

CVER

Annual Report

2015 and 2016

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1. Message from the Director

CVER had very successful years again in 2015 and 2016, with many of the details provided in subsequent pages. Highlights for the years were the completion of 2 successful Epi-on-the-Island courses. These included “Time Series Regression” and “Survival Analysis” in 2015, and “Bayesian Latent Class Modelling in Animal Health” and “Introduction to Multilevel Modeling” in 2016. CVER also hosted the workshop for the Atlantic Association for Research in Mathematical Sciences – AARMS in June 2015. The workshop aimed to foster research collaborations in the analysis of correlated data, and to facilitate further interactions among group members and collaborators to explore emerging statistical problems and challenges in the area. The participants of these courses and workshops were from Canada, USA, Greece, Argentina, Colombia, Uruguay, Denmark, Finland, Norway, China, and Thailand.

We also welcomed a number of new CVER members as graduate students and post-docs, and congratulated a number of CVER graduate students who completed their degrees and departed UPEI. We had faculty members and graduate students receiving awards for their research and knowledge translation efforts, both near and far. I would like to thank all CVER members for their talents and efforts to keep CVER an extremely strong brand within the veterinary epidemiology world. It is because of your commitment to research excellence and dedication to training/mentoring that we continue to be among the most successful Veterinary Epidemiology programs worldwide. With such an extraordinary CVER team, we will continue to grow and flourish. We hope you enjoy reading some details of our successes below.

Cheers!

John VanLeeuwen



2. Partners:

2.1. Canada Excellence Research Chair – by Dr. Ian Gardner



Drs. Raphael Vanderstichel, Omid Nekouei & Krishna Thakur at the Nitinat Hatchery in BC

The CERC in aquatic epidemiology continued to grow in 2015 and 2016



through the addition of the following 7 post-doctoral fellows: Gabriel Arriagada, Adel Elghafghuf, Diana Jaramillo, Emilie Laurin, Ana Marques, Thitiwan Patanasatienkul, Krishna Thakur; as well as a new Project Manager (Meghan Van Gaal) and an Administrative Assistant (Sheri Gregory). Joe

Lund continued in his role helping guide project and administrative management of the program.



Dr. Emilie Laurin & Dr. Raphael Vanderstichel at Marine Harvest salmon farm in BC

The CERC program is engaged in collaborative projects on both Canadian coasts. On the west coast, collaborations with the Department of Fisheries and Oceans and the salmon industry include studies of potential pathogen exchange between wild and farmed salmon using real-time PCR assays for 45 microbes and on statistical and simulation modeling of sea lice in farmed salmon with a focus of management plans (Krishna Thakur,

Emilie Laurin, Diana Jaramillo). Other projects with industry in BC include improving clinical surveillance for aquatic animal diseases with CFIA (Ana Marques), evaluating the effect of water salinity on sea lice abundance on farmed Atlantic salmon in the Nootka Area in BC (Gabriel Arriagada), and creating a sea lice data management program (Thitiwan Patanasatienkul). On the east coast, the focus in salmon aquaculture has been epidemiologic studies of sea lice, infectious salmon anemia, and bacterial kidney disease (Diana Jaramillo, Annette Boerlage, Raju Gautam). On PEI, the CERC has funded research on improving growth rate and managing growth variation in a land-based halibut farming organization (Diana Jaramillo). CERC also funded a project to evaluate multiscale spatial analysis of hydrodynamic conditions to improve models of disease transmission in finfish aquaculture with Dalhousie University.

Internationally, the CERC continued to contribute research and graduate student/postdoctoral funding to support sea lice research in Chile (Gabriel Arriagada and Adel Elghafghuf), salmon rickettsial syndrome in Chile (Derek Price), and aquatic epidemiology studies in China (Jia Beibei). In Vietnam, Annette Boerlage with the guidance of Jeff Davidson and Larry Hammell continued research projects documenting mortality and its possible causes in finfish in two parts of the country. Ian Gardner continued his collaborative research in Brazil on tilapia health and in Australia on improvement in diagnostic methods for fish diseases with postdoctoral fellow Emilie Laurin.

Finally, 9 seed grants (total of \$190,000) were funded in Summer 2015 and Spring 2016 focusing on high-risk high-reward projects that have the potential to garner extramural funding and include mentoring of early-career scientists by UPEI faculty members.

2.2. AVC Centre for Aquatic Health Sciences (CAHS)– by Dr. Larry Hammell

The AVC Centre for Aquatic Health Sciences at the Atlantic Veterinary College is an academic center of expertise for applied fish health research. Its activities were initially funded by the Atlantic Innovation Fund and research partners including several fish farming companies, provincial and federal government departments.

The Centre continues to work in Atlantic Canada, engaged primarily in clinical trials and field data studies to identify risk factors associated with aquatic food animal production activities. In addition, on an ongoing basis, the centre continues to provide sea lice classification training and site count monitoring to aquaculture production staffs that use the *FishiTrends*TM management system to monitor the aquaculture industry's sea lice control activities.

All funding for CAHS is provided from external sources.

Bacterial Kidney Disease (BKD)



After successful completion of a CAHS-led data study focused on surveillance, risk factors, and control options for Bacterial Kidney Disease in 2014, the CAHS team was awarded a follow-up study (led by Dr. Larry Hammell) to evaluate the diagnostic accuracy of BKD assays in 2015.

Accurate estimates of the diagnostic characteristics of an assay are fundamental for the interpretation of assay results, particularly when applied to asymptomatic individuals since brood stock testing involves fish lacking any clinical signs. Both clinicians and epidemiologists rely on the certainty of a true diagnosis to make informed decisions on treatments and risk management for brood stock and production populations. Co-investigator for this research project was Diana Jaramillo with contributions from Annette Boerlage (both post-doctoral fellows from CERC) as well as Nicole O'Brien, a provincial aquaculture epidemiologist and veterinarian with the Newfoundland (NL) government (and a PhD graduate from AVC-UPEI). Funding for this field project was provided by the provinces of NL and New Brunswick (NB) with a further supporting contribution from CERC.

The results of this project secured a collection of samples from BKD reference populations in NL and NB highly suited to the purpose of the estimating characteristics of BKD diagnostic tests. Results indicated that PCR and culture based tests have the highest diagnostic sensitivities while specificities were higher for IFAT and ELISA. Regarding diagnostic repeatability, IFAT showed the highest agreement, beyond chance. IFAT is the most common diagnostic option used for BKD in the Atlantic region.

Improving growth rate and managing growth variation in a land-based halibut farming



In collaboration with co-investigator Dr. Gerry Johnson, a funding award from the CERC Seed Grant Program and a contribution from the NSERC Industrial Research Assistance Program (IRAP) facilitated a partnership with Halibut PEI to evaluate the potential for productivity improvements at their land-based production facility in Victoria PEI. Halibut farming is considered to be a growth opportunity in the land based aquaculture industry with low environmental impact and a large economic potential in Canada.

The study occurred in two components, including a retrospective analysis of farm production records to identify factors affecting growth of juvenile Atlantic halibut, and a set of tank-based experiments to evaluate the effects of density and of increasing surface area within the tanks on growth of juveniles.

Diana Jaramillo (post-doctoral fellow CERC) was the field investigator for the project and was supported by the CAHS Technical Manager (Holly Burnley) for the execution of the tank-based trials.

Following some equipment development challenges and water quality issues that interrupted assessments in the first juvenile population, the trial was re-initiated in November 2016. This trial population was followed through until March 2017 at which time the test population was returned to the juvenile population in the production facility.

Sea Lice Monitoring Activities

In 2016, *FishiTrends* reached another milestone with its implementation at salmon production sites in Nova Scotia. With this achievement, *FishiTrends* has become the sea lice monitoring platform throughout Atlantic Canada. Monitoring the effectiveness trends for bath and in-feed treatments is an important function within the *FishiTrends* platform, providing important evidence to support decisions regarding use of on chemotherapeutic products in the aquaculture industry. CAHS team members continue to analyze data generated from *FishiTrends* to inform policies for precise sea lice monitoring before and after treatments as well as to detect indicators of sub-optimal treatment performance conditions that might lead to further sea lice burdens in aquaculture management areas (Raju Gautam, post-doctoral fellow CERC).

Support to Provincial Governments

CAHS has continued to support provincial aquatic animal health authorities in each of the Atlantic Provinces through the annual delivery of its Sea Lice Identification Training program and through the provision of periodic training activities in those jurisdictions using the *FishiTrends* platform.

Team members provided a scientific literature review and assessment of disease interactions between wild and farmed salmonid populations to the NS Department of Fisheries and Aquaculture in September 2016 (Larry Hammell with Sarah McConnachie, Post-Doctoral Fellow and current DVM student; in collaboration with Dr. Roland Cusack of NS provincial government).

Also in 2016, the CAHS team prepared a biosecurity review for the Aquatic Animal Health Division of the NL Department of Fisheries and Land Resources (Larry Hammell, Joe Lund, and Holly Burnley).

Student Externships

Since 2008 CAHS has collaborated with the Aquatic Animal Health Division of the NL government to offer practical aquatic veterinary service experience to students in the DVM program. Annually selected DVM students can participate in one of two programs: DVM students entering their 2nd or 3rd year can participate in a summer student experience in NL, for up to 6 weeks in collaboration with the CAHS applied research program; or 4th year DVM students can undertake a 2-3 week clinical externship alongside a NL provincial aquaculture veterinarian as part of their final year. Adele Doucet, Emily Egan and Sarah McConnachie (DVM students) participated in the 2016 program.

International Efforts

In March 2015, CAHS received funding from the Sustainable Trade Initiative (IDH) to partner with its Vietnamese collaborators on a pilot project (EUR 45,000 from IDH matched by CAHS and CERC in-kind) to assess the factors associated with increased mortality and reduced productivity on small-hold shrimp farms. Data collected for this study was managed using the Fish iTrends platform.



Data collection was undertaken by Vietnamese partners throughout the 2015 and 2016 (spring) shrimp crop cycles. CAHS team members (Matt Sanford, Programmer-analyst, and Gabriel Arriagada, CERC Post-doctoral fellow) worked extensively to upload and analyze the pond production records. Key production outcomes (shrimp survival, feed conversion and production yield) were analyzed using farm variables as predictors (e.g. stocking times, stocking densities, larval (PL) quality feed types and water quality).

A second phase of the study was undertaken to evaluate the feasibility of incorporating longitudinal influences on crop productivity (involving Thitiwan Patanasatienkul, Krishna Thakur, and Emilie Laurin, CERC post-doctoral fellows). A subset of the farm records collected through several production cycles were analyzed for influences of various environmental conditions (water temperature, salinity, pH, dissolved oxygen) on growth and survival through time.

The results of this project have demonstrated that both production management and environmental factors are important to assessing productivity of shrimp ponds in Vietnam. Further investigation with more ponds and more explanatory variables would expand and improve the predictive capacity for these productivity outcomes.

2.3. Maritime Quality Milk (MQM) – by Dr. Greg Keefe

Maritime Quality Milk (www.milkquality.ca) is the dairy research and service program of the Atlantic Veterinary College for the Atlantic Canadian provinces. Maritime Quality Milk focuses on milk quality and infectious disease research. By integrating research and service capacity, MQM has become one of the leading dairy health centers in Canada.

The past two years have been more successful years for the program. In 2015, the Atlantic Johne's Disease Initiative (AJDI) was renewed for another 3 years and continued to provide the region with support, in terms of testing, risk management and education, for strategically and cost-efficiently reducing the impact of Johne's disease on the dairy industry. The funding for the AJDI from 2015 to 2018 is provided by the 4 Atlantic Dairy Boards, Agriculture Canada growing Forward 2, and UPEI/AVC/MQM for a total of \$435,666.

Also in 2015, two new projects were introduced under the Atlantic Healthy Herds Initiative with funding through 2018 from the four Atlantic Dairy Boards, the four Atlantic Provincial Governments and UPEI/AVC/MQM for a total of \$669,477. The first project is on Bovine Leukosis Virus (BLV) on BLV surveillance, risk management and research into temporal patterns of BLV transmission. The second project is on Bovine Viral Diarrhea (BVD) for developing new techniques for bulk tank milk and sentinel animal monitoring.

MQM provides both scientific and administrative support to a project examining use of infrared technology in immunoglobulin-based diagnostics. Dr. Ibrahim Elsohaby continued as a Post-Doc to examine the use of infrared technology to determine the immunoglobulin content of bovine serum and colostrum. The results of his work are very promising, indicating that the system provides rapid quantification of IgG with good accuracy and high specificity and sensitivity.

MQM is a partner on 3 Dairy Farmers of Canada/AAFC Dairy Cluster program applications which were initiated in 2013 and have funding in place until 2018. MQM is leading a project on the identification of coagulase negative staphylococci species in bovine milk using Matrix-Assisted Laser Desorption/Ionisation Time-of-Flight Mass Spectrometry. In collaboration with colleagues from Laval, Guelph, and British Columbia, we are working on the validation of a cow comfort assessment tool in the Maritimes. In 2014, we've received a generous research grant that put funding in place until 2018 from the Sir James Dunn Animal Welfare Centre (SJDAWC) to broaden the scope of the initial project to include the evaluation of a web-based benchmarking system for motivating dairy producers to achieve meaningful improvements in cow comfort on their farms. MQM is also a core member of the National Dairy Biosurveillance Study which is being led by the University of Guelph. MQM received a second grant from SJDAWC in 2016 for an investigation into the welfare and health of calves in the Maritime Provinces of Canada.

MQM continues to maintain a web-based graphical analysis program which enables dairy farmers to view their farm's regulatory and payment data, either via computer or smartphone. Our MQM laboratory supports both research and service mandates and maintains USDA-proficiency accreditation for 5 Johne's disease testing methods.

2.4. Sir James Dunn Animal Welfare Centre (SJDAWC) – by Dr. Alice Crook

The SJDAWC promotes animal welfare through research, service and education. Over the past two years, research grants were awarded for the following projects: “Achieving meaningful improvements in dairy cow welfare by reducing lameness: Evaluating the effectiveness of herd performance benchmarking & integrated, web-based risk management” (G Keefe, M Cameron, M Cockram, S McKenna, J Sanchez); “Care of the dairy calf: Investigation into the welfare and health of calves in the Maritime provinces of Canada” (L Heider, M Cameron, J Sanchez, J McClure); and “Research and training to improve stall design and management for better cow welfare and productivity on smallholder dairy farms in Kenya—Phase 2” (J VanLeeuwen, S McKenna, S Richards, and G Gitau). Funding was also awarded for several service projects through which investigators work with community groups to provide direct services to animals.



The following graduate students funded through the SJDAWC (in whole or in part) received their degrees: R Cyril Roy, PhD; Niamh Caffrey, PhD; Matthew Saab, MSc.

The SJDAWC’s annual “Animal Welfare in Practice” conference was on applied equine behaviour in 2015 and on sheep welfare in 2016. The SJDAWC initiated an annual winter webinar series in 2016—the inaugural series addressed euthanasia decision-making and end-of-life care.

Dr. Michael Cockram (Chair in Animal Welfare) and Dr. Alice Crook (Coordinator, SJDAWC) contribute expertise on various provincial, national, and international boards and committees.

Further details on all activities (including graduate students, publications and presentations) can be found in the [SJDAWC 2015 Annual Report](#) and the [SJDAWC 2016 Annual Report](#).

2.5 Shellfish Research Group (SRG) – by Drs. Jeff Davidson and Sophie St. Hilaire

In 2015 and 2016, the Shellfish Research Group conducted a number of research projects including: compilation of mussel productivity data resulting from interviews; determining spatial availability for tunicate recruitment on anthropogenic structures; investigating decreased mussel productivity on PEI mussel farms during the autumn including remote monitoring; identifying critical ecological thresholds for tunicate infestations on mussel farms; the dispersal of lime when treating mussel socks for the club tunicate; Irish moss – green crab interactions in Basin Head MPA; an investigation into the decline of oyster production in the Hillsborough Bay; the characterization of shellfish movements in Nova Scotia for risk simulation models; assessing the effect of oyster seed enhancement on public fishing grounds on PEI; and tunicate population model development.

2.6 Smallholder Dairy Research Group (SDRG) – by Dr. John VanLeeuwen



L-R: Emily Egan, Krista Simonson. Part of the 2015 CFC funded research team.

The Smallholder Dairy Research Group has a dairy research, teaching and service program involving graduate students in epidemiology, veterinarians, veterinary students and other animal health professionals, and smallholder dairy farmers, and interacts with researchers in family science and human nutrition due to the spin-off benefits of more milk. The program has been a result of partnerships among the CVER faculty members and students, three

universities (University of Nairobi, Kenyatta University and Kasetsart University), two Canadian non-governmental organizations (Farmers Helping Farmers - FHF, and Veterinarians without Borders Canada - VWB), and dairy farmer groups primarily in Kenya. Research topics have investigated methods of enhancing milk productivity (through infectious disease control and dairy health management), and how dairy farming and higher milk production have improved sustainable livelihoods, human nutrition, and quality of life.

2015 and 2016 have again been very busy and successful years for the group. As part of a 4 year project funded by the Community Foundations of Canada (CFC), a pair of UPEI vet students went to Kenya for 3 months each year to help out with training smallholder dairy farmers, and assisting 3 Kenyan grad students conduct research projects on cattle nutritional management, reproductive management, and cow comfort in the Mt. Kenya region. This interdisciplinary project also included 3 non-veterinary graduate students conducting research and training on kitchen gardens and feeding programs that have been developed at two schools twinned with Canadian schools through FHF, and also on women's farms. Training methods included face-to-face seminars, demonstrations, and train-the-trainer. Since cell phones are commonly used in Kenya, the traditional training methods have been augmented by cell-phone transmission of information and advice for dairy and crop producers, with an assessment to determine the cell phone benefits. A formal evaluation of the benefits of the project to women's empowerment is being conducted as well. Other UPEI professors involved in these projects include: Drs. Shawn McKenna, Bronwyn Crane, Collins Kamunde, Jen Taylor, Colleen Walton, Charlene VanLeeuwen, and Tim Goddard.



The 2016 CFC Research Team (front, left to right): Grace Wanjohi, Ali Frye, Dr. Emily Kathambi, Dr. Jen Taylor, Dr. Joan Muraya, Dr. Dennis Makau, Catherine Williams, Kelsey Goodick; (back, left to right): Dr. John VanLeeuwen, Sarah Muthee, Kira Stratton and Anne Shileche.

Phase 2 and 3 of a randomized controlled trial study on cow comfort through improved stall design and management was conducted by Dr. Shauna Richards during the summers of 2015 and 2016. Teams of 3 Canadians and 2 Kenyans implemented these studies on farms, along with supervision from Drs. John VanLeeuwen, Shawn McKenna, Jeff Wichtel (now at U of Guelph), Collins Kamunde, Fabienne Uehlinger (now at U of Saskatoon) and George Gitau (U Nairobi).

There were four other ongoing research projects among Kenyan smallholder dairy farms: 1) an observational study on the incidence rate of subclinical mastitis in post-partum cows; 2) a clinical trial to determine the reproductive benefits of improved feeding of cows during the first 2 months post-partum; 3) a cost-benefit analysis of feeding dairy cows recommended amounts of dairy meal and vitamin/minerals; and 4) an observational study on the incidence risks of infections with various neonatal calf diarrhea pathogens, along with how nutrition influenced the incidence and severity of the diarrhea and mastitis. There was also a project among Thailand smallholder dairy farmers determining the frequency, reproductive impacts and factors of high milk urea nitrogen concentrations. There have been 1 Canadian grad student, 2 Kenyan grad students, and 1 Thai grad student working on these smallholder dairy projects, respectively.

Also in these two years, there were two more rotations of 3 UPEI vet students and 6 Nairobi vet students each year providing training to smallholder dairy farmers and veterinary professionals for knowledge transfer of the research results. The trips were also utilized to check up on research project analyses and reports.



Ethiopians using the phone app “VetAfrica Ethiopia”

The Smallholder Dairy Research Group has continued to expand its efforts and impacts into Ethiopia. Using Microsoft Azure, a cloud-based service, researchers developed the VetAfrica-Ethiopia (VAE) phone app for diagnosing and treating cattle. So far, VAE has supported the collection and management of information relating to around 2,000 cattle cases, enough to build a comprehensive database of cases on which the app can

draw to make more effective diagnoses. Its accuracy was tested through the participation of veterinarians who studied these cases in parallel. In over 80% of instances for certain diseases, their diagnoses matched that of the app. Other services were made available through this platform, including information on recommended treatment and matchmaking services to find a nearby veterinarian. The mobile app can greatly improve the timeliness, level of details collected, and integrity of data to ultimately reduce the cost of veterinary care, and facilitate the early detection of new diseases and outbreaks.

3. New or Returning CVER Team Members



Dr. Gabriel Arriagada was a Postdoctoral Fellow with CERC from August 2015 to May 2016. He received his PhD (Epidemiology) at the University of Prince Edward Island. Gabriel is a veterinarian specializing in epidemiology of aquatic animals. His main research interests focus on evaluating strategies for controlling infectious diseases that impact farmed finfish and shellfish.



Dr. Adel Elghafghuf started with CERC in May 2016 as a Postdoctoral Fellow. Adel received his PhD (Biostatistics) from the University of Prince Edward Island. Adel’s current research focuses on stochastic processes and statistical models for complex multivariate and interacting systems. His work involves applying state-space models to sea lice data to better predict sea lice abundance and understand the transmission patterns, as well as identifying factors that affect lice abundance and sources of infection.



Dr. Ibrahim Elsohaby started with MQM and Timeless Veterinary System Inc. as a Mitacs Elevate Postdoctoral Fellow in September 2017. Ibrahim's background and training is in Veterinary Epidemiology and Dairy Production. Ibrahim received an MVSc in Epidemiology of Infectious Diseases from Zagazig University, Egypt in 2010 and completed his PhD in Epidemiology from the University of Prince Edward Island in November 2015. Then he became employed as a Postdoctoral Fellow with MQM in April 2016. His research interests include multivariate data analysis, statistical modeling, risk analysis, diagnostic test validation, infrared spectroscopy, calf-cow health and dairy production.



Dr. Diana Jaramillo was a Postdoctoral Fellow with CERC from March 2015 to March 2017. Diana received her PhD (Epidemiology and Pathogenesis of NNV) from University of Sydney, Australia. Diana's research interests lie in the epidemiology of factors that limit the aquaculture industry, with emphasis on infectious diseases. Her previous work includes the study of viral diseases, such as NNV and EHNV, in finfish, with focus on transmission pathways, disease determinants, and diagnostics (development and validation).



Dr. Emilie Laurin started with CERC in December 2014 as a Postdoctoral Fellow. Emilie received her PhD (Johne's Disease epidemiology and microbiology) from the University of Prince Edward Island. Emilie is currently assisting with several ongoing research projects, including finfish, sea lice, and mollusc epidemiology and modelling; fish serology meta-analysis; environmental data platforms; bovine Johne's Disease epidemiology; avian toxoplasmosis; risk analysis; OIE/STARD reporting guidelines; and evaluation of a swine influenza virus surveillance program.



Dr. Ana Marques started with CERC in October 2016 as a Postdoctoral Fellow. Ana received her PhD (Veterinary Epidemiology) from the University of São Paulo-USP in Brazil. Her research interests include epidemiology in aquatic animals, surveillance systems design and analysis, machine learning for epidemiological mathematical modelling and risk analysis.



Dr Gregor McEwan is a Postdoctoral Fellow with the CERC in Aquatic Epidemiology. While his past research was in the field of Computer Science with a focus in Human Computer Interaction and online game communities, he now models sea louse infestations on Atlantic salmon farms. He completed his Ph.D. at the University of Saskatchewan in 2015 under the supervision of Professor Carl Gutwin. Previously he worked as a Research Engineer and Research Scientist at joint publicly and privately funded research institutions in Australia.



Dr. Omid Nekouei (DVM, PhD) joined CERC (Aquatic Epidemiology) in February 2017 as a Post-doctoral Fellow. He received a Doctor of Veterinary Medicine (DVM) (2001-2007) and Graduate studies, research, and teaching epidemiology and zoonoses (2008-2011) from the University of Tehran, and a PhD in veterinary epidemiology from the Atlantic Veterinary College, UPEI (2012-2015). He held a Post-doctoral fellowship at the University of Calgary (2016) before coming back to UPEI. His primary research interests are in epidemiology of infectious diseases, advanced statistical modeling, and quantitative risk assessment.



Dr. Thitiwan Patanasatienkul started with CERC in July 2015 as a Postdoctoral Fellow. Thitiwan's education background is in Veterinary Epidemiology. She received her DVM and MSc from Kasetsart University, Thailand and completed her PhD (Veterinary Epidemiology) at University of Prince Edward Island, Canada. She has been trained in both qualitative and quantitative analyses. Her research involves the application of modeling and GIS to understand animal health.



Dr. Julian Reyes started in the CVER in September 2016 as a Postdoctoral research fellow. He is a DVM from the University of Antioquia, Colombia, and has a Masters degree in Epidemiology completed in 2007 from the same University. He completed his Ph.D. at UPEI in 2016. His research interests include molecular epidemiology of bovine mastitis pathogens and other livestock diseases. Currently, he is working with Dr. Javier Sanchez in resistance and virulence characteristics of bovine mastitis bacteria.



Welcome (back) to Dr. Javier Sanchez who was on sabbatical from July to December 2016.



Dr. Krishna Thakur started with CERC in June 2015 as a Postdoctoral Fellow. Krishna's background and training is in Veterinary Epidemiology. Krishna received an MSc in Comparative Epidemiology from Purdue University in 2011 and completed his PhD in Epidemiology from the University of Prince Edward Island in 2015. His research interests include simulation and statistical modeling, risk analysis and epidemiology of disease/parasite spread.



Dr. Raphael Vanderstichel is an Assistant Professor in Veterinary Epidemiology, in the Department of Health Management. Raph began his career in a mixed-animal practice in England, and his interest in research prompted him to return in 2007 to the Atlantic Veterinary College to pursue a PhD in epidemiology. After completing his PhD (AVC, 2011), he became a Research Associate in Health Management working in conjunction with CFIA to develop statistical models to establish freedom from disease in Canadian swine. Raph's main areas of professional interests are disease surveillance and spatial epidemiology as applied to production animals, wildlife, and aquatic species. He is currently working with CERC team members on projects related to surveillance and transmission of pathogens affecting the aquaculture and shellfish industries.

CERC Staff



Meghan Van Gaal is CERC Project Manager. Her position commenced in October 2015



Sheri Gregory, Administrative Assistant started with CERC in October 2016

4. Guests

Visiting Professor: CERC hosted **Dr. Edmund Peeler**, from Cefas (Center for Environment, Fisheries and Aquaculture Science), Weymouth, U.K. He is a veterinary epidemiologist based at the Cefas Weymouth laboratory. His research has focused on the development and application of risk analysis methods in aquatic health management. Dr. Peeler visited with the Atlantic Veterinary College (AVC), sponsored by AVC faculty member Dr. Ian Gardner, for two weeks in June 2015.



The purpose of his visit was to:

- Conduct a systematic review of peer-reviewed papers applying serologic tests in finfish for purposes of diagnosis and research
- Present a seminar on application of epidemiologic methods for aquatic sciences to CERC faculty, graduate students and postdoctoral fellows.



Visiting Researcher: CERC, sponsored by AVC faculty member Dr. Raphael Vanderstichel, hosted **Dr. Jeff Barrell** from Dalhousie University for four weeks total (two weeks in June 2016 & two weeks in October and November 2016). At the time of his visit, Dr. Barrell was a Postdoctoral Fellow with the Department of Oceanography at Dalhousie University. During his visit with AVC, he provided support to two CERC research projects. His knowledge in the use of remote sensed data in oceanographic models and he was able to share research results and discuss further research opportunities with CERC researchers. While he was at AVC, he gave a seminar on oceanographic modeling tools and technology for improved spatial management of aquaculture health and his visit provided an opportunity to discuss and collaborate with many researchers at the AVC.



Visiting Researcher: CERC welcomed **Dr. Kiranpreet Kaur**, a senior research fellow at the Norwegian University of Life Sciences (NMBU), Norway. Dr. Kaur visited with AVC, sponsored by AVC faculty member Dr. Crawford Revie, for two weeks in October and November 2016. During her visit at AVC, she collaborated and provided support to CERC projects and spent much of her visit interacting with the CERC group that works on sea lice population dynamics, and whose agent-based modelling research is led by Dr. Gregor McEwan. Dr. Kaur's visit had a specific focus on the issue of model validation, which is critical to facilitation of better communication and exploitation of modelling results. Her research group at NMBU is internationally recognised to be leading scientific investigations that seek to unravel resistance mechanisms within the salmon louse that have been developing towards parasiticides.



Visiting Researcher: CERC, sponsored by AVC faculty member Dr. Ian Gardner, welcomed **Dr. Marina Delphino** from the University of Brasilia in Brazil for two weeks in November 2016. During her stay, she worked with Dr. Gardner on data analysis from her Tilapia research in Brazil.

5. Awards and Recognition

CERC Early Career Development Awards (ECD): A dedicated stream of CERC funding is available to assist early career development of CERC post-doctoral researchers and graduate students, and veterinary students at the AVC, in the form of an *Early Career Development Grant*. The following people received these awards in 2015 and 2016.

- **Ruth Cox:** 2015 ECD Award – Presented at ISVEE Conference in Mexico
- **Raju Gautam:** 2015 ECD Award - Presented at ISVEE Conference in Mexico
- **Carlos Lopez Mendez:** 2015 ECD Award – Four week practicum in fish pathology at BC Ministry of Agriculture Animal Health Centre, Abbotsford, BC.

- **Annette Boerlage:** 2016 ECD Award – Presented at the global conference in aquatic animal epidemiology AquaEpi 1-2016 in Oslo, Norway.
- **Laura Braden:** 2016 ECD Award - Presented on her research on acquired resistance to the myxozoan parasite, *Kudoa thysites*, in farmed Atlantic salmon at the International Conference of Fish & Shellfish Immunology in Portland, Maine.
- **Danielle Burnett:** 2016 ECD Award – Attended a course at the Summer Institute in Statistics and Modeling in Infectious Diseases, University of Washington in Seattle, Washington.
- **Diana Jaramillo:** 2016 ECD Award – Organized an AVC visit of Dr. David Cummins, a scientist working for the Australian Animal Health Laboratory, Commonwealth Scientific and Industrial Research Organization (CSIRO), with expertise in the development and optimization of molecular tests for the surveillance of aquatic pathogens.
- **Emilie Laurin:** 2016 ECD Award – Traveled to Canberra Australia to participate in a panel-discussion workshop to design standards for experimental and field studies to evaluate diagnostic accuracy of tests for infectious diseases in aquatic animals.
- **Terra MacDonald:** 2016 ECD Award – Participated in an external 4th year rotation at the Norwegian Veterinary Institute in Norway.
- **Brett MacKinnon:** 2016 ECD Award – Presentation on “The Epidemiology of Ulcer Disease in Atlantic Salmon (*Salmo salar*) in Atlantic Canada” at the Aquaculture Canada & Sea Farmers 2017 Conference in Halifax, NS.
- **Dylan Michaud:** 2016 ECD Award – Attended the Exploratory Analysis of Biological Data using R 2016 workshop in Toronto.
- **Derek Price:** 2016 ECD Award – 2016 ECD Award – Presented at the global conference in aquatic animal epidemiology AquaEpi 1-2016 in Oslo, Norway.
- **Krishna Thakur:** 2016 ECD Award – Presented at the global conference in aquatic animal epidemiology AquaEpi 1-2016 in Oslo, Norway.

CERC Short-term Research Placement Awards (STRP): A dedicated stream of CERC funding was used to fund short-term research opportunities at institutions external to AVC. The following people received these awards in 2015 and 2016.

- **Raju Gautam:** 2015 STRP Award – Two week placement at CFIA in Ottawa doing risk analysis training on nationally-regulated aquatic animal diseases.
- **Raphael Vanderstichel:** 2015 STRP Award – Three month placement to establish feasibility and methodology for developing a predictive simulation tool of area biomass on disease occurrence in collaboration with researchers at Norwegian Veterinary Institute and to strengthen research networks between two major salmon producing countries (Norway and Canada).
- **Jordan Poley:** 2016 STRP Award - Three week placement at the University of Victoria working in the lab with Dr. Ben Koop to validate and use a newly developed microarray to assess the impact of 2178 on the sea louse *Caligus rogercresseyi*.

In May 2016, **Dr. Ian Gardner** was honoured by the University of California Davis (UC Davis) School of Veterinary Medicine with a 2016 Alumni Achievement Award for his outstanding contributions to veterinary epidemiology. Congratulations Ian!



6. Graduate Program Highlights

- **Ms. Maureen Anderson** – Successfully completed her PhD comprehensive exams under the supervision of Dr. Sophie St.-Hilaire.
- **Dr. Babafela Awosile** – Successfully completed his PhD comprehensive exams under the supervision of Drs. J. McClure and Luke Heider.
- **Dr. Niamh Caffrey** – Successfully defended her PhD thesis under the supervision of Dr. Michael Cockram. Her thesis was titled “Transportation of animals for slaughter in Canada: welfare issues and regulatory control”.
- **Dr. Sunoh Che** – Started a PhD in Epidemiology. Supervised by Dr. Javier Sanchez.
- **Dr. Glen Duzier**- Successfully defended his MSc under the supervision of Dr. Crawford Revie. His thesis was titled “Syndromic classification through a retrospective analysis of porcine submissions to a regional animal health laboratory.”
- **Dr. Ibrahim El-Sohaby** – Successfully defended his Phd under the supervision of Dr. Greg Keefe. His thesis was titled “Emerging technologies for the assessment of bovine immunoglobulins in biofluids”.
- **Dr. Beibei Jia** - Successfully defended her PhD under the supervision of Dr. Ian Gardner and Sophie St-Hilaire. His thesis was titled “Application of Epidemiological Methods in Health Management of Farmed Warm-water Finfish in China.”
- **Dr. Emily Kathambi** – Started a MSc in Epidemiology. Supervised by Dr. John VanLeeuwen
- **Ms. Marianne MacSwain** – Started an MSc in Epidemiology. Supervised by Dr. Sophie St. Hilaire.
- **Dr. Dennis Makau** – Started a PhD in Epidemiology. Supervised by Dr. John VanLeeuwen.
- **Dr. Denise Méthé** - Successfully defended a PhD under the supervision of Drs. Jeff Davidson and Jeff Landry. Her thesis was titled “Eastern oyster, *Crassostrea virginica*: Productivity and physiology under varying temperature and salinity conditions.”
- **Dr. Joan Muraya** - Started a PhD in Epidemiology. Supervised by Dr. John VanLeeuwen.
- **Dr. Thomas Olney** – Started an MSc in Epidemiology. Supervised by Drs. Shawn McKenna and John VanLeeuwen.

- **Dr. Thitiwan Patanasatienkul** – Successfully defended her PhD under the supervision of Drs. Crawford Revie and Javier Sanchez. Her thesis was titled “The use of modelling approaches to explore interactions in two aquatic host-parasite systems.”
- **Ms. Allie Ralling** – Special student status working with Dept. of Veterans Affairs, under the supervision of Dr. Linda VanTil.
- **Dr. Niorn Ratanapob** – Successfully completed her PhD comprehensive exams, under the supervision of Drs. Shawn McKenna and Jeff Wichtel.
- **Dr. Julian Reyes-Velez** – Successfully defended his PhD, under the supervision of Dr. Greg Keefe. His thesis was titled “Epidemiology of *Streptococcus agalactiae* in Colombian dairy cattle”.
- **Dr. Shauna Richards** – Successfully completed her PhD comprehensive exams, under the supervision of Dr. John VanLeeuwen.
- **Ms. Jamie Rouette** – Started a MSc in Epidemiology. Supervised by Drs. Michael Cockram and Javier Sanchez.
- **Dr. Rayappan Cyril Roy** – Successfully defended his PhD thesis under the supervision of Dr. Michael Cockram. His thesis was titled “Animal welfare concerns of slaughter horse transportation”.
- **Mr. Matt Saab** – Successfully defended his MSc thesis under the supervision of Dr. J McClure. His thesis was titled, “Methicillin-resistant *Staphylococcus pseudintermedius* in Atlantic Canada”.
- **Dr. Krishna Thakur** – Successfully defended his PhD under the supervision of Drs. Javier Sanchez and Crawford Revie. His thesis was titled, “Simulation Models for between Farm Transmission of PRRS Virus in Canadian Swine Herds.”

7. Outreach - Some examples of these key initiatives are as follows.

The fifteenth annual meeting of the Canadian Animal Health Laboratorians Network (CAHLN) was held at the Atlantic Veterinary College (AVC) at the University of Prince Edward Island from June 5-8, 2016. Ian Gardner spoke about diagnostic test validation. Raphael Vanderstichel provided an update on aquatic diagnostics, aquatic health and surveillance. Larry Hammell presented on Collaborative research in aquatic animal health, Javier Sanchez presented on CRVE-net: a platform for risk analysis training and research and Sophie St-Hilaire presented on the cost of delaying disease management strategies in salt water pen aquaculture. Emilie Laurin presented on validating diagnostic tests in aquatic animals and Diana Jaramillo presented on measuring diagnostic accuracy of a disease in Atlantic salmon.

Many of the CERC seed grants had presentations at conferences throughout 2015 and 2016, such as: International Society for Veterinary Epidemiology and Economics (ISVEE) symposia in Fall 2015 (Annette Boerlage, Raju Gautam, Ruth Cox, Raphael Vanderstichel); Ocean Science Meeting in New Orleans in 2016 (Maya Groner, Raphael Vanderstichel), Atlantic Canada Fish Farmers Association in 2015 (Sophie St-Hilaire), Seagrass Meeting in 2016 (Maya Groner), 11th International Sea Lice Conference in Ireland in

2016 (Danielle Burnett, Gregor McEwan); AquaEpi 1 conference in Norway in 2016 (Thitiwan Patanasatienkul, Derek Price, Sophie St-Hilaire, Krishna Thakur).

Epi-on-the-Island 2015 - 2016

CVER hosted its annual Epi-on-the-Island courses in July 2015 and in June 2016 at the AVC. The courses had participants from across North America and as far away as Argentina, Colombia, Uruguay, Denmark, Finland, Norway, China, and Thailand.

Epi-on-the-Island 2015 included two 5-day courses. The first course, “Time Series Regression”, was instructed by Dr. Ben Armstrong from London School of Hygiene & Tropical Medicine, CVER’s Drs. Javier Sanchez and Henrik Stryhn. The second course, “Survival Analysis”, was instructed by CVER’s Drs. Ian Dohoo, Henrik Stryhn, and Javier Sanchez.

Epi-on-the-Island 2016 also included two courses. The first 3-day course, “Bayesian Latent Class Modelling in Animal Health”, was instructed by Dr. Wes Johnson from University of California, Irvine, CVER’s Drs. Ian Gardner and Henrik Stryhn. The second 5-day course, “Introduction to Multilevel Modeling”, was instructed by CVER’s Drs. Ian Dohoo, Henrik Stryhn, and Javier Sanchez.



Epi on the Island 2015



Epi on the Island 2016

The AARMS Collaborative Research Group Workshop 2015 at the AVC

CVER also hosted the workshop for Atlantic Association for Research in Mathematical Sciences – AARMS in June 2015. The workshop aimed to foster research collaborations in the analysis of correlated data, facilitate further interactions among group members and collaborators to explore emerging statistical problems and challenges in the area. The participants and presenters were from Greece, across the Atlantic Provinces, as well as from Saskatchewan, Ontario, and Québec.



Successful Start to a 4-year Dairy Project with Naari Dairy Co-operative Society in Kenya



(Right to left, sitting) Joan, Muraya, Dennis Makau, Krista Simonson and Emily Egan
(Vincent standing)

University of Prince Edward Island (UPEI) and Farmers Helping Farmers (FHF), a charity based in PEI, have begun an exciting new 4-year chapter in their ongoing efforts to improve the livelihoods of smallholder dairy farmers in central Kenya. They were recently successful in obtaining \$500,000 from the Canadian Queen Elizabeth II Diamond Jubilee Scholarships program which was created in June 2014 in honour of Queen Elizabeth's 60-year reign. It's a joint initiative of Universities Canada, the Rideau Hall Foundation, and Community Foundations of Canada, with

financial support from the federal government, provincial governments, and the private sector. The goal of the program is to help commonwealth countries train future leaders in development, known as Queen Elizabeth scholars, while providing assistance to developing commonwealth countries. Canadian university students participate in internships and study opportunities in various Commonwealth countries, and international students from those countries will pursue graduate studies in Canada and apply those new professional skills when they return to their home country. The successful 4-year proposal was primarily developed by Dr. John VanLeeuwen and Dr. Jeffrey Wichtel of UPEI's Atlantic Veterinary College (AVC) and Teresa and Ken Mellish from FHF.

The project started in May 2015 when the first two of eight veterinary students (2 per year) from UPEI, Krista Simonson and Emily Egan, traveled to Kenya to collect baseline information on local farms and to develop and deliver training programs in cattle health management for 3 months. The training was conducted in the Naari region of Kenya and training methods included verbal and written communications and demonstrations, and train-the-trainer for both Naari farmers and Naari Dairy Group personnel. The two Canadian students were joined by two Kenyan veterinarians, Drs. Joan Muraya and Dennis Makau, who have been selected to complete Ph.D. degrees at UPEI (supervised by Dr. John VanLeeuwen). Their research projects will investigate methods of improving reproductive success through hormone therapy and sexed semen, and improving cattle nutrition through drought-tolerant leguminous trees, respectively. The two Kenyans arrived in Canada in August 2015. When they finish their PhD programs, they will become professors at the Faculty of Veterinary Medicine at the University of Nairobi in Kenya, a partner on the proposal.



Krista Simonson, Joan Muraya and Emily Egan with their gifted chicken in the back of the taxi!

Dr. VanLeeuwen joined the two students for the first 3 weeks in Kenya to provide in-country orientation on the culture, the partners, the available resources, and the activity protocols. During this time, the group visited nearly 50 farms. The group examined all the cattle on the farms (ranging from 1 to 10 cattle), administered donated medicines to sick animals that required treatment, conducted reproductive checks and treatments where needed, and gave advice on how to manage their cattle better. The group received very warm receptions from the farmers who were excited to be randomly selected to be active participants in the project, offering the vet team cups of tea, fruits and vegetables, eggs, and even a couple of chickens.

In 2016, 2 more veterinary students (Kelsey Goodick and Ali Frye) traveled to Kenya to conduct training on other cattle health management topics for 3 months. They were joined by the first 2 of 6 nutrition students from UPEI (Catherine Williams and Kira Stratton), supervised in-country for 3 weeks by Dr. Jennifer Taylor, and from Canada by Dr. Colleen Walton, CVER members and professors of nutrition at UPEI. Kitchen gardens were developed at two schools twinned with Canadian schools through Farmers Helping Farmers and also on women's group farms. Since cell phones are commonly used in Kenya, a project was initiated that augmented traditional training methods with cell-phone messaging twice weekly, giving advice for dairy and crop producers on management and nutrition. The implementation of the cell phone project will be in 2017.

Four other Kenyan grad students went to UPEI to take courses toward Masters Degrees, conduct their thesis research in Kenya, and defend their theses at UPEI. Their research project topics include: 1) improving cow comfort on dairy farms (by new CVER member and MSc student Dr. Emily Kathambi – supervised by Dr. John VanLeeuwen); 2) enhancing school children nutrition through drought-tolerant school gardens and feeding programs (by Sarah Muthee – supervised by Dr. Jen Taylor); 3) assessment of augmentation of traditional training methods with cell-phone based training for Kenyan dairy and horticultural farmers (by Grace Wanjohi – supervised by Dr. Tim Goddard); and 4) program evaluation of the improvements in emotional empowerment and civic engagement associated with the project (by Anne Shileche – supervised by Charlene VanLeeuwen). The total project budget, including all the in-kind contributions, is valued at over \$1.1 million.

International Teaching

Dr. Ian Dohoo, who retired in 2012 but who retains an affiliation with CVER, continues to be active in teaching and research. He continues to work part-time on short-term teaching and research contracts with primary areas of activity involving partnerships with:

- The International Livestock Research Institute (based in Kenya) where he is working on a range of projects related to animal health and animal sourced foods
- UniResearch (based in Bergen, Norway) focusing on sea lice related projects
- Universities in Australia and New Zealand where Dr. Dohoo provides some graduate-level short courses in epidemiologic methods



Ian Gardner delivered a 2 day training course on diagnostic test evaluation to 19 participants at the 2015 conference of European Association of Fish Pathologists in Las Palmas.



8. Peer-Reviewed Journal Publications

1. Aguirre J, Greenwood SJ, McClure JT, Davidson J and Sanchez J. (2016) Effects of rain events on *Cryptosporidium* spp. levels in commercial shellfish zones in the Hillsborough River, Prince Edward Island, Canada. *Food and Waterborne Parasitology*. 5:7-13.
2. Ahlstrom C, Barkema HW, Stevenson K, Zadoks RN, Biek R, Kao R, Trewby H, Hauptstein D, Kelton DF, Fecteau G, Labrecque O, Keefe GP, McKenna SL, De Buck J. (2015) Limitations of variable number of tandem repeat typing identified through whole genome sequencing of *Mycobacterium avium* subsp. paratuberculosis on a national and herd level. *BMC Genomics*. 16:161.
3. Arriagada G, Stryhn H, Vanderstichel R, Campistó JL, Rees EE, Sanchez J, Ibarra R and St-Hilaire S. (2016) Evaluating the effect of synchronized sea lice treatments in Chile. *Preventive Veterinary Medicine*. 136:1-10.
4. Arriagada G, Vanderstichel R, Stryhn H, Milligan B and Revie CW. (2016) Evaluation of water salinity effects on the sea lice *Lepeophtheirus salmonis* found on farmed Atlantic salmon in Muchalat Inlet, British Columbia, Canada. *Aquaculture*. 464:554-63.
5. Assis GBN, Oliveira TF, Gardner IA, Figueiredo HCP and Leal CAG. (2016) Sensitivity and specificity of real-time PCR and bacteriological culture for francisellosis in farm-raised Nile tilapia (*Oreochromis niloticus* L.). *Journal of Fish Diseases*. DOI 10.1111/jfd.12559.
6. Bartolomé E and Cockram MS. (2016) Potential effects of stress on the performance of sport horses. *Journal of Equine Veterinary Science*. 40:84-93.
7. Boerlage AS, Nguyen KV, Davidson J, Phan VT, Bui TN, Dang LT, Stryhn H and Hammell KL. (2016) Finfish marine aquaculture in Northern Vietnam: Factors related to pathogen introduction and spread. *Aquaculture*. 466:1-8.
8. Boerlage AS, Stryhn H, Sanchez J and Hammell KL. (2016) Case definition for clinical and subclinical bacterial kidney disease (BKD) in Atlantic Salmon (*Salmo salar* L.) in New Brunswick, Canada. *Journal of Fish Diseases*. DOI: 10.1111/jfd.12521.

9. Boonyawiwat V, Patanasatienkul T, Kasornchandra J, Chaithep P, Yaemkasem S, Hammell LK and Davidson J. (2016) Impact of farm management on expression of Early Mortality Syndrome-Acute Hepatopancreatic Necrosis Disease (EMS/AHPND) on penaeid shrimp farms in Thailand. *Journal of Fish Diseases*. DOI: 10.1111/jfd.12545.
10. Burge CA, Closek C, Friedman CS, Groner ML, Jenkins C, Shore A and Welsh JE. (2016) The use of filter-feeders to manage disease in a changing world. *Integrative and Comparative Biology*. 56(4):573-87.
11. Cameron M, Keefe GP, Roy JP, Stryhn H, Dohoo IR, McKenna SL. (2015) Evaluation of selective dry cow treatment following on-farm culture: Milk yield and somatic cell count in the subsequent lactation. *Journal of Dairy Science*. 98:2427-36.
12. Cameron M, Saab M, Heider L, McClure JT, Rodriguez-Lecompte JC, Sanchez J. (2016) Antimicrobial Susceptibility Patterns of Environmental Streptococci Recovered from Bovine Milk Samples in the Maritime Provinces of Canada. *Frontiers in Veterinary Science*. 3(article 79); doi: [10.3389/fvets.2016.00079](https://doi.org/10.3389/fvets.2016.00079)
13. Caraguel C, Gardner IA, and Hammell LK. (2015) Selection and interpretation of diagnostic tests in aquaculture biosecurity. *Journal of Applied Aquaculture*. 27(3):279-98.
14. Dohoo C, Guernsey J, Gibson M, VanLeeuwen JA. (2016) Impact of biogas digesters on cookhouse volatile organic exposure for rural Kenyan farmwomen. *Journal of Exposure Science and Environmental Epidemiology*. 25:167-174.
15. Dorjee S, Sanchez J, Poljak Z, McNab WB, McClure JT, Revie C. (2016) One-Health Simulation Modelling: Assessment of Control Strategies against the Spread of Influenza between Swine and Human Populations using NAADSM. *Transboundary and Emerging Diseases*; 63:e229-244.
16. Eisenlord ME, Groner ML, Yoshioka RM, Elliot J, Maynard J, Fradkin S, Turner M, Pyne K, Rivlin N, van Hooidek R, Harvell CD. (2016) Ochre star mortality during the 2014 wasting disease epizootic: role of population size structure and temperature. *Philosophical Transactions of the Royal Society B*. 371(1689).
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18. Elmoslemany A, Revie CW, Milligan B, Stewardson L, and Vanderstichel R. (2015) Sampling of wild juvenile salmonids in Muchalat Inlet, British Columbia and an assessment of some factors associated with sea lice prevalence between 2004 and 2011. *Diseases of Aquatic Organisms*. 117:107-20.
19. Elsohaby I, Hou S, Riley CB, McClure JT, Shaw RA, Keefe GP. (2015) A rapid field test for the measurement of bovine serum immunoglobulin G using attenuated total reflectance infrared spectroscopy. *BMC Veterinary Research*. 11:218. [DOI 10.1186/s12917-015-0539-x](https://doi.org/10.1186/s12917-015-0539-x)
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21. Elsohaby I, McClure JT, Keefe GP. (2015) Evaluation of Digital and Optical Refractometers for Assessing Failure of Transfer of Passive Immunity in Dairy Calves. *Journal of Veterinary Internal Medicine*. 29(2):721-726. DOI: 10.1111/jvim.12560
22. Elsohaby I, McClure J, Riley C, Shaw A, Keefe G. (2016) Quantification of bovine immunoglobulin G using transmission and attenuated total reflectance infrared spectroscopy. *Journal of Veterinary Diagnostic Investigation*. 28:30-37 [doi: 10.1177:1040638715613101](https://doi.org/10.1177/1040638715613101)
23. Falzon L, VanLeeuwen JA, Menzies P, Jones-Bitton A, Shakya K, Avula J, Jansen J, Taylor MA, Learmont J, Peregrine A. (2015) Comparison of calculation methods used for the determination of anthelmintic resistance in sheep in temperate continental climate. *Parasitology Research*. 114(4):1631-43.
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25. Gautam R, Boerlage AS, Vanderstichel R, Revie CW and Hammell LK. (2016) Variation in pre-treatment count lead time and its effect on baseline estimates of cage-level sea lice abundance. *Journal of Fish Diseases*. 1297-1303 DOI10.1111/jfd.12460.
26. Gautam R, Vanderstichel R, Boerlage AS, Revie CW and Hammell KL. (2016) Evaluating bath treatment effectiveness in the control of sea lice burdens on Atlantic salmon in New Brunswick, Canada. *Journal of Fish Diseases*. DOI: 10.1111/jfd.12569.
27. Gehrels H, Knysh KM, Boudreau M, Theriault MH, Courtenay SC, Cox R and Quijon PA. (2016) Hide and seek: Habitat mediated interactions between European green crabs and native mud crabs. *Marine Biology*. 163(7):1-11.
28. Groner ML, Breyta R, Dobson A, Friedman CA, Froelich B, Garren M, Maynard J, Gulland F, Weil E, Wyllie-Echeverria S, and Harvell CD. (2015) Emergency response for marine diseases. *Science*. 347(6227):1210.
29. Groner ML, Burge CA, Van Alstyne K, Yang S, Harvell CD and Wyllie-Echeverria S. (2016) Plant characteristics associated with widespread variation in eelgrass wasting disease. *Diseases of Aquatic Organisms*. 118(2):159-168.
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41. Lewis N, Dube C, Sanchez J, VanLeeuwen JA. Sensitivity Analysis of a simulated outbreak of highly pathogenic avian influenza in Ontario, Canada. (2016) *Transboundary and Emerging Disease*. 64:3;938-950. DOI: 10.1111/tbed.12461.
42. Lutz-Collins V, Cox R and Quijon P. (2016) Habitat-disruption by a coastal invader: local community change and recovery in Atlantic Canada sedimentary habitats. *Marine Biology*. 163:177-89.
43. Maynard J, van Hooidek R, Harvell CD, Eakin CM, Liu G, Willis BL, Williams GJ, Groner ML, Dobson A, Heron SF, Glenn R, Reardon K and Shields JD. (2016) Improving marine disease surveillance through sea temperature monitoring, outlooks and projections. *Philosophical Transactions of the Royal Society B*. 371(1689).
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56. Poirier LA, Mohan J, Speare R, Davidson J, Quijon PA and St-Hilaire S. (2016) Moulting synchrony in green crab (*Carcinus maenas*) from Prince Edward Island, Canada. *Marine Biology Research*. 1-9.
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