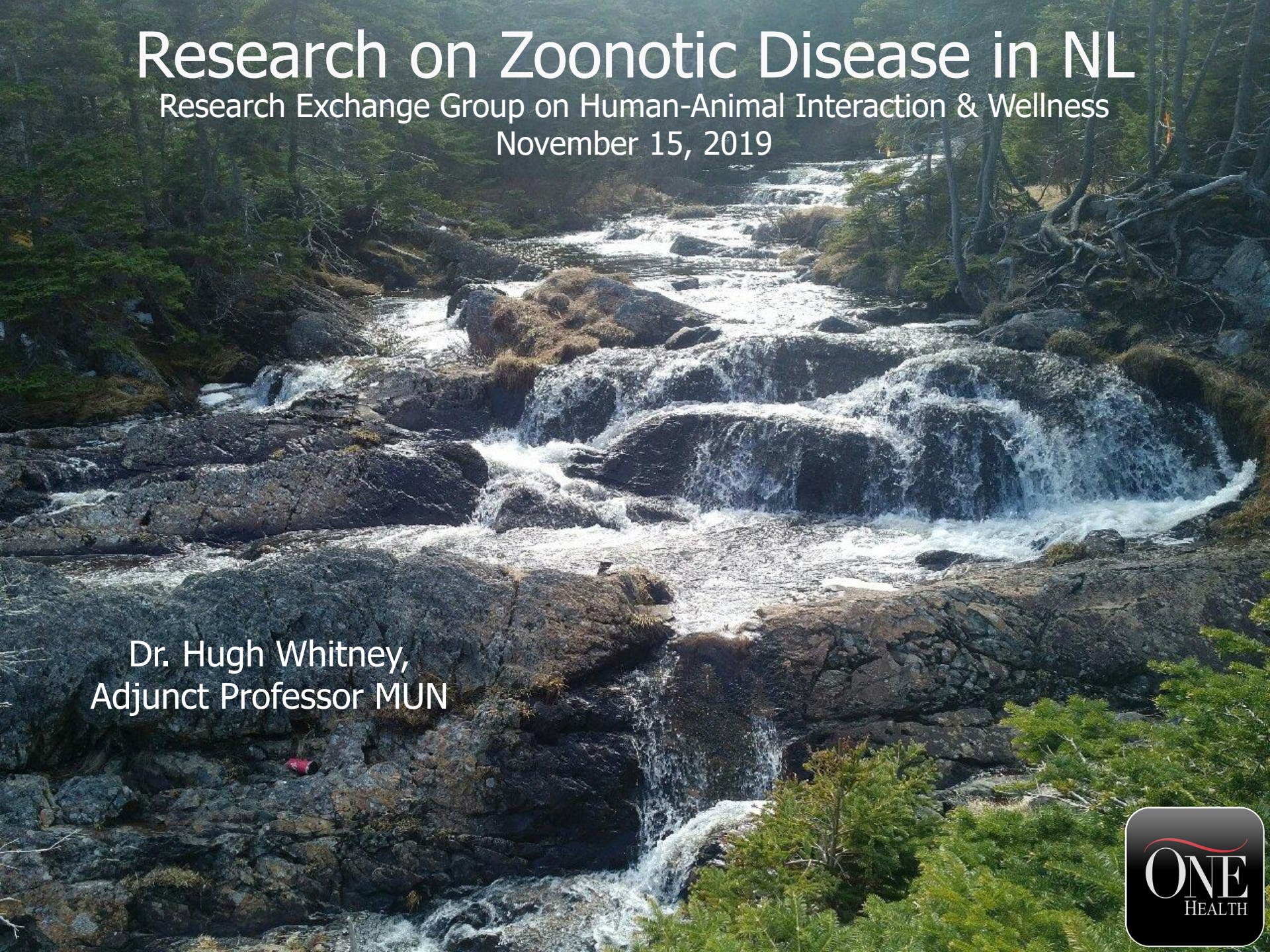
Research on Zoonotic Disease in NL

Research Exchange Group on Human-Animal Interaction & Wellness

November 15, 2019



Dr. Hugh Whitney,
Adjunct Professor MUN

ONE HEALTH

Chief Veterinary Officer for NL – 1985-2015
Adjunct Professor (MUN) – 1995 to present

A few relevant highlights:

- Eradication of rabies from island of Newfoundland in 1988 and 2002-04

- Surveillance for West Nile virus, Lyme disease, rabies and other zoonoses

- Research into numerous animal diseases with MUN

DMV – Université de Montréal
MSc (Veterinary Microbiology) – University of Saskatchewan
MA (History) – Memorial University

Research on Zoonotic Diseases in NL

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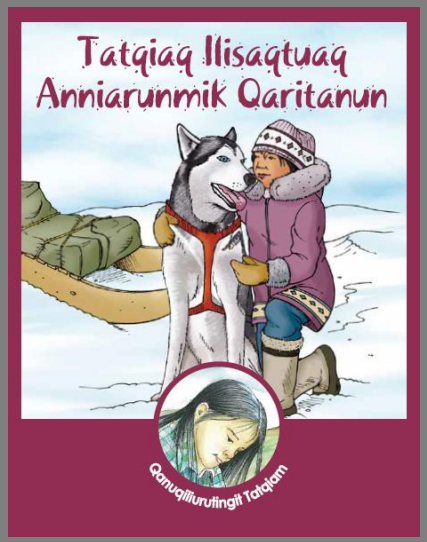

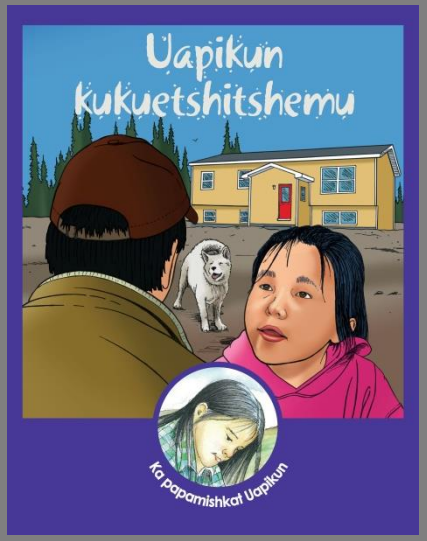

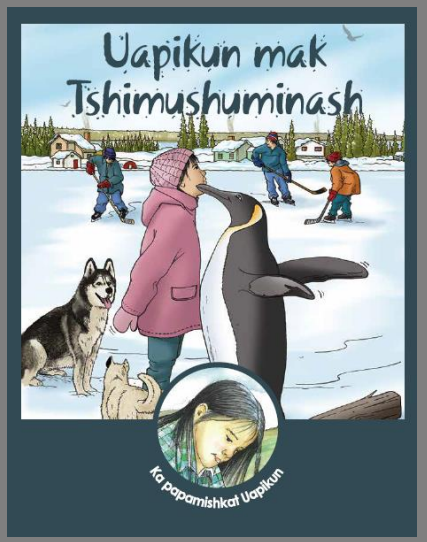

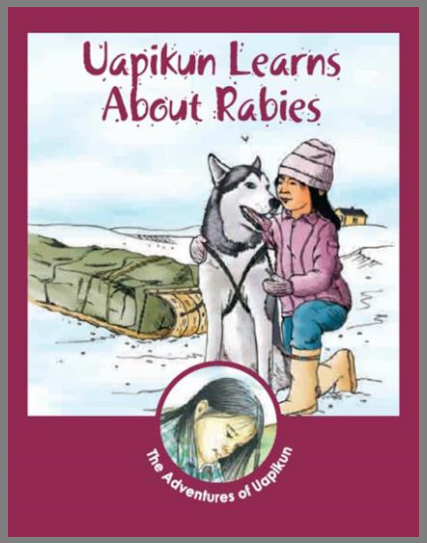

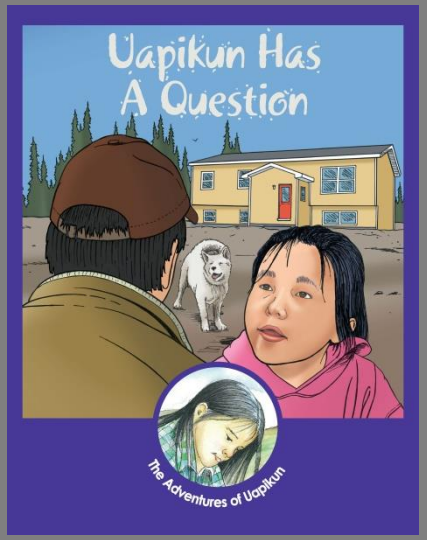

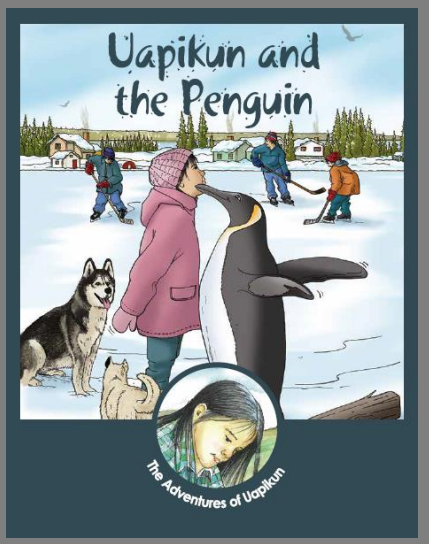

Use of animals for teaching children

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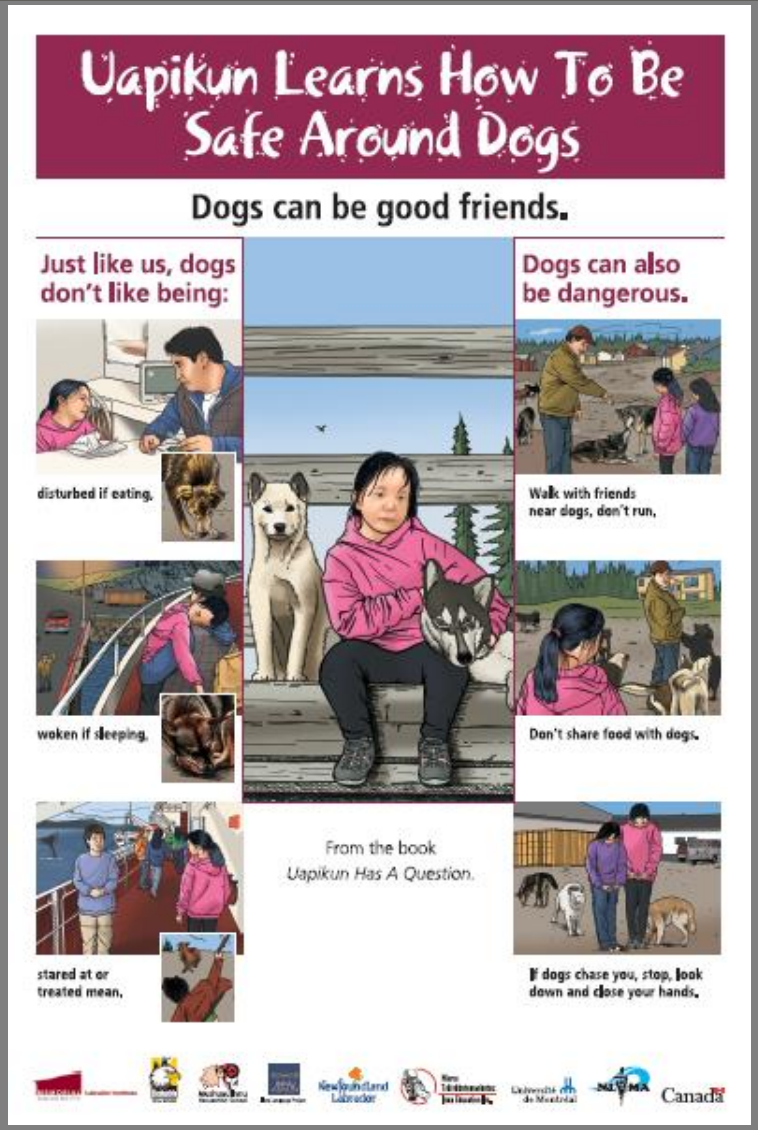

Understanding human behaviour helps to understand animal behaviour and vice-versa

The Importance of Zoonotic Disease Research in NL

1. Of economic interest to the commercial agricultural industry
2. Of interest to public health protection in the province
3. Of interest to wildlife managers and domestic animal owners
4. For public policy purposes
5. To encourage animal disease research that otherwise may not be done
6. To interest young people in research opportunities in this province
7. To assist in public education

Research of provincial scope versus national and international scope

Geographic isolation - If it's not done here, it may not be done at all

Dr. Andrew Lang
Microbiology, MUN

Dr. Atanu Sarkar
Medicine, MUN

Dr. Tom Chapman
Entomology, MUN

Dr. Joel Finnis
Climatology, MUN

Dr. Kapil Tahlan
Microbiology, MUN

Dr. James Valcour,
Epidemiology, MUN

Dr. Dawn Marshall
Genetics, MUN

Dr. Patrick Leighton,
UdeM

Dr. Robbin Lindsay,
PHAC

Dr. Nick Ogden,
PHAC

Dr. Susan Nadin-Davis,
CFIA

Research Collaborators

MUN

Atlantic Vet College

Environment Canada

CFIA Rabies Centre of Expertise

U Calgary

Faculté de médecine vétérinaire, UdeM

Ontario Vet. College

National Microbiology Laboratory

Collaborating Institutions

Avian influenza

Rabies

MRSA/MRSP

Arboviruses

Lyme disease

Research projects

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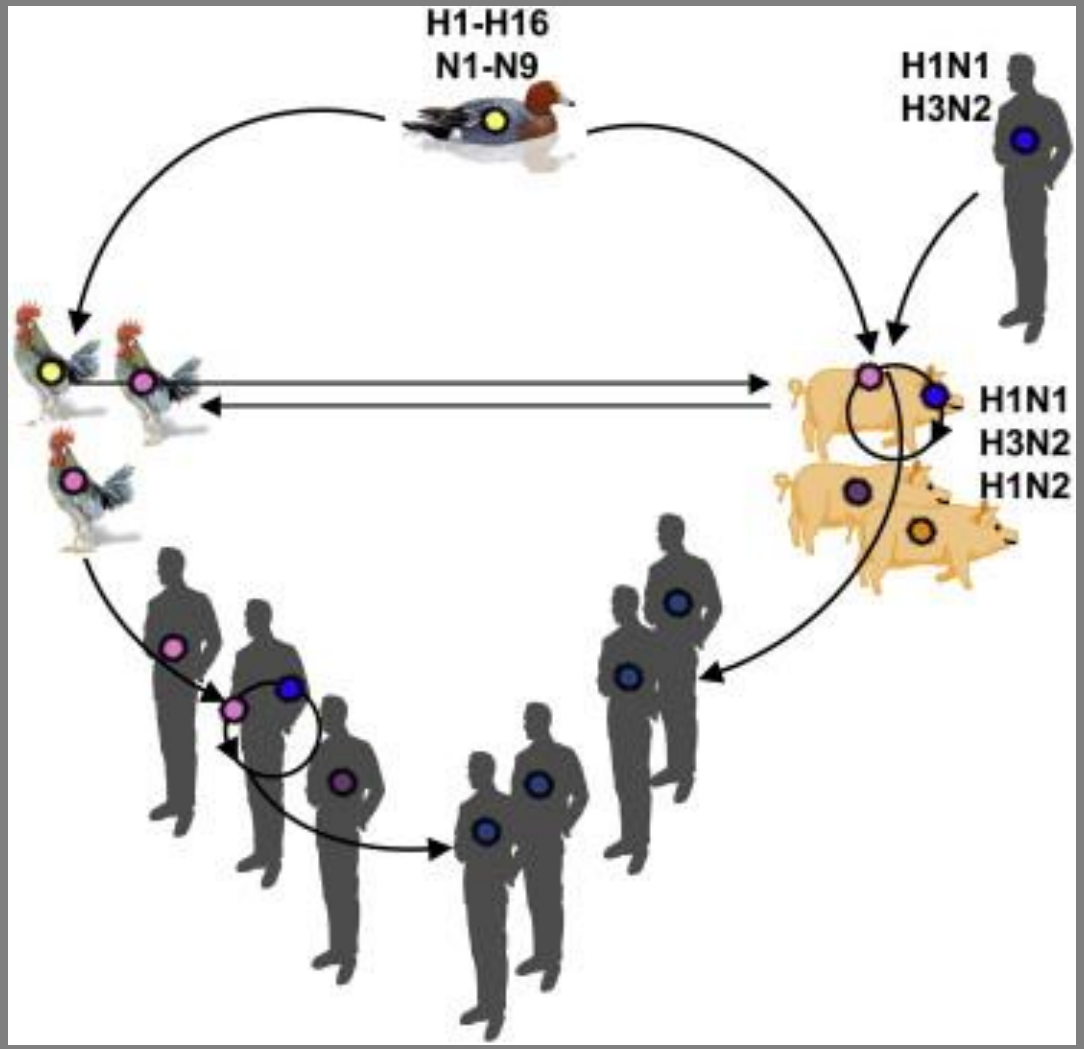
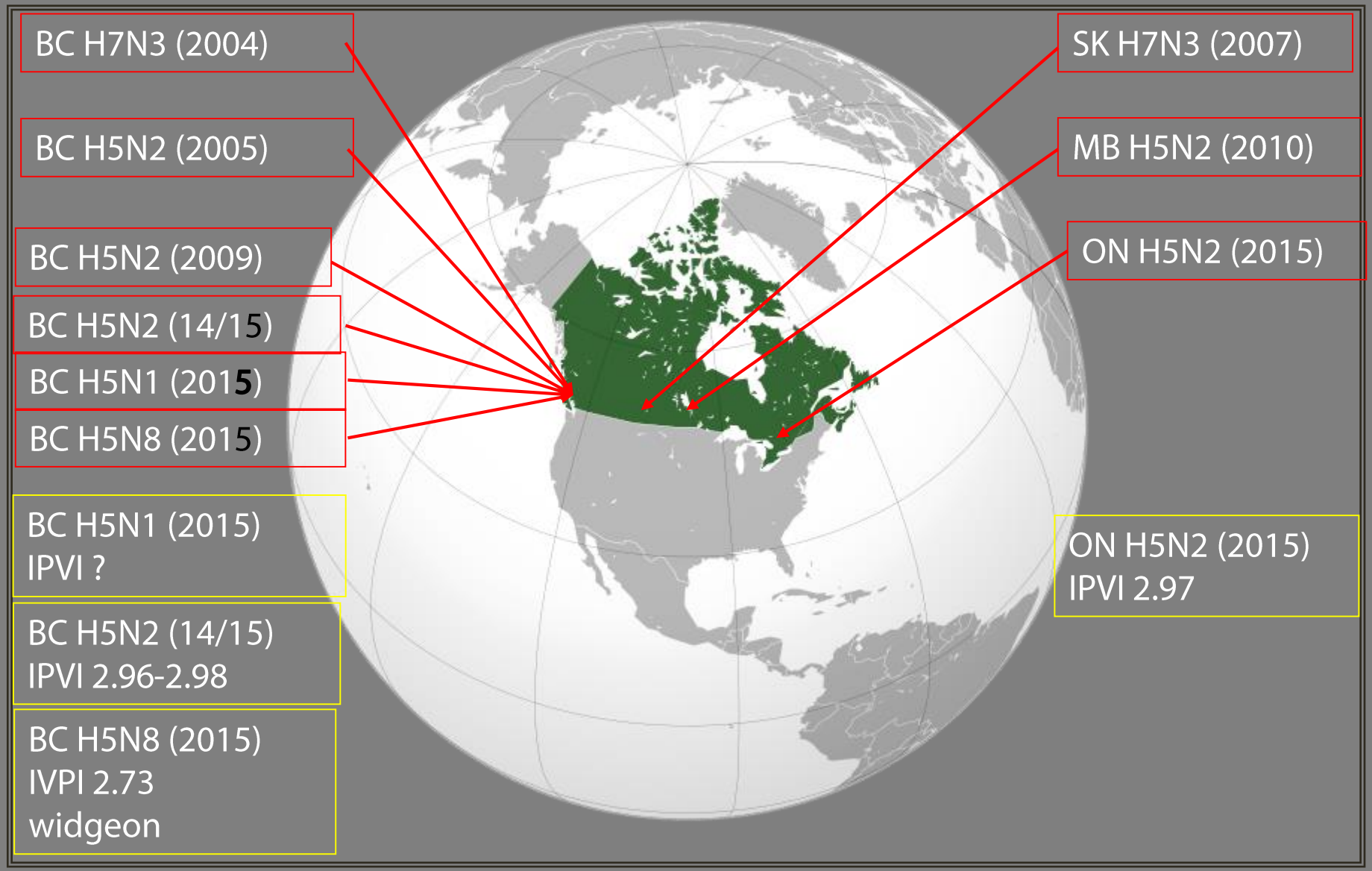
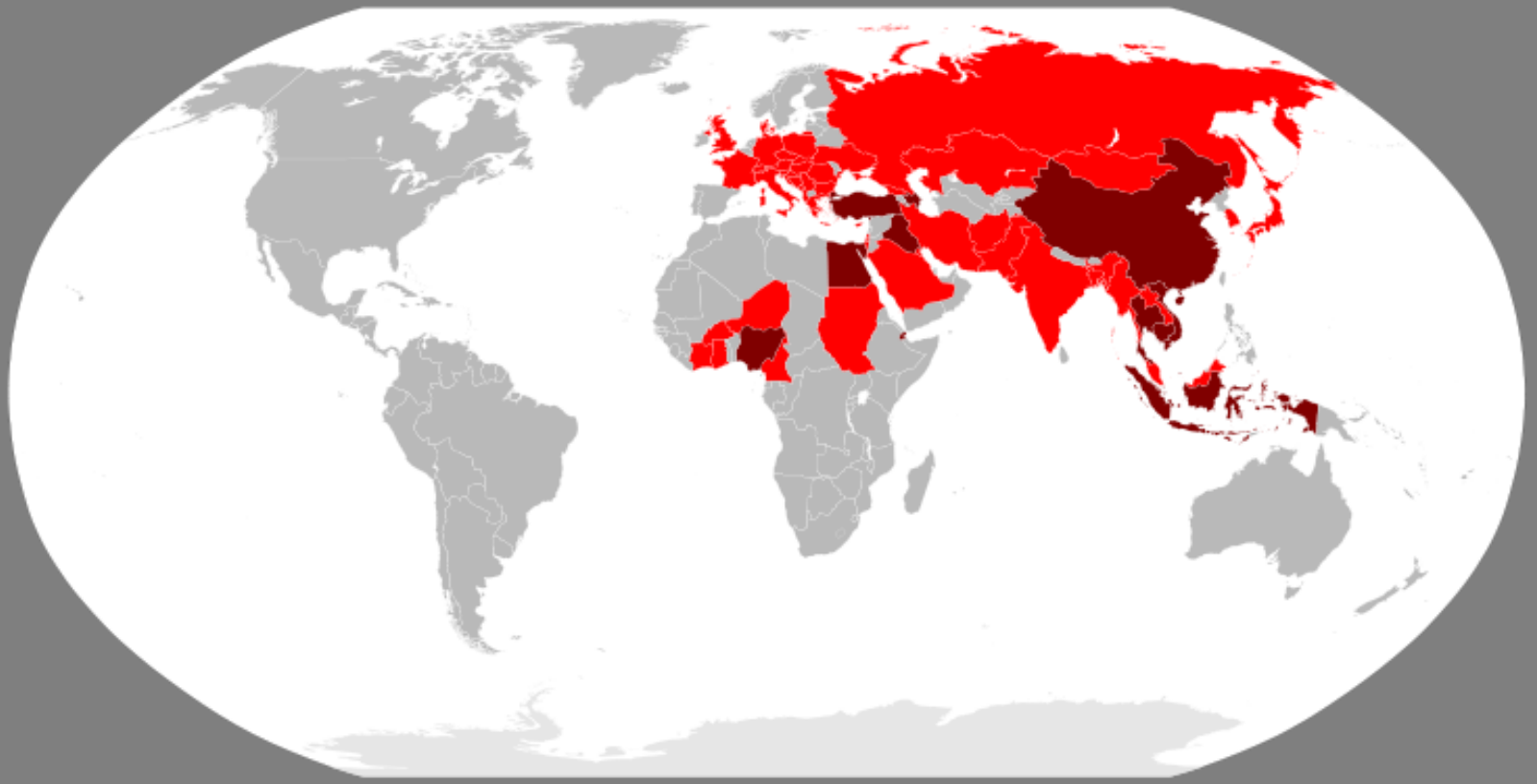


Influenza A – wild birds as reservoir



Influenza A – impact on the Canadian poultry industry

When the research started at MUN

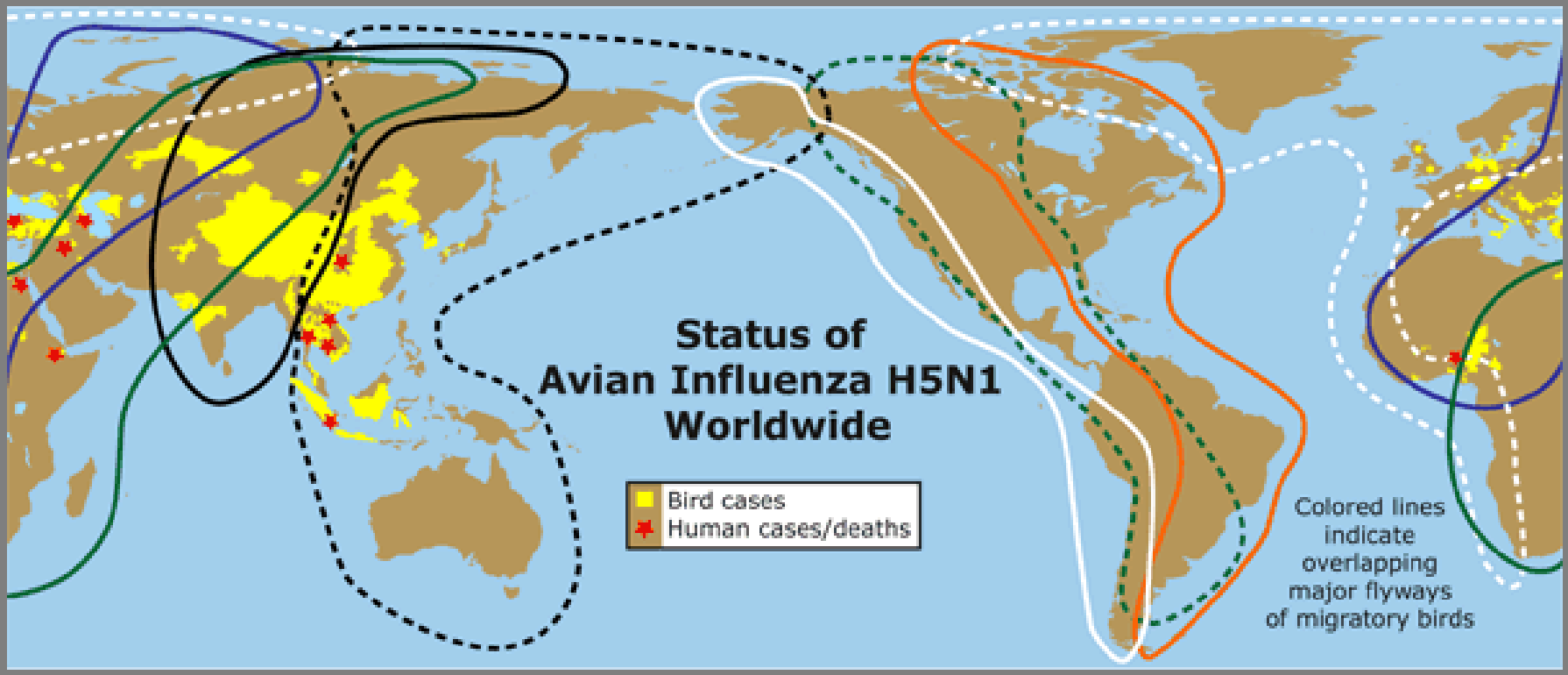


Countries where poultry died of H5N1

Countries where people died of H5N1

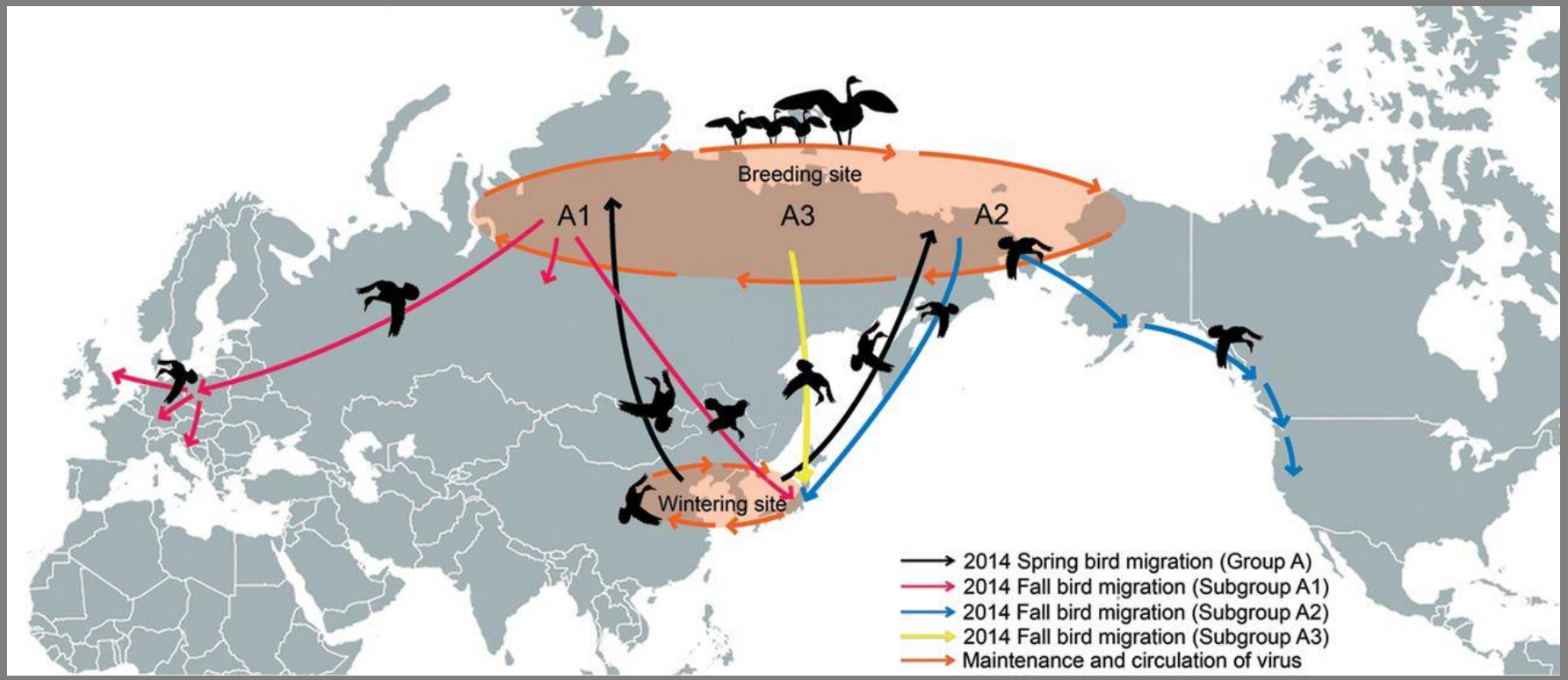
2003+

Avian Influenza – highly pathogenic H5N1 spread



North Pacific

Avian Influenza – risks to North America?



H5N8 presumably arrived in North America with migratory birds then reassorted into both H5N1 and H5N2, with H5N2 causing the most damage to the poultry industry.

Assumed movement of H5N8 to North America

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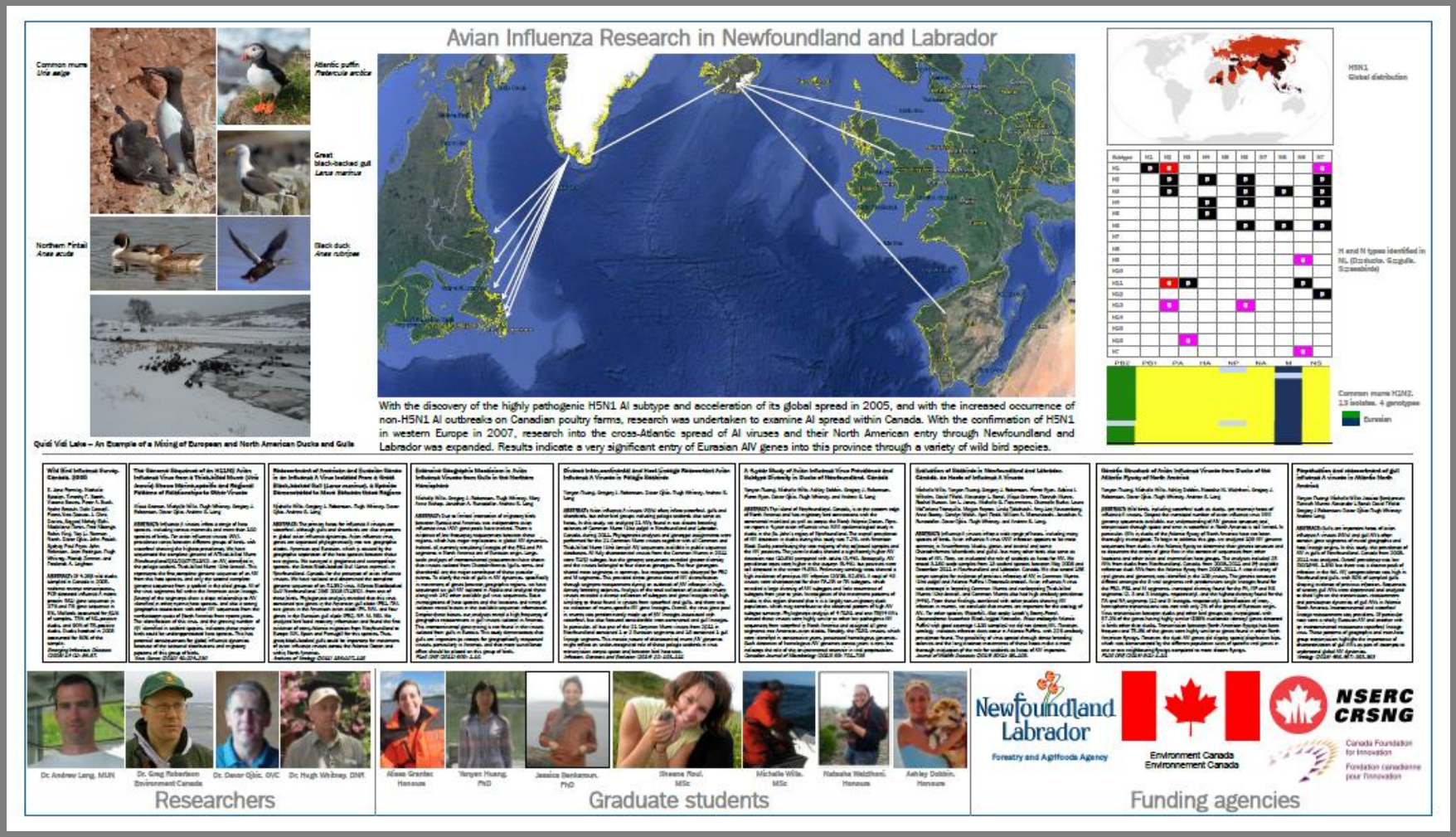

Avian influenza - findings to date

Analysis of influenza A viruses from gulls: an evaluation of inter-regional movements and interactions with other avian and mammalian influenza A viruses
Jessica Benkaroun, Dany Shoham, Ashley N.K. Kroyer, Hugh Whitney, and Andrew S. Lang. Accepted for publication in Cogent Biology, 2016.

In North America, only two wholly Eurasian avian IAVs have been found to date. One was an H16N3 virus from an American herring gull (*Larus smithsonianus*) in Eastern Canada, (Huang et al., 2014).

The other was the highly pathogenic avian influenza (HPAI) H5N8 virus that recently emerged in China, spread to South Korea, Japan and Siberia, and is proposed to have been transmitted through the Beringia region by migratory waterfowl into Pacific North America (Lee et al., 2015). This H5N8 arrival ended the long speculation about whether or not virulent Asian avian strains, such as H5N1, could be transmitted into the Americas by migrating birds.

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Demonstrated entry points for Eurasian IA virus into NA

Wild Bird Influenza Survey, Canada, 2005. E. Jane Parmley, Nathalie Bastien, Timothy F. Booth, Victoria Bowes, Peter A. Buck, Andre Breault, Dale Caswell, Pierre-Yves Daoust, J. Chris Davies, Seyyed Mehdy Elahi, Madeleine Fortin, Fred Kibenge, Robin King, Yan Li, Norman North, Davor Ojkic, John Pasick, Sydney Paul Pryor, John Robinson, Jean Rodrigue, Hugh Whitney, Patrick Zimmer, and Frederick A. Leighton. *Emerging Infectious Diseases* (2008) 14(1), 84-87

The genome sequence of an H11N2 avian influenza virus from a Thick-billed Murre (*Uria lomvia*) shows marine-specific and regional patterns of relationships to other viruses. Alissa Granter, Michelle Wille, Hugh Whitney, Gregory J. Robertson, Davor Ojkic, and Andrew S. Lang. *Virus Genes* (2010) 41:224–230.

Reassortment of American and Eurasian genes in an influenza A virus isolated from a great black-backed gull (*Larus marinus*), a species demonstrated to move between these regions. Michelle Wille, Gregory J. Robertson, Hugh Whitney, Davor Ojkic, and Andrew S. Lang. *Archives of Virology* (2011) 156:107–115

Extensive Geographic Mosaicism in Avian Influenza Viruses from Gulls in the Northern Hemisphere. Michelle Wille, Gregory J. Robertson, Hugh Whitney, Mary Anne Bishop, Jonathan A. Runstadler, Andrew S. Lang. *PLoS ONE* (2011) 6(6):1-10

Diverse Inter-continental and Host Lineage Reassortant Avian Influenza A Viruses in Pelagic Seabirds. Yanyan Huang, Gregory J. Robertson, Davor Ojkic, Hugh Whitney, Andrew S. Lang. *Infection, Genetics and Evolution* (2014) 22:103–111.

A 4-year Study of Avian Influenza Virus Prevalence and Subtype Diversity in Ducks of Newfoundland, Canada. Yanyan Huang, Michelle Wille, Ashley Dobbin, Gregory J. Robertson, Pierre Ryan, Davor Ojkic, Hugh Whitney, and Andrew S. Lang. *Canadian Journal of Microbiology* (2013) 59:701–708.

AI Publications

ONE HEALTH

Evaluation of Seabirds in Newfoundland and Labrador, Canada, as Hosts of Influenza A Viruses. Michelle Wille, Yanyan Huang, Gregory J. Robertson, Pierre Ryan, Sabina I. Wilhelm, David Fifield, Alexander L. Bond, Alissa Granter, Hannah Munro, Rachel Buxton, Ian L. Jones, Michelle G. Fitzsimmons, Chantelle Burke, Laura McFarlane Tranquilla, Megan Rector, Linda Takahashi, Amy-Lee Kouwenberg, Anne Storey, Carolyn Walsh, April Hedd, William A. Montevecchi, Jonathan A. Runstadler, Davor Ojkic, Hugh Whitney, and Andrew S. Lang. *Journal of Wildlife Diseases* (2014) 50(1):98–103.

Genetic Structure of Avian Influenza Viruses from Ducks of the Atlantic Flyway of North America. Yanyan Huang, Michelle Wille, Ashley Dobbin, Natasha M. Walzthoni, Gregory J. Robertson, Davor Ojkic, Hugh Whitney, Andrew S. Lang. *PLoS ONE* (2014) 9(1):1-10.

Perpetuation and reassortment of gull influenza A viruses in Atlantic North America. Yanyan Huang; Michelle Wille; Jessica Benkaroun; Hannah Munro; Alexander L Bond; David Fifield; Gregory J Robertson; Davor Ojkic; Hugh Whitney; Andrew Lang. *Virology* (2014) 456-457:353-363

Assessing the role of seabirds in the ecology of influenza A viruses. 2016. Lang, A.S., C. Lebarbenchon, A.M. Ramey, G.J. Robertson, J. Waldenström, and M. Wille. Avian Diseases 60: 378-386.

Analysis of influenza A viruses from gulls: an evaluation of inter-regional movements and interactions with other avian and mammalian influenza A viruses. Jessica Benkaroun, Dany Shoham, Ashley N.K. Kroyer, Hugh Whitney, and Andrew S. Lang. 2016 *Cogent Biology*. DOI: 10.1080/23312025.2016.1234957

Analysis of the variability in the non-coding regions of influenza A viruses. 2018. Benkaroun, J., G.J. Robertson, H. Whitney, and A.S. Lang. Veterinary Sciences 5: 76

AI Publications

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RABIES

Rabies - a fatal disease spread by an infected bite

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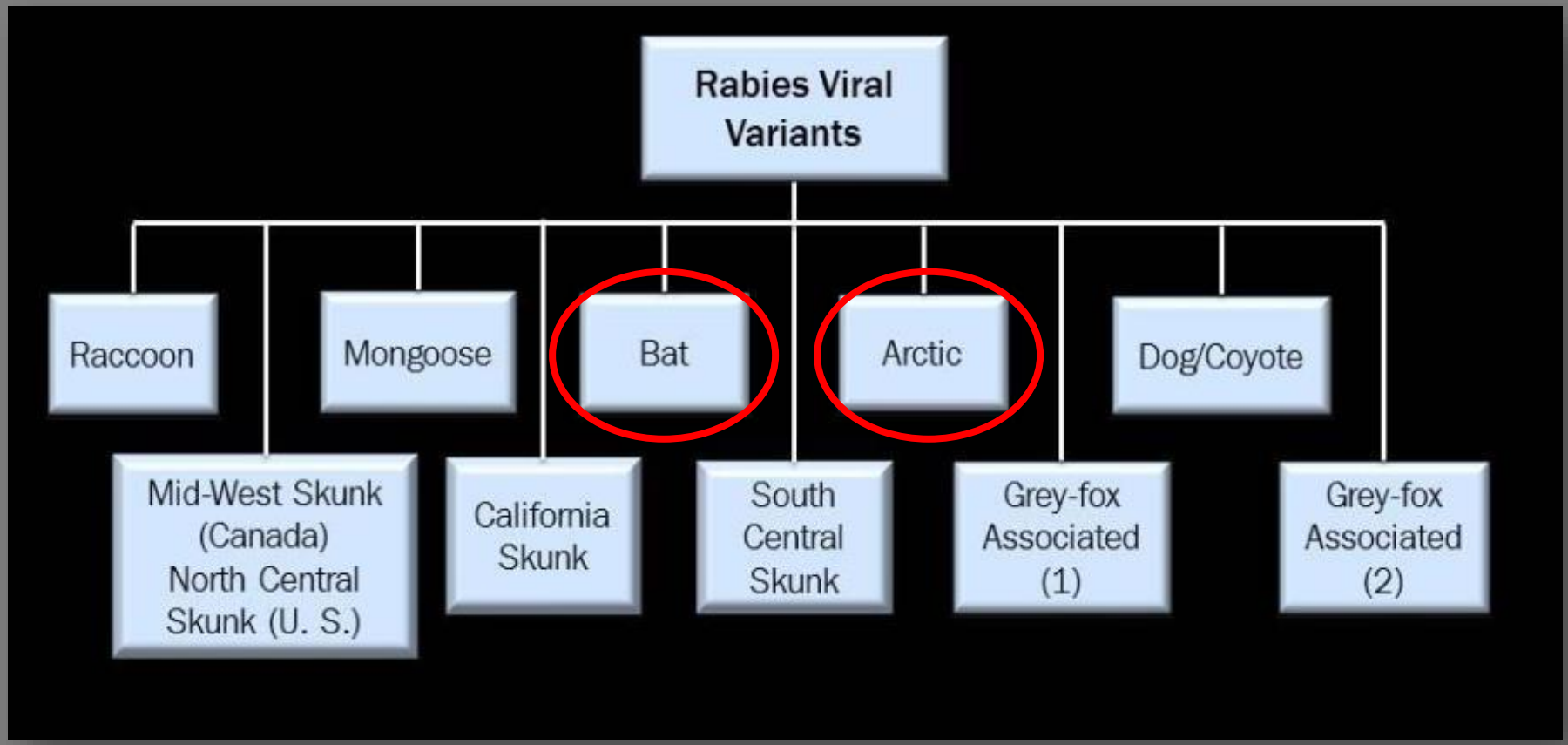


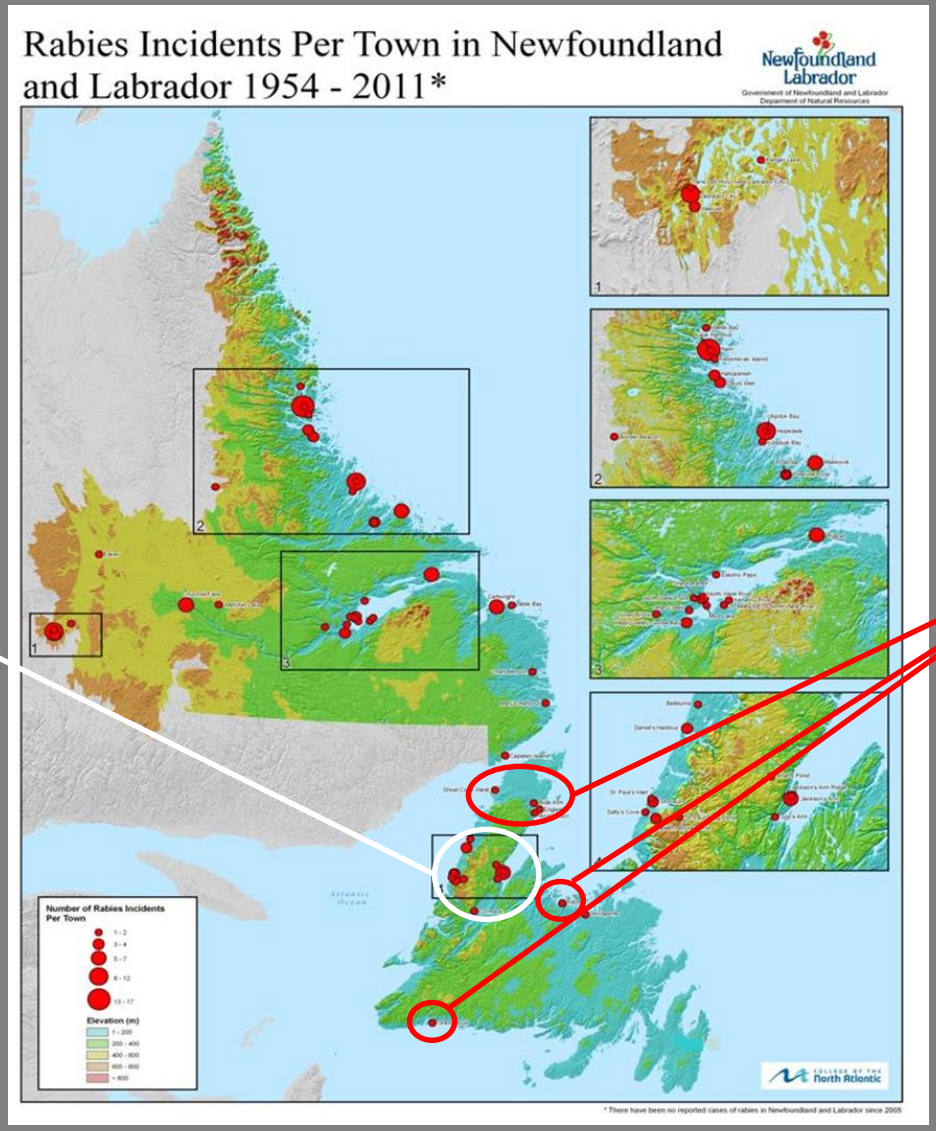
Different viral variants (lineages) are associated with different primary host species, originally determined by monoclonal antibody analysis.

Best able to persist in the primary host species.

Rabies – numerous geographic & species specific variants

2002-03 outbreak

1988 outbreak



Rabies - cases in NL

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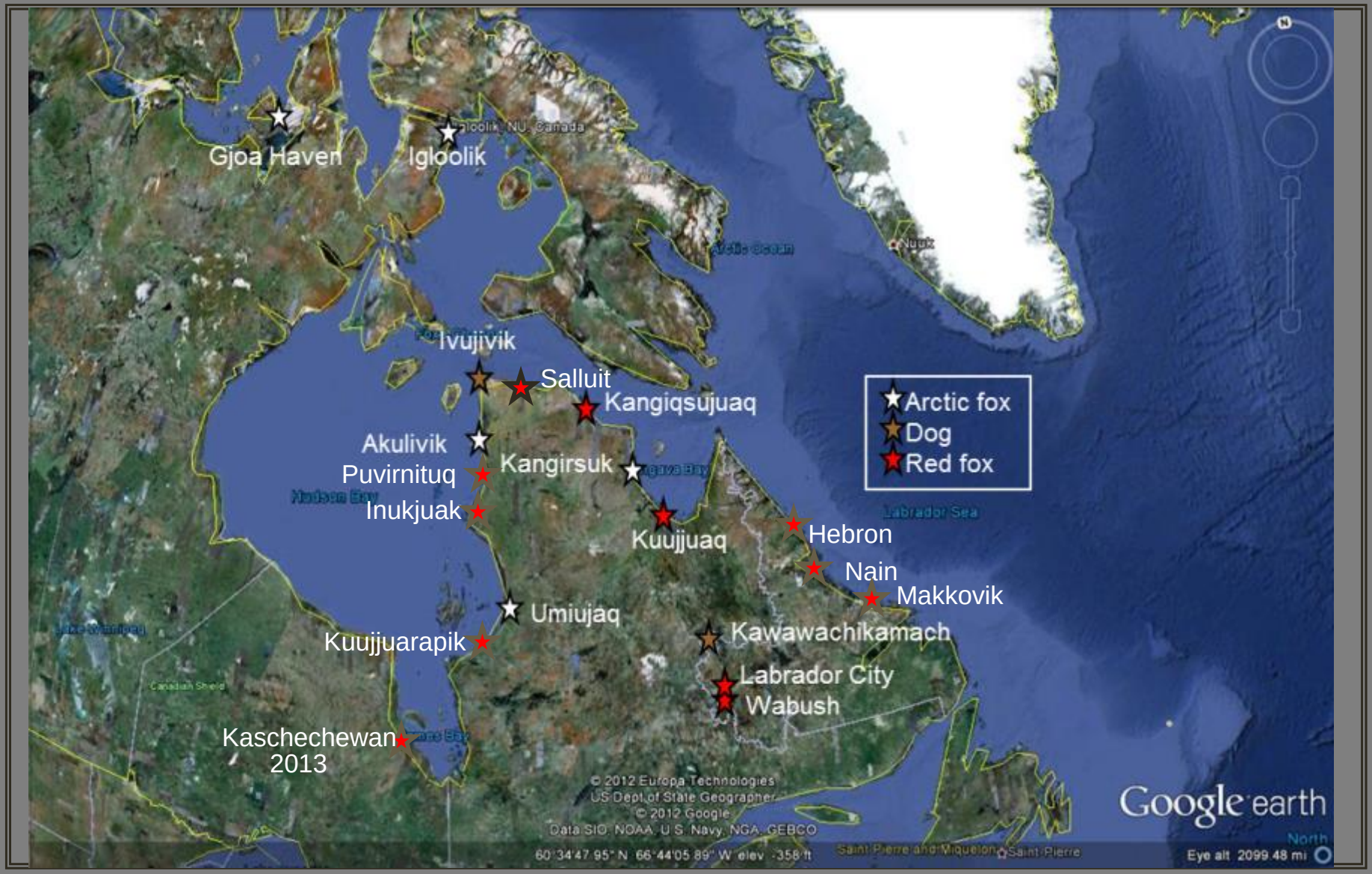
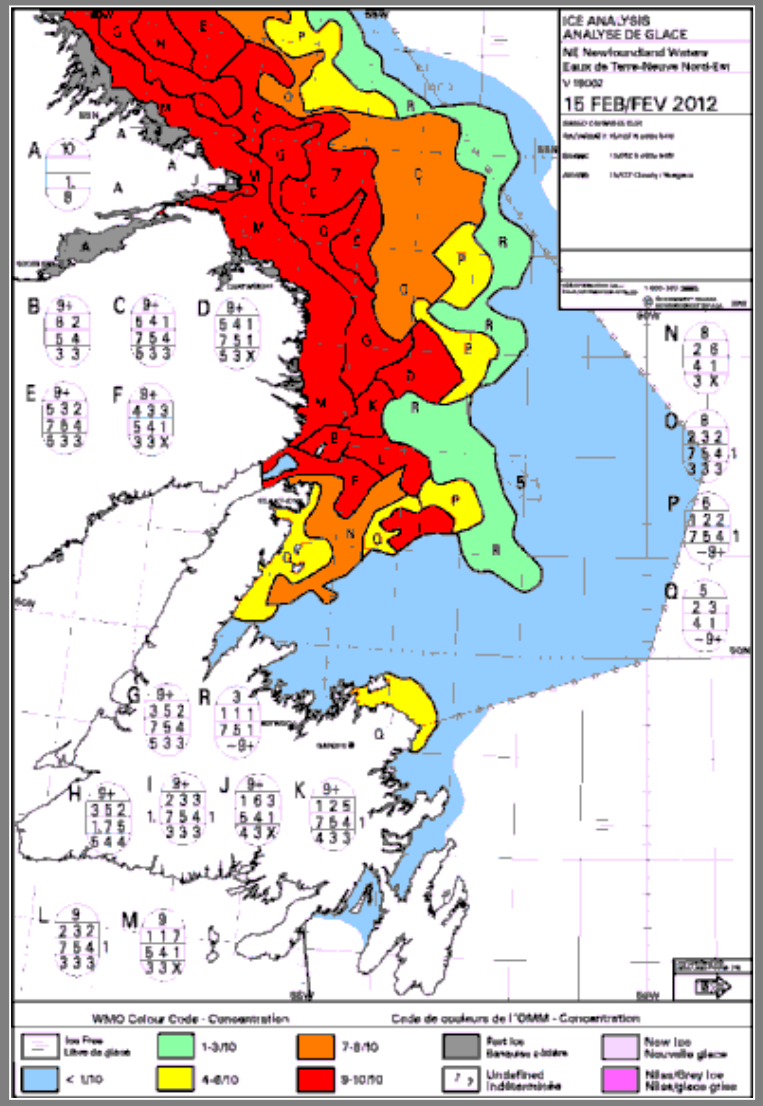
Rabies – Arctic fox lineage - a pan-Arctic reality

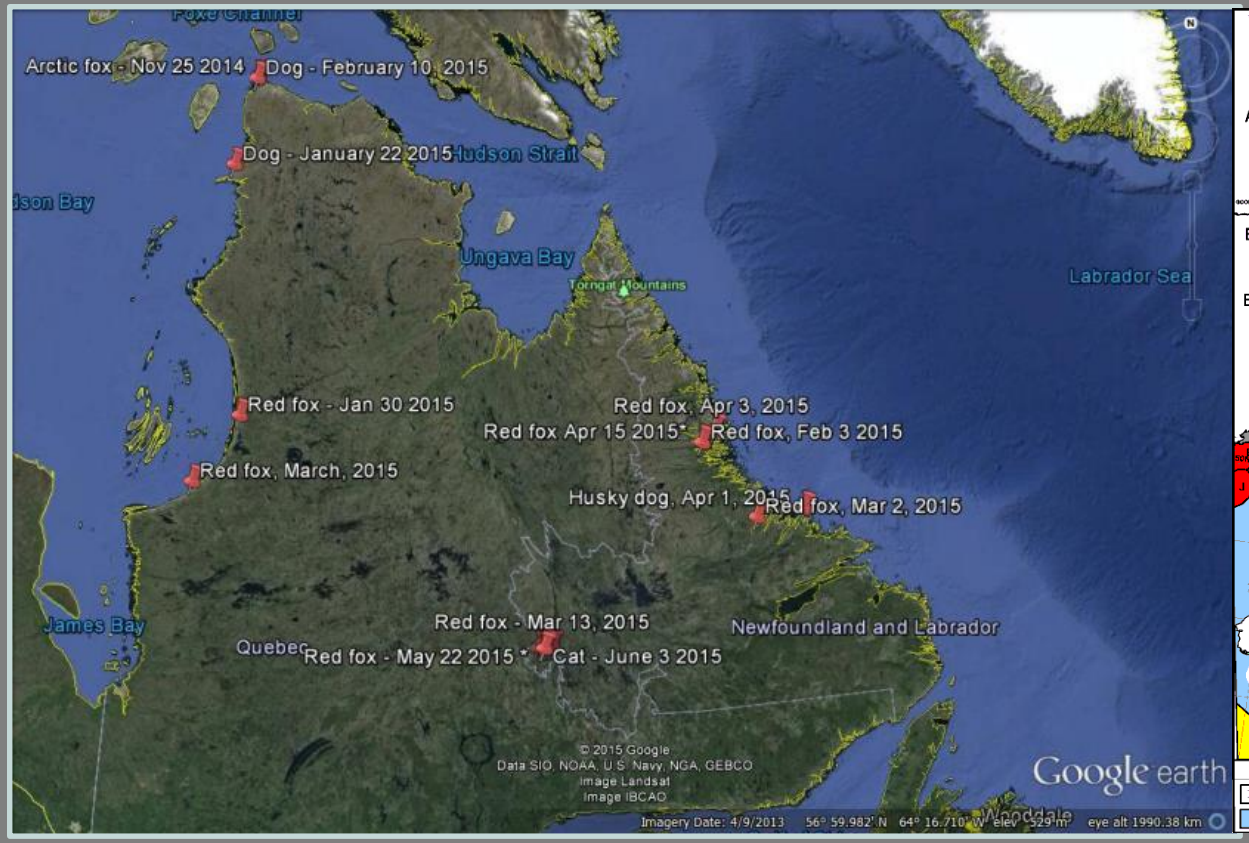


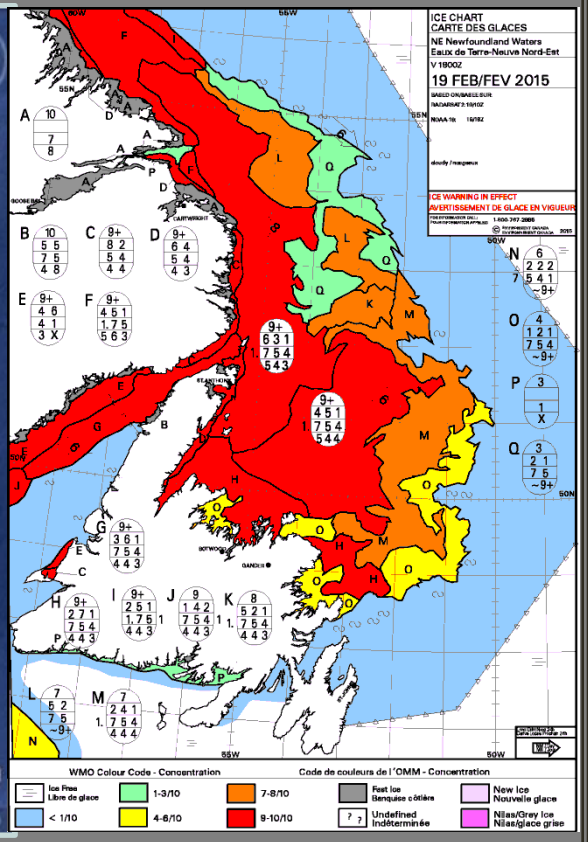
Rabies – Northeast Canada – 2011/2012



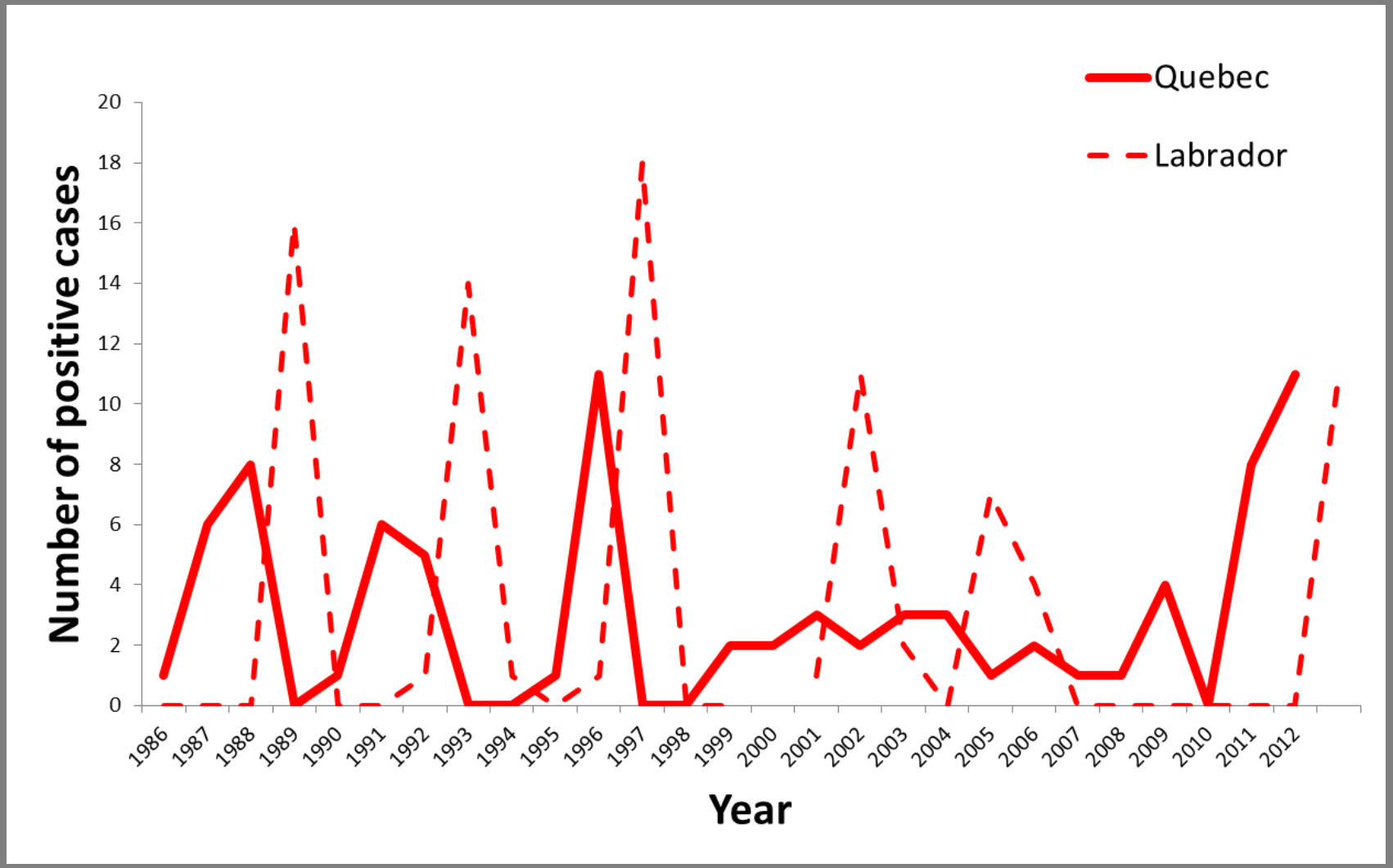
Rabies – the perpetual risk from ice bridges

2015

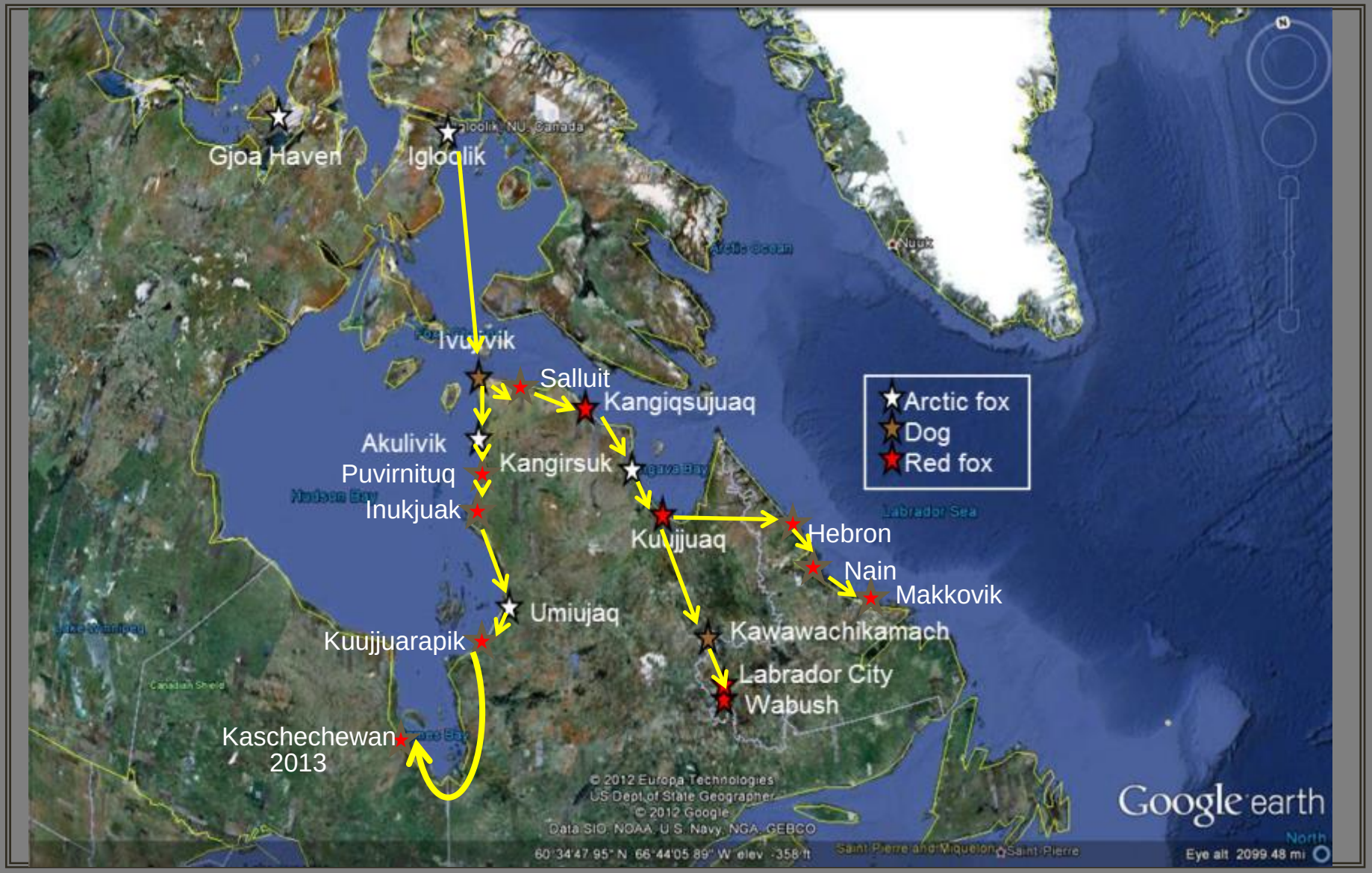




Rabies – the perpetual risk from ice bridges



Rabies - Synchronization of Que/Labrador outbreaks



Rabies – but how does it move through the North?

ArcticNet

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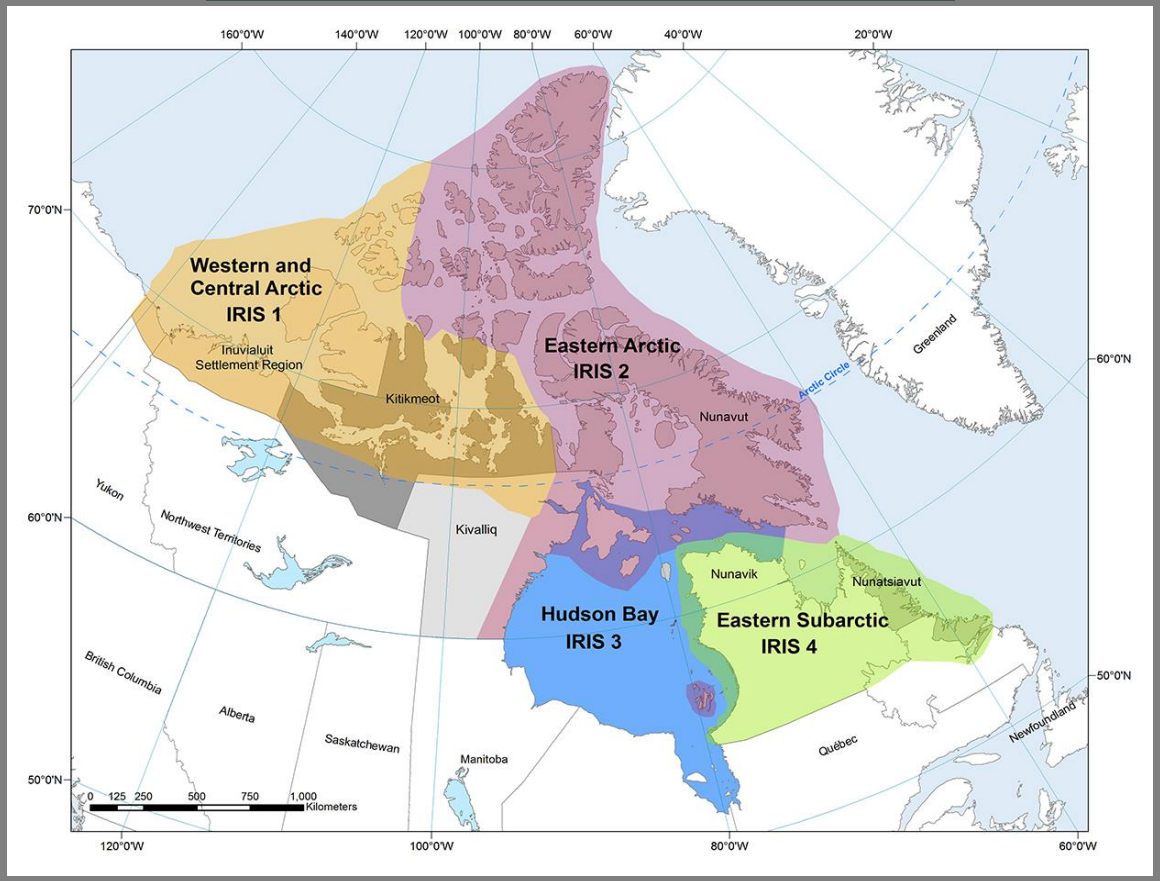

Rabies – Research in the Arctic

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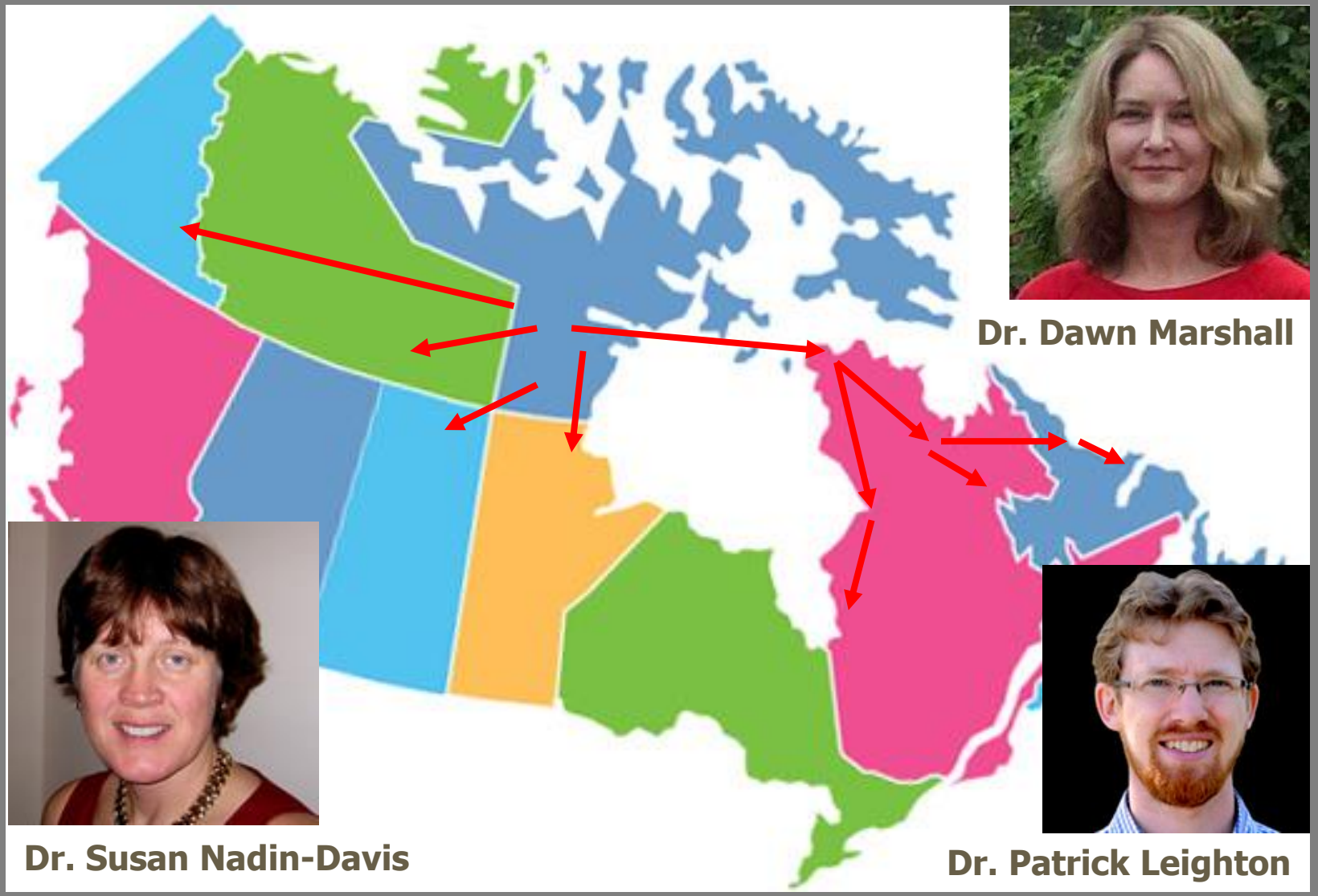
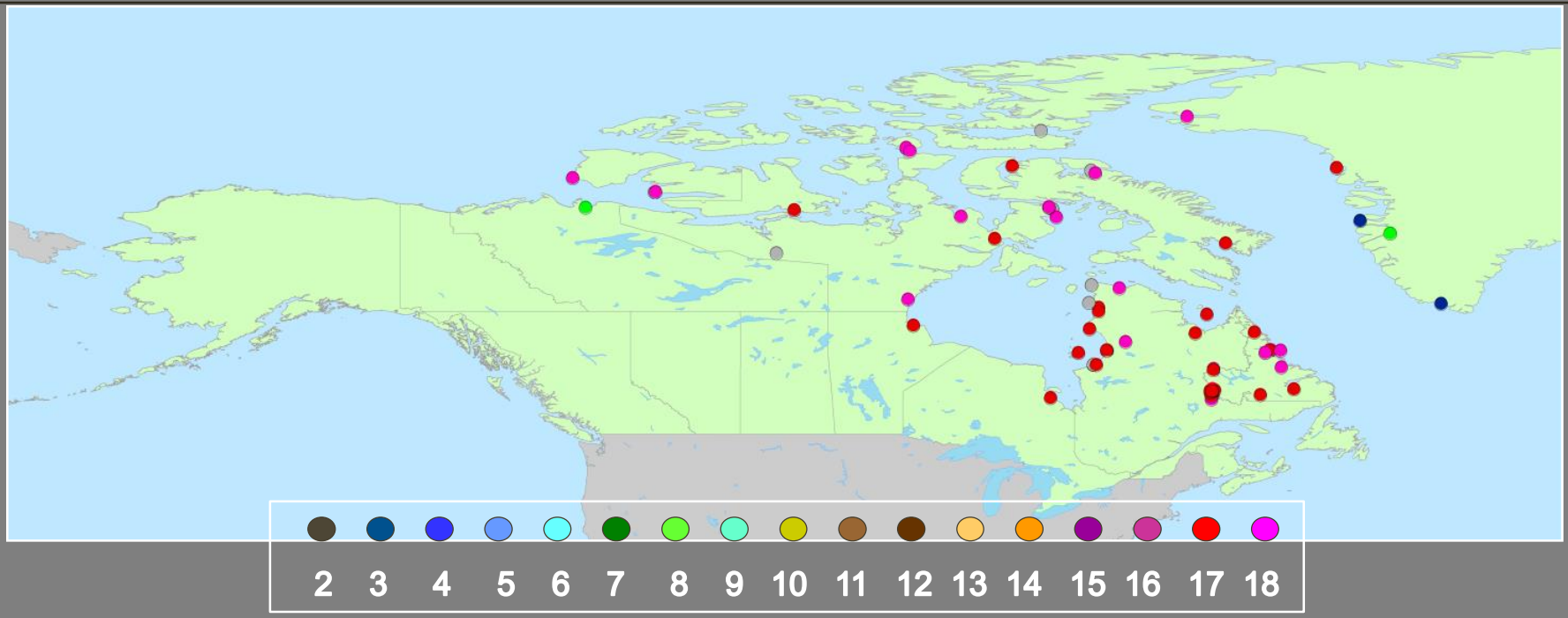


Rabies - Exploring the movement of Arctic fox rabies in N Canada

Rabies - Exploring the movement of Arctic fox rabies in N Canada



The arctic fox variant has four sub-lineages across the Arctic, A1-A4, with A3 being the most common.

A-3 has been divided into 18 groups based on whole genome sequencing.

Since 2010, all cases have been from viral groups 2, 8, 17 and 18; with 17 and 18 being the most dominant.

Rabies - Exploring the movement of Arctic fox rabies in N Canada

Red foxes	Arctic foxes
CAR	BAK
CHV	CHV
KUU	IGL
LAB	RAG
NWR	RAN
PHS	SAC
Other	Other

Mitochondrial control region (MCR) and microsatellite (MS) analysis of red and arctic fox samples.

Arctic foxes
33 MCR subtypes

Red foxes
18 MCR subtypes

Rabies – looking for variability in fox genetics

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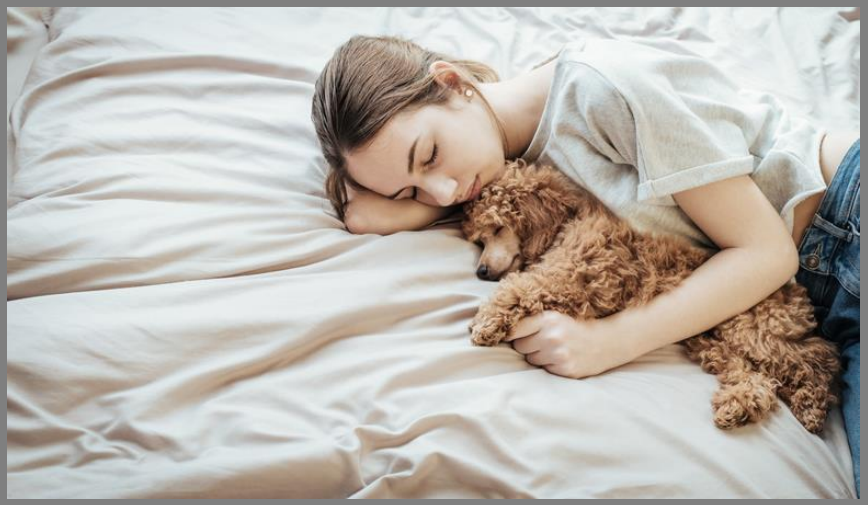
Relationships between fox populations and rabies virus spread in northern Canada

S.Nadin-Davis, E.Fallardeau, A.Flynn & H.Marshall, manuscript, 2019

Dr. Kapil Tahlan

Dr. James Valcour



MRSA/MRSP in NL & relationship with pet ownership

Methicillin resistant *Staphylococcus aureus* – human infection

Methicillin resistant *Staphylococcus pseudintermedius* – dog infection

MRSA/MRSP in NL & relationship with pet ownership

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Epidemiology

- prevalence in humans and dogs
- human risk associated with employment, source of dog, behaviour
- dog risk associated with medical history, source, age, activities

Dr. James Valcour

Microbiology

- genotypes isolated
- geographic distribution of genotypes
- possibility of resistant gene transfer between MRSA & MRSP

Dr. Kapil Tahlan

MRSA/MRSP in NL & relationship with pet ownership

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West Nile virus

Snowshoe hare virus

Jamestown Canyon virus

Arboviruses – chasing the headlines

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AEM
Journals.ASM.org

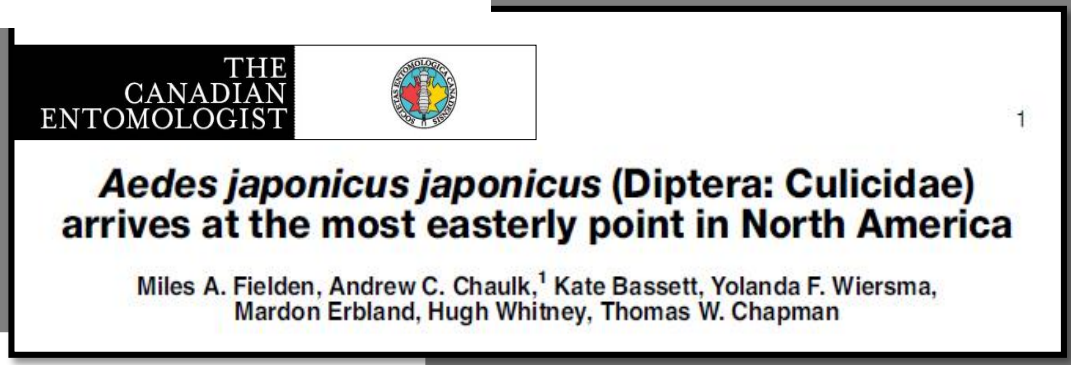
Roles of Host Species, Geographic Separation, and Isolation in the Seroprevalence of Jamestown Canyon and Snowshoe Hare Viruses in Newfoundland

Gregory Goff,[a] Hugh Whitney,[b] and Michael A. Drebot[c]

Environmental Sciences Department, Grenfell Campus of Memorial University, Corner Brook, Newfoundland, Canada[a]; Animal Health Division, Newfoundland and Labrador Department of Natural Resources, St. John's, Newfoundland, Canada[b]; and Viral Zoonoses, National Microbiological Laboratory, Public Health Agency of Canada, Winnipeg, Manitoba, Canada[c]

Significant pathogens do exist in NL

And the list of important vector species gets longer



THE CANADIAN ENTOMOLOGIST

1

***Aedes japonicus japonicus* (Diptera: Culicidae) arrives at the most easterly point in North America**

Miles A. Fielden, Andrew C. Chaulk,[1] Kate Bassett, Yolanda F. Wiersma, Mardon Erbland, Hugh Whitney, Thomas W. Chapman

Journal of Medical Entomology, 2016, 1–6
doi: 10.1093/jme/tjw105
Research article

OXFORD

Sampling, Distribution, Dispersal

The Arrival of the Northern House Mosquito *Culex pipiens* (Diptera: Culicidae) on Newfoundland's Avalon Peninsula

Andrew C. Chaulk,[1,2] Kate P. Carson,[1] Hugh G. Whitney,[3] Dina M. Fonseca,[4] and Thomas W. Chapman[1]

and more broadly distributed

Arboviruses – the need for sustained research

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Dr. Atanu Sarkar

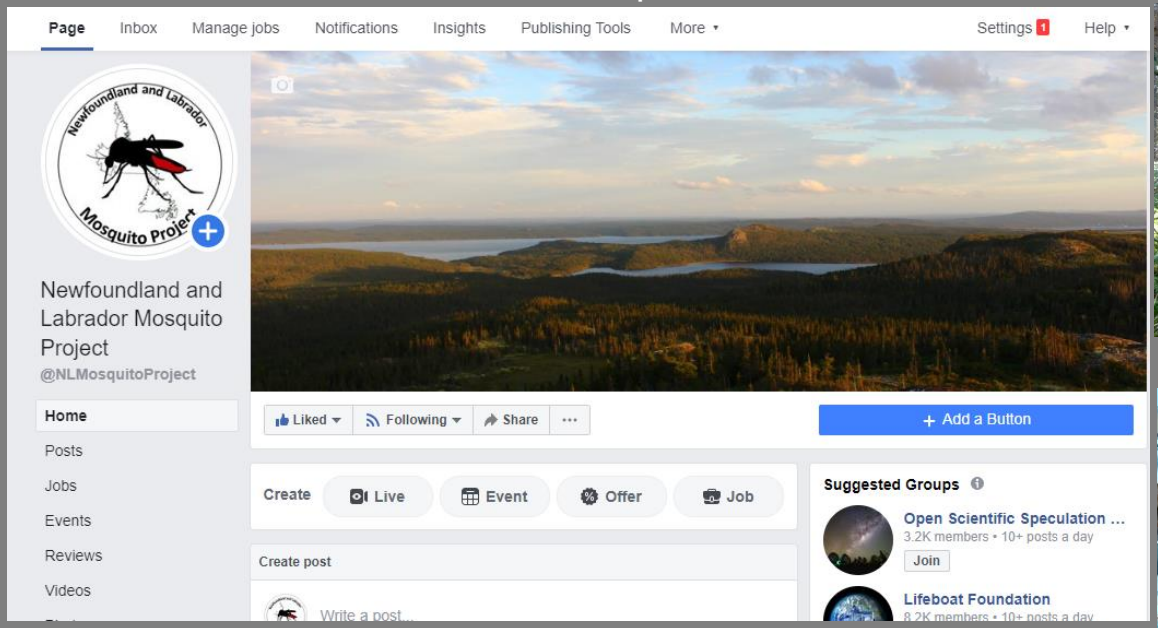
Dr. Andrew Lang

Dr. Tom Chapman

Dr. Joel Finnis

Dr. Hugh Whitney

Tegan Padgett



Kate Carson

Dr. Marta Canuti

Facebook Page: @NLMosquitoProject

Courtney White

NL Mosquito Project

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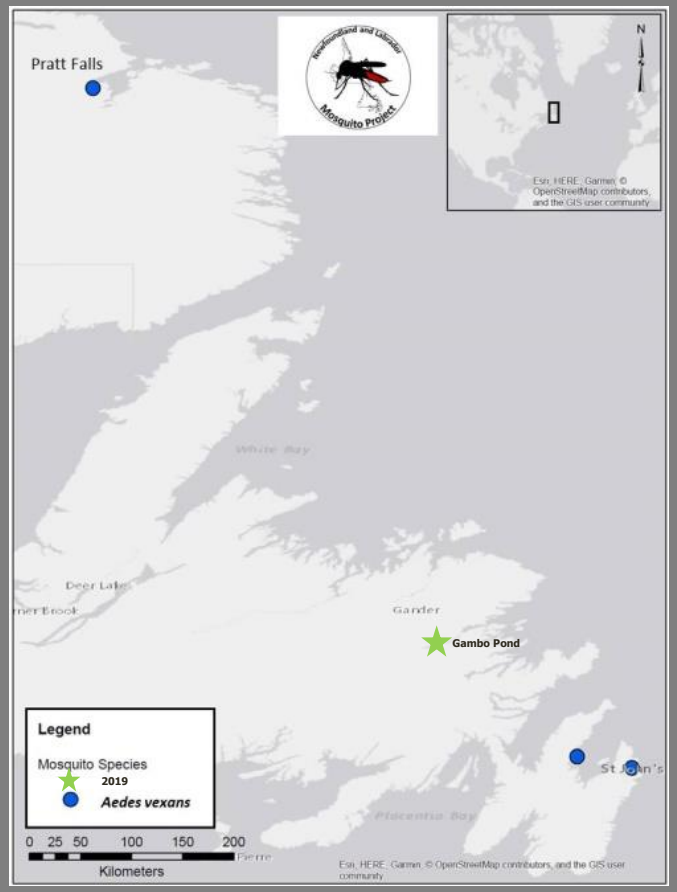
Aedes vexans
inland floodwater mosquito

image credit: Sean McCann via University of Wisconsin

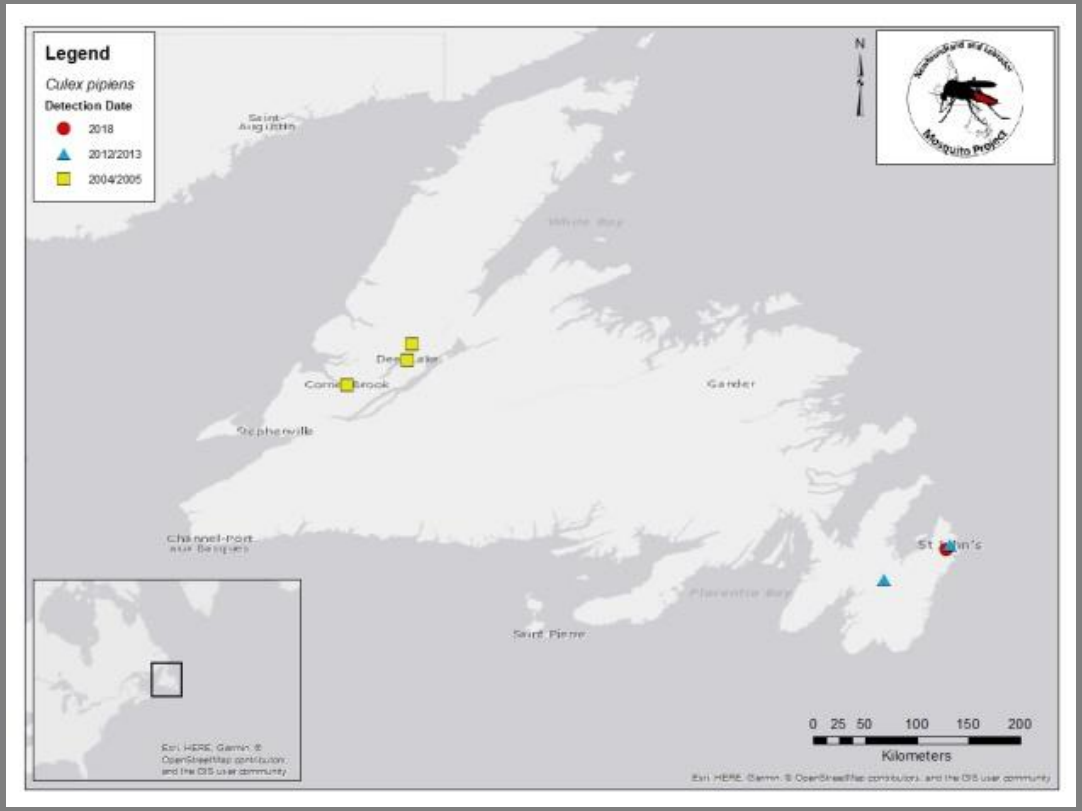


Its name means unpleasant, or troublesome (*Aedes*), and annoying (*vexans*). Voted as the greatest mosquito pest by the American Mosquito Control Association.

Culex pipiens

northern house mosquito

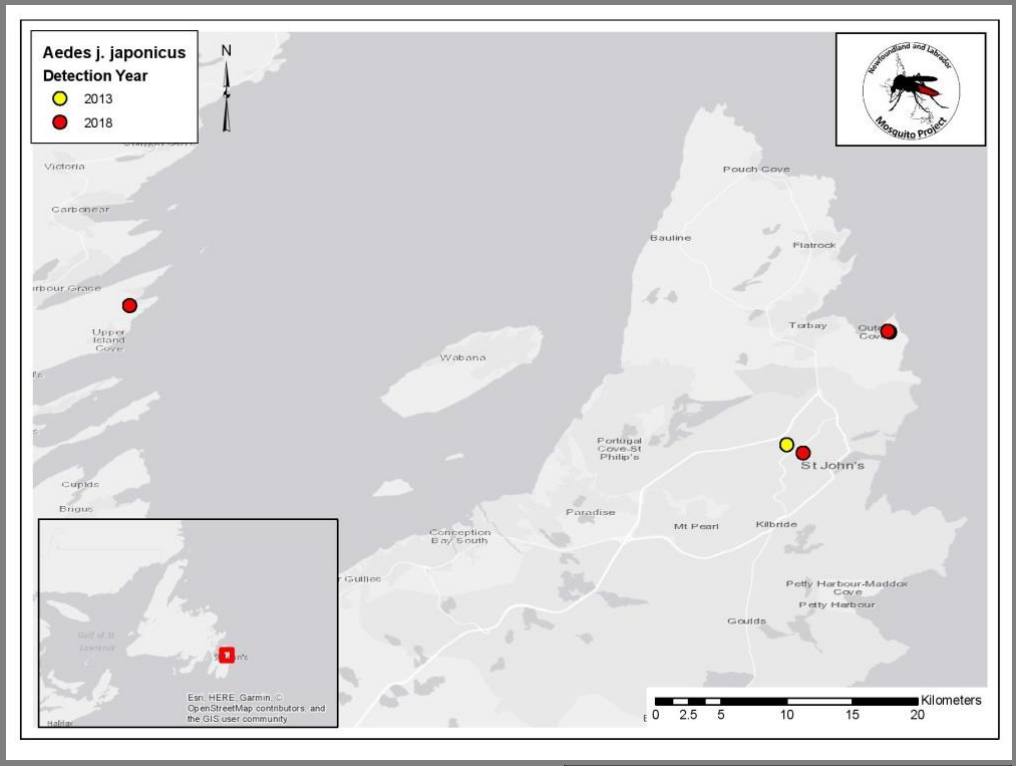
image credit: Dr. MJ Raupp, U of Maryland



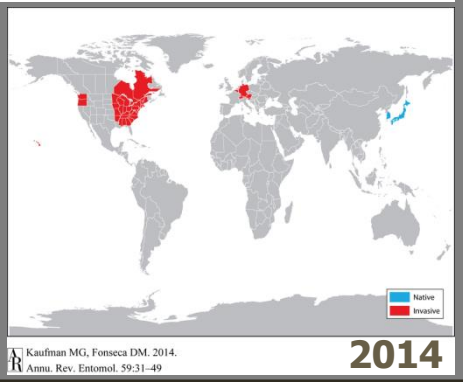
The most important vector of West Nile virus in eastern Canada. NL is the only province never to have recorded a single isolate in wild or domestic animals or humans. In the summer of 2018, all three Maritime provinces reported cases in birds.

Aedes japonicus japonicus
Asian bush mosquito

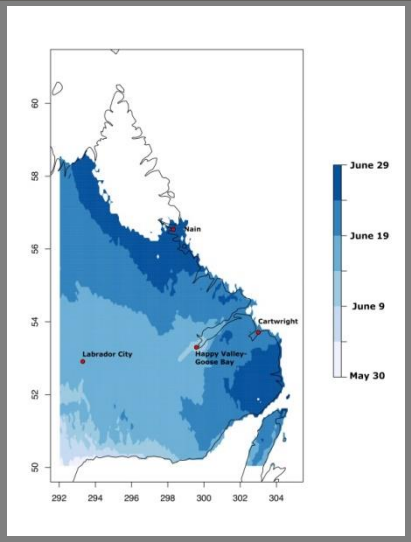
image source: US CDC

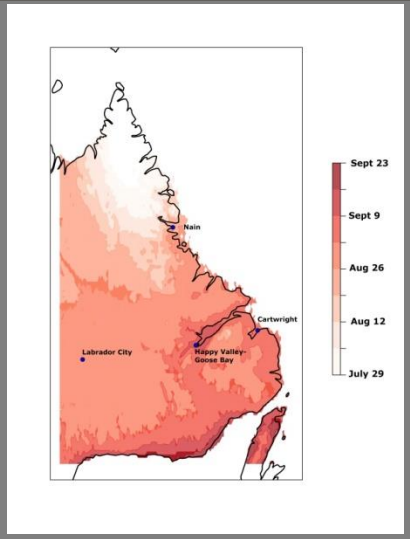


Aggressive biter, very important disease vector and globally invasive species.

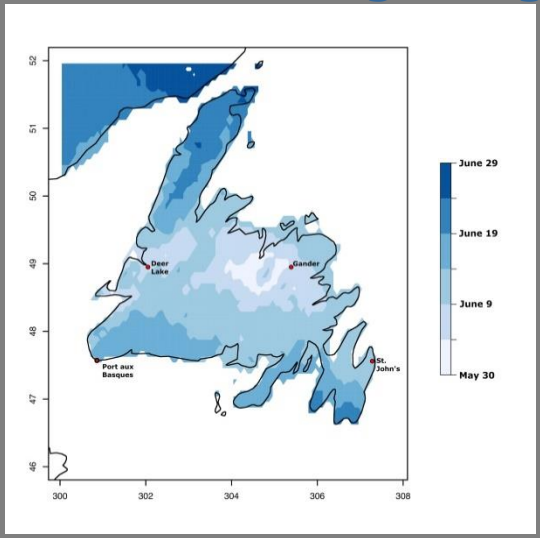


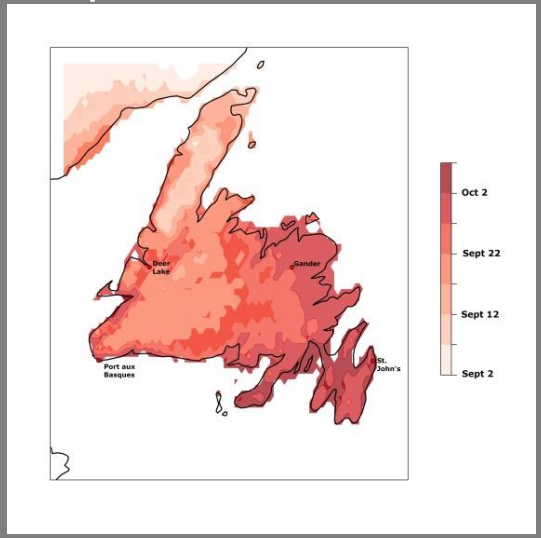
NL Mosquito Project



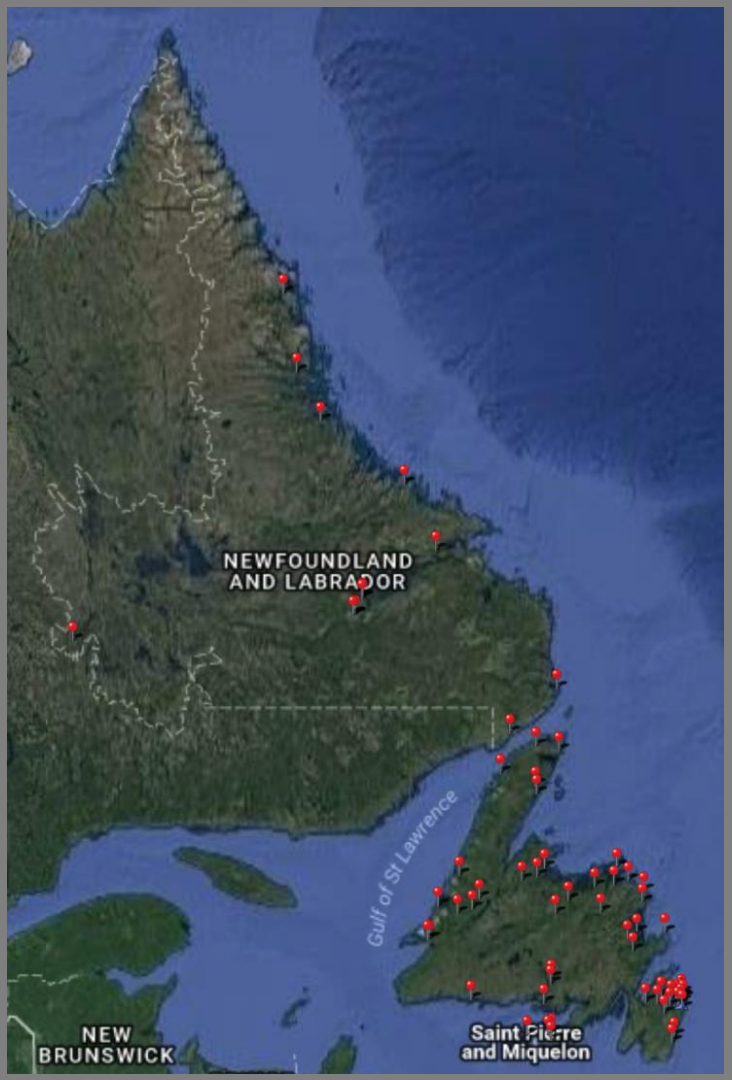


The **beginning** and **end** of mosquito season





NL Mosquito Project – the impact of climate change



NL Mosquito Project – participants in the project

Ticks and Lyme disease

Haemaphysalis leporis-palustris
The rabbit tick

Ixodes muris
The mouse tick

Ixodes uriae
The seabird tick

Ixodes angustus
The vole tick

Ticks – permanent populations

Ixodes marxi
The squirrel tick

Ticks – permanent populations?

Ixodes scapularis
The black-legged tick

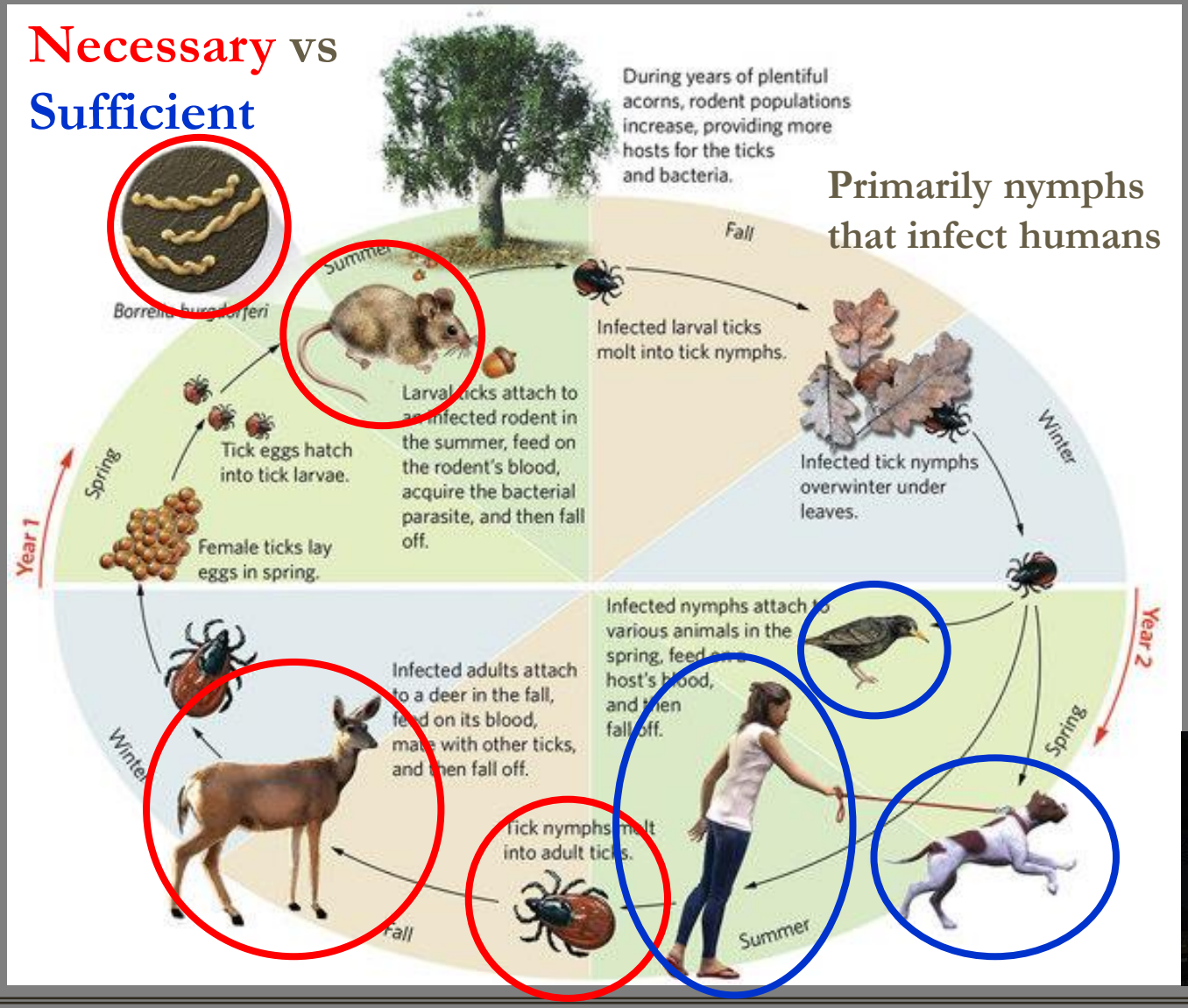
Rhipicephalus sanguineus
The brown dog or kennel tick

Ixodes ricinus
The sheep tick

Dermacentor variabilis
American dog tick

Ticks – transient populations

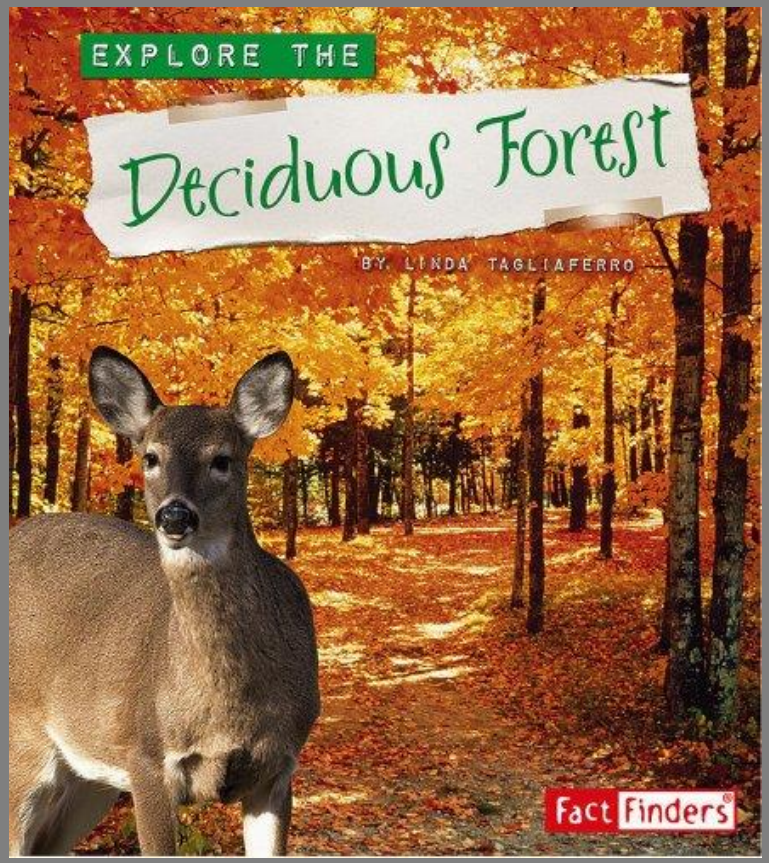
Necessary vs **Sufficient**



Primarily nymphs that infect humans

Life cycle of *Ixodes scapularis*

ONE HEALTH

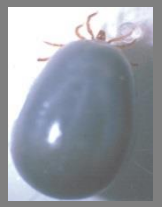


Deciduous forest (coniferous in Maritimes)

- Refuge from weather extremes
- Suitable hosts
- Suitable micro-climate for survival and host-seeking

Habitat of *Ixodes scapularis*

White-footed mouse



Mouse tick

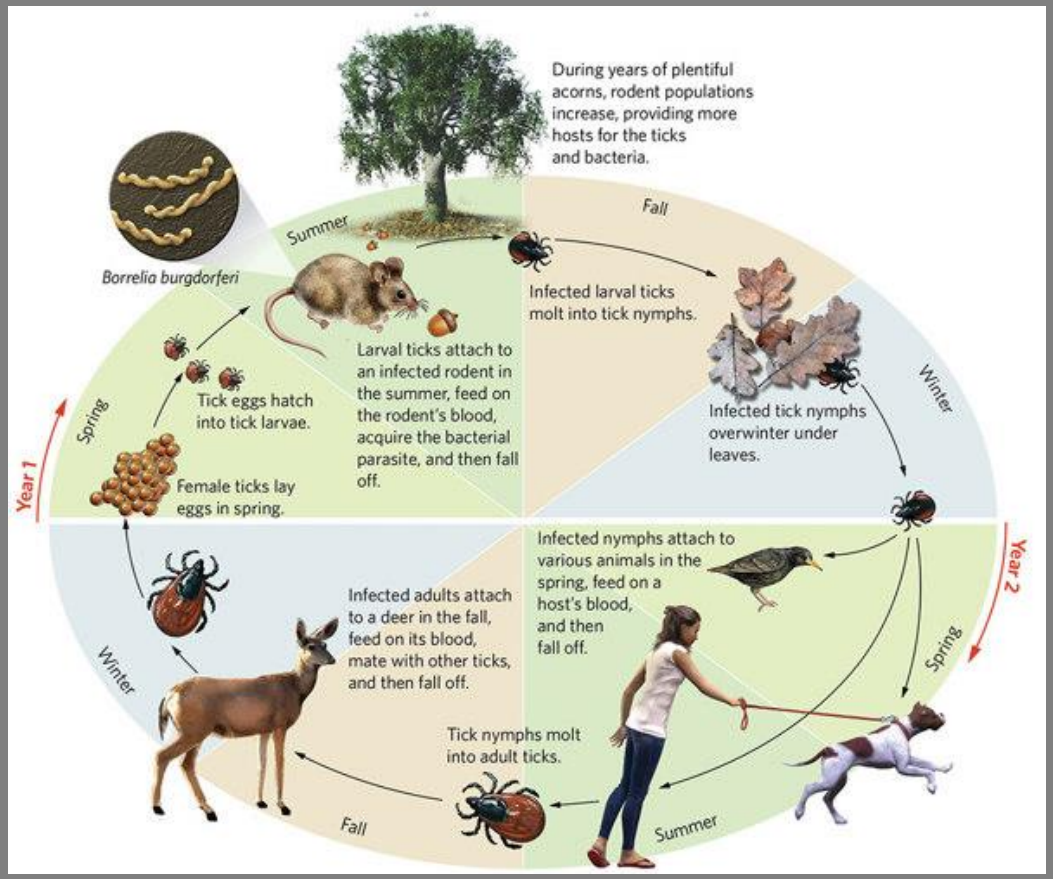
Mouse tick

Maintenance of *B. burgdorferi* in nature

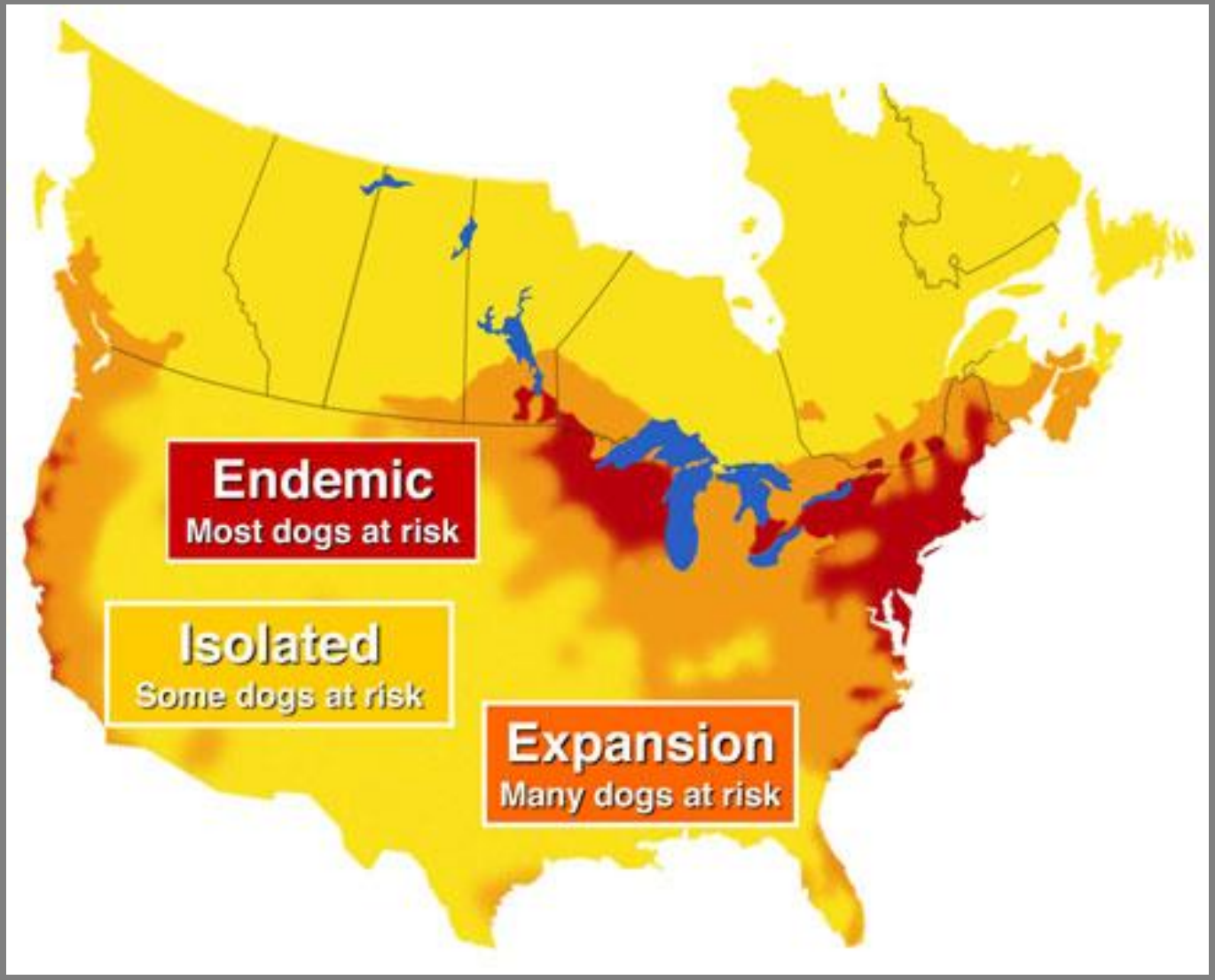
Rodent reservoirs for *Borrelia burgdorferi*

Ixodes scapularis
Borrelia burgdorferi

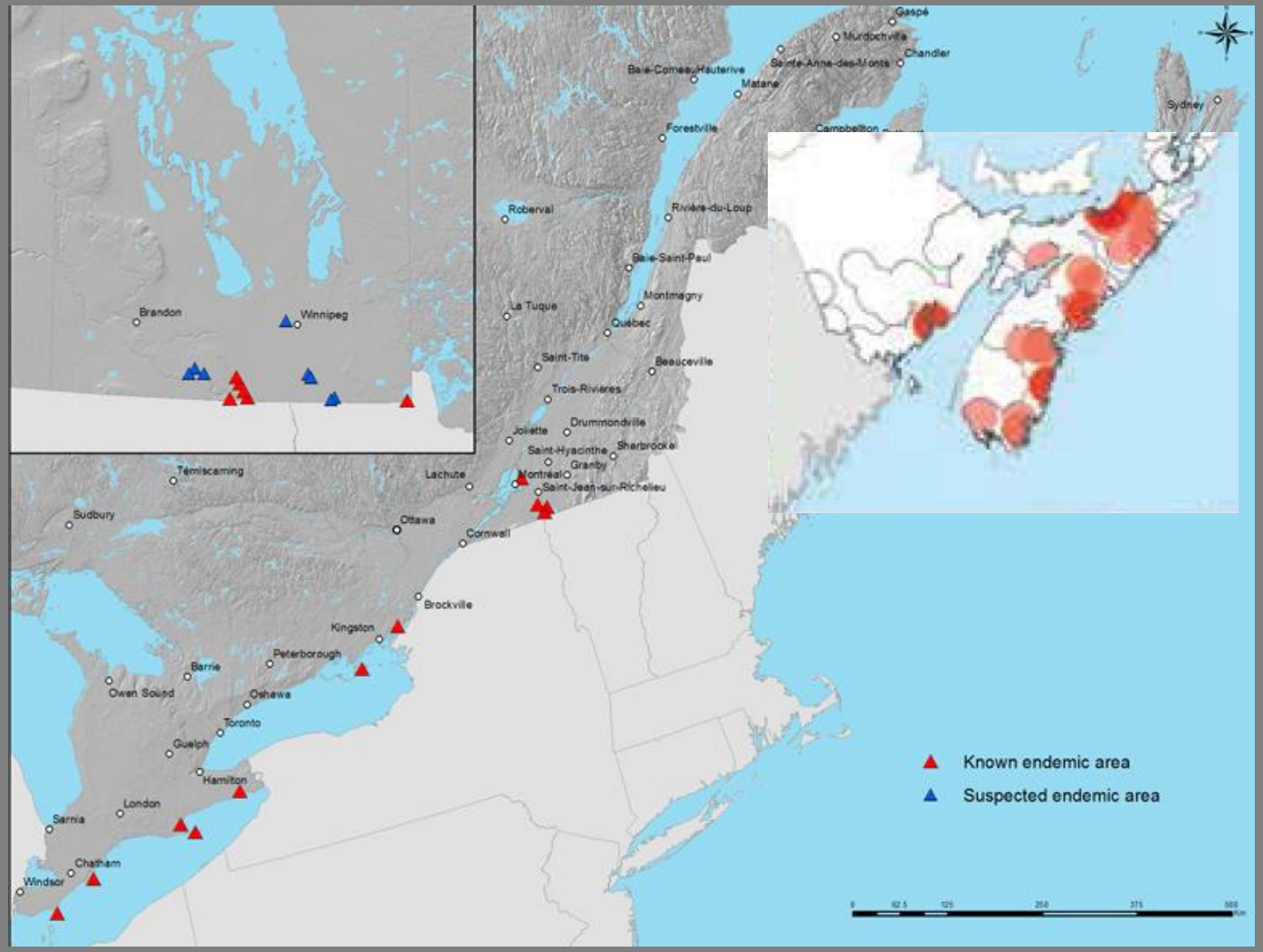
Mouse tick



Role of *Ixodes scapularis*



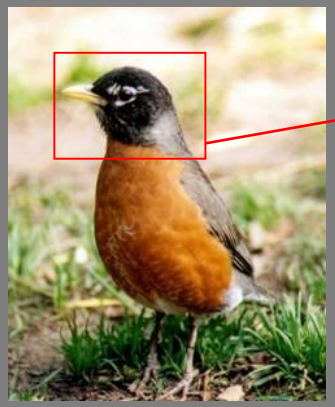
Range for *Ixodes scapularis*



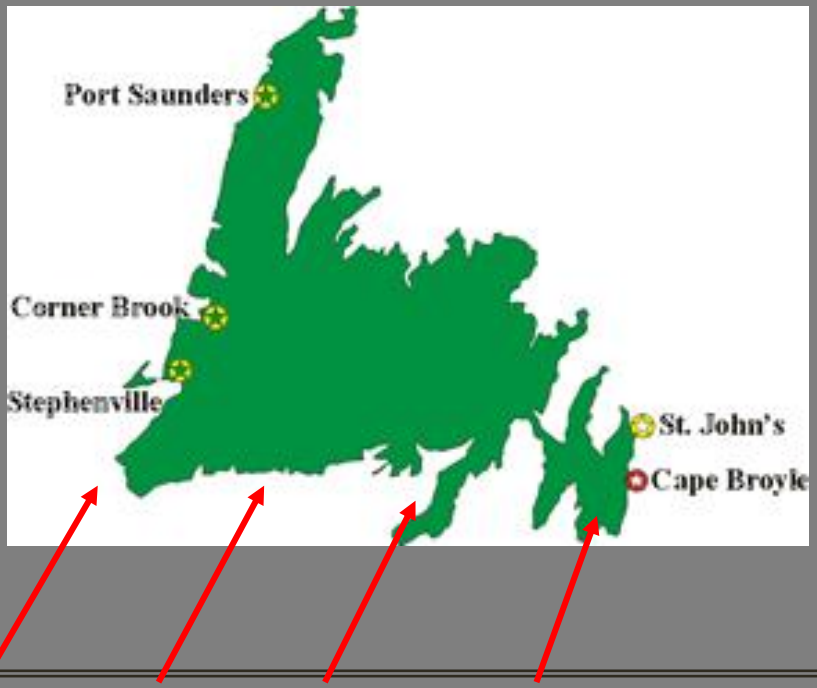
Range expansion for *Ixodes scapularis*

Canada
2004 – 40 human cases
2017 – 2025 human cases

Effect of climate change on range expansion



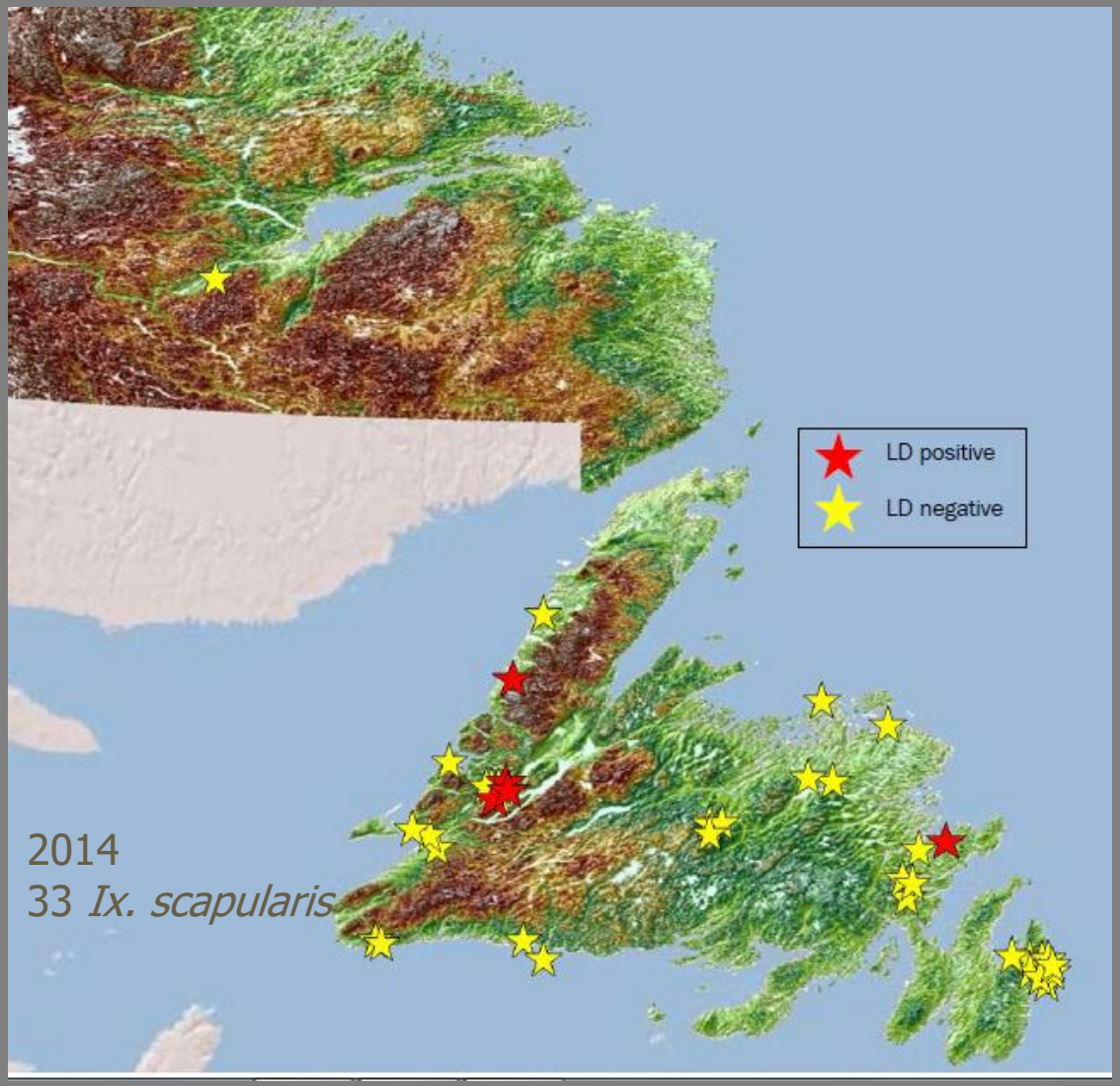
Ixodes scapularis



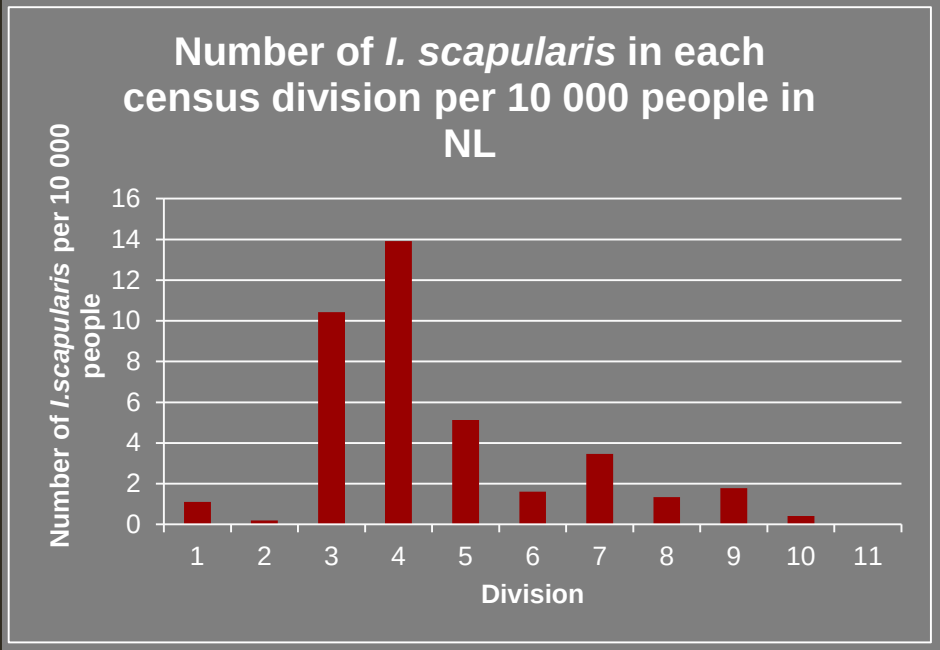
Adventitious ticks

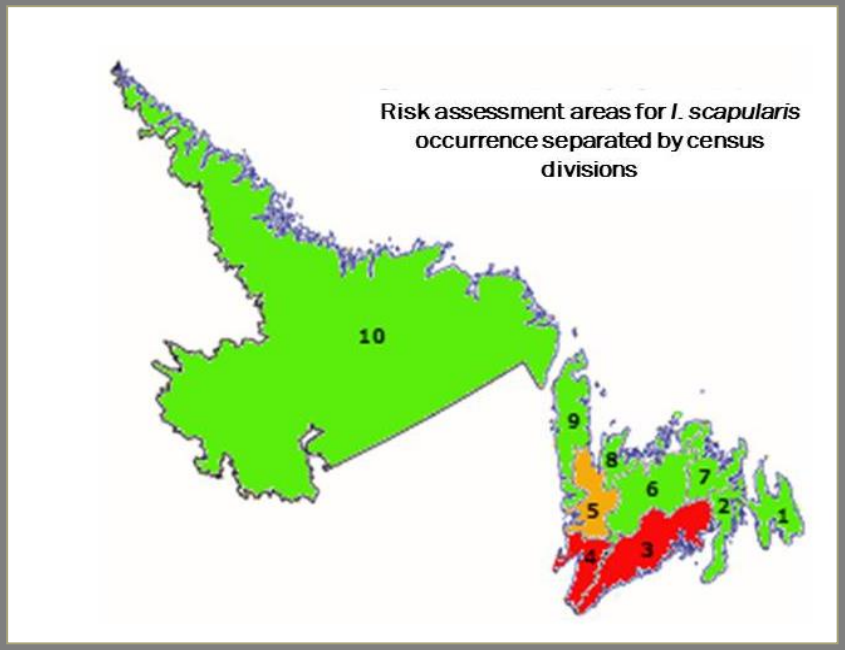
Adventitious ticks
"These ticks pose a low-level but geographically widespread potential risk of exposure to LD-infected ticks."

Adventitious ticks



Adventitious ticks





Risk assessment 2009-2013

Risk assessment SPM 2019

Hundreds of caribou grazing on N.L. farm - GFW, July 2012

Caribou as an alternative host?

Dr. Hannah Munro

FIG. 1. Locations of seabird colonies where *I. uriae* ticks were collected. 1, Campbell Island, New Zealand; 2, Crozet Islands; 3, West Point, Falkland Islands; 4, Egg and St. Lazaria Islands, Alaska; 5, Gannet Island, Canada; 6, Flatey Island, Iceland; 7, Nólsoy, Faeroe Islands; 8, Cape Sizun, France; 9, Bonden Island, Sweden.

Tick infested Atlantic puffin

Ixodes uriae

Borrelia garinii, an emerging heath threat in Europe

ONE HEALTH

Munro, H.J., N.H. Ogden, L.R. Lindsay, G.J. Robertson, H. Whitney, and A.S. Lang. 2017. Evidence for *Borrelia bavariensis* infections of *Ixodes uriae* within seabird colonies of the North Atlantic Ocean. Applied and Environmental Microbiology 83: e01087-17 **(Featured in Issue Spotlight)**

Hannah J.Munro, Nicholas H.Ogden, SamirMechai, L. RobbinLindsay, Gregory J.Robertson, HughWhitneyAndrew S.Lang. Genetic diversity of *Borrelia garinii* from *Ixodes uriae* collected in seabird colonies of the northwestern Atlantic Ocean. Ticks and Tick-borne Diseases, 10:6, 2019, 101255

Climate change

North Atlantic connections

Emerging zoonotic diseases

Need to have strong multidisciplinary research focus at MUN

Themes


Thank you