

# **CVER**

# **Biennial Report**

# **2019 – 2020**

## Table of Contents

<b>1. Message from the Director .....</b>	<b>1</b>
<b>2. Partners.....</b>	<b>2</b>
2.1. Canada Excellence Research Chair (CERC) in Aquatic Epidemiology – by Dr. Ian Gardner .....	2
2.2. Ocean Frontiers Institute (OFI) – by Drs. Krishna Thakur and Crawford Revie .....	3
2.3. AVC Centre for Aquatic Health Sciences (CAHS) – by Dr. Larry Hammell.....	3
2.3.1. Fish-iTrends Database Management .....	3
2.3.2. Infectious Salmon Anaemia Virus (ISAv) Strain Evaluation .....	4
2.3.3. Student Externships .....	4
2.3.4. International Efforts.....	4
2.4. Dairy Research Groups – By Dr. J McClure.....	5
2.4.1. Calf Longevity Project .....	5
2.4.2. Detection of $\beta$ -lactam resistance in <i>Staphylococcus aureus</i> bovine mammary isolates .....	5
2.4.3. Atlantic Healthy Herds II .....	5
2.5. Sir James Dunn Animal Welfare Centre (SJDAWC) – by Dr. Kathryn Proudfoot.....	6
2.6. Shellfish Research Group (SRG) – by Dr. Jeff Davidson .....	8
2.7. Smallholder Dairy Research Group (SDRG) – by Dr. John VanLeeuwen.....	8
2.8. Antimicrobial Resistance and Risk Analysis Groups – by Dr. Javier Sanchez.....	10
2.9. Veterinary Epidemiology and Social Science for Animals (VESSA) Group – by Dr. Caroline Ritter.....	11
2.10. Other Activities .....	11
2.10.1. ISVEE 2022 – by Dr. Javier Sanchez .....	11
2.10.2. Projects Related to Antimicrobial Resistance – by Dr. J McClure .....	11
<b>3. New CVER Team Members .....</b>	<b>11</b>
<b>4. Guests .....</b>	<b>12</b>
4.1. Visiting Professors.....	12
4.2. Visiting Graduate Students .....	12
<b>5. Awards and Recognition.....</b>	<b>13</b>
<b>6. Graduate Program Highlights .....</b>	<b>13</b>
<b>7. Outreach .....</b>	<b>15</b>
7.1. Epi on the Island.....	15
7.2. CVER Research Seminars.....	15
7.3. International Teaching.....	16
7.4. Training veterinarians, veterinary students and technicians, farmers and schools in Kenya .....	16
7.5. AquaEpi II Conference.....	17
<b>8. Peer-Reviewed Journal Publications .....</b>	<b>17</b>
<b>9. Books/Book Chapters .....</b>	<b>27</b>

## 1. Message from the Director



In the tradition of CVER biennial reports, this report covers activities in 2019 and 2020, but rarely has a biennial report covered years with so different experiences! Yet the coherence in our “stories” across these two years attests to both how relatively sheltered from the pandemic we have been on Prince Edward Island and to the resilience of the CVER group to find ways to continue its activities under difficult circumstances. The bottom line is that these years have been productive and successful for CVER, and I invite you to read about the details presented in this report.

Some highlights were: Dr. John VanLeeuwen was awarded the UPEI Faculty Association Merit Award for Scholarly Achievement in 2020; his PhD student Dr. Dennis Makau received the Governor General's Award for best PhD thesis at UPEI in 2019, and Dr. Nora Biermann, supervised by Drs. Amie Dyle and J McClure, received the Governor General's Award for best PhD thesis at UPEI in 2020; Drs. Krishna Thakur and Sonja Saksida were co-investigators of a successful OFI Phase-II funding application for a consortium of projects under One Ocean Health; and Dr. Javier Sanchez contributed significantly to the COVID-19 response at the provincial level (working closely with the provincial Chief Public Health Office), as well as at national and international levels.

The Epi-on-the-Island courses, “Survival Analysis” and “Applied Course in Quantitative Risk Modelling for Animal Health and Food Safety” in 2019, and “Introduction to Multilevel Modelling” in 2020 added to the long tradition of our successful summer program. The 2020 course became our first experience with a blend of in-person and online participation in summer courses, but surely not the last. The participants in our 2019 courses came from far away, and the participants in our 2020 course were scattered around the world!

We also had more faculty members and graduate students receiving awards for their research and knowledge translation efforts, both near and far. We welcomed a number of new CVER faculty members and graduate students. We also congratulated a number of CVER graduate students who completed their degrees, and sent our best wishes with the graduates and the post-doctoral fellows who departed UPEI.

I would like to thank all CVER members for their talents and efforts to keep CVER such a strong brand within the veterinary epidemiology world. It is because of everyone's commitment to research excellence and dedication to training and 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. I hope you will enjoy reading some details of our activities and accomplishments.

Sincerely,

Henrik Stryhn

## **2. Partners**

### **2.1. Canada Excellence Research Chair (CERC) in Aquatic Epidemiology – by Dr. Ian Gardner**

The CERC program in Aquatic Epidemiology ended in September 2019, and most of 2020 was dedicated to publishing research findings in peer-reviewed journals and transitioning post-doctoral fellows into new positions within provincial and national government agencies, private companies, or to other sources of funding such as the Ocean Frontier Institute with Dalhousie University. The following paragraphs provide a high-level description of the research program and some of its major achievements.

The CERC was a world-leading program in the discipline of aquatic epidemiology, having contributed to training of 22 highly-qualified personnel (HQP) and research scientists, and culminating in more than 130 peer-reviewed papers over the 9 years of its existence. Five previous HQP (Erin Rees, Raphael Vanderstichel, Krishna Thakur, Omid Nekouei and Babafela Awosile) are now in faculty positions in Canada, USA and Hong Kong. Of recent note, the CERC had the largest contingent of faculty and HQP other than the 2 Thai host institutions (Department of Fisheries and Kasetsart University, Bangkok) at the Second International Conference in Aquatic Epidemiology in 2019. One HQP (Omid Nekouei) and one AVC alumnus (Nicole O'Brien) received the only two awards at the conference (best oral presentation and best poster presentation).

CERC research focussed on infectious disease epidemiology (e.g. risk factor studies, computer simulation and statistical modelling of spatio-temporal patterns of disease, and evaluation of disease control measures including their cost-effectiveness) of important diseases, including sea louse infestations in salmon, and marine ecosystem health both nationally and internationally. Our team's research has mostly been transdisciplinary, integrated science with a major involvement of provincial and salmon company veterinarians, and federal government research scientists and regulators (Department of Fisheries and Oceans, DFO). In addition, we have collaborated with the Canadian Food Inspection Agency, when researching internationally-reportable diseases such as infectious salmon anaemia virus.

We used evidence-based science to answer questions from the Cohen Commission about the potential role of infectious diseases in the decline of wild Sockeye salmon in British Columbia and contributed to a balanced and objective discussion of this high profile issue through research and participation in DFO risk assessments for multiple infectious agents. In addition, CERC salmon health research has had international impacts through partnerships in Scotland, Norway, and Chile involving modelling of the spread of bacterial and parasitic infections. Evaluation and strengthening of existing management and prevention strategies of viral, bacterial and parasitic disease (especially sea lice which continues to be the highest priority disease for the global salmon industry) remained a key goal of the CERC team's research.

Infectious disease research was also conducted in warm water fish species (e.g. tilapia, carp, and pangasius) and shrimp in collaboration with research institutions in Brazil, China, Vietnam, and Thailand, but it was challenging to maintain overseas research programs as priorities of international funding agencies were often changed, making projects of more than 3 years duration difficult to support.

Despite COVID-19, we continue to contribute to research programs of our national and international collaborators in statistical, simulation and epidemiological modelling of infectious diseases.

One of the lasting benefits of our collaborative research has been our impactful partnership with oceanographers at Dalhousie University (Grant and Filguiera labs) in the combined use of ocean circulation models, particle tracking experiments, biological and most recently epidemiological models to answer questions relevant to transmission dynamics of aquatic infectious diseases. To my knowledge, this integrated approach is the first time combinations of models have been used to potentially predict future disease events associated with hydrodynamic dispersal of pathogens in the marine environment and evaluate effects of disease control measures. This work informs regulatory decisions about new site licences for Canadian salmon farms.

## **2.2. Ocean Frontiers Institute (OFI) – by Drs. Krishna Thakur and Crawford Revie**

Research on New Models of Salmon Health Management and on One Ocean Health is continued to be carried out by the CERC/CVER group as part of the Ocean Frontiers Institute Phase-I and Phase-II research programs, respectively. The Phase-I research includes agent-based models on sea lice treatment strategies and development of resistance (Dr. Jaewoon Jeong), state-space modelling of sea lice outbreaks in salmon farms around Grand Manan Island, New Brunswick (Dr. Adel Elghafghuf), assessing transmission patterns of sea lice among salmon farms in the Bay of Fundy, New Brunswick (PhD student Marianne Parent), and infectious viral disease spread models between salmon farms on the east and west coast of Canada (PhD student Joao Romero). Drs. Sonja Saksida and Krishna Thakur were co-investigators on a successful OFI Phase-II funding application led by Dr. Mark Fast for a consortium of projects under One Ocean Health, totalling more than \$0.7M directly attributed to projects related to CVER faculty members. One of the Phase-II research projects is on epidemiological and genomic determinants of epizootic shell disease in lobsters in Canada (PhD student Svenja Köpper) and aims to forecast the risk of the disease in key lobster fisheries areas under varying climate projections. Another project is evaluating the effectiveness of current antibiotic treatment practices on Atlantic salmon farms and will develop novel intervention strategies to avoid need for commonly-used therapeutants (Dr. Kristin Reynolds).

## **2.3. AVC Centre for Aquatic Health Sciences (CAHS) – by Dr. Larry Hammell**

The AVC Centre for Aquatic Health Sciences (AVC-CAHS) is a long-standing academic center of expertise for applied fish health research, operated entirely on external funding. The Centre continues to work with various groups in Atlantic Canada on a range of research projects, while also leading the activities of an OIE Collaborating Centre on Epidemiology & Risk Assessment of Aquatic Animal Diseases (ERAAAD).

### **2.3.1. Fish-iTrends Database Management**

This ongoing sea lice data management project, with three industry associations (ACFFA, NAIA, AANS) and involving Matt Sanford (Programmer) and Holly Burnley (Project Manager), continues to adjust to developments in the salmon aquaculture industry. All sites in NB, NS and NL are part of the FiT database. Non-chemical controls (e.g. mechanical and warm water methods) for lice removal in the aquaculture

industry are now part of the recording system. Records have been designed for synthesizing biological controls (i.e. cleaner fish).

A major undertaking over the last two years has been the upgrading of the software used on the [fishitrends.com](http://fishitrends.com) website. The site now offers better stability, security and increased performance. As a result, we are upgrading over 30 web pages and reports that require significant changes to make them compatible. We also take this opportunity to enhance the functionality of some aspects of this system to provide better analysis and improved user experience. The system provides the basis for OFI research on sea lice infestation on the East Coast, e.g. by Drs. Adel Elghafghuf and Marianne Parent (Section 2.2).

### **2.3.2. Infectious Salmon Anaemia Virus (ISAv) Strain Evaluation**

This project began late in 2020 and will continue into 2021. It will compare the fish level apparent prevalence of Infectious Salmon Anaemia virus (ISAv) between two NL marine cage sites considered to be infected with two different genotypes of the virus, and will further evaluate the different strains of ISAv found in samples collected from fish at two marine cage sites within the same Bay Management Area. Our team is working with Aquatic Animal Health Division of the NL Department of Fisheries, Forestry and Agriculture (NL FFA) to compile an extensive collection of retrospective ISAv diagnostic test (PCR, IFAT and cell culture) data available for 2020, with completion of further genotyping on selected samples. Apparent prevalence and molecular differences among the detected genotypes will be compared.

Another project with NL FFA evaluated the virulence and pathogenicity of ISAv in NL using diagnostic test results from 2012 to 2019. Our team compiled retrospective ISAv diagnostic test (qRT-PCR, IFAT and cell culture) results to investigate the relationship between qRT-PCR results and other testing methods (e.g. IFAT, cell culture), including the spatio-temporal pattern of pathogenic and non-pathogenic ISAv genotype detections.

### **2.3.3. Student Externships**

The primary focus in recent years in this collaboration with NL FFA has been on 4th year DVM students who undertake a 2-3 week clinical externship as part of their rotation schedule, in which students are mentored by NL FFA aquaculture veterinarians. COVID-19 prevented students from traveling to NL in 2020, but a veterinary student was engaged in research activities during the summer of 2019. We are hopeful that 2021 will see students return to NL for participation in external rotations.

### **2.3.4. International Efforts**

- ***OIE Collaborating Centre (ERAAAD)*** – Larry Hammell has been involved in several activities related to the Collaborating Centre, primarily focused on Code and Manual chapter review and revisions associated with diagnostic testing and surveillance for various aquaculture pathogens.
- ***IDH Sustainable Trade projects*** – AVC-CAHS has worked with IDH for the past few years and currently partners with them and two companies in Indonesia to work on expanding their capacity to utilize health and productivity data collected on shrimp and fish farms for predictive

models. Dr. Krishna Thakur and three postdoctoral fellows have been working on this during 2019-20, and some of the activities will continue into 2021.

## **2.4. Dairy Research Groups – By Dr. J McClure**

There are four major research projects, of which three are funded by the CBMRN Dairy Research Cluster 3 (DCF3) program, including the AVC node of the CaDNetASR network (Section 2.8).

### **2.4.1. Calf Longevity Project**

This DCF3 funded project has been active at UPEI since 2019 under the supervision of Drs. J McClure and Greg Keefe. The project involves collaborations with McGill University, Lactanet, and the Centre of Genetic Improvement of Livestock. The project aims to investigate the associations between calf genomics, calf health and calf management on the cows' adult productivity, longevity and welfare. Two PhD students, Gabriel Dallago (McGill University) and Elizah McFarland (UPEI), are carrying out the study at both calf and herd levels. At UPEI, analysis has begun on calf-level data collected from 2014-2015 in the New Brunswick Genome Project. At herd level, distribution of surveys about herd management and veterinary practices is currently underway to Quebec and New Brunswick producers. The distribution is planned to be completed by May 2021.

### **2.4.2. Detection of $\beta$ -lactam resistance in *Staphylococcus aureus* bovine mammary isolates**

Using well-defined susceptible and resistant *S. aureus* mastitis isolates from previous research, we can develop a matrix assisted laser desorption ionisation time-of-flight (MALDI-TOF)  $\beta$ -lactamase assay for rapid, cost effective and accurate determination of  $\beta$ -lactam resistance of *S. aureus* isolates. We have developed the assay, processed half of the isolates, and identified a specific peak associated with  $\beta$ -lactamase production. We are currently working on developing algorithms to identify any type of  $\beta$ -lactam resistance from the lysate pellet. This methodology can be extended to determine  $\beta$ -lactam resistance in other mastitis associated bacteria (e.g. *S. uberis*, *S. dysgalactiae*, *E.coli*, and *Klebsiella spp*). This work is being done by Drs. Ibrahim Elsohaby, Greg Keefe and J McClure and is supported by DCF3.

### **2.4.3. Atlantic Healthy Herds II**

Atlantic Health Herds (AHH) is an integrated research program, advancing infectious disease control and biosecurity for the Atlantic Canadian dairy industry. In this second phase (AHH-Phase 2), we focus on surveillance methods for Johne's disease (JD), bovine viral diarrhoea (BVD), and bovine leukemia virus (BLV). These three infectious diseases were identified, in consultation with the regional dairy boards, as priorities for control and prevention. The overall aim of this program is to further develop surveillance methods that will improve on diagnostic sensitivity to better identify and quantify infections within affected herds. Current projects include the continual surveillance programs for JD and BLV on dairy farms in the Maritimes. For BVD, we are also investigating the potential of detecting BVD from feed bunk swabs collected on farms using a PCR assay. For BLV, we have enrolled 32 farms to participate in a BLV proviral load (PVL) study, where individual BLV testing is performed on all cows and bred heifers. The PVL is measured on the BLV-positive animals. Producers will be encouraged to either cull or segregate animals with a high BLV PVL in an effort to reduce transmission of BLV to naïve animals.

Funding for this project is from the Canadian Agriculture Partnership provincial funds from Nova Scotia, New Brunswick, and Prince Edward Island.

## **2.5. Sir James Dunn Animal Welfare Centre (SJDAWC) – by Dr. Kathryn Proudfoot**

The SJDAWC promotes animal welfare through research, service and education. Over the past two years, research grants were awarded for the following projects:



### **2019**

- Ultrasonic vocalizations: A non-invasive ethologically relevant tool to assess home cage welfare in rats (P Bernard)
- Anthelmintic resistant cyathostomes: A threat to equine welfare on Prince Edward Island (WB Stoughton, M Neilsen)
- Development of an equine nasogastric intubation simulator as an aid or alternative to the use of animals in teaching (WB Stoughton, N Bressan)

### **2020**

- Assessment and prevention of pain related to udder engorgement in dairy cows (S McKenna, K Proudfoot, G Keefe, A Muckle, P Gamester)
- Working donkey welfare assessment and owner education in Meru County, Kenya – pilot (M Mellish)
- Understanding the natural behavior and stress response of newborn dairy calves (K Proudfoot, S McKenna, R Meagher, M Gordon)
- Prevention of bovine mastitis through a combination of cow comfort and mastitis interventions on small holder dairy farms in Kenya (J VanLeeuwen, L Heider, G Keefe, S McKenna, E Kariuki, G Gitau)

Several graduate students and veterinary summer research students were funded through these projects. In addition, the 2019 Sir James Dunn Animal Welfare Graduate Scholarship was awarded to three students: 1) Logan Bigelow (two-year funding towards PhD program) to work with P Bernard on the project “Ultrasonic vocalizations analysis: A non-invasive ethologically relevant tool to assess home cage welfare in rats”, 2) Mariana Fonseca (three-year funding towards PhD program) to work with J Sanchez and L Heider on the project “Assessment of antimicrobial stewardship on animal welfare, animal health, and antimicrobial resistance on dairy farms”, and 3) Madeline Stein (two-year funding towards MSc program) to work with M Evason and J McClure on the project “Evaluation of pet-owner and veterinary knowledge, attitudes and practices for companion animals in Canada.”.

Funding was also awarded for several service projects through which investigators work with community groups to provide direct services to animals.

- Medical and surgical care of homeless animals (P Moak, P Foley, R MacDonald, H Gunn McQuillan, M MacLean);



- Youth training in animal welfare in Kenya and Canada-Part 4 (J VanLeeuwen, S Richards);
- AVC humane dog training program (AM Carey);
- Financial aid for spay or neuter of companion animals of owners on fixed income (P Foley);
- Neutering feral cats on PEI (P Foley);
- AVC Wildlife Clinical Service (L Cusack);
- Improving animal health and welfare of pets in remote northern Canadian communities (J VanLeeuwen, C Gilroy, M Hopson, S Kutz, M Tuma).

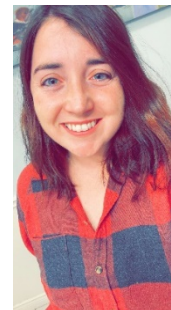
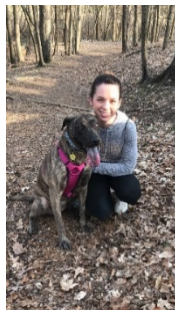


The graduate students funded through the SJDAWC (in whole or in part) defended their degrees in 2020: Anam Hanza (MSc), Peter Kimeli (PhD), and Jamye Rouette (MSc).

**Graduate Student: Peter Kimeli**

The SJDAWC's annual Animal Welfare in Practice Symposium was on dairy cow welfare assessment in 2019 and there was no conference in 2020 due to COVID-19. The SJDAWC's 2019 winter webinar series and 2020 fall webinar series were given by Dr. Karen L Overall and both focused on companion animal behaviour and welfare.

In collaboration with the AVC Animal Welfare Club, the SJDAWC awarded five grants in 2019 and two grants in 2020 to support students who were pursuing external rotations related to animal welfare, and assisted five students in 2019 and three students in 2020 to participate in the annual Intercollegiate Animal Welfare Assessment Contest. The AVC Animal Welfare club hosted or co-hosted several lectures including: maternal behaviour in dairy cows; declawing in cats; reptile husbandry laboratory animal medicine; clicker training for the AVC teaching beagles; and the role of veterinarians in cat and wildlife welfare.



**AVC's 2020 Animal Welfare Judging Team. From Left to Right: Lindsey Bailey, Nima Morady & Karen Yetmen**

Further details on all activities (including graduate students, publications and presentations) can be found in the [SJDAWC 2019 and 2020 Annual Reports](#).

## **2.6. Shellfish Research Group (SRG) – by Dr. Jeff Davidson**

Projects in 2019-20 included investigating decreased mussel productivity on PEI mussel farms; the effects and mitigation of invasive species on oyster growing gear; determining the effect of Hurricane Dorian on the shellfish aquaculture industry; conducting clinical trials to mitigate the presence of invasive species on mussel socks and collectors; and assessing the effect of oyster seed enhancement on public fishing grounds on PEI.



**Mussel culture**



**Mussel seed in sock**

Dr. Jeff Davidson was on the organizing committee for and also attended the AquaEpi II conference (Section 7.5), and was a peer reviewer for the Monterey Bay's Seafood Watch Farmed Mussel report.

In December 2019, Dr. Sonja Saksida joined the Department of Health Management as Assistant Professor in Aquatic Population Health. Although her primary focus will be on finfish, she will also contribute to the shellfish sector.

## **2.7. Smallholder Dairy Research Group (SDRG) – by Dr. John VanLeeuwen**

The Smallholder Dairy Research Group (SDRG) has a dairy research, teaching and service program involving AVC faculty members, graduate students in epidemiology, veterinarians, veterinary students and other animal health professionals, along with smallholder dairy farmers. The SDRG collaborates with researchers and students in family science and human nutrition due to the spin-off benefits to farm families from more milk production. The program has been a result of partnerships among UPEI and five other universities (University of Nairobi and Kenyatta University in Kenya, Kasetsart University in Thailand, and University of Antioquia and University of Nariño in Colombia), two Canadian non-governmental organizations (NGOs): Farmers Helping Farmers (FHF) and Veterinarians without Borders Canada (VWB), and dairy farmer groups. Research topics have included 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.

In 2019, the SDRG finished the 4-year \$1.2M interdisciplinary project funded by the Community Foundations of Canada (CFC). There were 6 graduate students involved in that project, and 14 UPEI student interns (8 veterinary students and 6 nutrition students), along with many UPEI professors. The dairy research activities in that project focused on dairy cow reproduction, nutrition and comfort. Dr. Dennis Makau received the Governor General's award for best PhD thesis at UPEI in 2019.



In late 2018, Phase 2 of this project started with another 4 years of funding (\$0.75M) for research, teaching and service involving smallholder dairy farmers in central Kenya through the Queen Elizabeth II Diamond Jubilee Scholarships program. This second phase has another 3 Kenyans coming to UPEI for a Ph.D. and 2 M.Sc. degrees, and another 13 UPEI veterinary and nutrition undergraduate students going to Kenya for three-month internships. Topics researched in Phase 2 include mastitis control (MSc student

Edward Kariuki), bovine viral diarrhea virus control (PhD student Daniel Muasya), and enhanced nutrition of farm families and school-aged children (MSc student Julie Oyoo). COVID-19 interrupted their research projects for a number of months, and complicated the field supervision processes, but their projects should be completed in 2021 or early 2022.

In August 2020, Peter Kimeli successfully defended his PhD thesis on calf comfort management, funded by SJDAWC. There was also another Kenyan graduate student registered at Nairobi University who piggybacked onto Peter Kimeli's project with a dry cow antibiotic and teat sealant trial. Smallholder dairy farm projects were completed by graduate students in Thailand (enhancing reproduction under heat stress) and Colombia (frequency and factors of ketosis and sub-acute ruminal acidosis in post-partum cows) in the last two years.



During 2019-20, there was another VWB student internship group of 3 pre-clinical veterinary students providing knowledge translation training and services to animal health professionals and smallholder dairy farmers in Kenya. Also, in partnership with FHF, there were two more groups of 3 UPEI senior veterinary students and 6 Nairobi senior veterinary students providing knowledge translation training and services in 2019 and 2020 to animal health professionals and smallholder dairy farmers in Kenya. In 2019, there was another student internship group of 4 veterinary and human nutrition students providing training and services to animal health professionals, farmers and/or schools in Kenya; however, summer 2020 did not see any Canadian interns volunteer their time in Kenya due to COVID-19.

The partnerships with the two Canadian NGOs have provided helpful additional human resources for the Kenyan activities of the SDRG, but the partnerships have also been good for these NGOs. Based partly on the successful research, teaching and service activities of the SDRG in Kenya, VWB now has a 7-year \$9M project funded by Global Affairs Canada in six countries: Kenya, Ghana and Senegal in Africa, and Laos,

Vietnam and Cambodia in SE Asia. Also partly based on its successful partnership with the SDRG, FHF now has a 4-year \$1.7M project in Kenya, also funded by Global Affairs Canada. Furthermore, the SDRG partnership with Nairobi University has enabled that university to secure major new research funding to research East Coast Fever and other infectious diseases that affect the smallholder dairy farming industry in Kenya. It is encouraging to see the many direct and indirect benefits of the SDRG to the partners involved, and we look forward to the continued fruits of these partnerships in the future.

## **2.8. Antimicrobial Resistance and Risk Analysis Groups – by Dr. Javier Sanchez**

The AMR group collaborates with Canada's four other veterinary colleges within the Canadian Dairy Network for Antimicrobial Stewardship and Resistance (CaDNetASR). This 5-year project, ending in March 2023, involves annual sampling and testing in the selected farms across five provinces. The CaDNetASR program has 6 PhD, 2 MSc, and 5 undergraduate students working on different projects related to surveillance and stewardship of antimicrobial usage and resistance. This component includes the potential use of genomic data to monitor antimicrobial resistance. The stewardship component involves aspects of calf health, periparturient diseases in dairy cows, and animal welfare. The AVC node of the CaDNetASR network is led by Drs. J. Sanchez and Luke Heider, and involves three UPEI graduate students involved with the project: PhD students Mariana Fonseca and Ana Soffia Jaramillo, and MSc student Landon Warder. A primary task during the last year has been the development of an automated process to quantify antimicrobial usage using dispensing records from veterinary clinics.

The Risk Analysis group is engaged in diverse fields. First, the group became involved in COVID-19 related activities at local and national levels: participated in biweekly meetings with Health PEI, and supported the local Chief Public Health Office with model projections; participated in weekly meetings of the PHAC External Modeling group; participated in seminar presentations for AARMS (Atlantic Association for Research in Mathematical Sciences); and participated in three large NSERC network proposals related to emerging infectious disease modeling using a One Health approach. The group was also actively involved in obtaining funding for a 6-month COVID-19 project to develop an information system and disease model for a region in Colombia, with colleagues from Universidad de Caldas (Columbia), Universidad Austral de Chile, and the National Institute for Agriculture Research from Barcelona, Spain.

Second, a project on a risk analysis framework for sea lice tolerance to freshwater treatment was completed with two published papers, with the participation of Drs. Emilie Laurin, Crawford Revie, Maya Groner and Marit Stormoen (Norway). Third, the group is collaborating with the International Livestock Research Institute (ILRI) on a project related to food safety: an exposure assessment is being conducted for health risks associated with the consumption of aflatoxin M1 through milk in dairy farms in Burkina Faso. A PhD student at the University of Bern and a researcher at ILRI are working on this project. Finally, the group started to work with PHAC's Risk and Capability Assessment Unit to develop a standard risk prioritization approach for health-related threats. A working group was established with members from three academic institutions from Canada, a government organization from the UK, and different PHAC offices.

## **2.9. Veterinary Epidemiology and Social Science for Animals (VESSA) Group – by Dr. Caroline Ritter**

The VESSA group was initiated in June 2020 when Dr. Ritter started her position as Canada Research Chair and Assistant Professor within CVER. Funding received from the John R. Evans Leaders Fund (JELF) will allow for renovations of a lab space and acquirement of necessary equipment. Research of the VESSA group will link epidemiology and social sciences using quantitative and qualitative methods. Specifically, the aim of the group is to improve animal health and welfare by accounting for the “human factor” that affects how animals are cared for. First projects are on dairy producers’ decision-making regarding antimicrobial use, in collaboration with the Risk Analysis Group, and assessment of horse owners’ motivators and barriers to improve horse welfare in PEI (in collaboration with the Sir James Dunn Animal Welfare Center).

## **2.10. Other Activities**

### **2.10.1. ISVEE 2022 – by Dr. Javier Sanchez**

ISVEE 16 was postponed for one year due to the COVID-19 pandemic, now to be held 7-12 August 2022 in Halifax, and with the AVC to host the post-conference workshops. Most of the plans for the conference are not affected by the postponement, but we aim to include novel options for virtual access and participation. CVER members are strongly involved in the planning of the conference as members of the Local Organizing Committee.

### **2.10.2. Projects Related to Antimicrobial Resistance – by Dr. J McClure**

Several projects on companion animal AMU/AMR are carried out in collaboration with Drs. Jason Stull, Michelle Evason and Matt Saab. One project is on methicillin resistant *Staphylococcus pseudintermedius* (MRSP) in dogs in Atlantic Canada over a period of 11 years (MSc student Ashlynn Webster). Another project is on attitudes, knowledge and influences of AMR and antimicrobial choices by dog and cat owners (MSc student Madeleine Stein).

Additionally, Dr. Aimie Doyle leads work with J. McClure and M. Saab on alcohol-based antiseptics for preparation of skin prior to surgical procedures, and a survey of equine parasitism on PEI, while looking for evidence of resistance to parasites, is led by Dr. Ben Stoughton (MVSc student Amanda Butler).

## **3. New CVER Team Members**



**Dr. Caroline Ritter** joined CVER in June 2020 as an Assistant Professor and Canada Research Chair. She received a DVM from the Tierärztliche Hochschule Hannover (Germany) in 2012 and a PhD from the Department of Production Animal Health at the University of Calgary in 2018. Caroline then joined the Animal Welfare Program (University of British Columbia) as a Banting Postdoctoral Fellow (2018-2020). Her aim is to grow the VESSA group while focusing on understanding ‘why’ and ‘how’ animal owners and guardians make certain decisions related to their animals, and how they can best be supported to improve animal health and welfare.





**Dr. Sonja Saksida** (BSc, DVM, MSc) joined the Department of Health Management as an Assistant Professor in December 2019. Sonja received her DVM in 1992 and her MSc in Population Medicine in 1995 both from the Ontario Veterinary College in Guelph, Ontario. She brings to the department over 25 years of experience in aquatic animal health which includes clinical finfish veterinary medicine, regulatory medicine, and applied disease research. Her interests lie in understanding and controlling disease and ensuring fish health management practices remain environmentally sustainable, prudent antibiotic use, wild-farmed species interaction and welfare.



**Dr. Katy Proudfoot** joined AVC as Director, SJDAWC, and Associate Professor, cross-appointed to the Departments of Health Management and Companion Animals, in October 2019. After completing her MSc and PhD at the University of British Columbia's Animal Welfare Program, Dr. Proudfoot was a faculty member at the Ohio State University's College of Veterinary Medicine. Her research focuses on the behaviour and welfare of dairy cattle, with a specific emphasis on understanding maternal behavior of cows before giving birth. She is also interested in creating sustainable solutions to surplus male calves from the dairy industry, and in conducting scholarly work around teaching animal welfare to veterinary students.

## 4. Guests

### 4.1. Visiting Professors

- **Professor Ane Nødtvedt**: a former graduate from AVC and now Professor in the Department of Production Animal Clinical Sciences, Faculty of Veterinary Medicine, Norwegian University of Life Sciences, visited CVER several times during the winter and spring of 2019, as part of a sabbatical leave from her home university, for collaborations with Dr. Javier Sanchez, discussions with the group and presenting a CVER Research Seminar (Section 7.2).

### 4.2. Visiting Graduate Students

- **Tanyanant Kaminsonsakul** – an exchange student from Kasetsart University in Thailand, taking epidemiology courses and analyzing swine farm connectivity data from August to December 2020 at CVER, supported by Canada-ASEAN Scholarships and Educational Exchanges for Development program, under the supervision of Krishna Thakur;
- **Passawat Thammahakin** – from Kasetsart University in Thailand, taking epidemiology courses and doing research from January to June 2020 at CVER under the supervision of Javier Sanchez;
- **Thitiwich Changtes** – from Kasetsart University in Thailand, taking epidemiology courses and doing research from January to June 2020 at CVER under the supervision of Javier Sanchez;
- **Monica Cecilia Miraballes** – from the National Institute of Agricultural Research in Uruguay, working on research with Javier Sanchez at CVER for 4 months starting from September 2019;

- **Ezekiel Omoshaba** – from the University of Agriculture, Abeokuta in Nigeria, working with J McClure at CVER for one year starting from March 2019 on research aspects of his PhD project on Methicillin-resistant *Staphylococcus aureus* (MRSA);
- **Ana María Colonia** – from the Universidad de Caldas, Colombia, doing research from January to May 2019 at CVER under the supervision of Javier Sanchez.

## 5. Awards and Recognition



**Dr. Dennis Makau** (supervisor: Dr John VanLeeuwen) received the Governor General's award for best PhD thesis at the UPEI Convocation Ceremony in May 2019. His thesis was entitled "Enhancing productivity and livelihoods of smallholder dairy farmers in Kenya through agroforestry and cellphone-mediated training."



**Dr. Nora Biermann** (supervisors: Drs Aimie Dyle and J McClure) received the Governor General's award for best PhD thesis in 2020. Her thesis title is "Investigation into various risk factors associated with surgical site infection in large animals."



**Dr. John VanLeeuwen** won the UPEI Faculty Association Merit Award of Scholarly Achievement in 2020. The award is given to faculty members who possess clear evidence of significant scholarly achievements in their field of study in the last five years. John had 52 abstracts in conference proceedings and 46 peer-reviewed journal articles accepted and/or published. John also was primary supervisor for 14 graduate students and helped supervise 9 other graduate students in the last 5 years.



**Dr. Omid Nekouei** (a CERC post-doctoral fellow) received the first Poster Prize at the second Aquatic Epidemiology Conference in Hua Hin, Thailand in November 2020.

## 6. Graduate Program Highlights

- **Danielle Burnett** – successfully defended her PhD thesis under the supervision of Drs. Jon Grant and Crawford Revie. Her thesis was entitled "Modeling sea lice dispersal from salmon farms in the Broughton Archipelago, British Columbia, Canada".
- **Dennis Makau** – successfully defended his PhD thesis under the supervision of Dr. John VanLeeuwen. His thesis was entitled "Enhancing productivity and livelihoods of smallholder dairy farmers in Kenya through agroforestry and cellphone-mediated training".

- **Emily John** – successfully defended her PhD thesis under the supervision of Drs. J. McClure and Maggie Cameron. Her thesis was entitled “Surveillance and control of Enzootic Bovine Leukosis in Atlantic Canada”.
- **Jamye Rouette** – successfully defended her MSc thesis under the supervision of Drs. Kathleen MacMillan, Michael Cockram and Javier Sanchez. Her thesis was entitled “Epidemiology of Musculoskeletal Injuries in Standardbred Racehorses on Prince Edward Island”.
- **Joan Muraya** – successfully defended her PhD thesis under the supervision of Dr. John VanLeeuwen. Her thesis was entitled “Improving productivity and reproductive efficiency of smallholder dairy cows in Kenya”.
- **Maureen Anderson** – successfully defended her PhD thesis under the supervision of Drs. Crawford Revie and Cory Neudorf. Her thesis was entitled “High-cost health care users in Saskatchewan: A population health perspective”.
- **Nora Biermann** – successfully defended her PhD thesis under the supervision of Drs. Aimie Doyle and J. McClure. Her thesis was entitled “Investigation into various risk factors associated with surgical site infection in large animals”.
- **Peter Kimeli** – Successfully defended his PhD thesis under the supervision of Dr. John VanLeeuwen. His thesis was entitled “Determinants and improvements of calf welfare status on smallholder dairy farms in Kenya”.
- **Anna J. Potter** – Started an MSc in Health Management. Supervised by Drs. Bronwyn Crane and John VanLeeuwen.
- **Ana Soffia Jaramillo** – Started a PhD in Epidemiology. Supervised by Dr. Javier Sanchez.
- **Edward Kariuki Nganga** – started an MSc in Epidemiology. Supervised by Dr. John VanLeeuwen.
- **Elizah D. McFarland** – started a PhD in Epidemiology. Supervised by Drs. J. McClure and Greg Keefe.
- **João Romero** – Started a PhD in Epidemiology. Supervised by Drs. Krishna Thakur & Ian Gardner.
- **Landon M. Warder** – started an MSc in Epidemiology. Supervised by Drs. Javier Sanchez and Luke Heider.
- **Madeleine Stein** – started an MSc in Small Animal Medicine. Supervised by Drs. Michelle Evason and J. McClure.
- **Mariana Fonseca** – started a PhD in Epidemiology. Supervised by Drs. Javier Sanchez and Luke Heider.
- **Paige Gamester** – started a PhD in Health Management. Supervised by Shawn MaKenna.
- **Rasaq Ojasanya** – started an MSc in Epidemiology. Supervised by Dr. Krishna Thakur.
- **Simon Bourassi** – started an MSc in Health Management. Supervised by Dr. J. McClure.
- **Svenja Köpper** – started a PhD in Epidemiology. Supervised by Krishna Thakur & Crawford Revie.



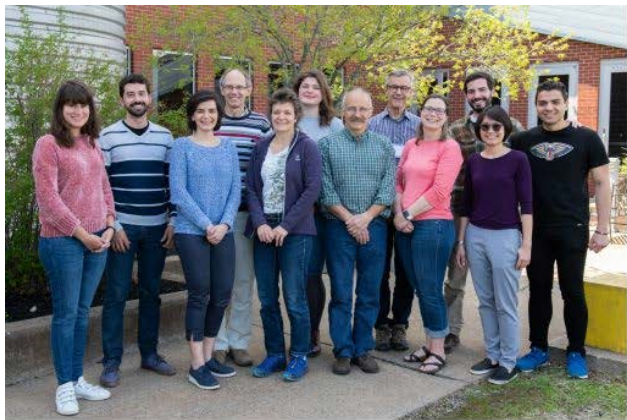
## 7. Outreach

This section describes some examples of outreach initiatives.

### 7.1. Epi on the Island

CVER hosted its annual Epi on the Island Summer Courses in June 2019 and August 2020. There were two 5-day summer courses in 2019 and one two-week summer course in 2020.

The first 5-day course in 2019, “Survival Analysis”, from Jun 3 to 7, was held at the AVC and had ten participants from China, Finland and across Canada. The course was instructed by Drs. Ian Dohoo and Henrik Stryhn of the AVC. The second 5-day course, “Applied Course in Quantitative Risk Modelling for Animal Health and Food Safety”, from Jun 24 to 28, was also held at the AVC. Thirteen participants were from Finland, Netherlands, Switzerland, USA and across Canada. The course was instructed by Drs. Håkan Vigre from National Food Institute at Technical University of Denmark, and Javier Sanchez of the AVC.



Epi on the Island 2019 – Survival Analysis



EOTI 2019 – Applied Course in Quantitative Risk Modelling

In 2020, due to COVID-19, the scheduled three Epi on the Island 2020 summer courses were reduced to one: Introduction to Multilevel Modelling, instructed by Drs. Ian Dohoo and Henrik Stryhn of the AVC. The course was held from Aug 17 to 28 with both in-class and online participation, where the former was restricted to local participants and a limitation was set for the number of online participants. In total, 17 participants from Australia, Ethiopia, Japan, Kenya, South Africa, the USA and across Canada took part in the course.

### 7.2. CVER Research Seminars

No CVER research seminars could be held in 2020, due to COVID-19, but in 2019 the following research seminars were organized:

- “Mediation Analysis – Dealing with Intervening Variables”, by Drs. Ian Dohoo and Javier Sanchez on October 10, 2019;
- “Controlling Respiratory Disease through Biosecurity Measures” by Dr. Ane Nødtvedt on June 17, 2019. Dr. Nødtvedt visited CVER during the winter and spring of 2019;

- “Ambient Light at Night and Breast Cancer Risk: A Case-Control Study in Canada” by Dr. Michael McIsaac on April 18, 2019. Dr. McIsaac is an Associate Professor at the School of Mathematical and Computational Sciences, UPEI.

### 7.3. International Teaching

- Drs. Larry Hammell and Krishna Thakur, along with CVER postdocs, Drs. Thitiwan Patanasatienkul and Marina Delphino, delivered a training program on Epidemiological analysis to shrimp industry data scientists in South East Asia in July 2020;
- During 2019-20, Dr. Ian Dohoo was engaged in several teaching and consultation activities outside UPEI:
  - Evaluation of measurement scales – Test run of an on-line course with just 3 participants done over 3 months in 2020;
  - Provided the course – Introduction to Multilevel Modelling in Norway over 7 days in 2019, with over 30 participants;
  - Consulted (remotely) with Dr. Knut Vollset on a meta-analysis of effect of PIT tagging in salmon research in Norway/PEI;
  - Continuation of working with ILRI in Nairobi Kenya (from 2015 – 2021) – Consulted on a variety of research projects each year, on site and on-line.



Multilevel Modelling course in Norway – 2019



ILRI in Ethiopia in November 2019

### 7.4. Training veterinarians, veterinary students and technicians, farmers and schools in Kenya

- UPEI and Farmers Helping Farmers continued to implement their 4-year second phase of the training program in central Kenya. The project provides scholarships to 3 Kenyans to come to UPEI for graduate student training (see Section 2.7 for details), conduct a research project in Kenya, and coordinate knowledge translation activities that include conventional scientific methods

(conferences and journal articles) along with training within the communities where the research was conducted.

- In 2019, there were 2 veterinary students providing training and services to animal health professionals and smallholder dairy farmers in Naari and Buuri, Kenya. They were accompanied by 2 human nutrition students who provided training to farmers and schools. They were first supervised by UPEI professors for the first 3 weeks of their 3-month summer internships, and by Kenyan professors and graduate students for the remainder of their internships in Kenya. Unfortunately, in summer 2020, no UPEI interns were able to go to Kenya due to COVID-19.

## 7.5. AquaEpi II Conference



The 2nd International Scientific Conference in Aquatic Animal Epidemiology was held November 4-6, 2019 in Hua Hin, Thailand. Current and former CVER members who attended the conference from left to right: Drs. Omid Nekouei, Annette Boerlage, Beibei Jia, Larry Hammell, Thitiwan Patanasatienkul, Nicole O'Brien, Jaewoon Jeong, Derek Price, Ian Gardner, Marina Delphino, Krishna Thakur, and Jeff Davidson.

## 8. Peer-Reviewed Journal Publications

The list includes publications accepted in 2020, even if published in 2021 (or later).

1. Akinkuotu, O. A., Takeet, M. I., Otesile, E. B., Olufemi, F., Greenwood, S. J., & McClure, J. T. (2019). Prevalence and mulilocus genotypes of *Giardia duodenalis* infecting pigs in Ogun state, Nigeria. *Infection, Genetics and Evolution*, 70, 53-60.
2. Akinkuotu, O. A., Takeet, M. I., Otesile, E. B., Olufemi, F., Greenwood, S. J., & McClure, J. T. (2019). Multi-locus genotyping and phylogenetic analyses of *giardia intestinalis* isolates from indigenous goats in Ogun state, Nigeria. *Acta Tropica*, 195, 15-22.
3. Aldrin, M., Jansen, P. A., & Stryhn, H. (2019). A partly stage-structured model for the abundance of salmon lice in salmonid farms. *Epidemics*, 26, 9-22.

4. Anderson, M. E. C., Stull, J. W., & Weese, J. S. (2019). Impact of dog transport on high-risk infectious diseases. *Veterinary Clinics of North America: Small Animal Practice*, 49(4), 615-627.
5. Anderson, M., Revie, C.W., Stryhn, H., Neudorf, C., Rosehart, Y., Li, W., Osman, M., Buckeridge, D.L., Rosella, L.C., Wodchis, W.P., 2019. Defining 'actionable' high-cost health care use: results using the Canadian Institute for Health Information population grouping methodology. *International journal for equity in health* 18, 1–14.
6. Arai, S., Rist, P., Clancey, N., Gilroy, C., Stryhn, H., & Amsellem, P. (2019). Fine-needle aspiration of cutaneous, subcutaneous, and intracavitary masses in dogs and cats using 22- vs 25-gauge needles. *Veterinary Clinical Pathology*, 48(2), 287-292.
7. Awosile, B., Reyes-Velez, J., Cuesta-Astroz, Y., Rodríguez-Lecompte, J. C., Saab, M. E., Heider, L. C., Keefe, G., Sánchez, J., McClure, J. T. (2020). Short communication: Whole-genome sequence analysis of 4 fecal bla<sub>CMY-2</sub>-producing *Escherichia coli* isolates from Holstein dairy calves. *Journal of Dairy Science*, 103(1), 877-883.
8. Badger, S., Abraham, S., Stryhn, H., Trott, D. J., Jordan, D., & Caraguel, C. G. B. (2019). Intra- and inter-laboratory agreement of the disc diffusion assay for assessing antimicrobial susceptibility of porcine *Escherichia coli*. *Preventive Veterinary Medicine*, 172, 104782.
9. Beaver, A., Proudfoot, K. L., & Von Keyserlingk, M. A. G. (2020). Symposium review: Considerations for the future of dairy cattle housing: An animal welfare perspective. *Journal of Dairy science*, 103(6), 5746-5758.
10. Biermann, N. M., McClure, J. T., & Doyle, A. J. (2020). Letter to the Editor: Response to letter regarding: Prospective, randomised clinical trial of four different pre-surgical hand antiseptic techniques in equine surgery. *Equine Veterinary Journal*, 52(1), 158-159.
11. Biermann, N. M., McClure, J. T., Sanchez, J., Saab, M., & Doyle, A. J. (2019). Prospective, randomised clinical trial of four different pre-surgical hand antiseptic techniques in equine surgery. *Equine Veterinary Journal*, 51(5), 600-605.
12. Beyene, T.J., Fitzpatrick, M.C., Galvani, A.P., Mourits, M.C., Revie, C.W., Cernicchiaro, N., Sanderson, M.W., Hogeveen, H., 2019. Impact of One-Health framework on vaccination cost-effectiveness: A case study of rabies in Ethiopia. *One Health* 8, 100103.
13. Boerlage, A. S., Stryhn, H., Armstrong, B., & Hammell, K. L. (2019). 2-stage hierarchical interrupted time-series analysis to quantify the long-term effect of subclinical bacterial kidney disease on performance of farmed Atlantic salmon (*Salmo salar* L.). *Preventive Veterinary Medicine*, 172, 104776.
14. Cantrell, D., Filgueira, R., Revie, C.W., Rees, E.E., Vanderstichel, R., Guo, M., Foreman, M.G., Wan, D., Grant, J., 2020. The relevance of larval biology on spatiotemporal patterns of pathogen connectivity among open-marine salmon farms. *Canadian Journal of Fisheries and Aquatic Sciences* 77, 505–519.
15. Cantrell, D.L., Groner, M.L., Ben-Horin, T., Grant, J., Revie, C.W., 2020. Modeling pathogen dispersal in marine fish and shellfish. *Trends in parasitology* 36, 239–249.



16. Cantrell, D.L., Vanderstichel, R., Grant, J., Filgueira, R., Revie, C.W., 2021. Validation of a sea lice dispersal model: principles from ecological agent-based models applied to aquatic epidemiology. *Aquaculture Environment Interactions*.
17. Cobo-Angel, C. G., Jaramillo-Jaramillo, A. S., Palacio-Aguilera, M., Jurado-Vargas, L., Calvo-Villegas, E. A., Ospina-Loaiza, D. A., ..., Sanchez, J., ..., Ceballos-Marquez, A. (2019). Potential group B *Streptococcus* interspecies transmission between cattle and people in Colombian dairy farms. *Scientific Reports*, 9(1).
18. Cockram, M. S. (2019). Fitness of animals for transport to slaughter. *Canadian Veterinary Journal* 60(4), 423-429.
19. Cockram, M. S., Dulal, K. J., Mohamed, R. A., & Revie, C. W. (2019). Risk factors for bruising and mortality of broilers during manual handling, module loading, transport and lairage. *Canadian Journal of Animal Science*, 99(1), 50-65.
20. Cockram, M.S., Dulal, K.J., Stryhn, H., Revie, C.W., 2020. Rearing and handling injuries in broiler chickens and risk factors for wing injuries during loading. *Canadian Journal of Animal Science* 100, 402–410.
21. Cramer, C., Proudfoot, K., & Ollivett, T. (2020). Automated feeding behaviors associated with subclinical respiratory disease in preweaned dairy calves. *Animals*, 10(6), 988.
22. Creutzinger, K. C., & Proudfoot, K. L. (2020). Design and management of group maternity areas for dairy cows. *Applied Animal Science*, 36(1), 124-132.
23. Deikun, L. L., Habing, G. G., Quigley, J. D., & Proudfoot, K. L. (2020). Health and growth of veal calves provided a fatty acid supplement and a dry teat. *Journal of Dairy Science*, 103(5), 4633-4642.
24. Delphino MK, Barone RF, Leal CA, Figueiredo HC, Gardner IA, Gonçalves VSP. Economic appraisal of vaccination against *Streptococcus agalactiae* in Nile tilapia farms in Brazil. *Preventive Veterinary Medicine*. 2019; 162:131-135.
25. Delphino, M. K, Mardones, F. O., Neumann, J., Gallardo, A., Jimenez, D., Peña, A., Rozas-Serri, M., Gardner, I. A. Cost-effectiveness of longitudinal surveillance for *Piscirickettsia salmonis* using qPCR in Atlantic salmon farms in Chile. *Journal of Fish Diseases*. 2020.
26. DeMone, C., Hwang, M. -H., Feng, Z., McClure, J. T., Greenwood, S. J., Fung, R., ... Shapiro, K. (2020). Application of next generation sequencing for detection of protozoan pathogens in shellfish. *Food and Waterborne Parasitology*, 21, e00096.
27. Denis-Robichaud, J., Kelton, D. F., Bauman, C. A., Barkema, H. W., Keefe, G. P., & Dubuc, J. (2019). Biosecurity and herd health management practices on Canadian dairy farms. *Journal of Dairy Science*, 102(10), 9536-9547.
28. Denis-Robichaud, J., Kelton, D. F., Bauman, C. A., Barkema, H. W., Keefe, G. P., & Dubuc, J. (2019). Canadian dairy farmers' perception of the efficacy of biosecurity practices. *Journal of Dairy Science*, 102(11), 10657-10669.

29. Dione MM, Dohoo I, Ndiwa N, Poole J, Ouma E, Amia WC, Wieland B. Impact of participatory training of smallholder pig farmers on knowledge, attitudes and practices regarding biosecurity for the control of African swine fever in Uganda. *Transboundary and emerging diseases*. 2020; 67(6):2482-93.
30. Doyle, A. J., Saab, M. E., Lewis, K., & McClure, J. T. (2019). Equine skin antiseptics using an alcohol-based rub. *Journal of Equine Veterinary Science*, 80, 61-63.
31. Dórea, F.C., Vial, F., Hammar, K., Lindberg, A., Lambrix, P., Blomqvist, E., Revie, C.W., 2019. Drivers for the development of an Animal Health Surveillance Ontology (AHSO). *Preventive Veterinary Medicine* 166, 39–48.
32. Edwards, E. M., Krawczel, P. D., Dann, H. M., Schneider, L. G., Whitlock, B., & Proudfoot, K. L. (2020). Calving location preference and changes in lying and exploratory behavior of preparturient dairy cattle with access to pasture. *Journal of Dairy Science*, 103(6), 5455-5465.
33. Elghafghuf, A., Vanderstichel, R., Hammell, L., & Stryhn, H. (2020). Estimating sea lice infestation pressure on salmon farms: Comparing different methods using multivariate state-space models. *Epidemics*, 31, 100394.
34. Elsohaby, I., Cameron, M., Elmoslemany, A., McClure, J. T., & Keefe, G. (2019). Effect of passive transfer of immunity on growth performance of preweaned dairy calves. *Canadian journal of veterinary research*, 83(2), 90-96.
35. Elsohaby, I., McClure, J. T., Riley, C. B., Bryanton, J., Bigsby, K., & Shaw, R. A. (2019). Transmission infrared spectroscopy for rapid quantification of fat, protein, and lactose concentrations in human milk. *Journal of Perinatology*, 38(12), 1685-1693.
36. Elsohaby, I., McClure, J. T., Waite, L. A., Cameron, M., Heider, L. C., & Keefe, G. P. (2019). Using serum and plasma samples to assess failure of transfer of passive immunity in dairy calves. *Journal of Dairy Science*, 102(1), 567-577.
37. Elsohaby, I., Mweu, M. M., Mahmmod, Y. S., McClure, J. T., & Keefe, G. P. (2019). Diagnostic performance of direct and indirect methods for assessing failure of transfer of passive immunity in dairy calves using latent class analysis. *Preventive Veterinary Medicine*, 164, 72-77.
38. Elsohaby, I., Riley, C. B., & McClure, J. T. (2019). Usefulness of digital and optical refractometers for the diagnosis of failure of transfer of passive immunity in neonatal foals. *Equine Veterinary Journal*, 51(4), 451-457.
39. Evason, M., Peace, M., Munguia, G., & Stull, J. (2020). Clients' knowledge, attitudes, and practices related to pet nutrition and exercise at a teaching hospital. *Canadian Veterinary Journal* 61(5), 512-516.
40. Evason, M., Stull, J. W., Pearl, D. L., Peregrine, A. S., Jardine, C., Buch, J. S., ... Weese, J. S. (2019). Prevalence of *Borrelia burgdorferi*, *Anaplasma* spp., *Ehrlichia* spp. and *Dirofilaria immitis* in Canadian dogs, 2008 to 2015: A repeat cross-sectional study. *Parasites & Vectors*, 12(1).

41. Feltes, E. S. M., Stull, J. W., Herron, M. E., & Haug, L. I. (2020). Characteristics of intrahousehold interdog aggression and dog and pair factors associated with a poor outcome. *Journal of the American Veterinary Medical Association*, 256(3), 349-361.
42. Fernández-Fontelo, A., Puig, P., Caceres, G., Romero, L., Revie, C., Sanchez, J., Dorea, F.C., Alba-Casals, A., 2020. Enhancing the monitoring of fallen stock at different hierarchical administrative levels: an illustration on dairy cattle from regions with distinct husbandry, demographical and climate traits. *BMC veterinary research* 16, 1–13.
43. Fontana, I., Delphino, M. K. V. C., Sesterhenn, P. M., Bertotto, D., Gonçalves, V. S. P. Ferreira, F. A sampling plan for phycotoxins surveillance in bivalve mollusc farms along the Santa Catarina coast, Brazil. *Aquaculture* 2020; 518, 734732.
44. Ford, L., Waldner, C., Sanchez, J., & Bharadwaj, L. (2019). Risk perception and human health risk in rural communities consuming unregulated well water in Saskatchewan, Canada. *Risk Analysis*, 39(11), 2559-2575.
45. Gardner IA, Colling A, Greiner M. Design, statistical analysis and reporting standards for test accuracy studies for infectious diseases in animals: progress, challenges and recommendations. *Preventive Veterinary Medicine* 2019: 162, 46-55.
46. Gemed BA, Amenu K, Magnusson U, Dohoo I, Hallenberg GS, Alemayehu G, Desta H, Wieland B. Antimicrobial Use in Extensive Smallholder Livestock Farming Systems in Ethiopia: Knowledge, Attitudes, and Practices of Livestock Keepers. *Frontiers in veterinary science*. 2020; 7:55.
47. Gomez, D. E., Rodriguez-Lecompte, J. C., Lofstedt, J., Arroyo, L. G., Nino-Fong, R., & McClure, J. T. (2019). Detection of endotoxin in plasma of hospitalized diarrheic calves. *Journal of Veterinary Emergency and Critical Care*, 29(2), 166-172.
48. Groner, M.L., Laurin, E., Stormoen, M., Sanchez, J., Fast, M.D., Revie, C.W., 2019. Evaluating the potential for sea lice to evolve freshwater tolerance as a consequence of freshwater treatments in salmon aquaculture. *Aquaculture Environment Interactions* 11, 507–519.
49. Hogshead, B. T., Pempek, J., Dhakal, S., Ghimire, S., Renu, S., Proudfoot, K. L., ... Renukaradhya, G. J. (2020). Bovine parainfluenza-3 antibodies in veal calves supplemented with cinnamaldehyde or lactoferrin. *Applied Animal Science*, 36(1), 118-123.
50. Jeong, J., Revie, C.W., 2020. Appropriate sampling strategies to estimate sea lice prevalence on salmon farms with low infestation levels. *Aquaculture* 518, 734858.
51. Jewell, M. T., Cameron, M., Spears, J., McKenna, S. L., Cockram, M. S., Sanchez, J., & Keefe, G. P. (2019). Prevalence of hock, knee, and neck skin lesions and associated risk factors in dairy herds in the Maritime Provinces of Canada. *Journal of Dairy Science*, 102(4), 3376-3391.
52. Jewell, M. T., Cameron, M., Spears, J., McKenna, S. L., Cockram, M. S., Sanchez, J., & Keefe, G. P. (2019). Prevalence of lameness and associated risk factors on dairy farms in the Maritime Provinces of Canada. *Journal of Dairy Science*, 102(4), 3392-3405.

53. Jia, B., Delphino M., Awosile, B., Hewison, T., Whittaker, P., Morrison, D., Kamaitis, M., Siah, A., Milligan, B., Johnson, S., Gardner, I. Review of infectious agent occurrence in wild salmonids in British Columbia, Canada. *Journal of Fish Diseases*. 2020; 43(2):153-175.
54. John, E. E., Keefe, G., Cameron, M., Stryhn, H., & McClure, J. T. (2020). Development and implementation of a risk assessment and management program for enzootic bovine leukosis in Atlantic Canada. *Journal of Dairy Science*, 103(9), 8398-8406.
55. Kananub S, Pechkerd P, Vanleeuwen JA, Stryhn H, Arunvipas P. Evaluation of influence of milk urea nitrogen on reproductive performance in small holder dairy farms. *Austral Vet J* 2020; Apr14.
56. Kananub S, Vanleeuwen JA, Arunvipas P. Reproductive performance under intensive heat stress management on a large dairy farm in central Thailand. *LRRD* 2019; 31(6):90.
57. Kathambi, E.K., VanLeeuwen, J.A., Gitau, G.K., Revie, C.W., 2019. Assessment of farmers' compliance in implementing recommended cow comfort changes and their effects on lying time, stall and cow cleanliness within smallholder dairy farms in Kenya. *Preventive veterinary medicine* 172, 104784.
58. Kathambi, EK., VanLeeuwen, JA., Gitau, GK., Kamunde C. Risk factors associated with cow lying time, and stall and cow cleanliness in smallholder dairy farms in Kenya. *Vet World* 2019; 12(7):1085-1092.
59. Kathambi EK, Gitau GK, Muchemi GM, Vanleeuwen JA, Wanyoike SK. Seroprevalence of bovine leukosis virus in contrasting farming systems in Kenya. *Ethiopian Vet J* 2019; 23(1):12-23.
60. Kimeli P, Makau D, Vanleeuwen JA, Gitau GK, Muraya J, McKenna SL, Heider LC. Factors associated with leg hygiene of smallholder dairy cows in Kenya. *East African J Sci, Tech, & Innovation*. 2019; 1(1):11-26.
61. Kimeli P, VanLeeuwen J, Gitau GK, Heider LC, McKenna SL, Greenwood SJ, Richards S. Evaluation of environmental and comfort enrichment on affective welfare in heifer calves on smallholder dairy farms. Accepted to *Preventive Veterinary Medicine* 2020.
62. Kimeli P, VanLeeuwen J, Gitau GK, Heider LC, McKenna SL, Greenwood SJ, Richards S. Effects of housing improvements and other factors on the growth of heifer calves on Kenyan smallholder farms. *Trop An Health Prod* 2021; 52:120-135.
63. Kimeli P, VanLeeuwen J, Gitau GK, Heider LC, McKenna SL, Greenwood SJ. Management factors associated with time-to-onset of gastro-intestinal parasitism in heifer calves on Kenyan smallholder farms. *Vet Parasit* 2020.
64. Kipyego SE, Gitau Gk, Vanleeuwen JA, Kimeli P, Okumu AT, Gakuya DW, Muraya J, Makau D. Sero-prevalence and risk factors of infectious bovine rhinotracheitis virus (type 1) in Meru County, Kenya. *Preventive Veterinary Medicine*. 2019:175.
65. Laurin E, Bradshaw J, Hawley L , Gardner IA, Garver K, Johnson SC, Thakur KK. Importance of sample size for estimating pathogen prevalence: A case example of infectious hematopoietic necrosis virus detection in mixed-stock Fraser River Sockeye salmon (*Oncorhynchus nerka*), British Columbia, Canada. *Canadian Journal of Fisheries and Aquatic Sciences*. 2020 (in press).



66. Laurin E., Groner M, Stormoen M, Revie C, Sanchez J. Framework approach for assessing risks in aquaculture despite data limitations: case of sea lice tolerance to freshwater treatments on salmon farms. *Aquaculture Environmental Interactions* 2020 (in press).
67. Laurin, E., I. A. Gardner, A. Peña, M. Rozas-Serri, J. Gayosa, J. Neumann Heise, F.O. Mardones. 2020 Bayesian estimation of diagnostic sensitivity and specificity of a qPCR and a bacteriological culture method for *Piscirickettsia salmonis* in farmed Atlantic salmon (*Salmo salar* L.) in Chile. *Journal of Fish Diseases* 2020 (in press).
68. Laurin E, Jaramillo D, Vanderstichel R, Ferguson H, Kaukinen KH, Schulze AD, Keith IR, Gardner IA, Miller KM. 2019. Histological and novel high-throughput molecular monitoring data from farmed salmon (*Salmo salar* and *Oncorhynchus* spp.) in British Columbia, Canada, from 2011–2013. *Aquaculture*; 499:220-34.
69. Laurin, E., K. Thakur, P. Mohr, P. Hick, M. St. J. Crane, I.A. Gardner. N.J.G. Moody, A. Colling, I. Ernst. To pool or not to pool? Guidelines for pooling samples for use in surveillance testing of infectious diseases in aquatic animals. *Journal of Fish Diseases*. 2019; 42:1471-1491.
70. Laurin, E., Stormoen, M., Revie, C., Sanchez, J., 2020. A stepwise integrated risk-assessment framework in aquaculture: the case of sea lice tolerance to freshwater treatments on salmon farms. *Aquaculture Environment Interactions* 12, 417–428.
71. Laurin E, Thakur K, Mohr P, Hick P, Crane M, Gardner I, Moody N, Colling A, and Ernst I (2019). To pool or not to pool? Guidelines for pooling samples for use in surveillance testing of infectious diseases in aquatic animals. *J Fish Dis* 42(11), pp.1471-1491.
72. Lee HS, Dao DT, Bui VN, Bui AN, Le DT, Nguyen-Viet H, Grace D, Thakur K, and Hagiwara K (2020). Prevalence and phylogenetic analysis of Hepatitis E virus in pigs in Vietnam. *BMC Vet Res* 16, 333.
73. Lee HS, Thakur K, Bui VN, Pham TL, Bui AN, Dao TD, Thanh VT, and Wieland B (2020). A stochastic simulation model of African swine fever transmission in domestic pig farms in the Red River Delta region in Vietnam. *Transbound Emerg Dis*.
74. Lee HS, Thakur K, Nghia VB, Ngoc, AB, Wieland B (2019). Simulation of control scenarios of porcine reproductive and respiratory syndrome in Nghe An province in Vietnam. *Transbound Emerg Dis*.
75. Leta, S., Fetene, E., Mulatu, T., Amenu, K., Jaleta, M.B., Beyene, T.J., Negussie, H., Kriticos, D., Revie, C.W., 2019a. Updating the global occurrence of *Culicoides imicola*, a vector for emerging viral diseases. *Scientific data* 6, 1–8.
76. Leta, S., Fetene, E., Mulatu, T., Amenu, K., Jaleta, M.B., Beyene, T.J., Negussie, H., Revie, C.W., 2019b. Modeling the global distribution of *Culicoides imicola*: an Ensemble approach. *Scientific reports* 9, 1–9.
77. Lilly, M. L., Gonçalves Arruda, A., Proudfoot, K. L., & Herron, M. E. (2020). Evaluation of companion animal behavior knowledge among first-year veterinary students before and after an introductory animal behavior course. *Journal of the American Veterinary Medical Association*, 256(10), 1153-1163.

78. Lindahl JF, Gill JPS, Hazarika RA, Fairuze NM, Bedi JS, Dohoo I, Chauhan AS, Grace D, Kakkar M. Risk Factors for Brucella Seroprevalence in Peri-Urban Dairy Farms in Five Indian Cities. *Tropical medicine and infectious disease*. 2019; 4(2).
79. MacKinnon B, Jones P, Hawkins L, Dohoo I, Stryhn H, Vanderstichel R, St-Hilaire S. The epidemiology of skin ulcers in saltwater reared Atlantic salmon (*Salmo salar*) in Atlantic Canada. *Aquaculture*. 2019; 501:230-8.
80. MacMillan, K., Millican, L., Burns, J., McClure, J. T., & Vanderstichel, R. (2020). Compliance with the Code of Practice for the Care and Handling of Equines on 50 horse farms in Prince Edward Island. *Canadian Veterinary Medical Association*, 61(9), 985-989.
81. Maina F, Mburu J, Gitau G, Vanleeuwen J, Yigzaw N. Factors influencing economic efficiency of milk production among small-scale dairy farmers in Mukurweini, Nyeri County, Kenya. Accepted to the *Trop An Health Prod*. 2019.
82. Makau D, Vanleeuwen JA, Gitau GK, Mckenna SL, Walton C, Muraya J, Wichtel JJ. Randomized controlled trial on the effect of *Calliandra* and *Sesbania* supplementation on milk production in dairy cattle on smallholder dairy farms in Kenya. *Vet Med Internat* 2020.
83. Makau D, Vanleeuwen JA, Muraya J, Gitau GK, Mckenna SL, Wichtel JJ. Livelihoods impacts of *Calliandra calothyrsus* and *Sesbania sesban*: supplementary feed in smallholder dairy farms in Kenya. *J Develop Agric Econ*. 2019; 11(10)234-246.
84. Makau D, Vanleeuwen JA, Muraya J, Gitau GK, Mckenna SL, Wichtel JJ. The effects of *Calliandra* and *Sesbania* supplementation on weight gain in dairy calves on smallholder farms in Kenya. *Preventive Veterinary Medicine* 2019; 172.
85. McEwan, G.F., Groner, M.L., Cohen, A.A., Imsland, A.K., Revie, C.W., 2019. Modelling sea lice control by lumpfish on Atlantic salmon farms: interactions with mate limitation, temperature and treatment rules. *Diseases of Aquatic Organisms* 133, 69–82.
86. Millican, L., Vanderstichel, R., McClure, J., & MacMillan, K. (2020). Demographic factors associated with Prince Edward Island horse farm owner awareness of the Code of Practice for the Care and Handling of Equines. *Journal of Applied Animal Welfare Science*, 23(3), 378-384.
87. Miraballes, C., Riet-Correa, F., Saporiti, T., Lara, S., Parodi, P., & Sanchez, J. (2019). Probability of *Rhipicephalus microplus* introduction into farms by cattle movement using a Bayesian Belief Network. *Ticks and Tick-borne Diseases*, 10(4), 883-893.
88. Morandi B\*, Vanleeuwen JA, Greenwood S, Conboy G. Endoparasites in dogs and cats diagnosed at the Veterinary Teaching Hospital (VTH) of the University of Prince Edward Island between 2000 and 2017. *Prev Vet Med*. 2019:175.
89. Muasya DW, Gitau GK, Thaiyah AG, Gakuya DW, Vanleeuwen JA, Mbatha P. A comparison between the indirect ELISA and tuberculin skin test in the diagnosis of bovine tuberculosis in Kenya. *East African J Sci Tech Innov*. 2019; 1(1):1-10.

90. Nekouei O, Vanderstichel R, Kaukinen K, Thakur K, Ming T, Patterson D, Trudel M, Neville C, and Miller KM (2019). Comparison of infectious agents detected from hatchery and wild juvenile Coho salmon in British Columbia, 2008-2018. *PLOS ONE* 14(9), e0221956
91. Niemi RE, Vilar MJ, Dohoo IR, Hovinen M, Simojoki H, Rajala-Schultz PJ. Antibiotic dry cow therapy, somatic cell count, and milk production: Retrospective analysis of the associations in dairy herd recording data using multilevel growth models. *Preventive Veterinary Medicine* 2020; 180:105028.
92. Okumu TA, John NM, Wabacha JK, Tsuma VT, Vanleeuwen JA. Seroprevalence antibodies for BVDV, *Brucella abortus* and *N. caninum* and their roles in the incidence of abortion/foetal loss in dairy cattle herds in Nakuru district, Kenya. *BMC Vet Res* 2019; 15(1):95.
93. Patanasatienkul T, Delphino MK and Thakur K (2020). Comparing the Effectiveness of Traditional and Alternative Baits in Prince Edward Island, Canada Lobster Fishery. *Front Mar Sc*, 7, p.902.
94. Patanasatienkul, T., Greenwood, S. J., McClure, J. T., Davidson, J., Gardner, I., & Sanchez, J. (2020). Bayesian risk assessment model of human cryptosporidiosis cases following consumption of raw Eastern oysters (*Crassostrea virginica*) contaminated with *Cryptosporidium* oocysts in the Hillsborough River system in Prince Edward Island, Canada. *Food and Waterborne Parasitology*, 19, e00079.
95. Patanasatienkul, T., Sanchez, J., Davidson, J., Revie, C.W., 2019. The application of a mathematical model to evaluate the effectiveness of control strategies against *Ciona intestinalis* in mussel production. *Frontiers in Veterinary Science* 6, 271.
96. Pichette-Jollette, S., Millette, G., Demontier, E., Bran-Barrera, D., Cyrenne, M., Ster, C., ..., Keefe, G. Malouin, F., Roy, J. P. (2019). Partial prediction of the duration and the clinical status of *Staphylococcus aureus* bovine intramammary infections based on the phenotypic and genotypic analysis of isolates. *Veterinary Microbiology*, 228, 188-195.
97. Poirier, L. A., Clements, J. C., Davidson, J. D. P., Miron, G., Davidson, J., & Comeau, L. A. (2019). Sink before you settle: Settlement behaviour of Eastern oyster (*Crassostrea virginica*) larvae on artificial spat collectors and natural substrate. *Aquaculture Reports*, 13, 100181.
98. Polinski, M., Laurin, E., Delphino, M., Lowe, G., Meyer, G., Abbott, C. Diagnostic accuracy evaluation of histopathology, PCR and qPCR for the detection of *Mikrocytos mackini* in Pacific oysters (*Crassostrea gigas*) using Bayesian latent class analysis. *Diseases of Aquatic Organisms* 2020 (in press).
99. Price, D., Laurin E, Mardones F, Jimenez D, Lara M, Gardner I. Effect of sampling time and surveillance strategy on the time to onset and magnitude of piscirickettsiosis (*Piscirickettsia salmonis*) outbreaks in Chilean farmed Atlantic salmon. *Aquaculture* 2020 (in press).
100. Price, D., Sanchez, J., Ibarra, R., & St-Hilaire, S. (2019). Variation in the concentration of antibiotics in tissue during oral antibiotic treatments in farmed salmonids. *Aquaculture*, 498, 587-593.
101. Ratanapob N, Vanleeuwen JA, McKenna SL, Wichtel M, Rodriguez-Lecompte JC, Menzies P, Wichtel JJ. Evaluation of the Precision Xtra® meter for monitoring blood  $\beta$ -hydroxybutyrate concentrations in late-gestation ewes. *JVDI*. 2019; 31:17-22.

102. Ratanapob N, Vanleeuwen JA, McKenna SL, Wichtel M, Stryhn H, Rodriguez-Lecompte JC, Menzies P, Wichtel JJ. Management factors influencing perinatal lamb mortality in Prince Edward Island flocks. *Preventive Veterinary Medicine* 2020; 180:105035.
103. Reyes, J., Rodriguez-Lecompte, J. C., Blanchard, A., McClure, J. T., & Sánchez, J. (2019). Molecular variability of *Streptococcus uberis* isolates from intramammary infections in Canadian dairy farms from the Maritime region. *Canadian Journal of Veterinary Research*, 83(3), 168-176.
104. Richards S, Vanleeuwen JA, Shepelo G, Wichtel JJ, Kamunde C, Uehlinger F, Gitau GK. Impact of mineral feeding on reproductive efficiency on smallholder dairy farms in Kenya. *LRRD* 2019; 31(6):80.
105. Ritter, C., Mills, K. E., Weary, D. M., & Von Keyserlingk, M. A. G. (2020). Perspectives of western Canadian dairy farmers on the future of farming. *Journal of Dairy Science*, 103(11), 10273-10282.
106. Robles, I., Kelton, D. F., Barkema, H. W., Keefe, G. P., Roy, J. P., Von Keyserlingk, M. A. G., & DeVries, T. J. (2019). Bacterial concentrations in bedding and their association with dairy cow hygiene and milk quality. *Animal* 2020;14(5):1052-1066.
107. Roche, S. M., Renaud, D. L., Genore, R., Shock, D. A., Bauman, C., Croyle, S., ..., Keefe, G.P., Kelton, D. F. (2020). Canadian National Dairy Study: Describing Canadian dairy producer practices and perceptions surrounding cull cow management. *Journal of Dairy Science*, 103(4), 3414-3421.
108. Roche, S. M., Genore, R., Renaud, D. L., Shock, D. A., Bauman, C., Croyle, S., ..., Keefe, G.P., Kelton, D. F. (2020). Short communication: Describing mortality and euthanasia practices on Canadian dairy farms. *Journal of Dairy Science*, 103(4), 3599-3605.
109. Roy RC, Riley CB, Stryhn H, Dohoo I, Cockram MS. Infrared Thermography for the Ante Mortem Detection of Bruising in Horses Following Transport to a Slaughter Plant. *Frontiers in Veterinary Science*. 2019; Volume 5.
110. Scott, H., Gilleard, J. S., Jelinski, M., Barkema, H. W., Redman, E. M., Avramenko, R. W., ...Keefe, G.,... Uehlinger, F. D. (2019). Prevalence, fecal egg counts, and species identification of gastrointestinal nematodes in replacement dairy heifers in Canada. *Journal of Dairy Science*, 102(9), 8251-8263.
111. Sellers ELLIE, Sarah Baillie, ..., Javier Sanchez, ..., John VanLeeuwen, Kristien Verheyen, Promoting Evidence-based Veterinary Medicine through the online resource 'EBVM Learning': User feedback. *Veterinary Evidence* Mar 2021, 6(1).
112. Silva-Opps, M., Mailhiot, J., Opps, S. B., & Sanchez, J. (2019). Exploring the effects of land-cover configuration, body size and trophic diversity on the avifauna richness of Prince Edward Island, Canada. *Open Journal of Ecology*, 9(7), 216-237.
113. Situma SN, Gitau Gk, Vanleeuwen JA, Mulei CM, Kimeli P. Clinical trial examining the effects of two calf feeding practices on calf growth and health on smallholder dairy farms in Mukurweini District, Nyeri County, Kenya. *East African J Sci, Tech, & Innovation*. 2020:1(3):1-15.
114. Smith, A. M., Arruda, A. G., Evason, M. D., Weese, J. S., Wittum, T. E., Szlosek, D., & Stull, J. W. (2019). A cross-sectional study of environmental, dog, and human-related risk factors for positive

canine leptospirosis PCR test results in the United States, 2009 to 2016. BMC Veterinary Research, 15(1), 412.

115. Stull, J. W., Anderson, M. E. C., & Weese, J. S. (2019). Dynamic nature of canine and feline infectious disease risks in the twenty-first century. *Veterinary Clinics of North America: Small Animal Practice*, 49(4), 587-598.
116. Thakur K, Vanderstichel R, Kaukinen K, Nekouei O, Laurin E, Miller KM (2019). Infectious agent detections in archived Sockeye salmon (*Oncorhynchus nerka*) samples from British Columbia, Canada (1985-1994). *J Fish Dis*.
117. Todd, C.D., Hanson, N.N., Boehme, L., Revie, C.W., Marques, A.R., 2020. Variation in the post-smolt growth pattern of wild one sea-winter salmon (*Salmo salar* L.), and its linkage to surface warming in the eastern North Atlantic Ocean. *Journal of Fish Biology*.
118. Vallejo-Timaran D, Reyes-Velez J, Vanleeuwen JA, Maldonado-Estrada J, Astaiza-Martinez J. Incidence and effects of subacute ruminal acidosis and subclinical ketosis with respect to postpartum anestrus in dairy cows in Colombia. *Heliyon* 2020;6(4): e03712.
119. Verdugo C, Zimin-Veselkoff N, Gardner I, Mardones F. Expert elicitation of the diagnostic performance of two tests for Bacterial Kidney Disease (BKD) surveillance in Atlantic salmon (*Salmo salar*) broodstock in Chile. *Aquaculture* 2020 (in press)
120. Vollset KW, Lennox RJ, Thorstad EB, Auer S, Bär K, Larsen MH, Mahlum S, Näslund J, Stryhn H, Dohoo I. Systematic review and meta-analysis of PIT tagging effects on mortality and growth of juvenile salmonids. *Reviews in Fish Biology & Fisheries*. 2020; 30(4):553-68.
121. Wagner, B. K., Cramer, M. C., Fowler, H. N., Varnell, H. L., Dietsch, A. M., Proudfoot, K. L., ... Pairis-Garcia, M. D. (2020). Determination of dairy cattle euthanasia criteria and analysis of barriers to humane euthanasia in the United States: Dairy producer surveys and focus groups. *Animals*, 10(5), 770.
122. Wynne JW, Thakur K, Slinger J, Samsing F, Milligan B, Powell J, McKinnon A, Nekouei O, New D, Richmond Z and Gardner I (2020). Microbiome profiling reveals a microbial dysbiosis during a natural outbreak of Tenacibaculosis (Yellow mouth) in Atlantic salmon. *Front Microbiol*, 11, p.2582.
123. Yamkasem J, Kumar Roy S, Khemthong M, Gardner I, Surachetpong W. Diagnostic sensitivity of pooled samples for detection of tilapia lake virus and application to the estimation of within-farm prevalence. *Transboundary and Emerging Diseases* 2020 (in press).

## 9. Books/Book Chapters

1. Cockram, M. 2020. Approaches to legislation and enforcement to minimize welfare issues at slaughter. In: *The Slaughter of Farmed Animals: Practical ways of enhancing animal welfare*. Edited by T. Grandin and M. Cockram. CABI Publishing, Wallingford, Oxon, UK. 279-297.

2. Cockram, M. 2020. Condition of animals on arrival at the abattoir and their management during lairage. In: *The Slaughter of Farmed Animals: Practical ways of enhancing animal welfare*. Edited by T. Grandin and M. Cockram. CABI Publishing, Wallingford, Oxon, UK. 49-77.
3. Cockram, M. 2020. Welfare issues at slaughter. In: *The Slaughter of Farmed Animals: Practical ways of enhancing animal welfare*. Edited by T. Grandin and M. Cockram. CABI Publishing, Wallingford, Oxon, UK. 5-34.
4. Cockram, M.S. 2019. Sheep Transport. In *Livestock Handling and Transport*, 5th Edition. Edited by T. Grandin. CABI Publishing, Wallingford, Oxon, UK. P 239-253.
5. Grandin, T. and Cockram, M. 2020. *The Slaughter of Farmed Animals: Practical ways of enhancing animal welfare*. CABI Publishing, Wallingford, Oxon, UK.
6. Grandin, T. and Cockram, M. 2020. The use of abattoir data to provide information on the welfare of livestock and poultry on the farm and during transport. In: *The Slaughter of Farmed Animals: Practical ways of enhancing animal welfare*. Edited by T. Grandin and M. Cockram. CABI Publishing, Wallingford, Oxon, UK. 245-278.
7. Vanleeuwen JA, et al., *Handbook for Kenya Dairy Farmers – 7th Edition*; Published by Farmers Helping Farmers. 2020. Charlottetown, PEI, Canada, pp. 113.