Climate Change and Infectious Disease Research and Surveillance Activities in Arctic Canada: Zoonotic Diseases and Food and Water Safety & Security

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Canada’s Northern Population

Climate Change and Infectious Diseases

• The North is undergoing rapid environmental change driven by climate change, resulting in:
  – Range shifts and northward expansions of wildlife diseases and parasites
  – Emergence of vector-borne diseases
  – Re-emergence of endemic disease

• Impacts on food safety and security

• Damage to infrastructure, affecting water quality and security
Public Health Agency of Canada

- Created in 2004 as a separate agency within the federal Health Portfolio
- Creation of the Agency promoted by the SARS outbreak, a disease of zoonotic origin
- PHAC responds to the Government of Canada’s commitment to help protect the health and safety of all Canadians and to increase focus on public health
PHAC Arctic Zoonoses Working Group

• Formed in 2008

• Composed of Federal and Provincial/Territorial public health and animal health experts and academics

• Development of white paper on zoonoses in the North that outlines:
  - Audit of zoonoses
  - A review of surveillance, prevention and control capacity in the North
  - Needs and gaps in knowledge, infrastructure and action
  - Success stories
  - Recommendations for improvements in control of zoonoses in the North that are sensitive to cultural needs
Climate-sensitive Infectious Disease Research & Surveillance Activities in Arctic Canada
Scope: Research and surveillance activities

• Food-related infectious diseases
  – Toxoplasma
  – Trichinella
  – Anisakid worms
  – Marine mammal Brucellosis
  – Salmonella, E. coli O157:H7
  – Terrestrial and marine mammal diseases

• Other zoonotic and vector-borne diseases
  – Echinococcus spp
  – Tularemia, California serogroup viruses, Leptospira, Coxiella, Toxocara, Hanta virus
  – Avian influenza

• Water-related diseases
  – Diarrheal diseases
Food Security & Food-borne Zoonoses
1. Investigation of the sources of *T. gondii* for Inuit communities and importance of river runoff in infection of marine mammals (seals) and Inuit

**Investigator(s):** A. Simon, N. Ogden et al. (University of Montreal & Public Health Agency of Canada)

**Study period:** 2007-2010

**Location:** Hudson Bay and Western Canadian Arctic

**Key findings:**

- Analysis of 41 sediment samples from water tanks: *all negative*
- *T. gondii* seroprevalence in seals shows variation by age and location
- Climate change may shift range of lynx populations in Arctic

Simon et al. 2011 *Parasitology*
2. Ecology of *Toxoplasma gondii* in wildlife in the Canadian Arctic

**Investigator(s):** S. Elmore, E. Jenkins et al. (University of Saskatchewan)

**Study period:** Aug 2010 – 2014

**Location:** Various locations in northwestern Canada, including a field site in western Nunavut

**Key findings:**

- 20% of foxes seropositive, suggesting local acquisition of *T. gondii*.

- Future work on testing tissues from rodents, migratory birds and Arctic fox to characterize and isolate *T. gondii*.

- Important baseline against climate change.

3. Nunavik Trichinellosis Prevention Program

**Investigator(s):** M. Simard et al. (Nunavik Research Center/ Makivik Corporation)

**Study period:** Ongoing since 1997

**Location:** Northern Quebec, Nunavik

**Key findings:**

- Ongoing testing for *Trichinella nativa* in tongues from all walrus harvested in Nunavik communities for prevention of Trichinellosis
- Adult and juvenile walrus of all sexes are infected
- There are areas where walrus are more infected than others
- This is an example of involving communities in research
4. Monitoring wildlife diseases, zoonoses and contaminants during the Nunavik muskoxen experimental hunt

**Investigator(s):** M. Simard et al. (Makivik Corporation)

**Study period:** 2006 to March 2011

**Location:** Kuujjuaq and Tasiujaq, Northern Quebec, Nunavik

**Key findings:**

- 61 muskoxen sampled to test safety of meat (contaminants, zoonoses) and to monitor herd health
- Similar or lower contaminant levels compared to caribou. Risk assessment for consumption is needed.
- Results will be compared with worldwide muskoxen populations. Disease results under analyses.
5. Engaging communities in the monitoring for zoonotic diseases for food safety concerns and wildlife health

**Investigator(s):** M. Simard et al., Makivik Corporation, IPY project  
**Study period:** Sampling: 2007-March 2011  
**Location:** Nunavik, Nunavut, Nunatsiavut, Northwest Territories (sub-Arctic and Arctic Canada)

**Key findings:**

- Capacity building though training and research lab establishment
- Developed diagnostic techniques for screening of *Salmonella* sp. and *E. coli* O157:H7
- Developed qPCR techniques and multi-species ELISA for *Toxoplasma gondii*
- Evidence of widespread *Trichinella* infection in northern mammals
- Anisakidae nematodes present in traditionally eaten marine mammals and fish
- Developed community-derived knowledge translation and transfer strategies
6. Identification of Emerging Infectious Diseases in Canadian Marine Mammals

**Investigator(s):** O. Nielsen et al. (Dept. of Fisheries and Oceans Canada)

**Study period:** Continuing (since 1995)

**Location:** Northwest Territories/Inuvialuit Settlement Region, and Nunavut

**Key findings:**

- Monitoring needed to ensure a healthy sustainable population of marine mammals in Canada (incl. subsistence food sources)
- Isolation and identification of new emerging infectious agents from marine mammals including: seal distemper virus, marine mammal *Brucella*, seal picornavirus, hemabartonella
- New virus strains being sequenced to determine phylogenetic relationship to other viruses

**Investigators:** P. Curry, S. Kutz et al. (U. Calgary); Circum-Arctic *Rangifer* Monitoring and Assessment Network (CARMA) collaborators

**Study period:** 2007-2009

**Locations:** Across northern Canada, and Greenland

**Key findings:**

- Filter-paper (FP) samples for antibody detection in caribou comparable to serum in antibody tests (validation for 8 pathogens total)
- Assessment of hunter-based FP collection in northern communities – analysis pending
- Circumpolar herd serosurvey of exposure to 9 pathogens, incl. zoonotics (*Brucella*, *West Nile virus*, *Toxoplasma gondii*) found low prevalences of exposure to zoonoses; WNV 0% prev. (important baseline)
8. Range Expansion of *Umingmakstrongylus pallikuukensis* in Muskoxen on Victoria Island

**Investigator(s):** S. Checkley, S. Kutz et al. (University of Calgary)

**Study period:** Sampling from 2007 to present

**Location:** Victoria Island, Nunavut

**Key findings:**

- Work ongoing to delineate and monitor northern range expansion of *U. pallikuukensis* infestation in muskoxen, climate change, and effects on sustainability of muskoxen populations and food security of local communities.
Other Zoonotic and Vector-borne Diseases
9. *Echinococcus granulosus* and other parasitic zoonoses of public health concern in indigenous communities in western Canada

**Investigator(s):** J. Schurer, E. Jenkins et al. (University of Saskatchewan)

**Study period:** Jan 2010 – June 2012

**Location:** Saskatchewan and various locations across northwestern North America

**Key findings:**

- *E. granulosus* detected in several new locations in North America.

- Genetic work suggests an endemic North American strain and a circumpolar strain of *E. granulosus* in cervids in Canada.

- This work forms a baseline against the effects of climate change on the distribution and abundance of cervid intermediate hosts for *E. granulosus*.

Jenkins EJ et al. 2011 *Vet Parasitol*
10. Distribution, diversity, and health significance of a pathogenic tapeworm (*Echinococcus multilocularis*) in wildlife in northwestern Canada

**Investigator(s):** K. Gesy, E. Jenkins et al., University of Saskatchewan

**Study period:** Jan 2010 – June 2012

**Location:** Various locations in northwestern Canada, including a field site in western Nunavut

**Key findings:**

- *E. multilocularis* detected in several new locations in North America, including a European isolate in central BC that may have greater zoonotic potential than native strains.

- This work forms a baseline as this parasite continues to emerge and re-emerge across the circumpolar north as a result of climate change and other factors.

*Jenkins EJ et al. 2011 Vet Parasitol*
11. Seroprevalence of zoonotic infections in Northern Quebec

**Investigator(s):** S. Campagna, E. Dewailly et al., (Institut National de Santé Publique du Québec)

**Study period:** Ongoing since 2007

**Location:** Northern Quebec (James Bay)

**Key findings:**
- Seroprevalence rates:
  - Leptospira sp. (23%)
  - Francisella tularensis (17%)
  - California serogroup viruses (JC and SSH viruses) (10%)
  - Other zoonoses (Toxoplasma gondii, Coxiella burnetii, Echinococcus granulosus, Toxocara canis, and Trichinella sp.) all ≤5%
  - No exposures to hantaviruses (Sin Nombre virus).
- Studies ongoing in other communities in Nunavik.
12. Inter-Agency wild bird Avian influenza survey

**Investigator(s):** Public Health Agency of Canada with Federal, Provincial/Territorial & US partners

**Study period:** Since 2005 (ongoing)

**Location:** Across Canada

**Approach:**

- Surveillance with focus on High Pathogenicity Avian Influenza (HPAI)
- National network for detecting wild bird die-offs, and sample collection and analysis
- Testing of all wild birds found dead for HPAI
- Seasonal testing of live waterfowl
Water Security & Water-borne Zoonoses
13. Indigenous Health Adaptation to Climate Change (IHACC)

**Investigator(s):** J. Ford, V. Edge, K. Thomas et al. (McGill University & Public Health Agency of Canada)

**Study period:** 2010-2015

**Location:** Canada, Peru, Uganda

**Approach:**
- Burden of illness survey in 3 communities
  - Collect data on GI events, food and water-related sources of infection, food security
- Water quality testing (*E. coli*, coliforms, *Giardia*)
- Qualitative scenario analysis to predict plausible future outlook for study communities given climate change impacts
13. IHACC

Remote indigenous communities

• Canadian Arctic (Inuit)

• Peruvian Amazon (Shipibo & Shawi)

• Southwest Uganda (Pygmy peoples)
Next Steps
Emerging Infectious Disease Surveillance in Canada

• Drivers of disease such as climate change, human population growth, increased production of agricultural livestock, global movement of animals, goods and people are creating favourable conditions for the emergence of disease

• PHAC is moving towards activities that are more aimed at prevention rather than outbreak response

• A key component of this will be integrated surveillance systems that include information from animal, human and ecosystem health domains
Opportunities for Addressing Climate Sensitive Infectious Diseases in the North

• Canadian High Arctic Research Station (CHARS)
  – Improve research & surveillance capacity

• One Health
  – Global interest and buy-in for One Health approaches

• Circumpolar relationships
  – Circumpolar surveillance for earlier detection of trends
Thank you