

ANNUAL REPORT **12-13**



Canadian Cooperative Wildlife Health Centre



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Who We Are

The CCWHC is Canada's national health system for wildlife. Established in 1992 and based in Canada's five colleges of Veterinary Medicine, we are a unique national network of Canada's wildlife health professionals and a Collaborating Centre of the World Organisation for Animal Health (OIE). We provide Canada with constant vigilance for wildlife health through constant monitoring, critical research, policy advice and educational programs.

What We Do

Health Surveillance is a national program that integrates the detection of disease occurrences, the identification of those diseases (diagnosis), the collection of health and disease information into a single database, and analysis and communication of results into a coordinated Canada-wide system for vigilance, assessment and response to wildlife health issues. CCWHC professional staff are skilled in coordinating, conducting and interpreting broad-scale monitoring programs, reporting on them in program-specific reports and databases, and providing ongoing advice, information and data management services

Education We are is dedicated to advancing the field of wildlife health through contributions to University curricula, training courses and workshops for continuing education, and development of future wildlife health professionals through programs of advanced study. The CCWHC also is dedicated to educating the public through informational websites, public presentations and the news media.

Research and Management We lead and collaborate in many research projects and programs on important wildlife health issues. Some of the programs currently underway include include surveillance for Avian Influenza viruses in wild birds, surveillance and research on White Nose Syndrome among bats, Chronic Wasting Disease, climate change, animal welfare, new measures of wildlife health and transmission of disease among wildlife, people and domestic animals.

Wildlife Health

Healthy wildlife populations are part of Canada's identity, and for good reason. Wild animal health is an indicator of the health of Canada. Management of wildlife health is vital to maintaining and enhancing the well-being of our environment and ourselves.

The CCWHC objective is to apply the best knowledge and science available to monitor and understand the health of Canada's wild animals and to keep decision-makers and the public informed and aware of wildlife health issues.

CCWHC Welcomes the Animal Health Centre

In June 2012, the Animal Health Centre (AHC), Ministry of Agriculture, Province of British Columbia, formally joined the CCWHC as a CCWHC diagnostic centre and regional node. The AHC and the CCWHC have worked together for many years and this new, formal partnership is the logical outcome of this long association. The AHC is the province's veterinary diagnostic laboratory and has always been the diagnostic centre for wildlife diseases in British Columbia. Integration into the CCWHC will improve the management of wildlife health information and positions the AHC to play a major role in delivering the full range of CCWHC wildlife health services in British Columbia. Already the AHC is participating in education and research on wildlife health in addition to its central role as a CCWHC diagnostic centre. With the Centre of Coastal Health in Nanaimo as a national CCWHC centre for epidemiology and surveillance, and the AHC in Abbotsford as a regional node, the CCWHC program in British Columbia has been greatly strengthened.



It is with great pleasure and considerable pride that I once again present to you this Annual Report from the Canadian Cooperative Wildlife Health Centre (CCWHC) for 2012-13. The depth, as well as the breadth, of CCWHC activities is impressive and is clearly evident in this Annual Report.

The annual national meeting of the senior staff of the CCWHC took place in Saskatoon this year. Thus, I was able to meet in person many of the people who are the power behind the success of the Centre, they speak with insight and passion about their work. The on-going program of wildlife disease surveillance that the CCWHC carries out 24/7 every day of the year is both significant and relevant. Discoveries are made year after year. New pathogens and diseases are found, for example unexpected protozoa infecting the brains of sea birds and mammals, beluga whales dying in childbirth and high infant mortality among the new-borns, and new nematode parasites in arctic ungulates. Well-known diseases are changing in distribution. The brain worm of white-tailed deer has moved far to the west, ticks and Lyme disease are racing northward as are some other parasites, quite likely in response to a changing climate. This emphasizes to me the incredible value of long-term, constant disease surveillance and long-term records, which are a central pillar of the CCWHC program.

Around the world, important nature conservation programs are financed by a mixture of government and private-sector subscription. This is true of the CCWHC now, but our financial resources are dominated by government contributions. The Executive Committee of the CCWHC is intent on achieving a better balance of government and non-government resources. To this end, it has formed a Development Subcommittee charged with finding sponsors for the CCWHC within Canada's business community. In 2012-13, this subcommittee developed a strategy for seeking such sponsorship, and we anticipate an active campaign starting in the second quarter of 2013-14.

The CCWHC unites Canada's five veterinary colleges and a wide range of other partners in a unique nation-wide program. Few other countries can claim an equivalent national health care and disease surveillance system for wildlife. This report will give you an account of one year in the life of the CCWHC. I also invite you to follow wildlife health events in Canada on the website: www.healthywildlife.ca.

Douglas Freeman
Dean
Western College of Veterinary Medicine
University of Saskatchewan





Executive Committee

- | | |
|-----------------------|--|
| Doug Freeman | Dean, WCVM (Chair) |
| Ian Alexander | CVO for Canada, Canadian Food Inspection Agency |
| Eric Boysen | Wildlife Director for Ontario |
| Marc Cattet | Elected CCWHC Staff member |
| Scott Deugo | Senior VP, Tecknion |
| Brett Elkin | CVO, Northwest Territories |
| James Gray-Donald | VP Sustainability, Bentall-Kennedy (Canada) |
| Wade Luzny | CEO Canadian Wildlife Federation |
| Rahul Maharishi | Assoc VP Marketing, TD Bank |
| Sue Milburn-Hopwood | Director-General, Canadian Wildlife Service |
| Darryl Neate | Sustainability Director, Oxford Properties |
| Mark Raizene | Director General (Zoonoses), Public Health Agency Canada |
| Carolyn Sedgewick | Assoc VP Strategic Planning, Canadian Tire |
| Jonathan Sleeman | Director, National Wildlife Health Center, USGS |
| Provincial CMOH – TBA | |

Management Committee

- | | |
|--------------------|---|
| Ted Leighton | Executive Director (Chair) |
| Patrick Zimmer | Headquarters Director (Vice-Chair) |
| Trent Bollinger | Western/Northern Regional Director |
| Kevin Brown | Information Technology Manager |
| Marc Cattet | CCWHC Executive Committee Member |
| Pierre-Yves Daoust | Atlantic Regional Director |
| Chelsea Himsworth | BC Diagnostic Node |
| Claire Jardine | Ontario/Nunavut Regional Director |
| Susan Kutz | Alberta Regional Director |
| Stéphane Lair | Quebec Regional Director |
| Dale Smith | Associate Director Ontario/Nunavut Region |
| Craig Stephen | Centre for Coastal Health Director |



Alberta

Susan Kutz	Director
Padraig Duignan	Pathologist
Mani Lejeune	Parasitologist
Jian Wang	Lab Manager

Associates:

Nigel Caulkett	Sylvia Checkley
Alessandro Massolo	Karin Orsel
Judit Smits	Craig Stephen

Centre for Coastal Health

Craig Stephen	Director
Jennifer Dawson	Research Associate
Tyler Stitt	Research Associate

Ontario & Nunavut

Claire Jardine	Director
Dale Smith	Associate Director
Doug Campbell	Pathologist
Dave Cristo	Projects Coordinator
Carol-Lee Ernst	Clerical
Jane Parmley	Epidemiologist
Erin Scharf	Technician
Lenny Shirose	Biologist

Associates:

Ian Barker	John Lumsden
David Pearl	

Western & Northern

Trent Bollinger	Director
Lorraine Bryan	Pathologist
Crystal Rainbow	Technician
Chloe Rollack	Technician
Marnie Zimmer	Biologist

Associates:

Janet Hill	Emily Jenkins
Vikram Misra	Cheryl Waldner

Atlantic Region

Pierre-Yves Daoust	Director
Fiep de Bie	Technician
Maria Forzán	Pathologist
Scott McBurney	Pathologist
Darlene Weeks	Technician

Associates:

Gary Conboy	Marion Desmarchelier
Heather Fenton	Shannon Ferrel
Spencer Greenwood	Dave Groman
Fred Kibenge	Shannon Martinson
Raphael Vanderstichel	

Headquarters Office

Ted Leighton	Executive Director
Patrick Zimmer	Director
Kevin Brown	Information Services Manager
Marc Cattet	Senior Research Scientist
Bevan Federko	Programmer Analyst
Nadine Kozakevich	Accountant
Chris Pinel	Systems Analyst
Christine Wilson	Technician

Associates:

Catherine Soos	Gordon Stenhouse
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British Columbia (Animal Health Centre)

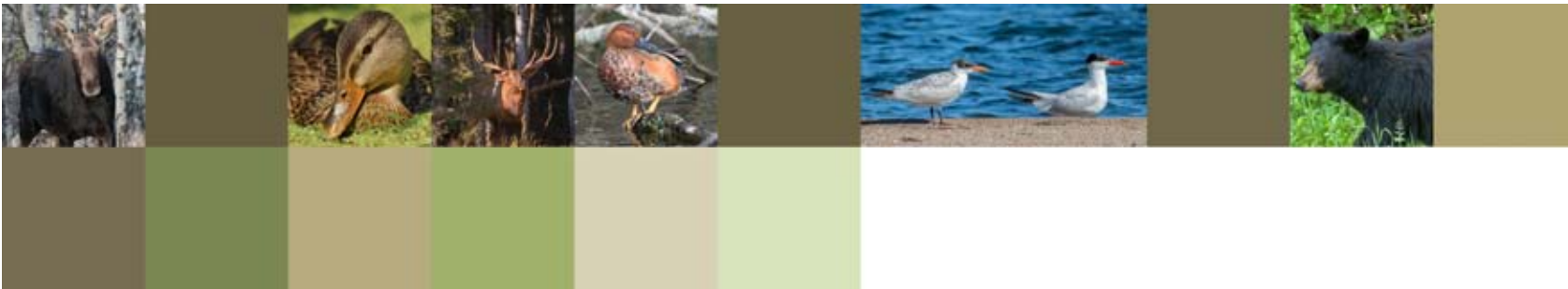
Chelsea Himsworth	Coordinator
Victoria Bowes	Pathologist
Ann Britton	Pathologist
Sean Byrne	Bacteriologist
Jane Pritchard	Laboratory Director
Stephen Raverty	Pathologist

Quebec

Stéphane Lair	Director
Joëlle Benoit	Technician
Kathleen Brown	Lab Manager
Viviane Casaubon	Technician
André D. Dallaire	Pathologist
Audrey Daigneault	Technician
St-Germain	
Judith Viau	Technician

Associates:

Julie Arsenault	Guy Fitzgerald
Sylvain Larrat	Fidisoa Rasambainvo
Arianne Santamaria-Bouvier	

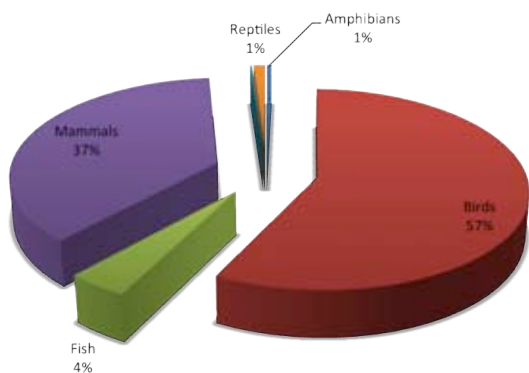


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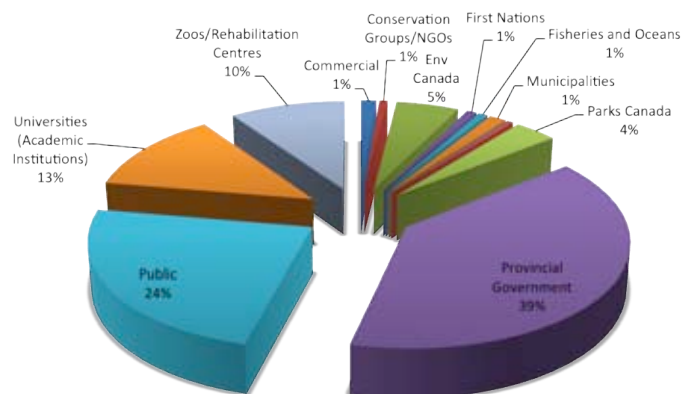
In 2012-2013, the number of wildlife specimens examined as part of the CCWHC health monitoring program rose by 6% from the previous year, with approximately 3600 specimens examined. The majority of specimens were birds and mammals and were provided to the program by government agencies and by public institutions, groups or individuals.

Among the particularly notable findings were several occurrences of wildlife poisonings, range expansions of several important parasites species, disease outbreaks among fish on the prairies and a resurgence of West Nile Virus in Eastern and Central Canada detected in wild birds.

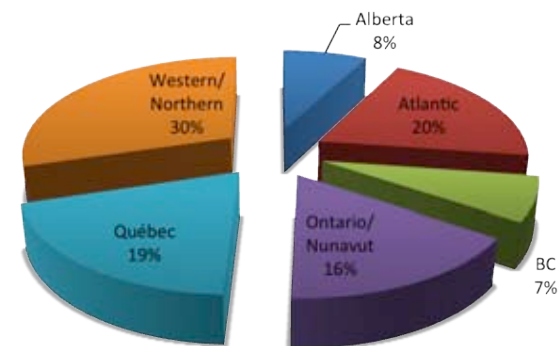
Specimens Examined by Taxonomic Grouping



Sources of Specimens Examined



Specimens Examined by CCWHC Region





The CCWHC Stress Lab

The CCWHC Stress Lab grew out of a long-standing research collaboration among David Janz (University of Saskatchewan), Marc Cattet (CCWHC Headquarters Office), and the Foothills Research Institute Grizzly Bear Program under the leadership of Gordon Stenhouse. This research endeavors to understand the role that long-term human-caused stress plays in the health of individual bears and in the performance of their populations. The premise is that rapid environmental change due to a range of human activities may be a persistent source of stress to resident grizzly bears. This has an impact on their health by diverting energy from essential biological functions, such as growth, immunity, and reproduction, toward physiological and behavioral stress-coping responses. It then follows that a decline in population performance, including decreased reproductive output and lower survival, becomes more likely as the number of bears with compromised health increases. This research recognizes the importance of the health of individual animals (wildlife health) in the performance of their populations and points toward the utility of developing biological markers (biomarkers) of long-term stress as early warning indicators of potential wildlife health and population performance issues.

Our development of long-term stress biomarkers began in earnest at the University of Saskatchewan in 2005 with the development and validation of a detection microarray for 33 stress-associated proteins (figure 1). This was followed with research on measurement of cortisol, a primary stress hormone, in hair samples from several threatened species, including grizzly bear, polar bear, and caribou. Both procedures can be applied to small amounts of biological samples taken from a wide range of mammals, not just grizzly bears, and the samples needed can be collected from animals without capture and restraint, e.g., with biopsy darting (figure 2), or barbed wire hair snags (figure 3). This is particularly important in light of our growing awareness that capture and restraint are also sources of long-term stress. A growing number of queries from other wildlife researchers interested in applying our biomarkers sparked the idea of forming a commercial diagnostic service, *The CCWHC Stress Lab*.

The CCWHC Stress Lab is now entering its third year of operation and while there is ongoing analysis of grizzly bear research samples, the number of samples submitted from other species and from external sources has gradually outpaced research submissions. These include samples from polar bear, moose, caribou, feral horse, harbor seal, elephant seal and bottlenose dolphin collected by researchers working in the Canadian Arctic, Norway, Alaska, California, and the eastern seaboard of the United States. The service operates on a cost-recovery basis with revenue used to expand the range of biomarkers we can measure in these same samples, including reproductive function and energy status. If you are interested in learning more about these services, please contact the CCWHC Headquarters Office at 1-800-567-2033 or headquarters@ccwhc.ca.

Figure 1

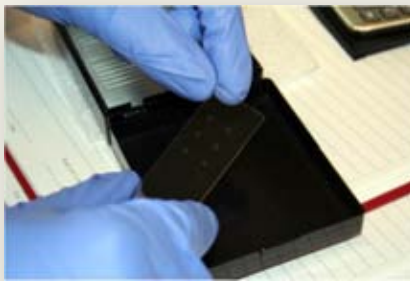


Figure 2



Figure 3





Sudden mortality of young grey seals in eastern Canada in winter 2012

In late February 2012, an unusual number of dead young grey seals (*Halichoerus grypus*) were reported on a small island off the east coast of Cape Breton Island, Nova Scotia. Approximately 2,500 grey seal pups are born on that island every year, and it is common to find several carcasses of pups that would have died of starvation. In this case, however, approximately 400 dead pups (16% of the average number of pups born) were counted, and the vast majority of them appeared to be in good body condition. Moreover, the time of year and the pattern of the pelt on the pups suggested that very few, if any, of them had yet gone into the water.

For logistical reasons associated with the weather, only 10 carcasses were examined. However, the cause of death in all 10 animals was the same, consisting of severe acute liver damage caused by a (microscopic) protozoan parasite subsequently identified as *Sarcocystis canis*, thanks to the help of scientists at the National Institutes of Health, in Bethesda, Maryland.

Details of the life cycle of *S. canis* are unknown. This protozoan has been associated with liver damage in a variety of species, including domestic dogs, black bears, California and Steller sea lions, and Hawaiian monk seals. The case in grey seal pups represents the largest mortality caused by this parasite that has been identified so far. It is tempting to compare this situation with that of another species of *Sarcocystis*, *S. neurona*, affecting sea otters on the west coast of North America. The final host of *S. neurona* is the American opossum, and parasite eggs in its feces are thought to gain access to the marine ecosystem through contaminated water runoff from the mainland. The term 'pollutogen' has been coined by some to describe the emergence of such microbial pathogens in unexpected places as a result of environmental pollution.

The age of the animals affected is also intriguing. Because a large proportion, perhaps all, of the pups had never gone into the water and eaten fish, it must be assumed that they became infected either while still in the mother before birth or from their mothers' milk, thus implying that the latter were carrying the parasite. It is not uncommon for such carriers to release the parasites into their blood stream in periods of stress, when their immune system is not as vigilant. What remains to be determined is the factor(s) that may have induced such a large proportion of the females to release these parasites in order for them to get access to the pups.





Warm-water perturbation in the Gulf of St. Lawrence and around Newfoundland in summer 2012

Highly abnormal behaviour of Northern Gannets (*Morus bassanus*) in eastern Canadian waters in early August 2012 likely reflected major changes in their oceanic environment. Some time between August 6 and 8, a very large proportion of the adults at the large breeding colony at Cape St. Mary's, off the southern coast of Newfoundland (the southernmost breeding colony in North America), abandoned their young on the nest. About one week later, approximately 40% of the chicks were still abandoned. At about the same time, there was also a major, but more gradual, desertion of nestling birds by their parents on Bonaventure Island, off the tip of the Gaspé Peninsula (the largest breeding colony of Northern Gannets in North America).

Some live adult birds caught around these colonies at this time were under weight, and the necropsy of a few adults and chicks, performed by the CCWHC (Québec and Atlantic regions) and by the Animal Health Laboratory, St. John's, Newfoundland and Labrador, indicated death from starvation, with no evidence of another underlying disease problem.

As expected, there was a marked decrease in reproductive success at these two colonies in 2012, with marked decreases in the fledging rate which, in the case Cape St. Mary's, decreased by almost 54%. These dramatic events coincided with a substantial increase in sea surface temperature (SST) in the region. This increase may have either forced fish prey, such as mackerel, into deeper, colder waters inaccessible to the Gannets, or it may have driven prey species to cooler waters in the north. Indeed, large numbers of Northern Gannets were observed well north of their normal foraging ranges in August 2012. Interestingly, adult Northern Gannets recovered their average normal weight by the end of August 2012, coinciding with a return to cooler SST.

Observations of marine mammals around that time may have also reflected some major changes in SST. There was, for example, a marked decrease in numbers of fin whales and humpback whales seen near the Saguenay estuary in August. There was also an unusually high number of beluga calves found dead in that region; the cause of these deaths was not determined, but may have been associated with this unusual SST.





Canada's National Wildlife Disease Database

Since its inception in 1992, the CCWHC has progressively developed and maintained a secure and unique computerized data repository that supports research and helps government agencies make sound decisions about wildlife health issues. The database facilitates real-time collaboration and eases data sharing and the exchange of information between researchers, wildlife disease managers and other stakeholders. Its adaptability accommodates the need to store, assess and communicate wildlife disease information for emerging issues and focused research and allows insights into disease occurrence trends at the local, provincial and national levels. In recent years concerns such as West Nile Virus, Avian Influenza, Chronic Wasting Disease and Rabies have all been monitored using this software specifically developed by the CCWHC. The two tables below provide examples of the type and quantity of information contained in the CCWHC database, which currently contains approximately 250,000 records spanning 20 years.

Specimen Composition by Class and Order 2008-2012

Taxonomic Order	2008	2009	2010	2011	2012	2013	Grand Total
Amphibians	57	181	139	117	15	0	509
Amphibians (Amphibia)	57	181	139	117	15	0	509
Birds	2617	2933	2342	2285	2026	275	12478
Birds (Aves)	11	14	14	16	26	0	81
Cranes (Gruiformes)	7	7	16	7	14	1	52
Cuckoos (Cuculiformes)	0	0	0	0	1	0	1
Game Birds (Galliformes)	24	25	18	20	11	7	105
Humminbirds (Apodiformes)	0	0	0	0	20	0	20
Kingfishers (Coraciiformes)	2	3	3	1	2	0	11
Owls (Strigiformes)	253	241	197	256	240	72	1259
Perching Birds & Songbirds (Passeriformes)	686	970	707	767	641	63	3834
Pigeons (Columbiformes)	103	87	100	106	85	21	502
Wading Birds (Ciconiiformes)	1076	1154	890	790	670	86	4666
Waterfowl (Anseriformes)	436	395	374	296	280	23	1804
Woodpeckers & Flickers (Piciformes)	19	37	23	26	36	2	143
Fish	93	74	94	205	149	14	629
Fish (Osteichthyes / Chondrichthyes)	93	74	94	205	149	14	629
Mammals	740	769	967	1059	1252	266	5053
Bats (Chiroptera)	73	129	288	388	286	127	1291
Carnivores (Carnivora)	353	305	322	344	568	82	1974
Cervids (Cervidae)	187	205	219	188	267	50	1116
Insectivores (Insectivora)	1	2	14	7	0	0	24
Lagomorphs (Lagomorpha)	21	22	15	24	17	2	101
Marine Mammals (Cetacea)	9	17	18	26	28	0	98
Rodents (Rodentia)	96	89	91	82	86	5	449
Other	69	98	86	31	76	89	449
Other	69	98	86	31	76	89	449
Reptiles	16	33	31	121	36	3	240
Reptiles (Reptilia)	16	33	31	121	36	3	240
Grand Total	3592	4088	3659	3818	3554	647	19358

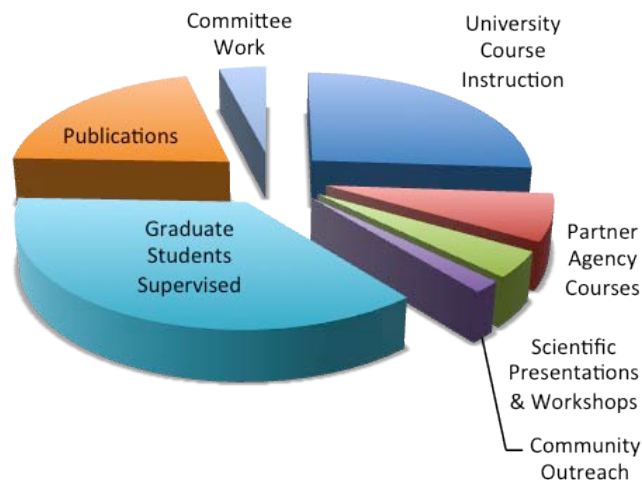
Specific Pathogen Occurrence 2008-2012

Pathogen or Disease	# cases tested from 2008 to 2012	Detected?
AIV	29500	yes
Anthrax	66	yes
Baylisascaris	134	yes
Botulism	160	yes
Bovine Tuberculosis	8	yes
Brucellosis	17	yes
Campylobacter sp	91	yes
Clostridium perfringens	233	yes
Cryptococcus	1	no
Cryptosporidium	27	yes
Chronic Wasting Disease	10404	yes
E.coli	810	yes
Echinococcus	21	yes
Giardia	13	yes
Leptospirosis	96	yes
Listeria	15	yes
Pasteurellosis	101	yes
Plague (Yersinia pestis)	2	yes
Psittacosis (Chlamydia psittaci)	8	yes
Rabies	8815	yes
Ringworm	6	yes
Salmonellosis	867	yes
Sarcocystis	456	yes
Staphylococcus	303	yes
Streptococcus	331	yes
Toxoplasmosis	58	yes
Toxocara	21	yes
Trichinellosis	28	yes
Tularemia	3	yes
West Nile Virus	2569	yes
Yersinia enterocolitica	2	yes
Yersinia pseudotuberculosis	8	yes



Education is a key activity for the CCWHC. Education supports disease surveillance through instruction and engagement of wildlife field personnel and the public, and creates wildlife health specialists through university programs. Educational workshops, held nationally and internationally, promote the ongoing professional development of wildlife health professionals, the development of programs and the interchange of knowledge, while addressing current issues affecting the health of wildlife, domestic animals, people and the environment. University-based academic programs supported by the CCWHC provide a steady flow of valuable teaching material and learning opportunities for undergraduate and graduate students, while also benefiting government agencies by contributing to the education of highly qualified personnel and by contributing to projects that address management and policy issues of direct interest to CCWHC partner agencies.

Invested Time in Educational Activities



In 2012-2013, CCWHC staff contributed approximately 700 hours of University course instruction, numerous scientific presentations, approximately 60 publications and book chapters, as well as partner agency courses and workshops.

Currently, there are 51 graduate students and associated research projects supervised and conducted via the CCWHC and its associates.

These graduate student projects include the evaluation of biomarkers of long-term stress in free-ranging grizzly bears, impacts of habitat and landscape features on reproductive success of wild ducks, leptospirosis in urban rats, antimicrobial resistant bacteria in wildlife in Ontario, factors affecting tick abundance and the prevalence of the bacterial agent of Lyme Disease in southern Ontario, body condition indices in Beluga Whales, Tularemia in Quebec wildlife, Chronic Wasting Disease dynamics in southern Saskatchewan, impact of climate and climate change on the transmission and spread of parasites, and Trichomoniasis in wild finch populations in the maritime Canada.



Avian Bornavirus: A cause of disease in free-ranging waterfowl in North America

A new strain of this recently discovered virus was identified in 2009 as a fatal infection of the nervous system in free-ranging Canada geese (*Branta canadensis*) and trumpeter swans (*Cygnus buccinator*) in southern Ontario.

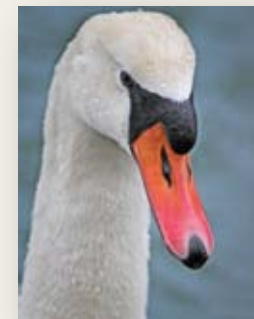
A retrospective evaluation of autopsies at the Toronto Zoo and the Canadian Cooperative Wildlife Health Centre (CCWHC) – Ontario from 1992 to 2011 revealed the presence of avian Bornavirus in tissues showing lesions resembling those described in parrots affected with proventricular dilatation disease, a fatal neurological condition of psittacine birds also caused by a bornavirus.

Although this unique genotype of avian bornavirus has been isolated from apparently healthy geese, swans and ducks in the United States, our findings confirmed that it can also cause disease and death in wild waterfowl species.

Between October 2010 and May 2012, samples were collected from 206 free-ranging Canada geese, 135 trumpeter swans, 75 mute swans (*Cygnus olor*) and 208 mallard ducks (*Anas platyrhynchos*) to estimate the prevalence of ABV infection in Ontario. At one site, 12.5 % of the geese caught had ABV in their faeces but none was found in geese sampled at three other locations. However, serum antibodies were present in birds at all four sites. The prevalence of shedding of ABV was found in 9% of the mute swans, and in none of the trumpeter swans and mallards. The reason for these differences among species and locations is unknown.

The waterfowl strain of avian bornavirus appears broadly distributed within the ranges of North American waterfowl species and has likely been present here for a substantial period of time. The significance of this virus on wild populations and the possible role of waterfowl as a vector of ABV for other species are currently unknown. Evaluation of European waterfowl for the presence of ABV is underway.

This study is part of Dr Pauline Delnatte's graduate work; she is supervised by Dr. Dale Smith at the University of Guelph, CCWHC Ontario/Nunavut





A Renewed Partnership with Sri Lanka

Since 2008, the CCWHC has been assisting university and government colleagues in Sri Lanka to enhance the country's capacity to understand and manage wildlife health, leading to the establishment of the Sri Lanka Wildlife Health Centre (SLWHC). Like the CCWHC, the SLWHC is a partnership among the national veterinary college and government agencies responsible for human and animal health and wildlife conservation. In 2013, the CCWHC and the SLWHC together proposed a 4-year development program to Canada's International Development Research Centre. Entitled *Building Research Excellence in Wildlife and Human Health in Sri Lanka*, a program of graduate training and research in pathology, epidemiology and sociology relevant to wildlife health management was proposed. This proposal was accepted, generously supported with a total of \$873,000 over four years, and began officially on 1 March 2013. Through this program, we anticipate training the small core of Sri Lankan scientists required to begin a national program of wildlife disease surveillance and also two Canadian graduate students who will focus on the human dimensions of cross-sectoral science and knowledge mobilization. We anticipate that several CCWHC staff members will participate in this program as teachers, research co-supervisors and student mentors, some traveling to Sri Lanka and others participating remotely through video links.





CCWHC Western & Northern Regional Centre Hosts Short Course for SIAST Students

In February 2013, 11 students from the Saskatchewan Institute of Applied Science and Technology (SIAST) Resource and Environmental Law (REL) program along with their 2 instructors came to the WCVM in Saskatoon for a two-day short course on wildlife diseases. The students from the REL program go on to become Conservation and Fish and Wildlife Officers who play a critical role in wildlife health surveillance.

The mornings were spent in the classroom discussing the role of the CCWHC, the importance of wildlife disease surveillance and an overview of zoonotic diseases. The students were exposed to different disease scenarios highlighting the basics of field investigations. Autopsy techniques, sample collection and safety precautions were discussed.

Afternoon sessions consisted of a demonstration autopsy to highlight the importance of collecting the appropriate samples in order to determine cause of death when whole bodies cannot be sent directly to the veterinary diagnostic lab. The students then had their chance to try out their autopsy skills with the assistance of CCWHC staff members.

This is the 2nd year that this course has been conducted and CCWHC Western Northern plans to be involved with SIAST in the future with similar short courses. This was a great way for the students to gain hands on skills for their careers and also allows the CCWHC to meet future Conservation and Fish and Wildlife Officers and recruit them as future participants in health surveillance.

Similar courses are conducted at other CCWHC centre; for instance, in the summer of 2012, CCWHC Alberta organized an autopsy workshop for Parks Canada personnel. The event was conducted at a Parks Canada necropsy facility. The event was well received and participants expressed their desire to have such workshops frequently.

First National Meeting of Canada's Marine Animal Emergency Response Networks

Thirty people from across the country, representing the four major marine animal emergency response networks (Newfoundland & Labrador, the Maritime Provinces, Quebec and BC), the federal government (Fisheries and Oceans Canada and Parks Canada), the Canadian Wildlife Federation, the CCWHC and the province of Prince Edward Island, met in Charlottetown in March of 2013. In recent years, the capacity of these groups to respond to marine animal incidents has declined. The purpose of this first-ever national gathering was to evaluate Canada's capacity to respond to incidents involving marine animals and to identify opportunities to sustain and increase this capacity. This workshop was organized by the Marine Animal Response Society with the support of the Government of Canada – Habitat Stewardship Program for Species at Risk, the Canadian Wildlife Federation and the Donner Canadian Foundation.

Canadians expect someone to respond when whales, seals, sea lions, sea turtles or sharks are discovered in trouble or carcasses are found. There are approximately 1000 marine animal incidents each year across the country. The Network's members respond to assist animals that are entangled, beached, injured or otherwise in distress, as well as to gather valuable information from dead animals. The CCWHC assists in the latter pursuit and has also developed of a database module to store stranding and other valuable observational data.

As a result of this meeting a working group was formed to investigate the benefits of establishing a cooperative of response networks to improve Canada's capacity to respond to marine animal incidents.

Necropsy demonstration by Dr. Pierre-Yves Daoust, CCWHC Atlantic Region





A Selection of Publications and Reports by CCWHC Staff and Associates

(For a larger list of recent publications please visit - http://www.ccwhc.ca/2012_2013_publications_list.php)

Daoust P-Y, M van de Bildt, D van Riel, G van Amerongen, T Bestebroer, **R Vanderstichel**, RAM Fouchier, and T Kuiken. 2012. Replication of two subtypes of low-pathogenicity Avian Influenza virus of duck and gull origins in experimentally infected Mallard ducks. *Veterinary Pathology Online* <http://vet.sagepub.com/content/early/2012/12/14/0300985812469633>

Daoust P-Y, and C Caraguel. 2012. The Canadian harp seal hunt: observations on the effectiveness of procedures to avoid poor animal welfare outcomes. *Animal Welfare* 21: 445-455.

Van Der Hoop JM, MJ Moore, SG Barco, TVN Cole, **P-Y Daoust**, AG Henry, DF McAlpine, WA McLellan, T Wimmer, and AR Solow. 2012. Assessment of management to mitigate anthropogenic effects on large whales. *Conservation Biology* 27:121-133.

Steele J, Cuyler C, Orsel K, **Kutz SJ** (In press) Differences in parasite diversity, prevalence, and intensity assessed through analyses of fecal samples from two West Greenland caribou populations. *Rangifer*. In Press.

Verocai GG, **Lejeune M**, Beckmen K, Kashivakura CK, Veitch A, Popko R, Fuentealba C, Hoberg E, **Kutz JS** (2012) Defining parasite biodiversity at high latitudes of North America: new host and geographic records for *Onchocerca cervipedis* (Nematoda: Onchocercidae) in moose and caribou. *Parasites & Vectors*, pp. 242.

Catalano S, **Lejeune M**, Liccioli S, Verocai GG, Gesy KM, Jenkins EJ, **Kutz SJ**, Fuentealba C, **Duignan PJ**, **Massolo A** (2012) *Echinococcus multilocularis* in urban and peri-urban Coyotes (*Canis latrans*) in Alberta, Canada. *Emerging Infectious Disease*, vol. 18, no. 10, pp. 1625-1628.

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Anholt RM, **Stephen C**, Copes R. 2012. Strategies for collaboration for the interdisciplinary field of emerging zoonotic diseases. *Zoonoses and Public Health.* 59(4): 229-240

Dissanayake R, **Stephen C**, Daniel S, Abeynayake P. 2012. Gap assessment of animal health legislation in Sri Lanka for emerging infectious diseases preparedness. *Outlook on Agriculture.* 41(3): 203-208

Boulanger J, **Cattet M**, Nielsen S, Stenhouse G, Cranston J. 2013. The use of multi-state models to explore relationships between changes in body condition, habitat, and survival of grizzly bears. *Wildlife Biology* (Accepted).

Cattet M. 2013. Falling through the cracks: shortcomings in the collaboration between biologists and veterinarians and its consequences for wildlife. *ILAR Journal* (Accepted).

Macbeth BJ, **Cattet M**, Obbard ME, Janz DM. 2012. Evaluation of hair cortisol concentration as a biomarker of long-term stress in free-ranging polar bears. *Wildlife Society Bulletin* (DOI: 10.1002/wsb.219).

Zedrosser A, **Cattet M**, Swenson JE, Stenhouse G. 2013. Same, but different: patterns of growth and determinants of size of brown bears in Canada and Sweden. *BMC Ecology* (In Review).

Harms N.J, Elkin B, Gunn A, Tracz B, Adamczewski J, Flood P, **Leighton FA**. 2012. Serum biochemistry and serum cortisol levels in immobilized and hunted muskoxen (*Ovibos moschatus*) from Northern Canada. *Arctic* 65(4): 401-410.

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Influenza Virus Detection in Wild Ducks. *Journal of Wildlife Diseases* 48(2): 444-448.

Jardine CM, Janecko N, Allan M, Boerlin P, Chalmers G, Kozak G, McEwen SA, Reid-Smith RJ. 2012. Antimicrobial Resistance in *Escherichia coli* Isolated from Raccoons (*Procyon lotor*) in Southern Ontario, Canada. *Applied and Environmental Microbiology* 78: 3873-3879.

Pham PH, Jung J, **Lumsden JS**, Dixon B, Bols NC (2012). Potential of waste items in aquatic environments to act as fomites for viral haemorrhagic septicemia virus. *Journal of Fish Diseases*, 35:73-77.

Henaux, **Parmley**, Soos, Samuel. 2013. Estimating transmission of avian influenza in wild birds from incomplete epizootic data: implications for surveillance and disease spread. *Journal of Applied Ecology* 50:223-31.

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Peregrine, A.S., E.J. Jenkins, B. Barnes, S. Johnson, L. Polley, **I.K. Barker**, B. De Wolf and B. Gottstein. 2012. Alveolar hydatid disease (*Echinococcus multilocularis*) in the liver of a Canadian dog in British Columbia, a newly endemic region. *Canadian Veterinary Journal* 53: 870-874.

Larrat, S., F. Bouchard, G. Séguin, **S. Lair**. Relationship between red vent syndrome and Anisakid larvae burden in wild Atlantic salmon (*Salmo salar*). *Journal of Wildlife Disease.* 49(2), 229-234. 2013.

Larrat, S., **A.D. Dallaire**, **S. Lair**. Emaciation and larval filarioid nematode infection in boreal owls (*Aegolius funereus*). *Avian Pathology.* 41(4), 345-349. 2012

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Matsumoto, T.;Samuel, M. D.; **Bollinger, T**; Pybus, M.; Coltman, D. 2013 Association mapping of genetic risk factors for chronic wasting disease in wild deer. *Evolutionary Applications* :6 (2): 340-352



The CCWHC responds to a wide range of requests for information and advice from partner agencies, the public and the media. These include participation in regional, national and international meetings and workshops, participation on scientific and government committees, and reports on specific issues. The CCWHC also responds to many general inquiries and strives to provide information by maintaining a technical information website: www.ccwhc.ca and a website of more general interest to the public: www.healthywildlife.ca.

Regional Examples

Nova Scotia Mainland Moose Recovery Team
 Parks Canada Eastern Animal Care Task Force
 Atlantic Society of Fish and Wildlife Biologists
 Maritime Marine Animal Response Network
 Prairie Diagnostic Services – Board of Directors
 External member of the GNWT Wildlife Care Committee
 Wildlife Chemical Immobilization (SK and AB)
 Ontario Working Group on Highly Pathogenic Influenza
 Subcommittee on wildlife Bird Surveillance (ON)
 Ontario Bat Working Group
 Ontario Zoonotic Influenza Working Group – Steering Committee
 OZIWG – Surveillance Sub-Working Group
 Ontario Rabies Advisory Committee
 Southern Ontario Bald Eagle Recovery Team
 Veterinary expertise for the "Réseau québécois d'urgence pour les mammifères marins"
 Provincial committee for the enhance surveillance of raccoon rabies in Quebec
 Provincial committee for the surveillance of Avian Influenza Virus
 Veterinary expertise for the regional CWS animal care committee
 Veterinary expertise for the animal care committee of the Université du Québec en Abitibi-Témiscamingue
 Veterinary expertise Aquarium du Quebec (conservation on native wildlife)
 Veterinary expertise Stations piscicoles du Quebec (Provincial fish hatcheries)

National Examples

CoSEWIC Terrestrial Mammals sub group
 Fur Institute of Canada (CAZWV representative)
 PrioNet Canada – Research Management Committee

Canadian Veterinary Reserve – Reservist
 Expert Witness Services
 Parks Canada Animal Care Committee
 Canada's Inter-agency Wild Bird Influenza Survey
 Canadian Association of Zoo and Wildlife Veterinarians
 White Nose Syndrome National Steering Committee
 Canadian Animal Health Surveillance Network
 Canadian Animal Health Laboratories Network
 National Marine Animal Stranding Network

International Examples

Wildlife Disease Association, Latin America Section
 NAMMCO Expert Group to assess the hunting methods of small cetaceans
 OIE Working Group on Wildlife Diseases
 US Fish and Wildlife Service – Federal/State WNS Consultation
 USFWS WNS Response Plan – Diagnostic Working Group
 Advisory Board of the Wildlife Disease Association Wildlife Veterinary Section
 Ontario Veterinary College International Committee and Global Vets
 Wildlife Focal Points – OIE
 Ad hoc Committee on Training Program Standards, Structure, and Evaluation of the American College of Zoological Medicine
 International Development Research Centre (Canada) – Building Research Excellence on the Wildlife-Human Health Interface in Sri Lanka



Health surveillance regularly identifies issues requiring more extensive assessment, research, or management responses. Special programs to pursue these health issues comprise a large component of CCWHC activities. Examples of such special projects include Avian Influenza Virus and West Nile Virus surveillance among wild birds, rabies surveillance, Chronic Wasting Disease transmission and management among wild cervids and coordinating Canada's national response to White-nose Syndrome in bats.

Summary Data 2012 Wild Bird Avian Influenza Survey

Province	# Tested	# Positive
British Columbia	295	2
Alberta	97	0
Saskatchewan	357	0
Manitoba	29	0
Ontario	166	3
Québec	529	3
New Brunswick	30	0
Nova Scotia	46	3
Prince Edward Island	105	0
Newfoundland & Labrador	1	0
Yukon Territory	2	0
Northwest Territories	7	0
Nunavut	0	0
Total	1664	11

Summary Data 2012 Rabies

Province	# Tested	# Positive
British Columbia	0	0
Alberta	6	0
Saskatchewan	52	1
Manitoba	5	0
Ontario	12	1
Québec	1004	1
New Brunswick	17	0
Nova Scotia	151	0
Prince Edward Island	29	0
Newfoundland & Labrador	20	0
Yukon Territory	3	0
Northwest Territories	0	0
Nunavut	0	0
Total	1299	3

Summary Data 2012 West Nile Virus

Province	# Tested	# Positive
British Columbia	10	0
Alberta	1	0
Saskatchewan	15	1
Manitoba	3	1
Ontario	66	35
Québec	52	36
New Brunswick	1	0
Nova Scotia	1	0
Prince Edward Island	0	0
Newfoundland & Labrador	0	0
Yukon Territory	0	0
Northwest Territories	1	0
Nunavut	0	0
Total	150	73

Summary Data 2012 White Nose Syndrome

Province	# Tested	# Positive
British Columbia	0	0
Alberta	1	0
Saskatchewan	1	0
Manitoba	0	0
Ontario	17	12
Québec	4	1
New Brunswick	10	9
Nova Scotia	38	32
Prince Edward Island	0	0
Newfoundland & Labrador	1	0
Yukon Territory	0	0
Northwest Territories	0	0
Nunavut	0	0
Total	72	54

Summary Data 2012 Chronic Wasting Disease

Species	2012		1997-2012	
	Positive	Negative	Positive	Negative
Mule Deer	25	243	306	27923
White-tailed Deer	7	209	73	15479
Elk	2	36	6	1525
Moose	0	14	0	116
Total	34	502	385	45043



Examination of rodent ectoparasite for pathogens of zoonotic importance

Rodents sometimes are reservoirs for infectious agents that can be transmitted from animals to humans. External parasites such as fleas and ticks on rodents can assist in transmitting such diseases to people. This is how some important infectious diseases are transmitted and these are anticipated to expand their range as our climate warms. In summer of 2012, CCWHC Alberta led a surveillance project at Sheep River Provincial Park (SRPP) to document the external parasites found on rodents and test them for potential human pathogens.

SRPP is located 100 km southwest of Calgary, Alberta in the foothills of the Rocky Mountains. This park is heavily used by people, has seasonal cattle grazing, and thus is a meeting ground for people, domestic animals and wildlife.

In all, 224 rodents were trapped and 872 external parasites were collected and now are being tested to see if they carried the agents that cause Plague Rocky Mountain spotted fever Tularemia Lyme Disease Babesiosis and Human Granulocytic Ehrlichiosis. So far, the agent that causes tularemia has been found.



Documenting Reproduction Failures in the St. Lawrence Beluga Whales

The CCWHC Quebec Region, monitors mortality in the threatened population of belugas from St. Lawrence Estuary^a. Dead calves less than one year of age were reported only occasionally (0-3 per year) from 1983 to 2007 comprising 8% of the total of carcasses found during that period. In 2008 and 2010, 8 dead calves were found each year. In 2012, a record high number of 16 beluga calves were found, accounting for 64% of the total of dead beluga. Autopsies have not identified a disease process that could have caused these mortalities. During this same period, there has been an increase in mortalities of pregnant females due to complications during calving (average of 1.2 cases/year from 2008 to 2012 compared to 0.2 case/year from 1983 to 2007). The calf mortalities were due primarily to calf-mother separation, resulting in starvation and dehydration of the lost calf. Possible causes of this increasing mortality of mothers and calves that must be explored include hormonal effects of different industrial chemicals, such as polybrominated diphenyl ethers, increase in disturbance from boaters, exposure to biotoxins produced by harmful algal blooms, and nutritional stress, these latter two possibly associated with higher than normal sea surface temperatures. Continued monitoring of calf production and mortality, autopsies and population surveys will determine whether these changes are transient or are a new threat to the recovery of this population of iconic whales.

^a In partnership with Parks Canada, Fisheries and Oceans Canada and the Groupe de recherche et d'éducation sur les mammifères marins,

Photo credit: GREMM, 2012





The Cohen Commission into the Decline of Fraser River Sockeye Salmon

The Cohen commission was struck, in part, to identify the causes for the decline of Fraser River sockeye salmon population including the impact of environmental changes along the Fraser River, marine environmental conditions, aquaculture, predators, diseases, water temperature and other factors that may have affected the ability of sockeye salmon to reach traditional spawning grounds or reach the ocean. The Centre for Coastal Health (a CCWHC associate organization and node for epidemiology) was commissioned to provide an expert report on the possible roll of public salmonid enhancement facilities in spreading disease to wild salmon. Salmonid enhancement is a large-scale aquaculture system supported by the federal government and communities to produce young salmon for release into the wild to supplement wild stocks. The review found several gaps in understanding the infection status of fish before their release and gaps in veterinary care and evaluation of those fish. It also identified an important absence of valid scientific methods, which can be used to evaluate the impacts of salmonid enhancement on wild fish. Some lessons from the Commission are discussed in a paper by CCH Director Craig Stephen titled `toward a new definition of animal health: lessons from the Cohen Commission and SPS Agreement` found in the online journal Optimum Online. The final reports from the Cohen Commission can be found at <http://www.cohencommission.ca/en/FinalReport/>



Brain worm in Western Saskatchewan

The recent confirmation of brain worm in a young moose showing neurological signs near Meadow Lake Saskatchewan is the most western diagnosis of this parasitic infection to date. *Parelaphostrongylus tenuis*, the cause of brain worm, is found commonly in white-tailed deer in eastern North America and the western boundary of its distribution is considered to be approximately the Manitoba-Saskatchewan border. The worm does not cause disease in white-tailed deer and elk and larvae shed from these natural hosts require a terrestrial snail to complete its life cycle. The abundance of this snail intermediate host is thought to be limited in the dry, short-grass prairie of Saskatchewan and the prairie acts as an ecological barrier to westward movement of this parasite. Although we occasionally diagnose brain worm in moose in the eastern part of Saskatchewan, this particular case is approximately 250 km west of any previously detected cases and is 84 km from the Alberta border. This diagnosis indicates the need for further monitoring of cervids in the area as moisture conditions in the boreal forest, high white-tailed deer densities, changing cervid behavior, and other factors, may be favoring the westward movement of this parasite. *P. tenuis*, when abundant in white-tailed deer and elk, has resulted in population declines in moose, caribou and mule deer in areas where their ranges overlap.



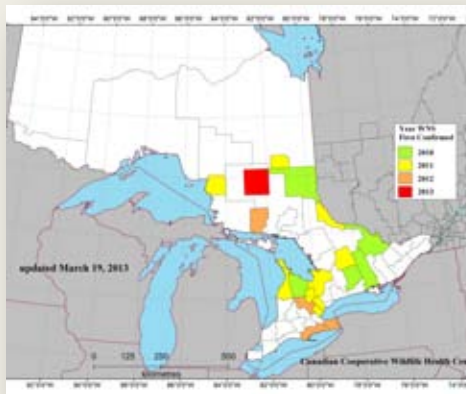


Responding to White-nose Syndrome

2012-13 saw the environmental crisis of White-nose Syndrome worsen in affected regions of Canada, particularly in the Maritime Provinces. Known hibernating populations of Little Brown Bat, Northern Long-eared Bat and Tricolored Bat have fallen by 95%-99% across Nova Scotia and New Brunswick, and extensive late-winter mortality from the disease was discovered on Prince Edward Island for the first time. In the next year, we may detect much less of this disease in previously affected areas because there are almost no bats left to die.

CCWHC is coordinating Canada's response to White-nose Syndrome (WNS). In November 2013 it partnered with the Canadian Wildlife Directors Committee and the Canadian Wildlife Federation to organize a national response-planning workshop. The workshop participants wrote a series of extensive action plans to achieve the goals articulated in the WNS management plans of both Canada and the United States. Based on these action plans, a flexible operating system was implemented that coordinates university, NGO, provincial-territorial and federal agency activities to obtain the maximum benefit from the available resources, and also to ensure communication and coordination with parallel actions taking place in the US. The Canadian response is focused on monitoring bat populations and tracking the occurrence of the disease, and on taking all possible steps to protect surviving bats and their habitats. Extra funds were provided to the CCWHC in 2012-13 by Environment Canada and by several provinces to support national coordination and mitigation activities.

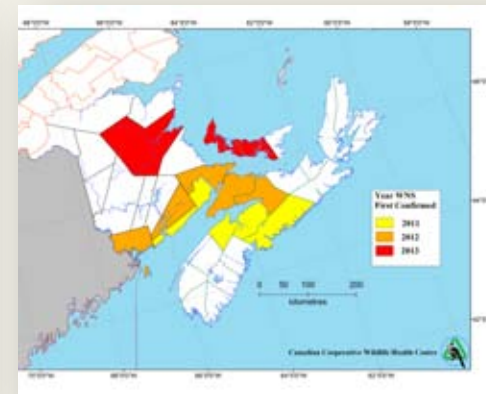
WNS in Ontario



WNS in Quebec



WNS in Atlantic Canada





A financial review of 2012-13 reflects a strong demand for services and expertise but reduced resources. Total cash revenues were down slightly from 2011-12 (approximately 1%) and totaled \$2,921,894. As a result of cost saving efforts and reduced service provision the CCWHC reduced its total expenditures by 9% from the previous year to \$3,003,610. This is a reduction of 26% from 2010-11.

Core program revenues comprised \$1,538,087, comparable to previous years, exceeding that generated by targeted programs (response and management), comprising 53% of total revenues. Cash contributions from the Government of Canada accounted for \$915,000 or 59% of the total, while core revenue from the provinces and territories accounted for \$491,203 or 32%. Cash contributions from other non-government organizations, including universities accounted for \$131,884 9% overall.

Revenue for separately funded Response and Management programs were up slightly from 2011-12 and totaled \$1,383,807, representing 47% of overall funding. Revenues in this category were derived from the Government of Canada (48%), Provincial and Territorial Governments (32%), as well as foreign governments and non-government sources, 20%.

Statement of Revenues and Expenses

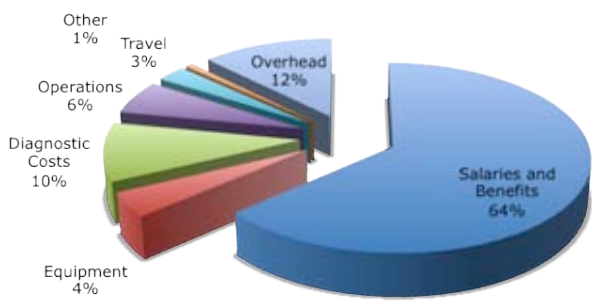
REVENUES	Core (General)	Special Projects	Total Revenues
Canadian Food Inspection Agency	150,000	249,953	399,953
Environment Canada	400,000	82,128	482,128
First Nations and Inuit Health Branch		4,972	4,972
Fisheries and Oceans		18,801	18,801
Foothills Research Institute		94,012	94,012
Parks Canada	125,000		125,000
PrioNet Canada		55,500	55,500
Public Health Agency of Canada	240,000	160,001	400,001
Alberta			
Alberta - Agriculture and Rural Development	5,000		5,000
Alberta - Community Development	4,000		4,000
Alberta - Fish and Wildlife	12,000		12,000
British Columbia	20,000		20,000
Manitoba	10,000		10,000
New Brunswick			
New Brunswick - Fish and Wildlife	10,259	3,617	13,876
New Brunswick - Health	5,000		5,000
Newfoundland & Labrador	21,700		21,700
Northwest Territories	16,000		16,000
Nova Scotia	9,500		9,500
Nunavut	15,000		15,000
Ontario			
Ontario - Agriculture, Food and Rural Affairs		50,000	50,000
Ontario - Health and Long Term Care	100,000		100,000
Ontario - Natural Resources	80,000	100,650	180,650
Prince Edward Island			
PEI - Environment	4,735		4,735
PEI - Health		1,050	1,050
Quebec			
MAPAQ	50,000		50,000
MRNF	50,000	9,185	59,185
MDDEFP	26,700	63,694	90,394
Saskatchewan			
Saskatchewan Agriculture and Food		40,280	40,280
Saskatchewan Environment	41,309	170,000	211,309
Yukon	10,000		10,000
USGS		14,800	14,800
Canadian Wildlife Federation	10,000	12,363	22,363
UCVM	121,884		121,884
Miscellaneous Income		252,802	252,802
TOTAL REVENUE	1,538,087	1,383,807	2,921,894
EXPENSES			Total Expenditures
Salaries and Benefits	1,292,160	611,134	1,903,294
Equipment	35,294	89,050	124,344
Diagnostic Costs	167,322	146,366	313,688
Operations	54,222	120,808	175,030
Travel	33,076	67,760	100,835
Other	8,521	10,459	18,981
Overhead	149,761	217,679	367,439
TOTAL EXPENSES	1,740,355	1,263,255	3,003,610
Revenue less Expenditures	-202,268	120,551	-81,717



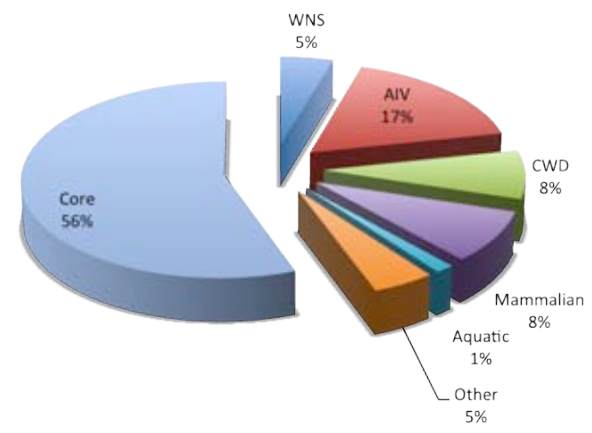
2012-13 Core Expenses by Region

Expense	HQ	W & N	ON/NU	QC	Atlantic	AB	Total
Salaries and Benefits	\$ 592,120.13	\$ 168,392.31	\$ 305,978.00	\$ 294,656.89	\$ 201,962.00	\$ 83,474.35	\$ 1,646,583.68
Equipment	\$ 10,187.04	\$ 26,372.10	\$ 116.55	\$ 4,911.16	\$ 1,316.00	\$ 2,694.61	\$ 45,597.46
Diagnostic Costs	\$ -	\$ 69,212.68	\$ 55,918.50	\$ 34,551.71	\$ 28,460.00	\$ 17,399.26	\$ 205,542.15
Operations	\$ 12,190.98	\$ 12,362.10	\$ 7,048.22	\$ 22,869.31	\$ 9,876.00	\$ 2,065.98	\$ 66,412.59
Travel	\$ 10,214.53	\$ 6,678.29	\$ 3,869.63	\$ 10,273.78	\$ 5,410.00	\$ 6,843.89	\$ 43,290.12
Other	\$ -	\$ 8,521.40	\$ -	\$ -	\$ -	\$ -	\$ 8,521.40
Overhead	\$ 75,873.91	\$ 43,730.83	\$ 55,939.64	\$ 55,089.43	\$ 37,053.60	\$ 16,871.71	\$ 284,559.12
Subtotal	\$ 700,586.59	\$ 335,269.71	\$ 428,870.54	\$ 422,352.28	\$ 284,077.60	\$ 129,349.80	\$ 2,300,506.52
Cost Recovery	\$ 181,640.15	\$ 52,113.38	\$ 158,000.24	\$ 106,412.37	\$ 45,113.60	\$ 16,871.71	\$ 560,151.45
Total	\$ 518,946.44	\$ 283,156.33	\$ 270,870.30	\$ 315,939.91	\$ 238,964.00	\$ 112,478.09	\$ 1,740,355.07

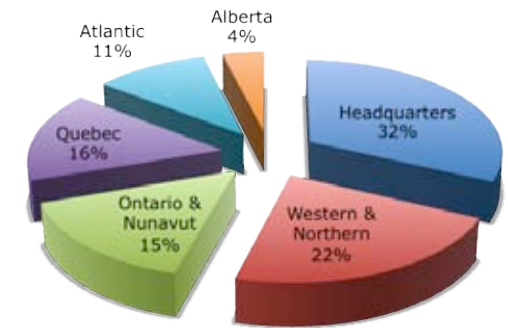
Total Expenses 2012-13



Total Revenue by Category



Total Expenses by Region





Safeguarding the Health of Canada's Wildlife

The Canadian Cooperative Wildlife Health Centre's mission is to provide an integrated partnership approach to the delivery of wildlife health services, research, and education in Canada and internationally.



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Special thanks to Hamilton Greenwood for the use of many of the photos featured in this report.

