**Significance statement**

A mechanistic understanding of spatial patterns in infection prevalence levels is essential to eventually anticipate how host-parasite interactions will respond to global change. Since most previous studies are constrained by context-dependencies such as spatial scaling, biological scaling and sampling design, a multi-scale approach to investigating host-parasite ecology is imperative. At the frontier across fields, our study proposes to use the spatial community ecology toolbox to gain insights on the multi-scale drivers of infection prevalence levels within lake fish communities. Our study highlights major potential biases relating to the sampling methods, the sampling effort and the environmental filtering.

We believe that this work will be of interest to a broad readership of ecology researchers as it integrates elements of landscape and community ecology in the understanding of disease ecology. This works builds on many years of research led by Sandra Binning on the black spot disease in fishes’ populations inhabiting North American lakes, and on previous work by Eric Harvey investigating the underlying mechanisms driving spatial variations in biodiversity.

**Data archiving statement**

Data are not yet provided in open access. Upon acceptance data will be archived on Borealis. Metadata is already available on Borealis: <https://doi.org/10.5683/SP3/80JDBU>.

**Conflict of interest statement**

The authors declare no conflicts of interest.

**Ethics statement**

Animal handling and collection was approved by the Université de Montréal’s animal care committee (protocol number 22-025) and a scientific fishing permit granted by the Ministère de l’Environnement, de la Lutte contre les changements climatiques, de la Faune et des Parcs (MELCCFP) of Québec (2022-05-16-1971-15-S-P).

**Funding statement**

This work was supported by grants from Natural Sciences and Engineering Research Council of Canada (NSERC) and the Research Chair Program to SB and EH. JV was supported by the Groupe de Recherche Interuniversitaire en Limnologie (GRIL, GRIL-PCR-21A08).

**Acknowledgements**

We thank Charles Gagnon, Léa Carrère, Charlie Sarran, Georges-Étienne Charette, Louis-Philippe Beauchamp, Ariane Côté and Jeffery D’amour Pigeon for help with data collection. We thank the staff of the Station de biologie des Laurentides for logistic support, Dominic Bélanger for helping with nutrient analyses, and lake associations and property owners for lake access. We thank Stéphane Bourassa for help on graphic designs. We thank Eric Pederson for comments on the manuscript. We acknowledge the traditional lands of the Kanien’kehá:ka, Omàmiwinini, and Anishinabewaki First Nations on which the field and laboratory work for this project took place.