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

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International Circumpolar Surveillance (ICS) Working Group
on Climate Sensitive Infectious Diseases
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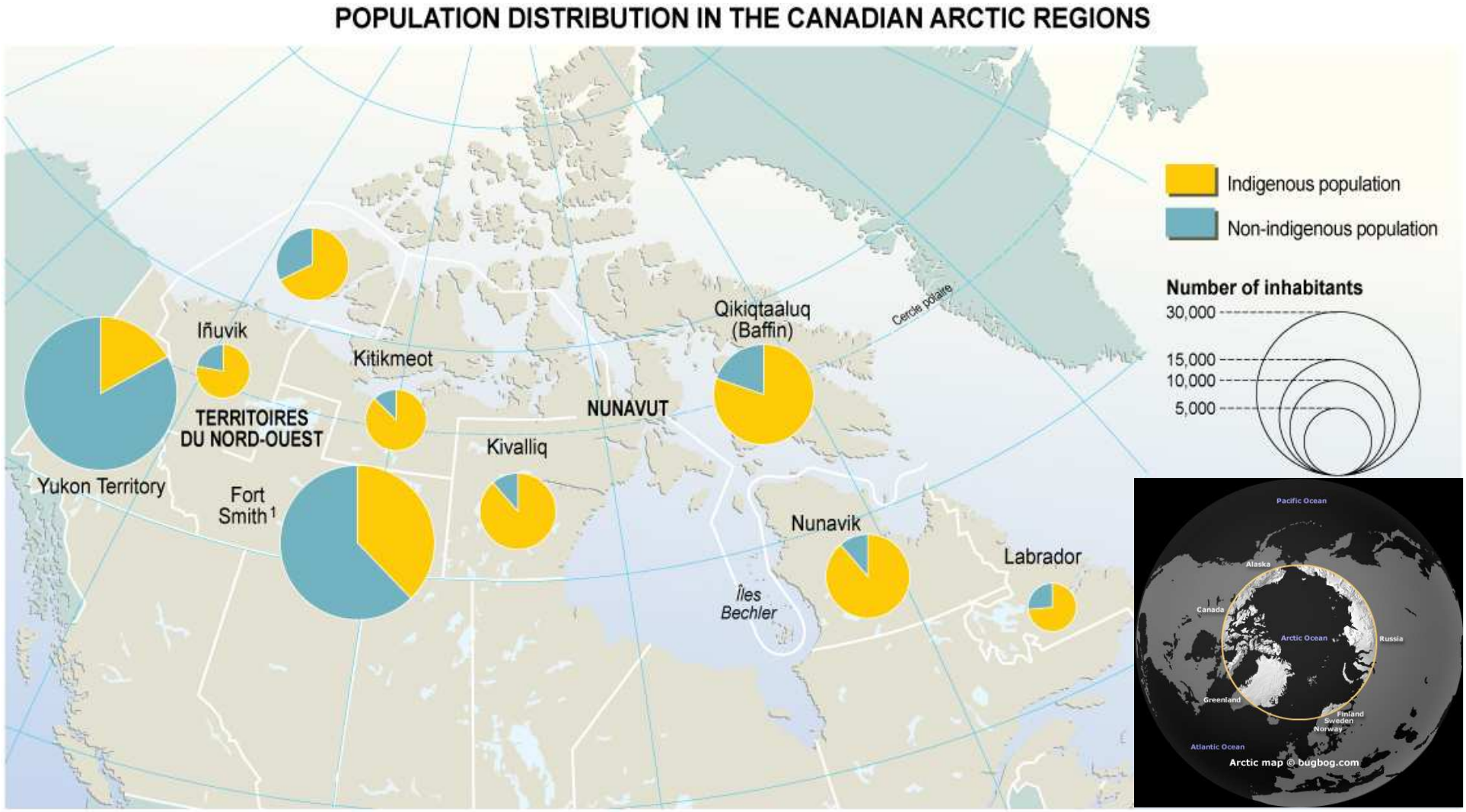
Canada's Northern Population



Source: Canada, Arctic indigenous population. (2004). In *UNEP/GRID-Arendal Maps and Graphics Library*. http://maps.grida.no/go/graphic/canada-arctic-indigenous-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

IPY: Gita Laidler

IPY: G. Carroll Tesh

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

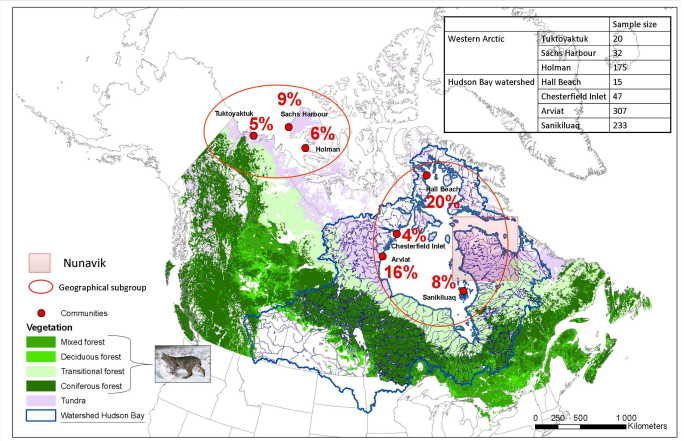
Investigator(s): A. Simon, N. Ogden et al. (University of Montreal & Public Health Agency of Canada)

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.

Elmore SA et al. 2011 *Vector-borne & Zoonotic Diseases* (in press)

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

7. Disease Surveillance in Caribou: Filter-paper Blood Sampling and Hunter-based Monitoring

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.

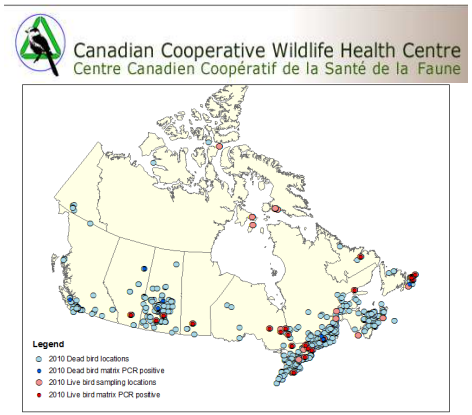
Campagna et al. 2011
Diagn Microbiol Infect Dis

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

Public Health Agency of Canada
Agence de la santé publique du Canada

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

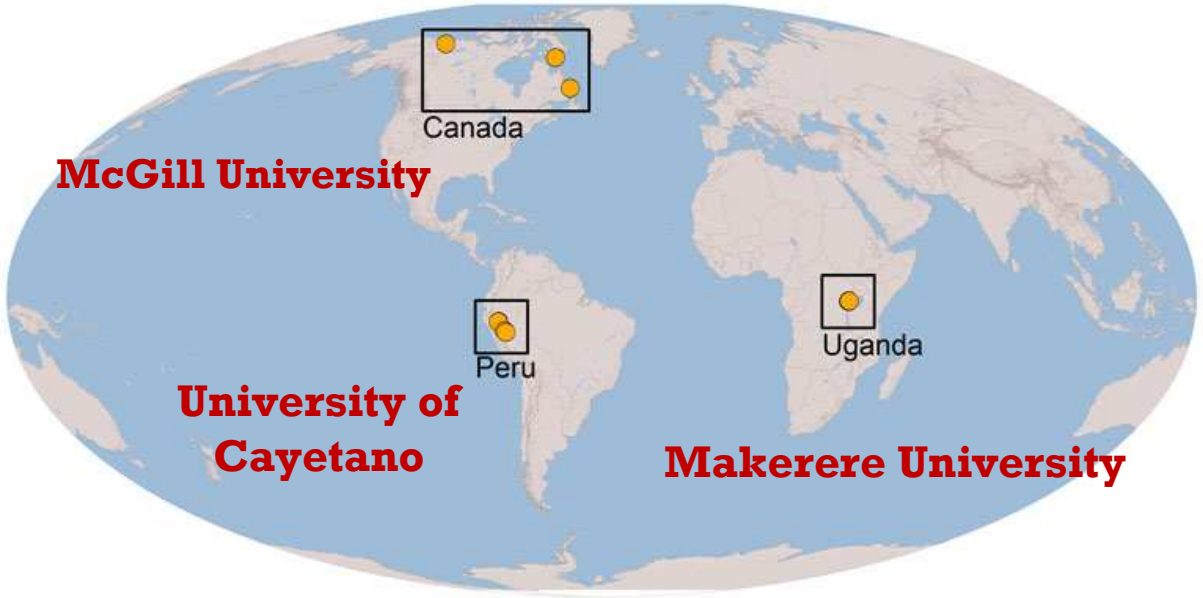
Approach:

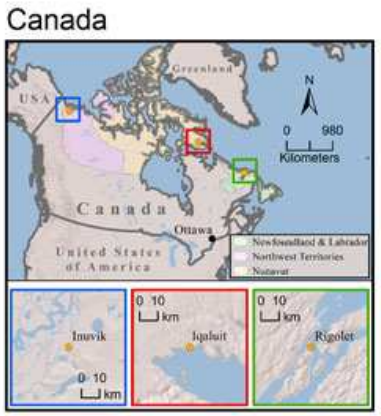
- Burden of illness survey in 3 communities
  - Collect data on GI events, food and water-related sources of infection, food security
- Water quality testing (*E. coli*, coliforms, *Giardia*)
- Qualitative scenario analysis to predict plausible future outlook for study communities given climate change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

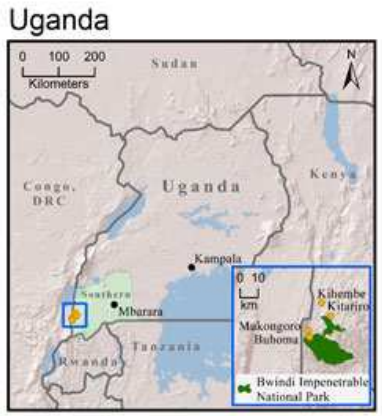
13. IHACC

Remote indigenous communities

- Canadian Arctic (Inuit)
- Peruvian Amazon (Shipibo & Shawi)
- Southwest Uganda (Pygmy peoples)







Next Steps

Emerging Infectious Disease Surveillance in Canada

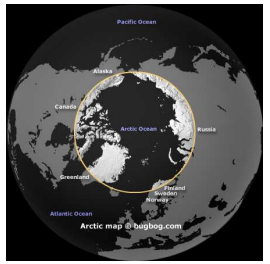
- Drivers of disease such as **climate change**, human population growth, increased production of agricultural livestock, global movement of animals, goods and people are **creating favourable conditions for the emergence of disease**

- 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

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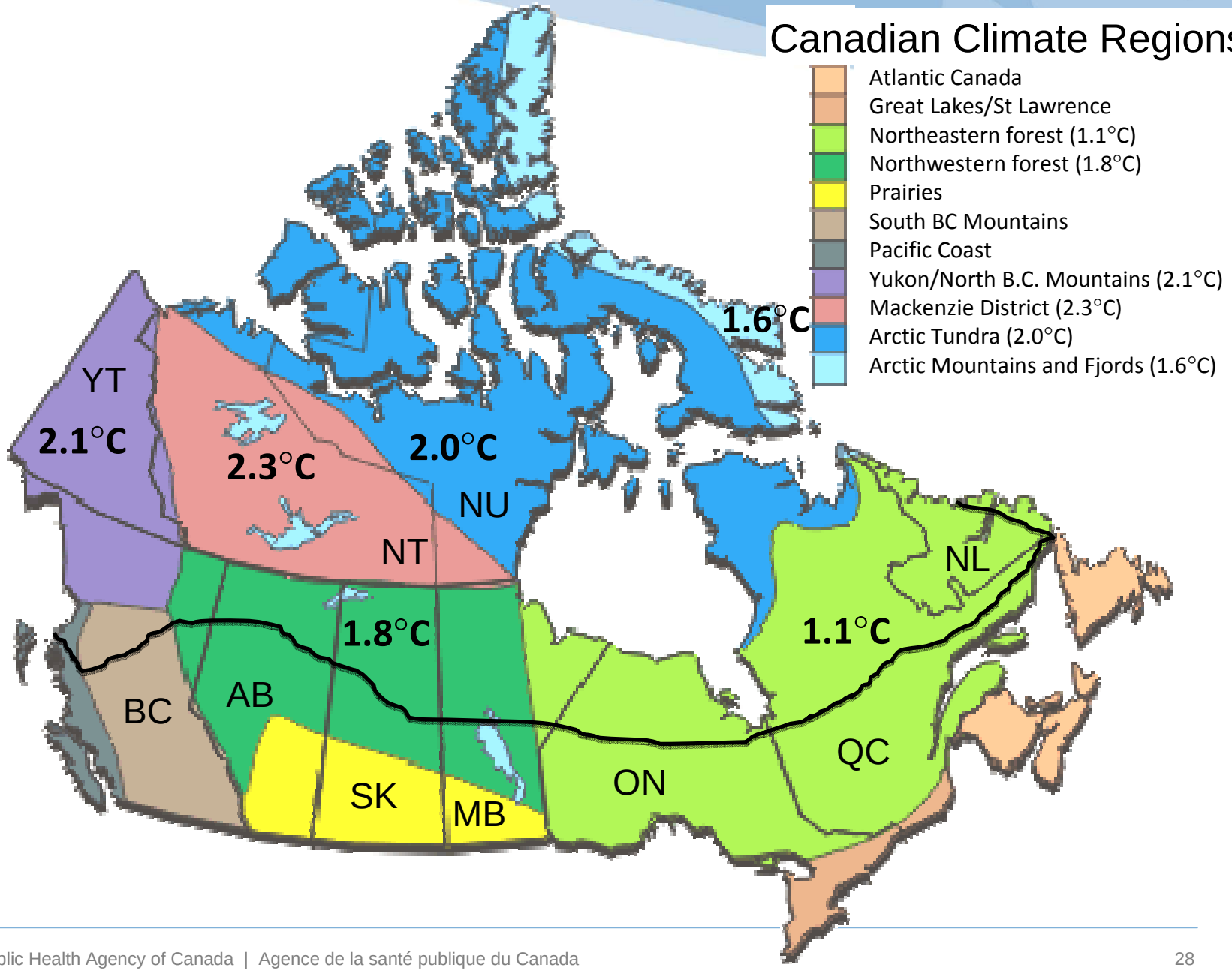
Canadian Climate Regions
Atlantic Canada
Great Lakes/St Lawrence
Northeastern forest (1.1°C)
Northwestern forest (1.8°C)
Prairies
South BC Mountains
Pacific Coast
Yukon/North B.C. Mountains (2.1°C)
Mackenzie District (2.3°C)
Arctic Tundra (2.0°C)
Arctic Mountains and Fjords (1.6°C)
1.6°C
YT
2.1°C
2.3°C
2.0°C
NU
NT
NL
1.8°C
1.1°C
BC
AB
SK
MB
ON
QC