

Centre for Veterinary Epidemiological Research

ATLANTIC VETERINARY COLLEGE | UNIVERSITY OF PRINCE EDWARD ISLAND



CVER ANNUAL REPORT | 2011

UPEI
UNIVERSITY
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ISLAND



CVER Annual Report 2011

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Message from the Outgoing Director

2011 brought big changes to CVER. Most notably, Ian Gardner arrived as the Canada Excellence Research Chair in aquatic epidemiology. In August of 2011, I stepped down as Director and Ian G. took over (with formal ratification by the Board of Governors imminent). My reason for stepping down as Director is that I will be retiring from UPEI in the summer of 2012 and I wanted to provide an opportunity for a smooth transition. I am grateful to Ian G. for accepting the nomination of the CVER Steering Committee and his election by the membership at large.



Many good things happened during 2011, but those will be covered in the rest of this report. I would like to conclude by expressing my sincere appreciation to all of the members of CVER for their support for the creation of this Centre (2006-2007) and for their ongoing support of the Centre since then. It has been a pleasure having you as colleagues.

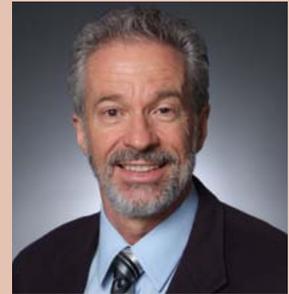
CVER has a bright future because of your dedication and ability to work as a true team.

Best wishes,

Ian Dohoo

Message from the New Director

As incoming Director, I would like to thank Ian Dohoo for his outstanding contributions to veterinary epidemiology both nationally and internationally. Most importantly, he has articulated a clear vision for veterinary epidemiology at AVC and throughout Canada, and has provided inspiration to many in the field, including me. He has positively influenced the careers of graduate students, post-doctoral fellows and many faculty members, and encouraged many with only a limited interest in veterinary epidemiology to embrace it as a holistic, systems-based approach to investigate and solve population health problems. The development and expansion of CVER is among his most notable contributions and highly valued by all of his colleagues, and an important legacy that needs to be nurtured and supported.



Finally, I would like to wish Ian, and his wife Sue, a long, healthy, and enjoyable retirement, wherever that may take them.

Sincerely yours,

A handwritten signature in black ink that reads "Ian Gardner". The signature is fluid and cursive.

Ian Gardner

Canada Excellence Research Chair



The Canada Excellence Research Chair (CERC) in Aquatic Epidemiology was awarded by the Canadian government to the University of Prince Edward Island (UPEI). The program officially started at UPEI on April 1, 2011 with the arrival of Dr. Ian Gardner as the selected chair. Through a very productive career in veterinary epidemiology (terrestrial and aquatic) at the University of California-Davis, Ian established himself as one of the global leaders in veterinary epidemiology. We are delighted to have him come to UPEI and take over the leadership of CVER.

The goal of the CERC program is to make UPEI and Canada the global leaders in applied aquatic epidemiology research with an ecosystem health focus. The CERC team is multidisciplinary and includes epidemiologists; statisticians; finfish, crustacean and mollusc clinicians; ecosystem health and regulatory veterinary medicine specialists whose work focuses on holistic approaches to assist the

Canadian and international aquaculture industries improve their productivity, sustainability, and health management.

The CERC program is now 9 months old and making excellent progress, especially in building research and response capacity, and setting up collaborative links. Research activities are in the initial phase and team members are submitting extramural grants for funding as opportunities arise.

Highlights for the year:

Erin Rees joined the team as a research scientist with expertise in disease modeling. She will work initially on sea lice, in association with Crawford Revie. Three post-doctoral fellows were hired: Ahmed Elmoslemany, Eva Jakob, and Maya Groner. Ahmed has started working on data analysis associated with a Decision Support System for sea lice. Eva and Maya will start on February 1, 2012. Two international graduate students (Jia Beibei from China and Gabriel Arriagada from Chile) and one domestic student (Amanda Borchardt) are CERC supported.



The Strategic Advisory Board, which includes representatives from government, industry, and academia from many countries, met at the end of May to provide guidance to the team and develop metrics and goals as part of the strategic plan. The first version of the plan has been finalized and will guide activities over the life of the 7-year program.

Links with government and industry partners were further developed. Ian Gardner participated in a CFIA initiative to develop national standards for the aquatic animal compartmentalization program to ensure that imports and exports of aquatic animals are consistent with international standards for aquatic animal health. He also helped lead a workshop on modern approaches to test validation for fish diseases, in collaboration with Peter Wright, Department of Fisheries and Oceans, Moncton, and Rich Jacobsen, Professor Emeritus, Cornell University.

Larry Hammell investigated bio-security practices associated with aquaculture of warm-water species in Vietnam, participated in the World Organization for Animal Health (OIE) aquaculture meetings in Vietnam, Paris, and Panama, and taught in OIE Aquatic Focal Points Training at Rhodes University in South Africa. Further interactions with Rhodes University, possibly leading to a Collaborating Centre twinning project, are being discussed.

Finally, the CERC website is close to being finalized and is expected to be available publicly in February 2012.

For enquiries about graduate study opportunities in the CERC program, please contact Ian Gardner

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Partners



CENTRE FOR AQUATIC HEALTH SCIENCES

The Centre for Aquatic Health Sciences (CAHS) completed another rewarding year. The World Organization of Animal Health (OIE) Collaborating Centre for Epidemiology and Risk Assessment of Aquatic Animal Diseases hosted its first joint meeting with the National Veterinary Institute of Norway at AVC in July. Under the OIE umbrella, Dr. Larry Hammell, Director of CAHS and Co-director of the OIE Collaborating Centre investigated bio-security practices associated with aquaculture of warm-water species

in Vietnam, participated in the OIE aquaculture meetings in Vietnam, Paris, and Panama, and taught in OIE Aquatic Focal Points Training at Rhodes University in South Africa. Future plans include a potential “twinning” project in South Africa and Vietnam. Leadership of the Collaborating Centre passed to Norway for the 2011-12 research years.

CAHS technical staff continued their close collaboration with fish farmers in the Bay of Fundy, New Brunswick. Sea lice counts were conducted on marine cage sites to monitor lice loads and the efficacy of sea lice treatments. Training for marine cage site workers on sea lice identification continues to be offered by CAHS staff to industry and surpassed the milestone of more than 200 site workers achieving training certification.

The laboratory bioassay techniques developed by Dr. Jillian Westcott of the CAHS have now been adopted for widespread use. Treatments that are routinely assessed in our lab include SLICE, Salmosan and Alphamax. A graduate student, Amanda Borchardt, is developing a similar approach for hydrogen peroxide treatments. The CAHS team has continued to perform bioassay analysis of the effectiveness of multiple sea lice treatment products and through its research program has done more bioassays than any other group, globally, over the past four years.

Data collected through the Centre’s research becomes part of the Decision Support System (DSS) which is a web-based application that allows users to enter, edit, and review data, generating summary reports/graphs designed to assist those making treatment decisions associated with sea lice management on salmon farms. The DSS has been adopted by the local salmon industry as an essential tool providing assurance and monitoring of the sea lice threat on an industry-wide basis in the Bay of Fundy.



Recently developed capabilities in DSS, based on farmers’ input, include a “weekly threat report” of changing sea lice burdens at sites and within varying Bay Management Areas (BMA), and a company “dashboard” which provides production managers and company veterinarians with a rolling four-week summary of the most current information linked to key decision factors for lice burdens, treatment outcomes, reporting compliance, etc. on a site-, company-, BMA-, or industry-wide basis. This decision support platform can be delivered via the web to a desktop, tablet, or mobile device and further builds our capacity to deliver results with the speed and flexibility required for farmers, veterinarians, and regulating agencies. These capabilities support the CAHS mission of providing sound science to inform fish health policy decisions based on near real-time inputs.



At the request of the New Brunswick government, CAHS conducted independent, third-party audits on sea lice counts reported by production sites in the Bay of Fundy. This role was offered in acknowledgement of the mutual respect and trust that CAHS team members have developed with both producers and regulators of the industry over the past decade. In 2011, CAHS audited 70 per cent of the active production sites.

MARITIME QUALITY MILK

Maritime Quality Milk (MQM) had a very strong year in 2011. Under the leadership of Dr. Greg Keefe, the program continues to focus on projects relevant to the regional and national dairy industry. The main focus remains milk quality and infectious disease research, particularly related to paratuberculosis (Johne's disease).



In 2011, MQM launched the Atlantic Johne's Disease Initiative (AJDI). The three-year, \$1.2-million program is supported by Dr. Keefe's Innovation Chair funding, the four regional dairy boards, and their respective ADAPT (AAFC) Councils. AJDI aims to reduce the impact of Johne's in the region through a structured evaluation and risk management strategy. More than 40 regional veterinarians have participated in accreditation training and over 260 farms have signed up for the program in just 5 months. Research within the program will centre on program outcome assessment and communication effectiveness. Norman Wiebe has been hired as project manager and Dr. Karen MacDonald-Phillips will lead the research component.

In support of AJDI and our ongoing diagnostic test evaluation and development program (Drs. Emilie Laurin and Carrie Lavers), MQM maintains USDA-proficiency certification for the 5 main modalities for diagnosing the disease. In addition to Dr. Keefe, the Johne's team includes Dr. Shawn McKenna, Dr. Marcelo Chaffer (MQM microbiologist), Natasha Robinson and Maria Vasquez (laboratory technicians), and Theresa Andrews and Heather Jack (field technicians).

Researchers at MQM continue to work on technologies to aid dairy farmers in making antibiotic treatment decisions. Dr. Kim MacDonald completed her PhD work evaluating the MQM mastitis treatment decision kit. With appropriate training, the system provides accurate diagnostic support and can lead to a 40 per cent reduction in antibiotic use for the treatment of clinical mastitis. In a joint project with Dr. Jean-Philippe Roy at the University of Montreal, Dr. Maggie Cameron continues to assess the system for use in cows at dry off. Preliminary results indicate that targeted dry cow treatment could reduce antibiotic use by an even greater proportion in this group of animals.

MQM is partnering with the Université de Laval, the University of Saskatchewan, the Université de Montréal, and the University of Guelph through the Dairy Farmers of Canada on a national project to study the sources of variability in BTM iodine concentration and to formulate effective extension programs to moderate this variability.

The MQM-sponsored program evaluating methods for monitoring parasite burdens in dairy herds was completed with the PhD defense of Dr. Raphael Vanderstichel. Guidelines for how the ELISA test should be used have been formulated and publications of these results in peer-reviewed journals are in preparation.

MQM has undertaken many smaller projects of importance to the regional dairy sector. Under the leadership of post-doctoral fellow, Dr. Ahmed Elmoslemany, MQM has worked with the provincial dairy industry to evaluate new technology and data-management approaches for an advanced milk-quality management and regulatory program for



PEI. We continue to work with the New Brunswick dairy industry on the pressing issue of cattle-bedding options, and conducted a field trial of 5 materials in 2011.

MQM has become an internationally recognized program for dairy disease management and milk quality, and our work is predominantly featured at international conferences. Building on our previous work on Colombian milk quality, in 2011 we welcomed Dr. Nicholas Ramirez and Dr. Julian Reyes from the University of Antioquia, Medellin Colombia as a visiting professor and PhD student, respectively.

MQM looks forward to a productive year in 2012, as we continue to work with the dairy industry to support the maintenance and enhancement of milk quality.

THE CANADIAN REGULATORY VETERINARY EPIDEMIOLOGY NETWORK

Formally launched in the spring of 2009, CRVE-Net's first term ended March 31, 2011, and a one-year funding extension has been provided by CFIA. Under the direction of Dr. Javier Sanchez, the main focus for the following term was the delivery of a four-month graduate course in quantitative risk assessment methodologies and the development of a multi-institutional 3-year proposal for the renewal of CRVE-Net. Additionally, the following activities are among other training and research activities that were carried out in 2011.



The Epi-on-the-Island course was back again this year and was hosted by CVER at the Atlantic Veterinary College. Two courses were offered under the instruction of CRVE-Net Director, Dr. Javier Sanchez; Dr. Dirk Pfeiffer of the Royal Veterinary College in London; and Drs. Ian Dohoo and Henrik Stryhn (more under Outreach).

Further building on the relationships established with health officials in China in 2010, the 5 veterinary colleges in Canada have seen a lot of activity in recent months with respect to epidemiology in China. With a recognized lack of graduate-level epidemiology training in their country, the China Agricultural University (CAU) has expressed interest in partnering with our "western" universities to develop a graduate-level program in epidemiology (more under Outreach). After a strategy document was signed, work is now under way to

create a partnership between CAU and the University of Prince Edward Island with the end result being a graduate program in veterinary epidemiology.

This project will involve other partners (Food and Agriculture Organization of the United Nations (FAO) and the Veterinary Bureau of the Chinese Ministry of Agriculture). It is also the intent that this effort will include participation



from other western universities (most notably Canadian colleges and the Royal Veterinary College) and will eventually be extended to include partnerships between other universities in China and participating western schools.

The first step in this proposal was to select three candidates to receive their PhD training in epidemiology in Canada. Eleven potential candidates were identified by CAU and FAO. Dr. Sanchez traveled to China in October to interview these candidates. Three scholarships have now been granted by the Chinese Academy of Science to allow the identified candidates to begin their studies in Canada.

In January 2011, 23 individuals from the 5 Canadian veterinary colleges and other interested stakeholders met at the Ontario Veterinary College to discuss teaching of public health and regulatory medicine in the Canadian DVM curriculum. Dr. Sanchez attended the meeting on behalf of CRVE-Net and UPEI. Funding was provided by CRVE-Net and was hosted by the Centre for Public Health and Zoonoses in Guelph, Ontario. The original intention of the meeting was to discuss public health and regulatory medicine teaching in the DVM program, opportunities for collaboration among participants in offering this material, and graduate training programs in public health and regulatory medicine. However, the timing of this workshop coincided with the public comment period for the North American Veterinary Medical Education Consortium core competency initiative. Therefore, workshop participants elected to spend the majority of the 2-day workshop discussing core competencies for veterinarian students in public health and regulatory medicine. The remainder of the time was spent discussing opportunities for collaboration and resource-sharing. Participants expressed interest in having another meeting devoted to discussion of graduate level training in public health and regulatory medicine.

Research projects continue to be one of the key pillars of CRVE-Net as it completes its first term. In addition to the above-mentioned funded projects, two PhD projects have been funded by the Canadian Swine Health Board to look at between-farm transmission of the Porcine Respiratory and Reproductive Syndrome virus. One of the projects involves the development of a disease-spread model using animal movement information in Canada. The second project will look at this by developing a risk-assessment model using a Bayesian Belief Network approach.

Looking ahead to 2012, CRVE-Net will focus on the development of training and research capacity through multi-institutional teams of expertise across the country.

SIR JAMES DUNN ANIMAL WELFARE CENTRE

The Sir James Dunn Animal Welfare Centre (SJDAWC) at the Atlantic Veterinary College promotes animal welfare through research, service, and education. In September, the Centre held the seventh annual Animal Welfare in Practice Conference: Lameness in Dairy Cows, which included presentations on gait scoring, risk factors, management to address lameness, and pain management (the presentations can be viewed at www.upei.ca/awc). The conference was co-hosted by the SJDAWC and the AVC Animal Welfare Club with generous assistance from the Animal Welfare Foundation of Canada.

PhD students Niamh Caffrey and Cyril Roy continue their programs under the supervision of Dr. Michael Cockram (Professor and Chair in Animal Welfare), and Dr. Ian Dohoo (Professor of Epidemiology) using epidemiological methods



to study the welfare implications of animal transportation. Niamh Caffrey's project, "Transportation of animals for slaughter in Canada—current practice, welfare issues, and regulatory control" is in its third and final year. Funded by the SJDAWC and The Animal Welfare Foundation of Canada, the final stage of this project is an epidemiological study of risk factors for mortality in broilers transported to slaughter. Dr. Michael Cockram and Dr. Crawford Revie (Professor and Canada Research Chair Epi-informatics) have obtained matching funding from the Canadian Poultry Research Council and the SJDAWC for a project titled "Identification of risk factors during broiler transportation that influence injury and mortality," which will fund a graduate student to continue and expand the existing project. Cyril Roy's project on the welfare of horses transported for slaughter has also made considerable progress in 2011. Cyril conducted field work at an equine slaughter plant in Iceland, which involved recording the characteristics of the journeys taken by the horses to the slaughter plant

and assessing their welfare on arrival, using a range of behavioural, physiological, and health measurements. This approach has also been undertaken in Canada. Cyril will complete his field work in 2012. A third PhD student, Jackie Ellis, continues her program under Dr. Cockram's supervision on environmental enrichment and stress in shelter cats.

A book chapter discussing the relationships between animal welfare, and health and disease was published in 2011 in a leading textbook on animal welfare (Cockram MS, Hughes BO. 2011. Health and Disease. Chapter 8. p 120-137. In Animal Welfare. 2nd edition. Eds Appleby M, Hughes B, Mench J, Olsson A. CABI, Wallingford, UK). Also in 2011, the SJDAWC and the Animal Welfare Committee of the Canadian Veterinary Medical Association collaborated to produce a second edition of the poster "Examples of Anaesthetic and Pain Management Protocols for Healthy Dogs and Cats" (Lemke K and Crook A). The poster and accompanying handout "Fundamental Points in Perioperative Pain Management" are available in English and French at upei.ca/awc/Outputs/Veterinary_education.

Three research projects and one new service project were funded through the SJDAWC in 2011, and funding was renewed for three existing service projects. Please see the fall 2011 issue of SJDAWC News at www.upei.ca/awc for more information about these projects and other SJDAWC initiatives, including recent publications.



SHELLFISH RESEARCH GROUP

In December 2011, the Shellfish Research Group completed an Atlantic Innovation Fund project on mitigation of tunicates on aquaculture farms. The research focused on the pathophysiology of death in *Styela clava*, exploring the life cycle of colonial and solitary tunicates, discovering and testing new treatments for the mortality of tunicates, developing diagnostic tools for the identification of tunicates, conducting field trials to assess the efficacy and economics of various high-pressure water treatment regimens, developing treatment platforms for treatment options, and using a new innovative device to assess the impact of tunicate fouling

and mitigation treatments on mussel health.

Dr. Jeffrey Davidson continues to participate in a research project in partnership with health management officials in South and Southeast Asia with a goal of building the capacity for research and practice in ecosystem approaches to health in Southeast Asia. The hypothesis for this project is that bringing individuals together from different countries and institutions with an array of experience and expertise in the prevention of emerging infectious diseases (EIDs), public health, and health promotion will enable participants to investigate and respond more effectively to complex ecosystem health issues, with a particular focus on EIDs.

PARTNERS OUTSIDE AVC



CVER continues to serve as an umbrella organization for a wide range of people carrying out population-based research. These members come from UPEI departments, such as Nursing and Applied Health Sciences, and outside university institutions. One major collaborative project that has grown tremendously over the past few years and involves several of these departments is summarized below.

Dr. John VanLeeuwen, Professor of Ruminant Health Management and Epidemiology at the AVC, has been working extensively with both Kenyan dairy farmers and Farmers Helping Farmers (FHF)—a PEI-based non-governmental organization—for some time now, and 2011 was another busy and active year for the Kenyan Smallholder Dairy Program.



In January, John and three AVC students—Murray Gillies (New Brunswick), Erika Kubik (New Brunswick), and Erin Ramsay (PEI)—worked with Kenyan veterinarians, animal health technicians, and smallholder dairy farmers. In partnership with Farmers Helping Farmers and the Faculty of Veterinary Medicine at the University of Nairobi (FVM-UoN)—5 Kenyan veterinary students joined them—they provided veterinary medicine services and extension to improve the health and productivity of dairy cattle on poor subsistence dairy farms. This was the 7th year that this course in International Dairy Health Management was offered. Support for this project came from the Canadian International Health Agency, FHF, AVC, FVM-UoN, and private donations.

In June, one of John's Kenyan graduate students, Dr. Waweru Kabaka, successfully defended his MSc thesis, investigating the prevalence, risk factors and treatment of gastrointestinal parasites in Kenyan smallholder dairy farms. Support for this project was from the FHF, AVC, FVM-UoN, and the XXIII World Veterinary Congress Foundation.



In July, John was joined by 2 veterinary students (Valerie Montpetit of the Faculty of Veterinary Medicine in Montreal, and Laura Field of Western College of Veterinary Medicine in Saskatoon), and again worked with the Kenyan smallholder dairy farmers, conducting a pilot project on failure of passive transfer in calves, and providing additional veterinary services and extension. Support for this project was from Veterinarians without Borders-Canada, FHF and AVC.

In August, a Canadian graduate student, Carolyn Dohoo, based at Dalhousie University and co-supervised by John VanLeeuwen and Judy Guernsey of Dalhousie, successfully defended her MSc thesis which investigated the impacts of biogas digesters on human health, quality of life, and the environment among Kenyan smallholder dairy farmers. Support for this project was from the FHF, AVC, and the RURAL Centre based at Dalhousie, enabled by the Canadian International Development Agency (CIDA).

In October, John, Kim Critchley (UPEI Dean of Nursing), and Colleen Walton (Department of Health Management PhD candidate) led a multidisciplinary team (veterinary, nursing, nutrition, education, family science, environmental studies, and business) of UPEI faculty in the preparation and submission of a \$5-million proposal to CIDA to conduct a 5-year project to assist Kenyan universities and smallholder dairy farmers. The team included Drs. Jeff Wichtel, Rosemary Herbert, Jennifer Taylor, Kevin Teather, Carolyn Peach-Brown, and Janet Ferguson, and Ed Gamble, Charlene VanLeeuwen and Carolyn Francis.

In November, another one of John's Kenyan graduate students, Dr. Royford Bundi, successfully defended his MSc thesis, investigating the prevalence, risk factors, diagnosis, and treatment of mastitis in Kenyan smallholder dairy farms. Support for this project was from the FHF, AVC, FVM-UoN, and the XXIII World Veterinary Congress Foundation.

John plans to return to Kenya in January 2012 to continue his work with Kenyan veterinarians.

Research Activity

The major research areas of the core membership of CVER remain the same as in 2010. They are:

- finfish health (in particular sea lice)
- shellfish health
- dairy health (mastitis treatment, Johne's disease, milk quality)
- regulatory veterinary epidemiology (risk analysis and disease modelling)
- welfare of animal transport (horses and other domestic species), and
- diagnostic test evaluation (ISA, avian influenza).

Outreach

A number of major outreach activities took place in 2010. Some examples of these key initiatives are as follows:

- Epi-on-the-Island - This ever-popular, annual, 2-part course provides instruction in advanced methods in veterinary epidemiology. The first course focused on managing and analyzing spatial data using open-source software and was run by Drs. Javier Sanchez and Dirk Pfeiffer (Professor of Veterinary Epidemiology, The Royal Veterinary College, University of London). The second part was an introduction to multilevel modeling and was taught by Drs. Ian Dohoo and Henrik Stryhn. A truly international group gathered at UPEI for the 2 modules in early July. Two dozen participants represented several countries including Canada, USA, Norway, Taiwan, Singapore, New Zealand, Brazil, Puerto Rico, Ireland, Austria, Bolivia, and Bhutan.



- CVER and China partnerships build - A memorandum of understanding has been signed between China Agricultural University (CAU) and UPEI, facilitated by CRVE-Net. Dr. Ian Dohoo has developed a strategy document entitled “Development of Veterinary Epidemiology Training Capacity in China” with the objective to create a partnership between CAU and UPEI, and the end result being a graduate program in veterinary epidemiology.

- International teaching - Dr. Larry Hammell travelled to Grahamstown, South Africa in mid September to teach an OIE aquatic focal points workshop to fish health specialists from more than 10 countries. In December, Dr. Hammell also presented web-based lectures in surveillance for Aquatic Animal disease in Adelaide, Australia to 18 participants from both New Zealand and Australia. Also, Drs. Ian Dohoo and Henrik Stryhn visited Copenhagen, Denmark to teach a five-day advanced survival analysis course. Finally, in November 2011, Javier Sanchez and Raphael Vanderstichel joined members of the Canadian Cooperative Wildlife Health Centre (CWHC) in Argentina and Botswana to deliver the 3-day interactive workshop on wildlife surveillance systems.



Graduate Program

CVER has 25 graduate students, 8 enrolled in MSc programs and 17 working towards their PhDs. Several students completed their research in 2011.

- Dr. Tim Burnley completed his PhD under the supervision of Drs. Henrik Stryhn and Larry Hammell. His thesis was titled “Atlantic salmon vaccine performance and production characteristics evaluated through multisite clinical field trials.”
- Dr. Raphael Vanderstichel completed his PhD under the supervision of Dr. Ian Dohoo. His thesis title was the “Development of guidelines for immunological monitoring of gastrointestinal parasites in dairy cattle.”
- Dr. Kimberley MacDonald completed her PhD under the guidance of Dr. Greg Keefe. Her thesis was titled “Evaluation of a 3M Petrifilm-based on-farm culture system and treatment decision algorithm for clinical mastitis in Canada.”
- Dr. Alejandro Ceballos-Marquez completed his PhD under the guidance of Drs. Jeff Wichtel and Herman Barkema. His thesis was entitled “Selenium supplementation in cattle: Transfer to milk and udder health.”
- Louis Ferguson completed his MSc under the guidance of Dr. Jeffrey Davidson. His thesis was titled “Investigating vectors for aquatic invasive species of tunicates in the Canadian shellfish aquaculture industry.”
- Nicole Lewis completed her MSc titled “Analysis of simulated outbreak data and spatial analysis of highly pathogenic avian influenza for preparedness planning and policy.” Her supervisors were Drs. Javier Sanchez and John VanLeeuwen.



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