than sufficient to inactivate Pathogenic viruses (a typical Lethal dose is Lethal dose 8 mJ/cm²) and Pathogenic bacteria (a typical Lethal dose is 3 mJ/cm² (Bernoth et al., 1997)) with a minimum safety factor of 19 and 50

respectively. Providing the ultrafiltration system is well maintained this should also trap continue to trap and remove bacterial pathogens efficiently.

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Dated January 10th, 2020

By: 
Dr. Ian Bricknell

STATE OF MAINE
County of Lewiston, ss.

January 10, 2020

Personally appeared the above-named Ian Bricknell and made oath as to the truth of the foregoing pre-filed testimony.

Before me,



Christine Anne Greaves
Notary Public, State of Maine
My Commission Expires November 29, 2021

Notary Public / Attorney at law

Curriculum vitae

Name: Ian Robert Bricknell
Date of Birth: 15 July 1961
Age at 1 January 2019: 57
Marital status: Married.

**Educational History**

- 1986-1989 University of Lancaster PhD Supervised by the Late Prof. W.T.W. Potts "The Ion Transporting Cells of Aquatic Insects" awarded August 1990.
 1983-1986 University of Reading B.Sc. (First Class Honours) Pure Zoology, final year project (supervised by the Late Prof. L.B. Halstead) "The Paeleopathology of Pleistocene Proboscideans."
 1980-1983 Luton College of Higher Education (now Luton University) HND Medical Microbiology (merit)
 1977-1979 Luton VIth Form College 3 'A' levels 1 'S' level
 1972-1977 Denbigh High School Luton 8 GCE 'O' levels including English and Mathematics

Employment History

- 2007 to date Libra Professor of Aquaculture Biology School of Marine Sciences, University of Maine.
 2007 - 2013 Founding Director University of Maine's Aquaculture Research Institute
 2000 - 2007 Fisheries Research Services (FRS) Marine Laboratory, Aberdeen (the FRS Marine Laboratory is an executive agency of the Scottish Executive), Principal Scientist (Department Head), Aquaculture & Aquatic Animal Health.
 1992-2000 Fisheries Research Services (FRS) Marine Laboratory, Aberdeen (the FRS Marine Laboratory is an agency of the Scottish Executive), Senior Scientist, Aquaculture & Aquatic Animal Health.
 1989-1992 FRS Marine Laboratory, Aberdeen, Higher Scientific Officer, Fish Immunology Section. Start date October 2nd 1989
 1983-1989 *University education*
 1982-1983 Public Health Laboratory Service, Luton and Dunstable Hospital: Basic Grade MLSO, Immunology Department.
 1979-1982 Public Health Laboratory Service, Luton and Dunstable Hospital: Junior (Grade B) MLSO, Immunology Department.

Current Areas of Responsibility

Professor of Aquaculture Biology, School of Marine Science, University of Maine. Current research team 1 Post-Doctoral Research Fellow, 2 Graduate Students, 6 undergraduate research students

Previous Responsibilities

Group Leader of the Fish Immunological Diagnostics department at the FRS Marine Laboratory's Aquaculture & Aquatic Animal Health programme based at the Marine Laboratory Aberdeen. The departments' main role is to develop policy and draft new legislation, provide advice to government ministers and industry on current research and policy issues in fish immunology and disease control, the feasibility of new fish, shellfish & algae, such as halibut, for commercial aquaculture and fish vaccinology. Duties included the day to day management of a staff of 8 scientists, 2 Post Doctoral Research Fellows, 4 technicians and 4 PhD students. Management of the FRS Marine Laboratory's fish immunology laboratory, Aberdeen. Management of the FRS Marine Laboratory's Experimental Fish Research Station, Aultbea, WesterRoss UK.

Scientific input into the following projects during my tenure at the MLA.

PI:- Fish alpha virus aetiology, epidemiology and diagnosis; Inflammatory processes in PD, CMS & HSMI. Infectious Salmon Anaemia Virus research programme, Halibut cultivation, disease and vaccination problems, larval survival and immunology, Cod cultivation, disease and vaccination problems, larval survival and immunology, *In vitro* methods for the culture of sea lice, the physiological basis for sea lice infection, novel vaccines against sea lice. The application of immunostimulants to improved larval fish survival, Sea lice biology and epidemiology, the natural infective pressure of sea lice on wild salmonid populations. The immune response of Atlantic Cod to *Lernaeocera branchialis* infection

ICES Responsibilities

2009 Member ICES SciCon Committee (2009-2012)
2006 Member ICES ConC Committee (Term of Office May 2006 to May 2009)
2005 Chair ICES Mariculture Committee (Term of Office 1 January 2006 to 31 December 2008)
2002-2005 UK Member ICES Mariculture Committee
1996-2002 UK Member of the ICES Working Group Marine Fish culture (WGMAFC)

Attributes and Awards

Vising Professor the University of Stirling UK 2016 - to date
EAFP Research Excellence Award 2005
Presidential Award of the American Plecoptera Society (1992)
University prize (Reading University) in Zoology 1986.
Co-winner of the Alison Grisley Prize (Reading University) 1985.
President of the Zoological Society of Reading University 1985-1986.

Research grants and awards

Grants Prior to Current Post Tenure review

2008 MAIC: Vaccination studies in juvenile cod, SMS **\$27,218**
2008 NRAC: Investigations into the potential health and economic benefits of bivalve/finfish co-culture MAAHL/SMS **\$150,000**
2008 DMR: Tools and techniques to recognize lobster stressors MAAHL/ SMS **\$54,510**
2008 DMR: Health Risks of lobster bait to marine animals MAAHL/ SMS **\$50,413**
2009 NRAC: Examination of finfish pathogen physiology and predictive ecology in a bivalve/finfish integrated multi-trophic aquaculture system SMS **\$200,000**
2010 NRAC: Breeding resistance to Sea Lice and ISAV in Atlantic Salmon SMS **\$199,350**
2011 NOAA Sea Grant: The Aquatic Animal Health Ecology of an Industry Deployed Integrated Multi-trophic Aquaculture System SMS **\$399,544**
2011 MTAF: FISHLab: Fishery Innovation, Sustainability & Health Lab **\$664,000**
2012 NRAC An investigation of effective vaccine targets in the salmon louse, *Lepeophtheirus salmonis* – an alternative lice control measure **\$199,925**
2012 The role of wild and farmed fish in modulating the infectious pressure of the sea louse (*Lepeophtheirus salmonis* Krøyer 1837) **\$461,438**
2012 Disease mitigation on fish farms: distinguishing origin and transport vectors of sea lice through food web analysis **\$254,411**
2014 NSF EPSCoR Co PI SEANET (Sustainable Ecological Aquaculture Network) **\$20 Million**

Total Dollars Awarded: 2007-2014 \$22,715,222

Recent International Collaborators

Prof Berjot Magnadottir University of Reykavik Iceland, Dr. B., Bragason, University of Reykavik Iceland, Dr. G. Nicholas University of London UK, Dr Sigidur Gudmundsdottir University of Reykavik Iceland, Dr S., Dodds, University of Nottingham UK, A.W. Dr Sigrund Lange University of London UK, Prof James Bron University of Stirling UK, Dr Roy Dalmo University of Tromso Norway, Prof Giuseppe Scapigliati, University of Viterbo, Italy, Prof Jan Rombert, Wageningen University Netherlands, Prof, Seonghoon Kim, University of Seoul, Korea, Prof. Miseon Park, Gangneung University, Korea, Dr Frank Kane, Marine Institute Galway Ireland, Dr Mark Fast, & Dr Kim Thompson Morden Research Institute Edinburgh Scotland.

Previous UK Core Funding

FC1199	Alpha viruses detection and diagnosis (2006-2009)
FC1198	Sea lice infective pressures (2005-2009)
FC1194	Seasonal Influences on Disease Susceptibility (2003-2004)
FC1193	Sea Lice Epidemiology And Biology (2003-2007)
FC1183	Molecular And Immunological Characterisation Of Scottish ISAV (2002-3)
FC1186	Developmental Immunity Of Larval Fish (2000-2004)
FC1173	Characterisation Of Scottish IPNV (1998-2002)
FC427	Vaccines Against Sea Lice (1994-2000)
FC286	Halibut Cultivation (1992-2000)
FC486	Vaccines against <i>Aeromonas salmonicida</i> (1989-1996)
C028	New Vaccines against Enteric Red Mouth Disease (1997-2000)
C682	Immunostimulants and Larval Fish (2001-2004)
C035	Applications of Artificially Culture Salmon Skins For the Maintenance Of Sea Lice (1996-2003)

UK Grant funding

Value of external research grants obtained 2000-2008

2008-2010	NRAC Funded project "Investigations into the Potential Health and Economic Benefits of Bivalve/Finfish Co-Culture" (\$150,030)
2005-2007	SARF Funded Project: The Aetiology of CMS & HSMI (with <i>Prof S. Adams & Prof H. Ferguson</i> £112,000)
2005-2008	FSBI Funded PhD studentship "The Immunology of <i>Lernaeocera branchialis</i> , (with <i>Dr J Bron & Dr K. Thompson</i> £66,000)
2005	BMFA small research grant programme. Vaccination against <i>Vibrio anguillarum</i> 02β in Atlantic cod (£7,750)
2004-2007	SFIA & Schering Plough Funded PhD studentship: Characterisation of <i>Vibrio</i> sp. in Marine Aquaculture (with <i>Prof S. Adams & Dr K. Thompson</i> £87,000)
2004	NRC Canada short project "Induction of Defence Proteins in Fish Mucus" £12,600 (with <i>Prof S Johnson</i>)
2004-2007	EWOS Funded Post doctoral fellowship Semio-chemicals and Host Identification in Salmon Lice (with <i>J. Mordue (Luntz)</i> , £106,000)
2003	Project Leonardo Grant for "ISH Detection of IPNV in gonadal tissue of Atlantic salmon" (£11,342)
2003-2007	Novartis funded PhD studentship the role of acetate synthesis in improving the <i>in vitro</i> culture of sea lice (£65,000)
2001-2002	BMFA grant "Non destructive assessment of the disease status of marine fish broodstock" £20,500

- 2001-2004 EU FAIR V Programme “Stimulation of fish larval defence mechanisms against infectious diseases” (With R. Dalmo, J. Rombert, B. Gudmonsðottir, T. Bowden, & G. Scapatliati €1,400,000) URL <http://www.nfh.uit.no/prosjektvis.aspx?id=87>
- 2000-2002 Aquahealth Limited funding, “The aggressins of sea lice as possible immuno-therapeutics” (With C. Sommerville. T. Bowden & R. Wootton £145,000)
- 2000-2001 BMFA grant for a research technician on “Modelling the uptake of immuno-therapeutics in larval marine fish” £18,500
- 2000-2001 CEC Funding proposal “research into aspects of the diagnosis of infectious salmon anaemia (ISA) and survival of ISA virus in the marine environment.” (With R. Raynard & C. Cunningham £60,000)
- 2000-2003 FRS PhD. Studentship “Chemical ecology of the host seeking stage of sea lice” (with J. Mordue (Luntz), £36,000)
- 2000-2003 ARC PhD. Studentship “The Physiological Basis for A Sea Louse Vaccine” (With P Billingsley and R. Raynard, £56,000)
- 1997-1999 Aquaculture Vaccines Ltd. Research Fellowship “The Protective Antigens of *Yersinia Ruckerii*”. (£104,908)
- 1997-2000 British Halibut Association Grant “The Potential Role of Probiotics and Immunostimulants in Halibut Culture” (With Harry Birkbeck Glasgow University £58,948)
- 1997-2000 Link (MAFF and SSGA) Aquaculture PhD Studentship “Immunological Interactions between Atlantic salmon and the Sea Louse” (£45,442)
- 1996-1999 DTI Technology Foresight Challenge Grant “Halibut Cultivation” (£134,000)
- 1997 Two Project Leonardo Grants “Immune Parameters of Atlantic Halibut” & “Antibody Responses in Atlantic Halibut (£11,342)
- 1996 Project Leonardo grant “Complement Stability In Marine Flatfish” (£4,370)
- 1994-1996 British Council M.Phil. Studentship ‘*In Vitro* Methods for the Culture of *Lepeophtheirus Salmonis*.’ (£24,745)
- 1992-1996 SOAEFD PhD Studentship ‘The Regulation of the Immune System of Atlantic salmon’ (£21,226)
- 1990-1994 Co-author of Four Annual Grants from the Scottish Salmon Growers Association Totalling £365,000 (With A.E. Ellis and A.L.S. Munro)

Teaching Experience

Courses Taught Prior to 2015-19 Post Tenure Review

- 2008 SMS598 Special Topics Marine Science “Bioethics and the design of aquatic experiments
- 2009 SMS421 Fish Aquaculture II 6 lectures and 3 labs Fish “Immunology, biosecurity and Fish vaccinology
- 2007 SMS211 Introduction to Aquaculture
- 2008 SMS598 Special Topics Marine Science Aquatic animal experimental design and bioethics
- 2008 SMS211 Introduction to Aquaculture
- 2009 SMS598 Special Topics Marine Science Diseases of Aquatic Animals
- 2009 SMS211 Introduction to Aquaculture
- 2010 SMS401 Critical Issues in Aquaculture Infectious Diseases of Fish and Shellfish
- 2010 SMS211 Introduction to Aquaculture
- 2010 SMS401 Critical Issues in Aquaculture Vaccinology
- 2011 SMS421 Fish Aquaculture II 6 lectures and 3 labs Fish Immunology, biosecurity and Fish vaccinology
- 2011 SMS422 Fish Biology this course was completely revised for 2011 and will become a 4 credit course with a new lab in 2013.
- 2012 SMS401 Critical Issues in Aquaculture introduction to fish parasites
- 2012 SMS422 Fish Biology

2013 SMS422 Fish Biology with Laboratory Module
2014 SMS422 Fish Biology with Laboratory Module
2014 SMS401 Critical Issues in Aquaculture introduction to fish parasites
2015 SMS491 The Biology of Sharks

Courses taught in the UK

2006 to 2007 “Bioethics: The ethical use of animal experimentation” (as part of the final year course for the BSc Zoology & Biology). University of Aberdeen.

1998 to 2007 “History of Aquaculture”, “Aquaculture systems” and “Diseases of Emerging Aquaculture Species” modules: on the MSc “Marine and Fisheries Science: Sustainable management of living marine resources” at the University of Aberdeen.

1999 to date “Vaccines Against Fish Parasites” Module 4: Bi-annual Fish Immunology Course, Université de Wageningen, Wageningen, Netherlands.

1994 to date “Practical Applications of Lower Vertebrate Immunology”: (as part of the Developmental Immunology course): Taught to BSc Immunology, Medicine, and Veterinary Sciences students, University of Glasgow.

1990 to 2001 “Fish Immunology” and “Immunological detection of fish diseases” B.Tech Aquaculture Scottish Agricultural College Aberdeen

Membership of Professional and Academic Bodies.

Fellow of the Royal Entomological Society (*by invitation*).

Associate of the Institute of Medical Laboratory Sciences (*by examination*)

Member of the European Association of Fish Pathologists.

Member American Fisheries Society

Member of the Palaeontology Association

American Fisheries Society

World Association Copepodologists

Membership of Committees & Outside Organisations.

External Service and Professional Bodies Prior to 2015-19 Post Tenure Review

Associate Editor for Aquaculture, Journal of Applied Ichthyology 2014-To Date, ICES.

Chair of the Sea lice 2014 Executive and organising committee, Mariculture Science Committee

2007 to date, Chair Scientific Committee 7th NOFFI Fish Immunology Conference, Stirling University, June 2007, Paisley University, Biological Sciences Subject Health Review Committee

Member 2006, AHJWG committee 1999-2007, Chair AHJWG working group on interactions between aquaculture species 2003-2005, Member of the ICES Marine Fish Culture Working group 1999-2003 SEERAD representative on the following:- CSG halibut scientific steering committee, CSG scallop scientific steering committee, CHABOS Lectin working group 1996-97, SSGA furunculosis working group 1992-1997, Technology Foresight halibut cultivation committee 1991-1998, cod farming demonstration consortium 1997-2000.

Publications

(Not including symposiums, proceedings etc.)

Ian Bricknell & Molly Westbrook. The temperature of egg incubation does not impact the sex ratio of gargoyles geckos (*Rhacodactylus auriculatus*, Bavay, 1869) *Herpetologica* (In Review)

Jessica Piesz, Sarah Barker & **Ian Bricknell** (2020) Anti-chemotactic activity in the secretory/excretory products of *Lepeophtheirus salmonis*; Fish and Shellfish Immunology (Accepted & in Press)

Michael Pietrak, Alexander Jensen, Gayle Barbin Zydlewski & **Ian Bricknell**. The Three-Spined Stickleback; *Gasterosteus aculeatus* Linnaeus 1758, Plays a Minor Role as Host of *Lepeophtheirus salmonis*; (Krøyer 1837) in the Gulf of Maine. *Journal of Fish Diseases* Volume: 42 Issue: 7 Pages: 985-989

Barker, S.E., **Bricknell, I.R.**, Covello, J., Purcell, S., Fast, M.D., Wolters, W. & Bouchard, D.A. (2019) Sea lice, *Lepeophtheirus salmonis* (Kroyer 1837), infected Atlantic salmon (*Salmo salar* L.) are more susceptible to infectious salmon anemia virus. *PLOS ONE*, **14**.

Magnadottir, B., Bragason, B.T., **Bricknell, I.R.**, Bowden, T., Nicholas, A.P., Hristova, M., Gudmundsdottir, S., Dodds, A.W. & Lange, S. (2019) Peptidylarginine deiminase and deiminated proteins are detected throughout early halibut ontogeny - Complement components C3 and C4 are post-translationally deiminated in halibut (*Hippoglossus hippoglossus* L.). *Developmental and Comparative Immunology*, **92**, 1-19.

Bowden, T.J., **Bricknell, I.R.** & Preziosi, B.M[§]. (2018) Comparative pathogenicity of *Vibrio* spp., *Photobacterium damsela* ssp *damsela* and five isolates of *Aeromonas salmonicida* Var *achromogenies* in juvenile Atlantic halibut (*Hippoglossus hippoglossus*). *Journal of Fish Diseases*, **41**, 79-86.

Bricknell, I. (2017) Types of Pathogens in Fish, Waterborne Diseases. (Chapter 3), In: *Fish Diseases Prevention and control strategies* (ed. by J. Jeney), pp. 53-74. Wiley, London.

Frederick, C[§]., Brady, D.C. & **Bricknell, I.** (2017) Landing strips: Model development for estimating body surface area of farmed Atlantic salmon (*Salmo salar*). *Aquaculture*, **473**, 299-302.

Piesz, J.[§], Barker, S[†]. & **Bricknell, I.** (2016) Effects of the secretory/excretory products of *Lepeophtheirus salmonis* on Atlantic salmon leukocyte migration. *Fish & Shellfish Immunology*, **53**, 84.

Borsky, A.J.[¥] & **Bricknell, I.R.** (2016) The ontogeny of neurosensory structures in larval Atlantic halibut, *Hippoglossus hippoglossus* (Linnaeus, 1758). *Journal of Applied Ichthyology*, **32**, 669-674

Pert, C.C., Fryer, R.J., Cook, P., Kilburn, R., McBeath, S., McBeath, A., Matejusova, I., Urquhart, K., Weir, S.J., McCarthy, U., Collins, C., Amundrud, T., **Bricknell, I.R.**, 2014. Using sentinel cages to estimate infestation pressure on salmonids from sea lice in Loch Shiel, Scotland. *Aquac. Environ. Interact.* **5**, 49-59.

Molloy, S.D., Pietrak, M.R., Bouchard, D.A., **Bricknell, I.**, 2014. The interaction of infectious salmon anaemia virus (ISAV) with the blue mussel, *Mytilus edulis*. *Aquac. Res.* **45**, 509-518.

Bricknell I, Langston A (2013) Aquaculture: It's not all about Atlantic Salmon. *J Fisheries Livest Prod* 1:e103. doi: 10.4172/2332-2608.1000e103

The settlement and reproductive success of *Lepeophtheirus salmonis* (Kroyer 1837; Copepoda: Caligidae) on atypical hosts (2012)
Pert Campbell C.; Mordue (Luntz) A. Jennifer; O'Shea Brid; & **Bricknell Ian R.**

Bowden, T.J., **Bricknell, I.R.**, 2013. Management of finfish and shellfish larval health in aquaculture hatcheries. Woodhead Publ. Food Sci. Technol. Nutr., 223-245.

Barker, S., Covello, J.M., Bouchard, D., Wolters, W., Fast, M., **Bricknell, I.**, 2013. Lice and ISAV: Are 'lousy' salmon more susceptible? Fish Shellfish Immunol. 34, 1637-1638.

Potential role of *Mytilus edulis* in modulating the infectious pressure of *Vibrio anguillarum* O2 beta on an integrated multi-trophic aquaculture farm (2012)
Pietrak Michael R.; Molloy Sally D.; Bouchard Deborah A. & **Bricknell Ian R.**
Aquaculture Volume: 326 Pages: 36-39 DOI: 10.1016/j.aquaculture.2011.11.024

Molloy SD, Pietrak MR, Bouchard DA & **Bricknell IR** (2011)
Ingestion of *Lepeophtheirus salmonis* by the blue mussel *Mytilus edulis*
Aquaculture Volume: 311 Issue: 1-4 Pages: 61-64

D. A. Bouchard, D. Basti, and **I. Bricknell** (2010)
Where Has All The Gaffkemia Gone?
Pages 99-106 In Cipriano, R. C., Bruckner, A., and Shchelkunov, I. S., editors. Aquatic Animal Health: A Continuing Dialogue Between Russia And The United States. Proceedings of the Third Bilateral Conference Between the United States and Russia: Aquatic Animal Health 2009. 12-20 July 2009. Shepherdstown, West Virginia. Michigan State University, East Lansing, Michigan.

Basti D, **Bricknell I**, Chang ES & Bouchard D.A. (2010)
Biochemical Reference Intervals For The Resting State In The Adult Lobster *Homarus Americanus*
Journal of Shellfish Research Volume: 29 Issue: 4 Pages: 1013-1019

Cook PF, McBeath SJ, **Bricknell IR**, & Bron JE (2010)
Determining the age of individual *Lepeophtheirus salmonis* (Kroyer, 1837) copepodids by measuring stored lipid volume; proof of principle
Journal Of Microscopy Volume: 240 Issue: 1 Pages: 83-86

Basti D, **Bricknell IR**, Hoyt K & Bouchard DA (2010).
Factors affecting post-capture survivability of lobster *Homarus americanus*
Diseases Of Aquatic Organisms Volume: 90 Issue: 2 Pages: 153-166

Kilburn R, **Bricknell IR**, Cook P, et al (2010).
Design and application of a portable, automated plankton sampler for the capture of the parasitic copepods *Lepeophtheirus salmonis* (Kroyer 1837) and *Caligus elongatus* (Von Nordmann 1832)
Journal of Plankton Research Volume: 32 Issue: 6 Pages: 967-970

Urquhart K, Pert CC, Fryer RJ, & **Bricknell IR** (2010)
A survey of pathogens and metazoan parasites on wild sea trout (*Salmo trutta*) in Scottish waters
ICES Journal of Marine Science Volume: 67 Issue: 3 Pages: 444-453

Patricia Noguera, Catherine Collins, David Bruno, Campbell Pert, Anna Turnbull, Alison McIntosh, Katherine Lester, **Ian Bricknell**, Stuart Wallace, & Paul Cook (2009)

- Red vent syndrome in wild Atlantic salmon *Salmo salar* in Scotland is associated with *Anisakis simplex sensu stricto* (Nematoda: Anisakidae)
Diseases of Aquatic Organisms Vol. 87 (3) 199–215
- Pert CC, Raffell J, Urquhart K & **Bricknell IR** (2009)
The pathogen burden of early returning sea trout (*Salmo trutta* L.) infected with *Lepeophtheirus salmonis* (Kroyer, 1837), in the River Shieldaig, Scotland
Bulletin of the European Association of Fish Pathologists Volume: 29 Issue: 6 Pages: 210-216
- Gratacap, R.M.L., Thompson, K.D., **Bricknell, I.R.** & Adams, A. (2009)
Lipopolysaccharide extraction: a phenol alternative.
Journal of Fish Diseases, 32, 811-814.
- Basti, D., **Bricknell, I.**, Beane, D. & Bouchard, D. (2009)
Recovery from a near-lethal exposure to ultraviolet-C radiation in a scleractinian coral.
Journal of Invertebrate Pathology, 101, 43-48.
- Campbell C. Pert, A. Jennifer Mordue (Luntz), Robert J. Fryer, Bríd O'Shea, **Ian R. Bricknell** (2009)
The settlement and survival of the salmon louse, *Lepeophtheirus salmonis* (Krøyer, 1837), on atypical hosts
Aquaculture 288 321–324
- McCarthy, U.M., Bron, J.E., Brown, L., Pourahmad, F., **Bricknell, I.R.**, Thompson, K.D., Adams, A., Ellis, A.E. (2008)
Survival and replication of *Piscirickettsia salmonis* in rainbow trout head kidney macrophages.
Fish & Shellfish Immunology 25, 477-484.
- McCarthy UM, Urquhart KL, **Bricknell IR** (2008)
An improved in situ hybridization method for the detection of fish pathogens
Journal of Fish Diseases 31(9) 669-677
- K. Urquhart, C. C. Pert, R. Kilburn, R. J. Fryer, and **I. R. Bricknell** (2008)
Prevalence, abundance, and distribution of *Lepeophtheirus salmonis* (Krøyer, 1837) and *Caligus elongatus* (Nordmann, 1832) on wild sea trout *Salmo trutta* L.
ICES Journal of Marine Science, 65, 171-173.
- B. O'Shea, A.J., Mordue (Luntz), R.J Fryer, & **I.R. Bricknell** 2006
Determination of the Surface Area of a Fish
J Fish Dis 29(7):437-40
- I.R. Bricknell**, S. Dalesman, B. O'Shea, C.C. Pert, & J. Mordue 2006
The Effect of Environmental Salinity on Sea lice (*Lepeophtheirus salmonis*) Settlement Success
Dis Aquat Org. 71(3):201-12
- McBeath, S. J., Ellis, L. M., Cook, P. F., Wilson, L., Urquhart, K. L. and **Bricknell, I. R.**
Rapid development of polyclonal antisera against infectious salmon anaemia virus and its optimisation and application as a diagnostic tool.
J Fish Dis 29 (5), 293–300.
- The Sea Bass (*Dicentrarchus labrax* L.): A Peripatetic Host of *Lepeophtheirus salmonis*? 2006
C.C. Pert, K. Urquhart and **I.R. Bricknell**

Bull EAFP 26(4) 163-165

Bergljót Magnadóttir, Bjarnheiðu K. Guðmundsdóttir, Sigrún Lange, Slavko Bambir, Agnar Steinarsson, Matthias Oddgeirsson, Tim Bowden, **Ian Bricknell**, Roy Dalmo & Sigríður Guðmundsdóttir 2006

Immunostimulation of cod (*Gadus morhua* L.) larvae and juveniles
J Fish Dis 29 147-155

James Bron, Campbell Pert, Christina Sommerville, Hege Helleberg & **Ian Bricknell** 2006

Diseases of gadoid fish (an update)

Bulletin of the European Association of Fish Pathologists 26(1) 43-46

I.R. Bricknell, J.E. Bron & T.J. Bowden 2005

Diseases of Gadoid Fish in Cultivation: A Review

ICES Journal of Marine Science 63 253-266

Sigrun Lange, Slavko H. Bambir, Alister W. Dodds, Tim Bowden, **Ian Bricknell**, Sigrun Espelid, Bergljót Magnadóttir 2005

Complement component C3 transcription in Atlantic halibut (*Hippoglossus hippoglossus* L.) larvae.

Fish & Shellfish Immunology 20 (3) 285-94.

Ian Bricknell & Roy A. Dalmo 2005

The use of immunostimulants in fish larval aquaculture

Fish & Shellfish Immunology 19 (5) 457-472

Bowden, T.J., Butler R. and **Bricknell I.R.** 2004

Seasonal variation of serum lysozyme levels in Atlantic halibut (*Hippoglossus hippoglossus* L.)

Fish and Shellfish Immunology Fish & Shellfish Immunology 17(2): 129-135.

David W. Verner - Jeffreys, Robin J. Shields, **Ian R. Bricknell** and T. Harry Birkbeck 2004

Effects of different water treatment methods and antibiotic addition on larval survival and gut microflora development in Atlantic halibut (*Hippoglossus hippoglossus* L.) yolk-sac larvae

Aquaculture 232 (1-4): 129-143

I.R. Bricknell, H.E. Hayes, P. Billingsley, A.J. Vigneau, C. Sommerville & R.S. Raynard 2003

Vaccines Against the Salmon lice (*Lepeophtheirus salmonis*)- A Holy Grail, or just around the corner?

Journal of Parasitology 89(S) 149-157

M. Snow, R.S. Raynard, A.G. Murray, D.W. Bruno, J.A. King, R. Grant, **I.R. Bricknell**, N. Bain & A Gregory 2003

An Evaluation of current Diagnostic tests for the detection of infectious salmon anaemia virus (ISAV) following experimental water-borne infection of Atlantic salmon *Salmo salar* L.

Journal of Fish Diseases 26, 135-145

I.R. Bricknell, & T.J. Bowden 2003

Immunostimulants and their role in fish health management

Fish Farmer Magazine 26(1) 10-11

Timothy J Bowden, Katy Adamson, Philip MacLachlan, Campbell C Pert and **Ian R Bricknell** 2003

- Long-Term Study of antibody response and injection-site effects of oil adjuvants in Atlantic halibut (*Hippoglossus hippoglossus* L.)
Fish & Shellfish immunology 14 363-369
- David W. Verner - Jeffreys, Robin J. Shields, **Ian R. Bricknell** and T. Harry Birkbeck 2003
Changes in the gut-associated microflora during the development of Atlantic halibut (*Hippoglossus hippoglossus* L.) larvae in three British hatcheries.
Aquaculture 219 21-43
- T.J. Bowden, D Menoyo-Luque, **I.R. Bricknell** & H Wegiland 2002
Efficacy of Different Administration Routes for Vaccination Against *Vibrio anguillarum* in Atlantic Halibut (*Hippoglossus hippoglossus* L.)
Fish & Shellfish Immunology 12 (3) 283-285
- Louisa Wilson, Katy Adamson, Laura Ellis, Paul Cook, Sonia McBeath & **Ian Bricknell** 2002
An Alkaline Phosphatase-Based Method for the Detection of Infectious Salmon Anaemia Virus (ISAV) in Tissue Culture and Tissue Imprints
Journal of Fish Diseases 25:615-619
- I.R. Bricknell**, P.F. Bisset & T.J. Bowden 2002
The Function of Atlantic Salmon (*Salmo salar* L.) Antibodies Under Extremes of pH and Osmolarity.
Fish & Shellfish Immunology 13:215-219
- Hiney M., Rodger H., **Bricknell I.**, Casburn P. & Mulcahy D. 2002
Aquaculture development and regulation: incompatibility or harmony?
Bulletin of the European Association of Fish Pathologists 22:178-184
- Robert S Raynard, **Ian R Bricknell**, Peter F Billingsley, Alasdair J Nisbet, Antoine Vigneau and Christina Sommerville 2002
Development of vaccines against sea lice
Pest Management Science 58:569-575
- D.A. Smail, R. Grant, K. Ross, **I.R. Bricknell** & T.S. Hastings 2001
The use of haemabsorption for the isolation of infectious salmon anaemia virus on SHK-1 cells from Atlantic salmon (*Salmo salar* L.) From Scotland
Bulletin of the European Association of fish Pathologists 20(5) 212-214
- T. J. Bowden, K. Lester, P. MacLachlan and **I. R. Bricknell** (2000)
Preliminary Studies into the Short-Term Effects of Adjuvants on Atlantic Halibut (*Hippoglossus hippoglossus* L.)
Bulletin of the European Association of fish Pathologists 20(4) 148-152
- M. Snow, C. O. Cunningham **I. R. Bricknell.** (2000)
Susceptibility of Juvenile Atlantic Cod (*Gadus morhua*) to Viral Haemorrhagic Septicaemia Virus Isolated from Wild Caught Atlantic Cod.
Diseases of Aquatic Organisms 41:225-229
- Bricknell I.R.**, Bowden, T.J., Verner-Jefferys D.W., Bruno D.W., Shields R.S., and Ellis A.E. (2000)
Susceptibility of Juvenile and sub-adult Atlantic halibut (*Hippoglossus hippoglossus*, L.) to infection by *Vibrio anguillarum* and efficacy of protection induced by vaccination.
Fish & Shellfish Immunology 10:319-327

Ron Stagg, David Bruno, Carey Cunningham, Trevor Hastings & **Ian Bricknell** (1999)
Infectious Salmon Anaemia: Epizootiology and Pathology.
State Veterinary Journal 9(3) 1-5

Trevor Hastings, Gilles Olivier, Roland Cusack, **Ian Bricknell**, Åre Nylund, Martin Binde,
Pauline Munro, Charles Allen (1999)
Infectious Salmon Anaemia
Bulletin of the European Association of fish Pathologists 19(6) 286-288

Bricknell I.R. Bowden, T.J., Bruno D.W., MacLachlan P., Johnstone R. and Ellis A.E. (1999)
Susceptibility of Atlantic halibut, *Hippoglossus hippoglossus*, (L.) to infection with typical and
atypical *Aeromonas salmonicida*.
Aquaculture 175 1-13

Bricknell I.R. Bowden, T.J., King J. A. & Ellis A.E. (1999)
Duration of Protective Antibodies and the Correlation with Protection in Atlantic Salmon (*Salmo
Salar* L.) Following Vaccination with An *Aeromonas Salmonicida* Vaccine Containing Iron
Regulated Outer Membrane Proteins and Secretory Polysaccharide.
Fish Shellfish Immunol. **9** (2)139-151

O'Dowd A.M., **Bricknell I.R.**, Secombes C.J., & Ellis A.E.(1999)
The Primary and Secondary Antibody Responses to Iron Restricted Outer Membrane Proteins
Antigens Atlantic Salmon (*Salmo salar* L.) Immunised with A-layer Positive and A-layer
Negative *Aeromonas Salmonicida* Bacterins)
Fish Shellfish Immunol. **9** (2) 125-138

Ferguson Y., **Bricknell I.R.**, Glover L.A., MacGregor D.M., and Prosser J.I. (1998)
Transmission of *lux*-Marked and wild type *Aeromonas salmonicida* strains between Atlantic
salmon (*Salmo salar* L.)
FEMS Microbiology Ecology vol. 27 pp. 251-260

R. Vipond, **I.R. Bricknell**, Emma Durant, T.J. Bowden, A.E. Ellis, Mary Smith and S.M.
MacIntyre, (1998)
Defined deletion mutants can identify the major virulence factors of *Aeromonas salmonicida*.
Infection and Immunity, **May 1998**, p1990-1998

I.R. Bricknell, T.J. Bowden and A.L. Langston, (1997)
Halibut Health and Immunology
Bulletin of the European Association of Fish Pathologists **17(6) 267-269**

Bowden, T.J., Butler R., **Bricknell I.R.** and Ellis A.E. (1997)
Serum trypsin-inhibitory activity in five species of farmed fish
Fish and Shellfish Immunology **7**, **377-385**

Smail D.A. **Bricknell I.R.** and Patterson D. (1997)
The inability to detect Infectious Pancreatic Necrosis Virus (IPNV) in crustacean diets for larval
Atlantic halibut, *Hippoglossus hippoglossus* L..
Bulletin of the European Association of Fish Pathologists **17(4) 129-131**

Bricknell I.R. Bowden T.J. Lomax, L. and Ellis A.E. (1997)
Antibody response and protection of Atlantic salmon (*Salmo salar*) immunised with an
extracellular polysaccharide of *Aeromonas salmonicida*

Fish and Shellfish Immunology 7 (1) 1-16

Bricknell I.R., Bruno D. W. and Stone J. 1996
Aeromonas salmonicida infectivity studies in goldsinny wrasse *Ctenolabrus rupestris*, L.
Journal of Fish Diseases **19**, 469-474

I. R. Bricknell, D. W. Bruno, T.J. Bowden and P. Smith 1996
Fat Cell Necrosis Syndrome in Atlantic Halibut (*Hippoglossus hippoglossus* L.).
Aquaculture **144** 65-69

Bricknell I.R. and Bruno D. W. 1995
Sudden fish death associated with Alcian Blue marking.
Bulletin of the European Association of Fish Pathologists **15(3)** 1-2

Bricknell I.R. 1995
A reliable method for the induction of experimental furunculosis
Journal of Fish Diseases **18(2)** 127-133

R.S. Raynard, A.L.S. Munro, J. King, A. E. Ellis, D. W. Bruno, **I. R. Bricknell**, P. Vahanakki, R. Wotton, C. Sommerville, A. Petrie, B. Vivers, O. Andrade-Salas, W. Melvin, T. Amezega, M. B. Labus, J.J. Coull, P. Relly, M.F. Mulcahy, M. O'Donoghue, and J. O'Connell. 1994
Development of a vaccine for the control of sea lice (*Lepeophtheirus salmonis* and *Caligus elongatus*) in Atlantic salmon (*Salmo salar*)
ICES **CM 1994/F:7**

Bricknell I.R. & Ellis A.E. 1993
The development of an effective vaccine against furunculosis
Fish Farmer **16(5)** 16-19

Coleman G., Bennett A.J., Whitby P.W. and **Bricknell I.R.** 1993.
A 70 kDa *Aeromonas salmonicida* serine protease - β -galactosidase hybrid protein as an antigen and its protective effect on Atlantic salmon (*Salmo salar* L.) against a virulent *A. salmonicida* challenge.
Biochemical Society Transactions **21(49S)**

Ellis A.E., **Bricknell I.R.** & Munro A.L.S. 1992.
Patent PCT/GB92/01016 Vaccines against *Aeromonas salmonicida*

Bricknell I.R., Ellis A.E. & Munro A.L.S. 1992.
Patent D/IPR/1G0024 Methods for the detection of the protective antigens of *Aeromonas salmonicida*.

Bricknell I.R., Ellis A.E. & Munro A.L.S. 1992.
The Current Status of a Scottish Furunculosis Vaccine.
ICES **CM 1992/F:29**

Ellis A.E., **Bricknell I.R.** & Munro A.L.S. 1992.
The Status of Furunculosis Vaccines.
Bulletin of the Aquaculture Association of Canadian **92(1)** 10-14

Potts W.T.W. and **Bricknell I.R.** 1992.
The Ionic Composition of Ion Transporting Cells in Stonefly Nymphs.
Scanning Microscopy **6(1)** 287-294

Bricknell I.R. 1991.
X-Ray Microanalysis as a Tool for Measuring Intracellular Ions
Microscopy and Analysis **5(3) 7-13**

Bricknell I.R. & Potts W.T.W., 1989
Silver Staining of Ion Transporting Cells
Practical Exercises in Biology Vol. 7 (W.T.W. Potts Ed.) Lancaster University Press,
Lancaster.

Bricknell I.R. & Potts W.T.W., 1989
The Distribution of the Mitochondria Rich Ion Transporting cells of British Plecoptera, In relation
to the Habitat
Entomologist **108(3) 176-183**

Bricknell I.R. & Potts W.T.W., 1988
The Effects of Acidification on the Coniform Mitochondria Rich Ion Transporting Cells of
Plecoptera
Proceedings of the Royal Microscopic Society **23 107-108**

Bricknell I.R. & Potts W.T.W. 1988
The Effects of Low pH on the Coniform Mitochondria Rich Ion Transporting Cells of Plecoptera.
Institute of Physics Conference Series **93(3) 583-584**

Bricknell I.R. 1986.
The Paeleopathology of Pleistocene Proboscideans
Modern Geology **11(4) 186-202**

Invited papers/plenary lectures

Ian Bricknell "Osmoregulation in sea lice, or how freshwater became a salmon farmers best
friend University of Toulouse; Toulouse France 18th November 2019

Ian Bricknell "Sea lice vaccinations, Chapter 30" Atlantic Fish Farmer's Association of Atlantic
Canada, Huntsman Research Institute St Andrews Canada 24th October 2019

Sea Lice Secreted Products Can Reduce *Lepeophtheirus salmonis* Infection in Atlantic Salmon
Jessica L. Piesz[†], Sarah E. Barker, Ian R. Bricknell WAS New Orleans March 2019

I Bricknell. Disease Ecology in Integrated aquaculture systems Second international
symposium on IMTA Busan University Republic of Korea 14-15th September 2018

Ian Bricknell. A Physiological Basis for sea lice vaccines. John Hopkins University Invited
Lecture Series May 2018

Ian Bricknell. Why are sea lice such a successful parasite in farmed fish? the Institute of
Marine Environmental Technology Public Lecture Series Baltimore May 2018

Ian Bricknell. 30 Years in the trenches. Where did we go wrong (and Right) in Sea Lice
research? 44th Eastern Fish Health Workshop Chattanooga TN 9-14th April 2018

Ian Bricknell and Jessica Piesz "Why Current Vaccines Against Sea Lice Don't Work"
Aquaculture America San Antonio Texas Feb 2017

Ian Bricknell “Hunting the Bugs, disease ecology in a simple ecosystem” Incheon Technical University South Korea July 2017

Ian Bricknell “Aquaculture in a changing Environment” 1st International symposium on Integrated Multi Trophic Aquaculture, Busan South Korea August 2017

I Bricknell. That’s Because you are an Evil Aquaculture Scientist. World Aquaculture 2016 Las Vegas Nevada Feb 22-26 2017

Ian Bricknell “Advancing knowledge in IMTA via information exchange and cooperative research between USA and Korea.” Annual JPA meeting University of Washington January 2016

I Bricknell & Emma Taccardi “The Lumpfish *Cyclopterus lumpus* as a Potential Biological Control for Sea Lice on Salmon Farms” 40th Eastern Fish Health Conference, Virginia Sept 2015

Where are all the sea lice? Searching the wild fish of Cobscook Bay
A. Jensen, M. Pietrak*, S. Barker, G. Zydlewski and **I. Bricknell**
Sea Lice 2014 Aug31st-Sept 5th Portland Maine

C. Frederick*, M. Pietrak, S. Barker, D. Brady and **I. Bricknell**
Where are all the sea lice? A first glance at sentinel fish in Cobscook Bay
Sea Lice 2014 Aug31st-Sept 5th Portland Maine

J.L. Piesz*, **I.R. Bricknell**, Hernan Pizarro, S.E. Barker
Increased susceptibility to infectious salmon anemia virus (ISAv) in *Lepeophtheirus salmonis* – infected Atlantic salmon
Sea Lice 2014 Aug31st-Sept 5th Portland Maine

A physiological approach to vaccines against fish parasites
Ian Bricknell¹, Sarah Barker¹ and James Bron²
¹ Aquaculture Research Institute 2 5735 Hitchner hall, University of Maine Orono, ME 04469-5735, ² Institute of Aquaculture University of Stirling, Stirling, UK FK9 4LA
<https://www.was.org/wasmeetings/meetings/showabstract.aspx?Id=28651>

Disease risks on integrated multi-trophic aquaculture farms: reshaping disease paradigms
Michael Pietrak*, Sally Molloy, Deborah Bouchard, and **Ian Bricknell** Aquaculture Research Institute University of Maine 5735 Hitchner Hall Orono, ME 04469-5735
<https://www.was.org/wasmeetings/meetings/showabstract.aspx?Id=28694>

Ecological aquaculture in land-based and open water systems or How to Manage Diseases in Artificial Ecosystems **I Bricknell** Bremerhaven Forum February 2013
<http://www.aquaculture-forum.de/en/workshop-iii/>

Barker, S., Covello, J.M., Bouchard, D., Wolters, W., Fast, M. and **Bricknell, I.**
Sea Lice and ISAv: Are ‘lousy’ salmon more susceptible?
1st International Conference of Fish and Shellfish Immunology, Vigo, Spain, June 25- 28, 2013.

Barker, S., Bouchard, D., Covello, J.M., Wolters, W., Fast, M. and **Bricknell, I.**
Are ‘lousy’ fish more susceptible to ISAV infection? And what is the role of lice in transmitting ISAv?
Atlantic Canada Fish Farmers Association Annual Fall Workshop, St Andrews, N.B.,

November 14-15, 2012.

Covello, J.M., Barker, S., Bouchard, D., Wolters, W., Fast, M. and **Bricknell, I.**
Effects of Sea Lice Infections and ISA-V on Atlantic Salmon: host strain differences.
Atlantic Canada Fish Farmers Association Annual Fall Workshop,
St Andrews, N.B., November 14-15, 2012.

T.J. Bowden and **I.R. Bricknell.** Getting to the point. How to develop an injectable vaccine.
Eastern Fish Health Workshop, Gettysburg. April 2013

I Bricknell & M Pietrak Gangneung Sea Grant International Symposium"
Held at Gangneung University Republic of Korea March 26th 2013
Vaccines against fish parasites

I Bricknell" 1st International Integrated Multi-Trophic Aquaculture (IMTA) Symposium"
Busan, Republic of Korea March 28-29, 2013
Pietrak M, Bouchard, D. & **Bricknell I**

Preparation of finfish for disease diagnostics
<http://www.northeastaquaculture.org/>
Finfish Culture in Recirculating Aquaculture Systems: Let's Talk Integration
M Pietrak & **I Bricknell**
NACE 2013 Mystic Connecticut

<http://www.northeastaquaculture.org/>
Disease Risks on Integrated Multi-Trophic Aquaculture Farms: Reshaping Disease Paradigms
M Pietrak D Bouchard Sally Dixon-Molloy & **I Bricknell**
www.northeastaquaculture.org/
NACE 2013 Mystic Connecticut

Deploying a Commercial Scale Mussel Raft on a Salmon Farm: More than just growing fish and mussels
Mike Pietrak, Chris Bartlett, Dana Morse, Jeff Robinson, Sally Molloy, Deborah Bouchard, David Miller, and **I Bricknell.**
[Http://www.northeastaquaculture.org/](http://www.northeastaquaculture.org/)
NACE 2013 Mystic Connecticut

Gulf of Maine Research Institute SeaState Lecture 7.0 Series March 8, 2012
Integrated Multitrophic Aquaculture. How to Manage Diseases in an Artificial Ecosystem
Ian Bricknell, (invited speaker)

Scratch My Itch: Those Pesky Sea Lice
Dr **Ian Bricknell** (invited speaker)
37th Eastern Fish Health Workshop; High Peaks Resort, Lake Placid, New York 23 - 27 April 2012

2011 First EWOS Fish Biotechnology Lecture, Immunostimulants a new dawn in fish vaccines?
Ian Bricknell
PEI Veterinary School May 2011

2010 Plenary Lecture Immunology of Fish Parasites,
Ian Bricknell

1st EOFFI Conference Viterbo Italy June 3-8

2009 Plenary Lecture Prevalence of Gaffkemia in Pounded Lobsters. Third Bilateral Conference Between the 2009 David Basti, Deborah Bouchard & **Ian Bricknell**
Distribution of Sea Lice in Enclosed Bays, PEI Veterinary School Lecture Series
United States and Russia: Aquatic Animal Health 2009 July 12 – 20, 2009 Clarion Hotel and Conference Center Shepherdstown, West Virginia, U.S.A.

2008 GMRI Sea State 3.0 - Sea Lice: Do They Come From Fish Farms?

Ian Bricknell

March 15th GMRI Portland ME

Keynote lecture: Monitoring the Infective Pressure of *Lepeophtheirus Salmonis* (Krøyer 1837) on Wild Salmonid Populations in Loch Torridon, Scotland

Ian R. Bricknell, Campbell C. Pert, Paul Cook, Rachael Kilburn, Sonia McBeath

World Aquaculture Society San Antonio Texas Feb 27-March 3rd 2007 Special session SEA LICE- Infection Dynamics on Farms and Interactions with Wild Salmon

Plenary lecture: The physiology of sea lice (*L. salmonis*) in relation to successful settlement on its host's

I.R. Bricknell & J.E. Bron

ICOPA XI, The Scottish Exhibition and Conference Centre (SECC), Glasgow Scotland UK.
6-11th August 2006

Sea Lice infection of salmonid smolts in estuaries

I.R. Bricknell

Invited speaker: University of Aberdeen Seminar series May 2006

Flexibacter ovoliticus and other emerging pathogens in the UK halibut industry

I.R. Bricknell

Plenary lecture BMFA VIIIth annual conference, November 2006 Date & location TBC)

Biosecurity in ornamental aquaculture: keeping Koi Herpes virus out

I.R. Bricknell

Plenary lecture: OATA conference, 13th-14th November 2006 The Britannic Royal Hotel, Coventry

Selected recent papers/plenary lectures

Advances in *Vibrio anguillarum* 02 β vaccines in farmed Atlantic cod

I.R. Bricknell & K. Urquhart

Plenary lecture BMFA annual conference, Oban, November 8-9 2005

Rapid Detection of BKD in Salmonid Fish by IFAT

K. Urquhart*, P. Cook, S. J. McBeath, J. E. Bron, and **I. R. Bricknell**

11th International meeting of the EAFP Copenhagen September 2005

Workshop 4 Diseases of gadoid fish

Ian Bricknell & James Bron (coordinators)

11th International meeting of the EAFP Copenhagen September 2005

0-119 Emergence of Disease risks to gadoid in culture

Ian Bricknell, Tim Bowden, S.C. Johnson & James Bron

11th International meeting of the EAFP Copenhagen September 2005

0-120 Parasites of Cultured gadoids: current perspectives and future prospects

James Bron, A.P. Shinn, S.C. Johnson & **Ian Bricknell**

11th International meeting of the EAFP Copenhagen September 2005

The Survival of the parasitic sea louse (*Lepeophtheirus salmonis*) to the infectious copepodid stage and their survival on atypical hosts

Campbell Pert, A. Jennifer Mordue (Luntz) & **Ian Bricknell**

11th International meeting of the EAFP Copenhagen September 2005

Immunostimulants in Aquaculture

Ian Bricknell, Tim Bowden & Roy Dalmo

Plenary lecture Aquatech Chile, Puerto Monte August 2005

Sea Lice (*Lepeophtheirus salmonis*) A European problem?

Ian Bricknell & James Bron

Plenary lecture Aquatech Chile, Puerto Monte August 2005

Dealing with Emerging Fish Disease: Gadoid Diseases

Ian Bricknell, James Bron, Katy Urquhart & Tim Bowden

Plenary lecture Aquatech Chile, Puerto Monte August 2005

Post Settlement Dynamics of the Parasitic Sea Louse, *Lepeophtheirus salmonis* (Copepoda: Caligidae)

Brid O'Shea, A. Jennifer Mordue (Luntz) & **Ian Bricknell**

9th international conference on copepoda, Tunis, Tunisia, July 2005

Sea Lice (*Lepeophtheirus salmonis*) Settlement Success at Low Salinity

Ian Bricknell, Sarah Dalesman, Brid O'Shea, Campbell Pert & A. Jennifer Mordue (Luntz)

9th international conference on copepoda, Tunis, Tunisia, July 2005

Growing Sea Lice in the laboratory

Ian Bricknell & James Bron

Plenary Lecture

9th international conference on copepoda, Tunis, Tunisia, July 2005

The Use of Genomics, Proteomics and Immunology in Studies of the Parasitic Copepod (*Lepeophtheirus salmonis*)

Fast MD, Bron JE, **Bricknell IR**, Ross NW, Johnson SC

Plenary Lecture

9th international conference on copepoda, Tunis, Tunisia, July 2005

I.R. Bricknell

Disease of Gadoid fish: A Review

Plenary Lecture

BMFA VIIth Annual Scientific Meeting

Oban 2-3 November 2004

Disease Of Gadoid Fish In Cultivation: What Do We Know And What Do We Need To Know?

I.R. Bricknell & T.J. Bowden

Plenary Lecture

ICES Mariculture of Gadoids Conference

Bergen June 2004

Salmon Lice Settlement Success at Low Salinity

I.R. Bricknell, S. Dalesman & J.A. Mordue

6th Sea Lice Conference Huntsman Marine Science Centre St. Andrews New Brunswick
Canada June 2003

Settlement of Salmon Lice on “Dead End” Hosts

I.R. Bricknell, C.C. Pert & J.A. Mordue

6th Sea Lice Conference Huntsman Marine Science Centre St. Andrews New Brunswick
Canada June 2003

The physiological environment found in the gut of the sea louse (*L. salmonis*)

I.R. Bricknell, J.E. Bron, P. Cook, K. Adamson, A.J. Vigneau, R.S. Raynard and P.F. Billingsley

10th EAFP Meeting Malta September 2003

Winner of a 2003 EAFP Best Poster Award

Do Infected Salmon Recruit More Sea Lice, *Lepeophtheirus salmonis*, Than Naïve Fish?

Bríd O’Shea, A.J. Mordue (Luntz) **I.R. Bricknell**

10th EAFP Meeting Malta September 2003

The Fecundity Of The Salmon Louse, *Lepeophtheirus salmonis* and Their Survival On Atypical Hosts

Campbell C. Pert, A. Jennifer Mordue (Luntz) and **Ian R. Bricknell**

10th EAFP Meeting Malta September 2003

Host Preferences of the Salmon Louse, *Lepeophtheirus salmonis*

Bríd O’Shea, A.J. Mordue (Luntz), **I.R. Bricknell**

6th Sea Lice Conference Huntsman Marine Science Centre St. Andrews New Brunswick
Canada June 2003

The Impact of Salinity on Survival of *Lepeophtheirus salmonis*

S.Dalesman, **I.R. Bricknell**, C. Pert* B. O’Shea and A.J. Mordue (Luntz)

6th Sea Lice Conference Huntsman Marine Science Centre St. Andrews New Brunswick
Canada June 2003

Ready Salted: Salmon Louse Aminopeptidase

A.J. Vigneau, **I.R. Bricknell**, R.S. Raynard and P.F. Billingsley

6th Sea Lice Conference Huntsman Marine Science Centre St. Andrews New Brunswick
Canada June 2003

Vaccines Against Sea Lice: A Holy Grail or Just Around the Corner?

I.R. Bricknell

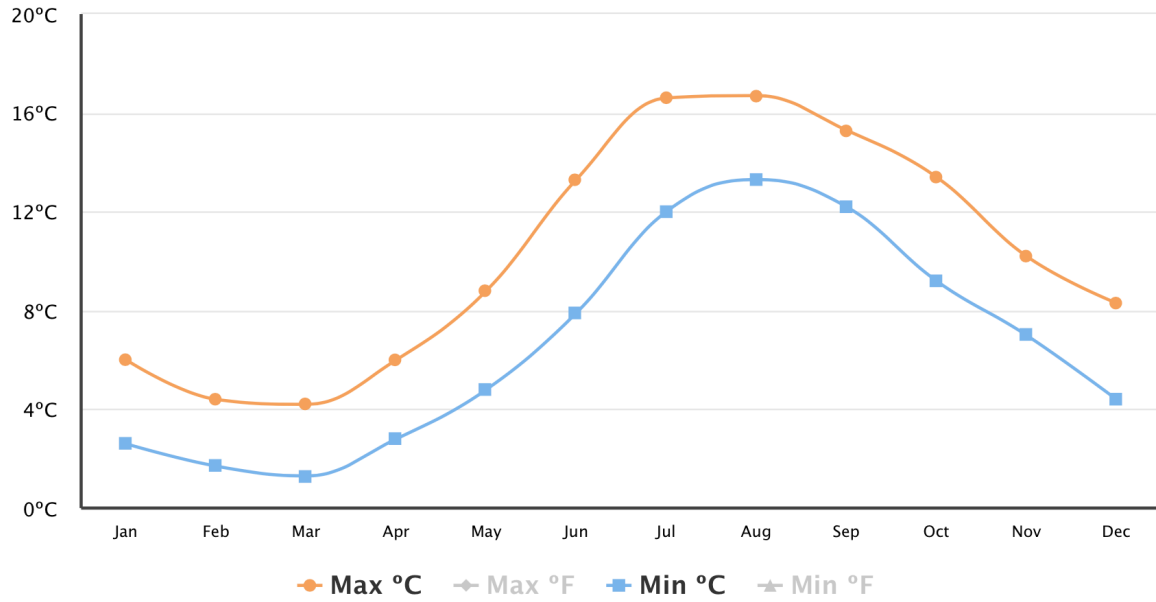
Plenary Lecture

ICOPA X Canada House, Vancouver, Canada July 2002

ANON. 2020a. *Belfast Sea Temperatures* [Online]. 2020. Available: <https://www.seatemperature.org/north-america/usa/belfast.htm> [Accessed 9th January 2020].

Monthly average max / min water temperatures

The graph below shows the range of monthly Belfast water temperature derived from many years of historical sea surface temperature data.



ANON. 2020b. *Marseille Sea Temperatures* [Online]. Available: <https://www.seatemperature.org/europe/france/marseille.htm> [Accessed 9th January 2020].

Monthly average max / min water temperatures

The graph below shows the range of monthly Marseille water temperature derived from many years of historical sea surface temperature data.

