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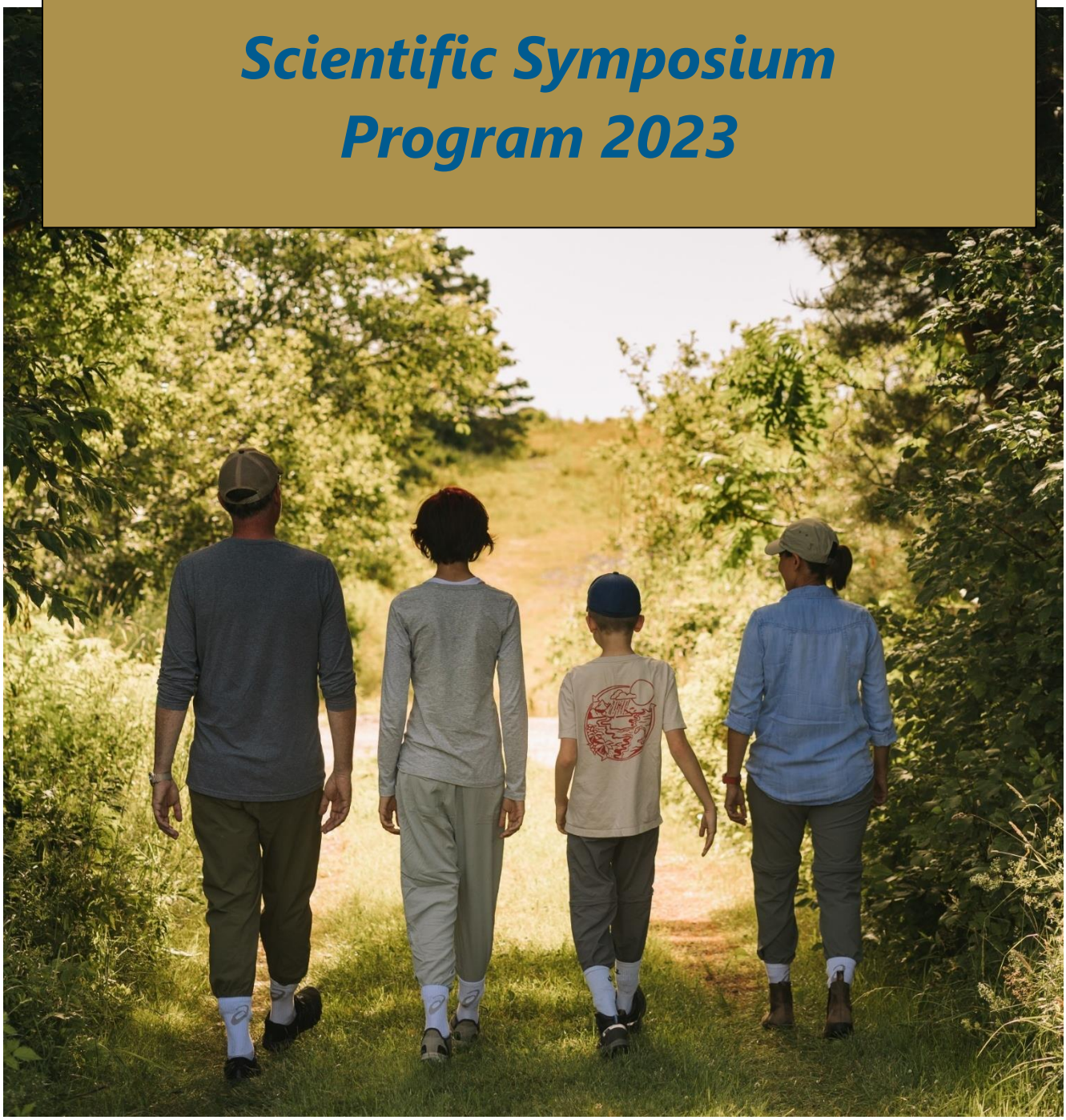
Scientific Symposium Program 2023



Eight years later, how are Canadians adapting to ticks and tick-borne diseases?

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Lyme disease (LD) has been emerging across Canada over the past few decades and is now endemic in several regions. Other tick-borne diseases (TBDs) such as anaplasmosis, babesiosis, and Powassan virus disease are also being reported with increasing frequency. With no vaccine available at present, personal preventive behaviours are important in preventing tick bites and subsequent infection. Previous research indicates an inadequate adoption of tick bite preventive behaviours among Canadians, despite a high awareness of LD. The principal objective of this study was to explore how Canadians are adapting to ticks and TBD. More specifically, the study aimed to measure: 1) how tick exposure, knowledge of TBD, and adoption of tick bite preventive behaviours have changed from 2014 to 2023, and 2) impacts of ticks and TBD, unrelated to infection. A pan-Canadian survey was conducted between January 2023 and May 2023, stratified by province, gender, age, and education (n=3734). Participants answered questions related to ticks, TBD, and tick bite preventive measures, as included in a 2014 pan-Canadian survey (n=2876), and questions related to impacts of ticks and TBD unrelated to infection, informed by prior qualitative research. In 2023, 88% of respondents had heard of LD, which was similar to 2014. Awareness of other TBDs was much lower, at 6.6%, 4.6%, and 4.5% for anaplasmosis, babesiosis, and Powassan virus disease, respectively. Reported tick exposure varied across Canada from 9% (Quebec) to 23% (Atlantic Canada). The percentage of respondents demonstrating a high Global Knowledge Score increased by 1%, with Quebec showing the largest increase (84% vs 70%). The percentage of respondents demonstrating a high Global Preventive Score increased from 33% to 38% (range: 31% in Quebec to 46% in Atlantic Canada). Reported impacts included avoiding certain areas completely, stress or anxiety, reduced appreciation of nature or the outdoors, and a preference to not have pets in the future (agreement in 27%, 17%, 17% and 16% of respondents, respectively). This study suggests that after eight years, there has been concerningly little improvement regarding adoption of tick bite preventive measures at the Canadian level. Furthermore, these results show for the first time the extent of impacts unrelated to infection in the population. Given the predicted trajectory of TBDs in the face of climate change, the development of strategies to promote preventive measures and lessen negative impacts is becoming increasingly important. **Keywords:** Preventive behaviours, tick exposure, adaptation, impacts.

Oral Presentations - Session 3: Ecology of Tick-borne Pathogens

High habitat richness limits the risk of tick-borne encephalitis in Europe: a multi-scale study

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Background: The natural transmission cycle of tick-borne encephalitis (TBE) virus is enhanced by complex interactions between ticks and key hosts strongly connected to habitat characteristics. The diversity of wildlife host species and their relative abundance is known to affect transmission of tick-borne diseases (such as, for example, Lyme disease). In the current context of global biodiversity loss, we explored the relationship between the habitat richness index (HRI) and the pattern of human TBE cases in Europe to assess the role of HRI in disease risk mitigation. **Methods:** We assessed human TBE case distribution across 879 European regions using official epidemiological data reported to the European Surveillance System (TESSy) between 2017 and 2021 from 15 countries. We statistically explored the relationship between TBE presence and a novel variable - the habitat richness index (HRI) - describing the diversity of European ecosystem types. We also validated our findings at local scale using data collected between 2017 and 2021 in 227 municipalities located in Trento and Belluno provinces, two known TBE foci in northern Italy. **Findings:** Our results showed a significant parabolic effect of HRI on the probability of presence of human TBE cases in the European regions included in our dataset, and a significant, negative effect of HRI on the local presence of TBE in northern Italy. At both spatial scales, TBE risk decreases in areas with higher values of HRI. **Interpretation:** To our knowledge, no efforts have yet been made to explore the relationship between habitat richness and TBE risk, both in local and in large scale geographical contexts, probably due to the scarcity of high-resolution, large-scale data about the abundance or density of critical host species, such as rodents and ungulates. To overcome this lack of data, in this study we considered habitat richness as proxy of vertebrate host biodiversity to disentangle its role in driving TBE European occurrence at different spatial scales. The results suggest that biodiversity loss could considerably enhance disease risk for both humans and wildlife,

which may influence biodiversity conservation policies within a One Health context approach. **Keywords:** Europe, Habitat Richness, One Health, Tick-borne encephalitis, Statistics.

The UPTick Project: Characterizing tick-borne disease risk across the residential-to-woodland gradient

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Eastern Ontario is now considered an area of Lyme disease emergence by public health officials. This is largely due to the northward range expansion of the blacklegged tick resulting from climate and environmental changes that allow this vector species to persist in the region. With high tick density and infection rates observed across the Ottawa municipal region, this is a unique location for exploring the characteristics of potential tick habitat where changing neighbourhoods coincide with greenspace. In this study, we collected ticks and small mammals in four discrete neighbourhoods across sites identified as residential, woodlands, or interface zones between the two. In addition to testing for tick-borne pathogens, we monitored the intensity of deer activity and recorded ecological observations at each surveillance site. We constructed separate mixed-effect models to test for site-specific characteristics associated with three outcomes: nymphal tick density, the presence of infected nymphal ticks, and the presence of infected ticks of any life stage. We applied a Poisson distribution to model nymphal density and a binomial distribution in both presence-absence models, including a random term for the sampled neighbourhood and controlling for the sampling year and month to allow for seasonal differences. Compared to residential zones, we found a strong increasing gradient in density from interface to woodland zones, with 4 and 15 times as many nymphal ticks, respectively. We also found that characteristics of site ecology, such as soil moisture, leaf litter depth, understory density, and observed activity of deer and small mammals, influenced both nymphal density and the likelihood of observing infected ticks. Our results suggest that risk within neighbourhoods, especially those undergoing urban development, is important to consider in areas with increasing entomological hazard. **Keywords:** disease ecology; urban development; ecological modelling.

Integrated human behavior and tick risk maps to prioritize Lyme disease interventions using a 'One Health' approach

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Lyme disease (LD) risk is emerging rapidly in Canada due to range expansion of its tick vectors, accelerated by climate change. The risk of contracting LD varies geographically due to variability in ecological characteristics that determine the hazard (the densities of infected host-seeking ticks) and vulnerability of the human population determined by their knowledge and adoption of preventive behaviors. Risk maps are commonly used to support public health decision-making on Lyme disease, but the ability of the human public to adopt preventive behaviors is rarely taken into account in their development, which represents a critical gap. The objective of this work was to improve LD risk mapping using an integrated social-behavioral and ecological approach to: (i) compute enhanced integrated risk maps for prioritization of interventions and (ii) develop a spatially-explicit assessment tool to examine the relative contribution of different risk factors. The study was carried out in the Estrie region located in southern Québec. The blacklegged tick, *Ixodes scapularis*, infected with the agent of LD is widespread in Estrie and as a result, regional LD incidence is the highest in the province. LD knowledge and behaviors in the population were measured in a cross-sectional health survey conducted in 2018 reaching 10,790 respondents in Estrie. These data were used to create an index for the social-behavioral component of risk in 2018. Local Empirical Bayes estimator technique were used to better quantify the spatial variance in the levels of adoption of LD preventive activities. For the ecological risk analysis, a tick abundance model was developed by integrating data from ongoing long-term tick surveillance programs from 2007 up to 2018. Social-behavioral and ecological components of the risk measures were combined to create vulnerability index maps and, with the addition of human population densities, prioritization index maps. Map predictions were validated by testing the association of high-risk areas with the current spatial distribution of human cases of LD and reported tick exposure. Our results demonstrated that social-behavioral and ecological components of LD risk have markedly different distributions within Estrie. The occurrence of human LD cases or reported tick exposure in a municipality was positively associated with tick density and the prioritization risk index ($p < 0.001$). This research is a second step towards a more comprehensive integrated LD risk assessment approach, examining social-behavioral risk factors that interact with ecological risk factors to influence the management of emerging tick-borne diseases, an approach that could be applied more widely to vector-borne and zoonotic diseases. **Keywords:** Social-behavioral, ecological, risk maps, prevention, Lyme disease, One Health.

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