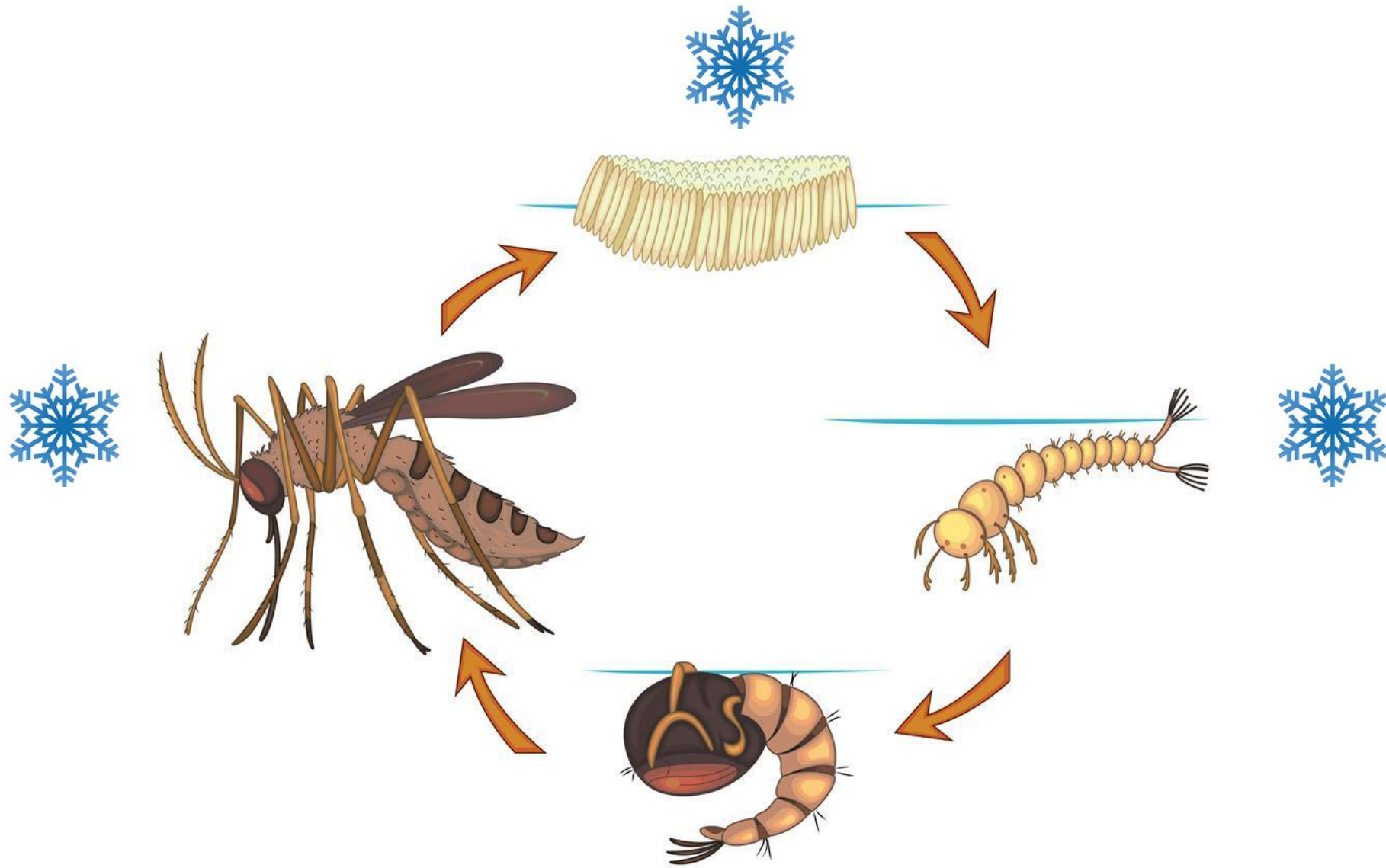
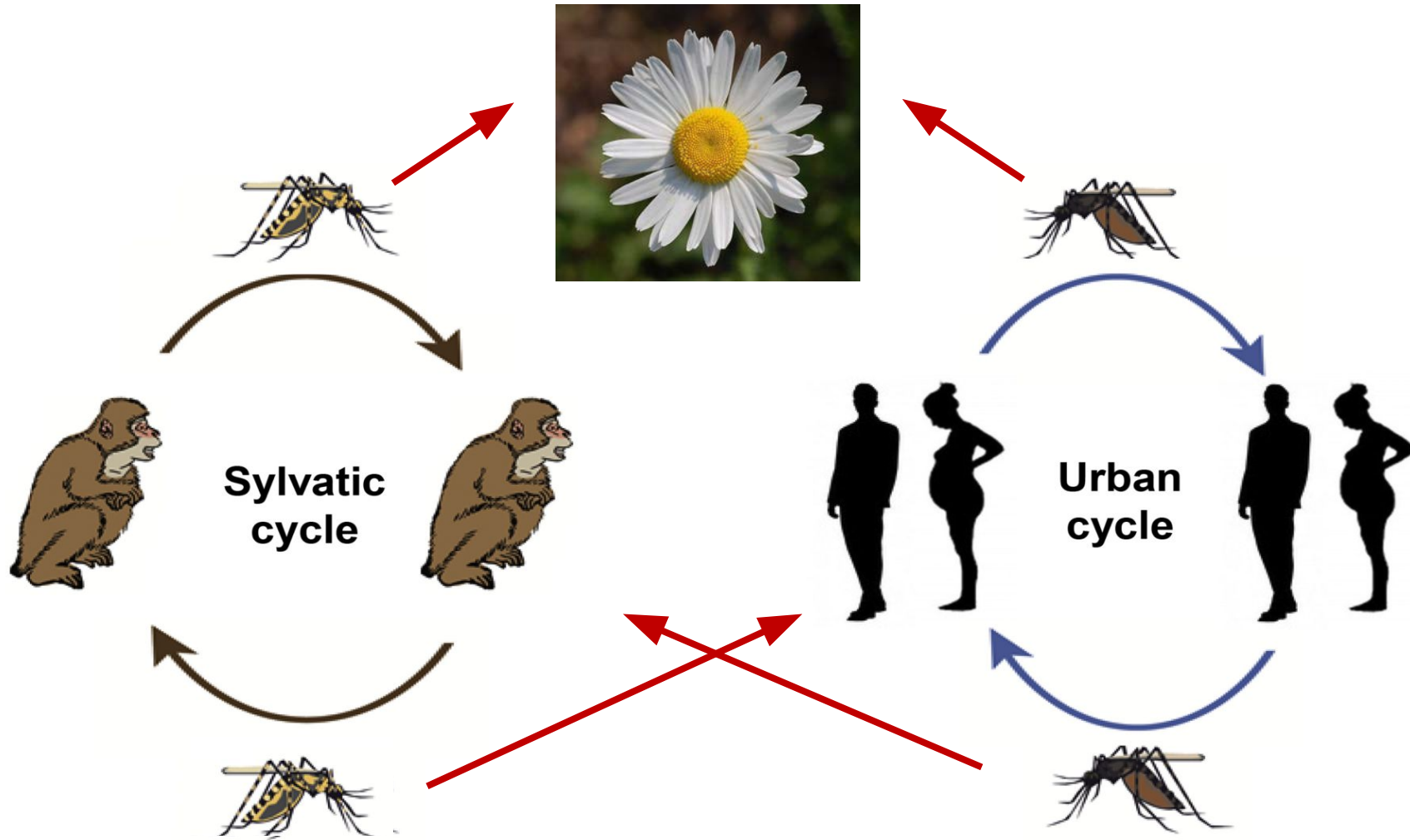


Surveying mosquito distribution in BC and Yukon Territory in a changing climate

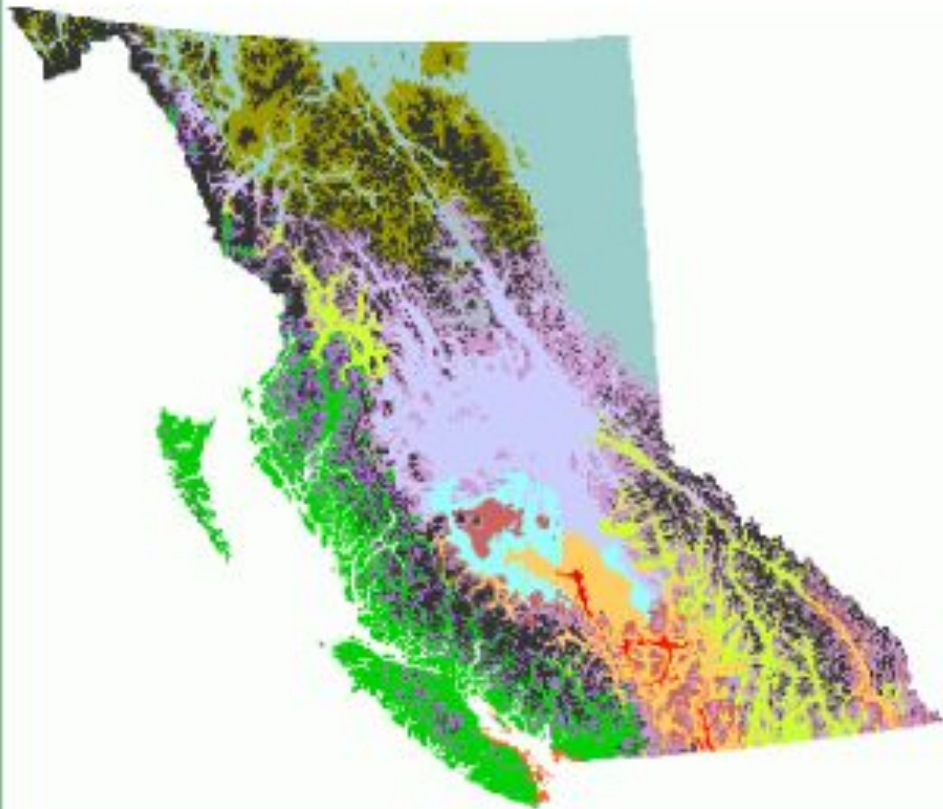




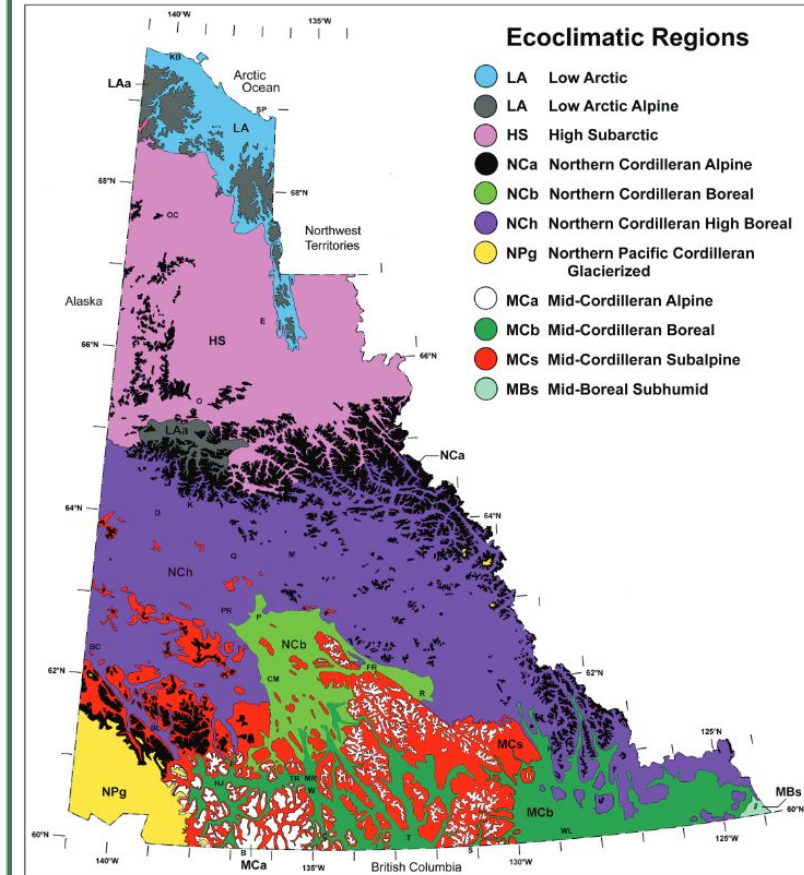


Climate/environment of BC and YT

Biogeoclimatic Zones of BC



AT	Alpine Tundra
SWB	Spruce-Willow-Birch
BWBS	Boreal Black and White Spruce
SBPS	Sub-Boreal Pine-Spruce
SBS	Sub-Boreal Spruce
MH	Mountain Hemlock
ESSF	Englemann Spruce-Subalpine Fir
MS	Montane Spruce
BG	Bunchgrass
PP	Ponderosa Pine
IDF	Interior Douglas-fir
CDF	Coastal Douglas-fir
ICH	Interior Cedar-Hemlock
CWH	Coastal Western Hemlock



Mosquito diversity of BC and YT

- More than 50 species are present in BC and more than 30 in YT.
- Most of these are in the genus *Aedes*, but we also have several species of *Anopheles*, *Culex*, *Culiseta*, and *Coquillettidia*.
- Most are native, but there are some (2-3) that are invasive.



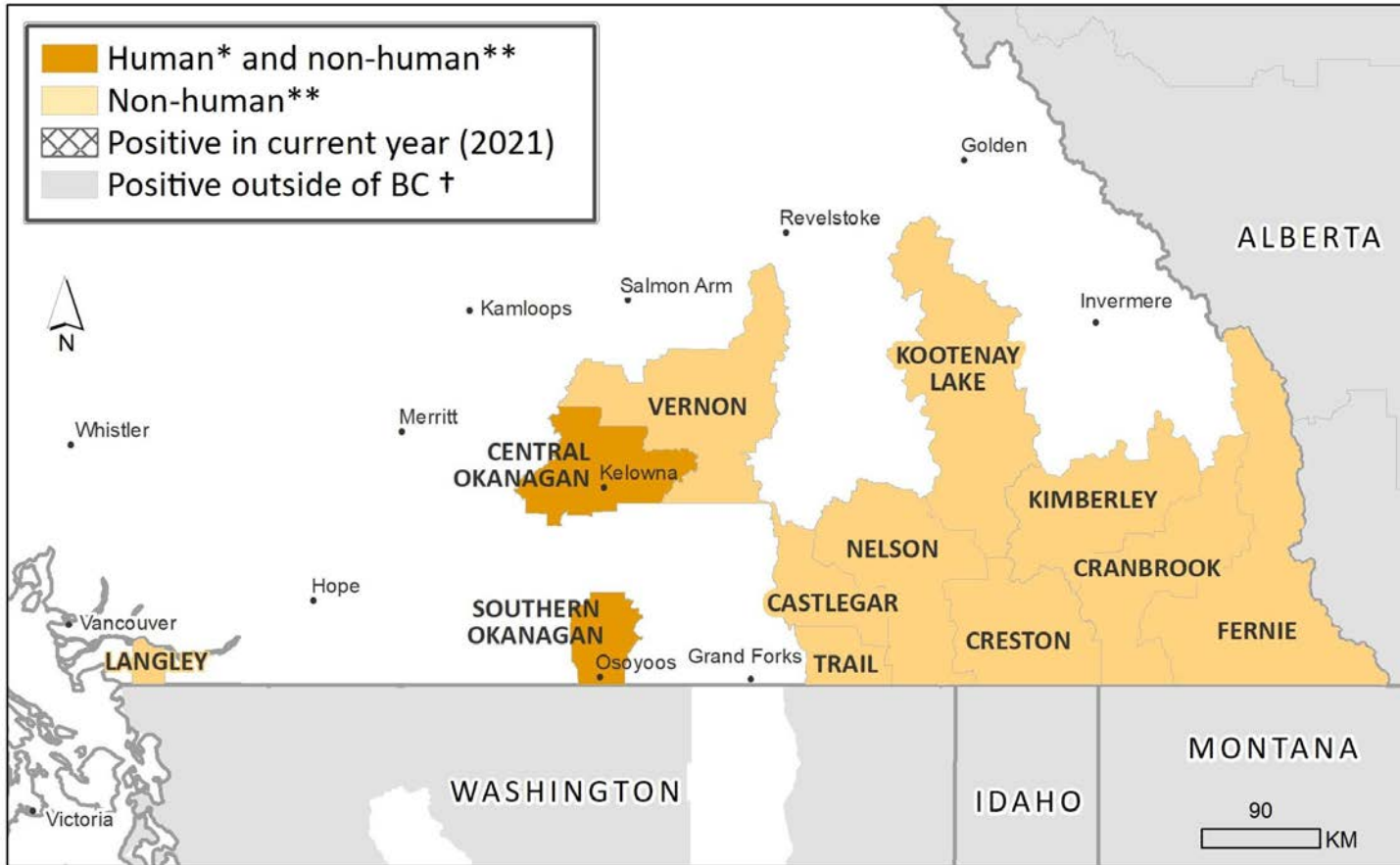
S.L. Doggett, Department of Medical Entomology, NSW, Australia



Sean McCann

<i>Aedes japonicus</i>	BC (invasive)	JEV*
<i>Aedes sierrensis</i>	BC	Dog heartworm
<i>Aedes togoi</i>	BC (?)	JEV* and <i>Brugia malayi</i> *
<i>Anopheles earlei</i>	BC + YT	Malaria
<i>Anopheles freeborni</i>	BC	Malaria
<i>Anopheles punctipennis</i>	BC	Malaria
<i>Culex pipiens</i>	BC (invasive)	WNV, JEV*
<i>Culex restuans</i>	BC	WNV
<i>Culex tarsalis</i>	BC + YT	WNV, WEEV, JEV*,
<i>Coquillettidia perturbans</i>	BC + YT	WNV, EEV*, CSGV

WNV and WEEV



West Nile virus in BC, 2009-2021 (<http://www.bccdc.ca>)

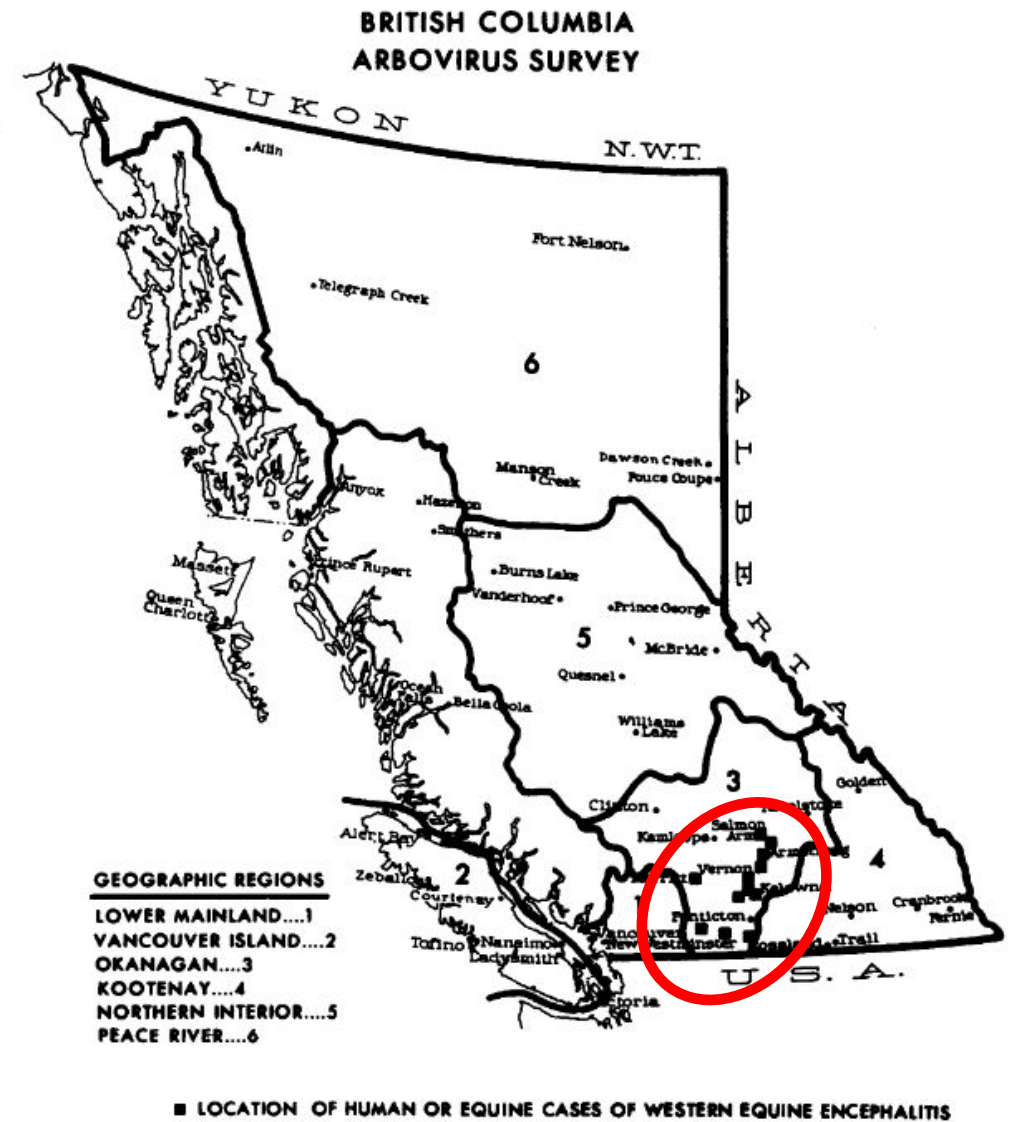


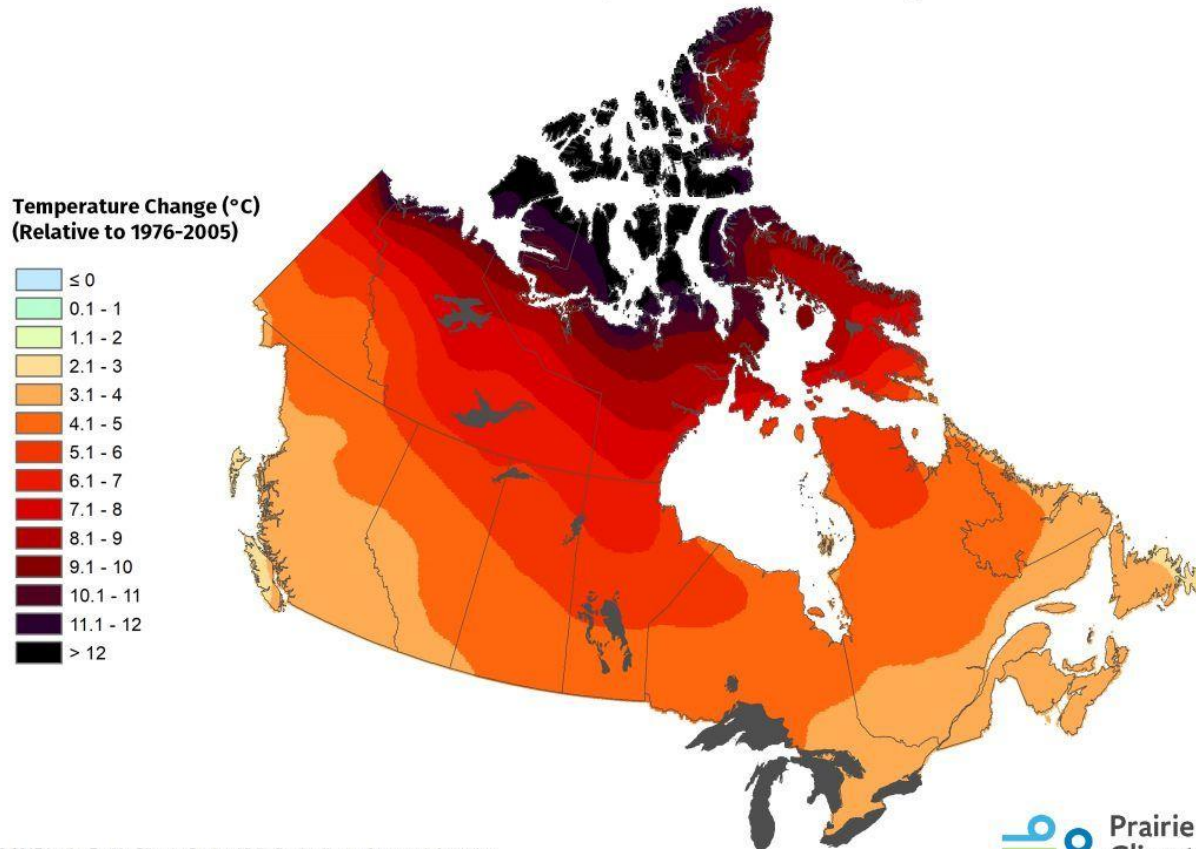
FIG. 1—Location of human or equine cases of western equine encephalitis

Kettyls *et al.*, 1972

Changing climate

2051-2080 Projected Change in Mean Temperature: November

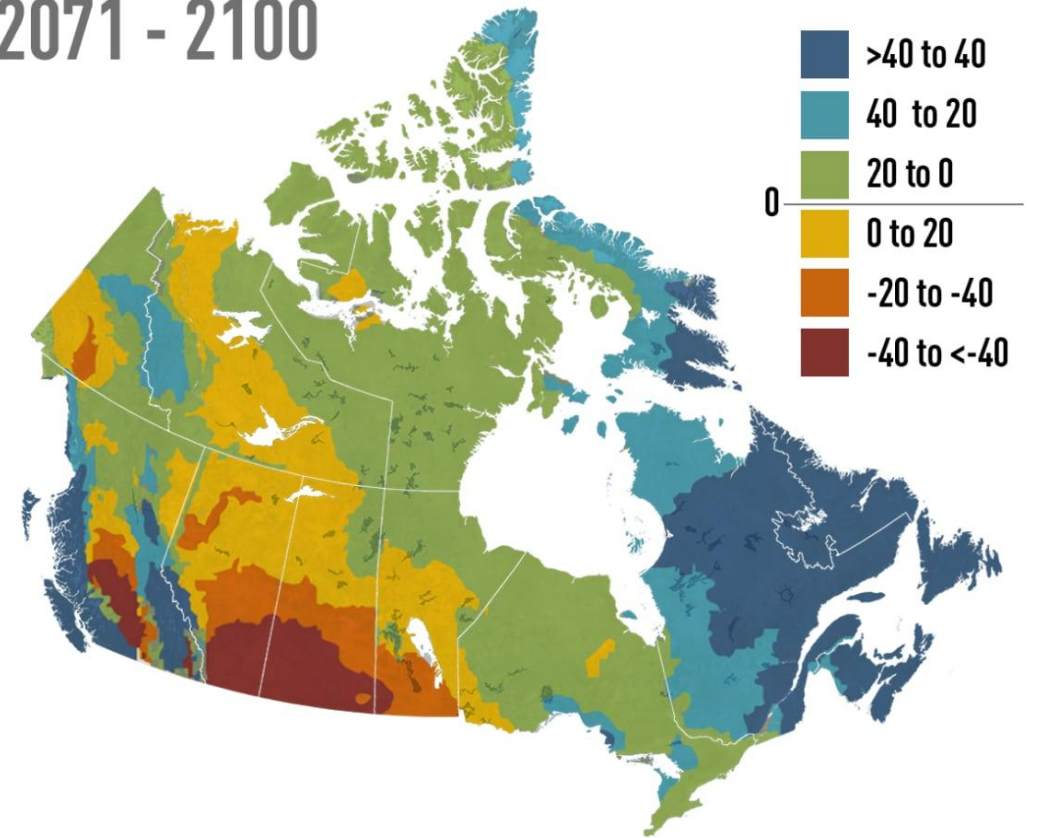
Under the RCP8.5 scenario, relative to a baseline of 1976-2005



© 2017 by the Prairie Climate Centre. Visit climateatlas.ca for more information.
Map Data: Ensemble of 12 CMIP5 models (BCSD Statistically Downscaled Climate Scenarios)
provided by the Pacific Climate Impacts Consortium, University of Victoria (pacifclimate.org).

 **Prairie
Climate Centre**
From Risk to Resilience

CLIMATE MOISTURE INDEX CONTINUED EMISSIONS INCREASES 2071 - 2100



CBC News

SOURCE: NRCan - CFS

Climate change considerations

- Key elements for mosquito distribution are changes in temperature and changes in precipitation.
- Warmer, shorter winters allow for easier overwintering. Warmer, longer summers allow mosquito populations and pathogen levels to develop quicker and become more prevalent.
- May see a shift in mosquito community ecology as non-vector species are replaced with vector species. Therefore, these species are important as well.
- We could see new invasive mosquitoes or changes in movements of animal hosts.

Knowledge gaps

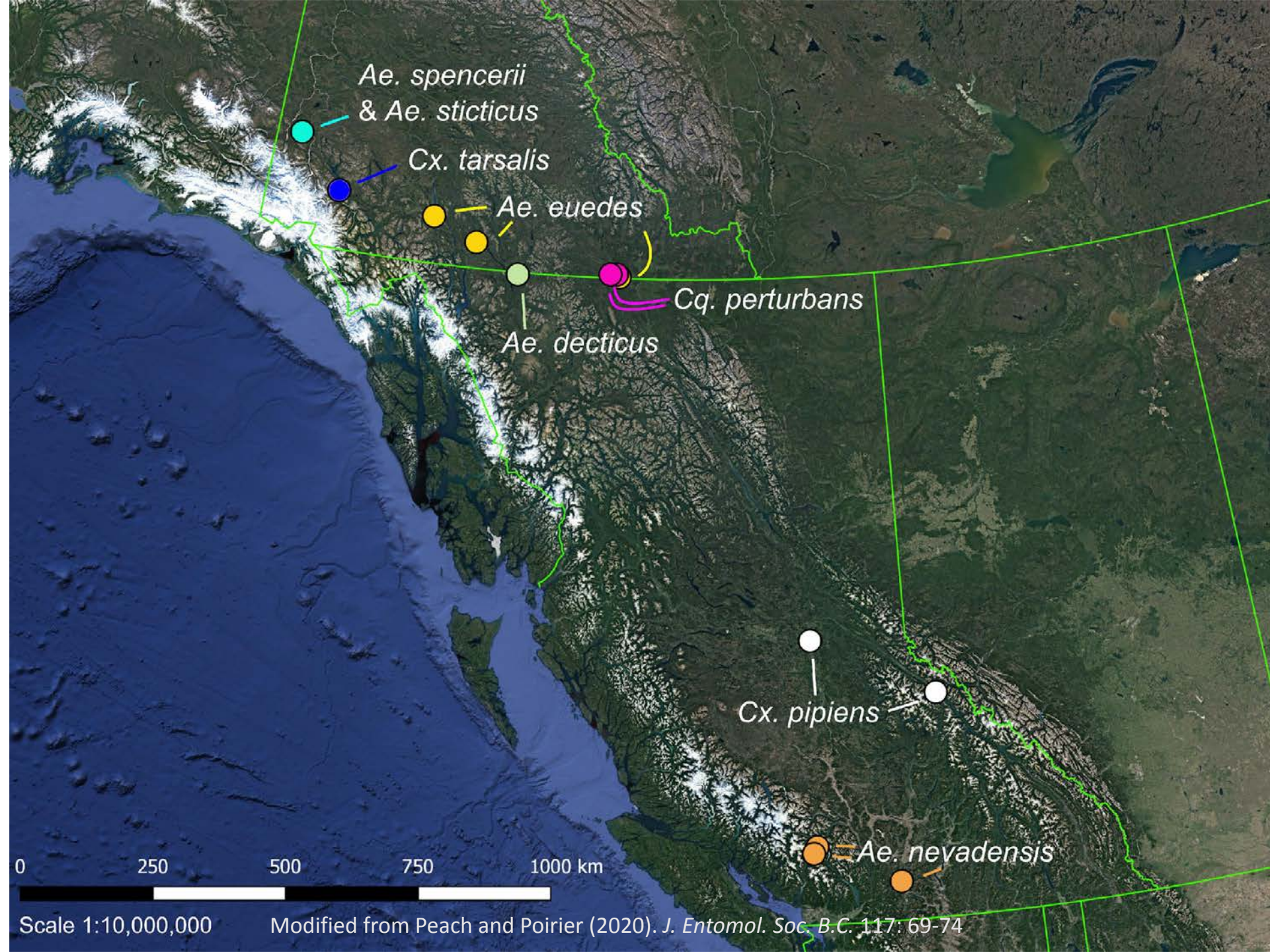
- What is present? Will distributions change?
- We may not be able to answer the second question due to lack of baseline knowledge.
- Challenges due to ineffectiveness of programs like iNaturalist for mosquito ID and the need for specialized mosquito surveys.



A photograph of a man in a plaid shirt and a tan cap examining a plant in a forest. He is wearing a backpack and has a water bottle. In the background, another person is visible near a tree. The forest is dense with evergreen trees, and mountains are visible in the distance. The right side of the image is faded to white.

Current work

- Surveys
- Models
- Citizen science



0 250 500 750 1000 km

Scale 1:10,000,000

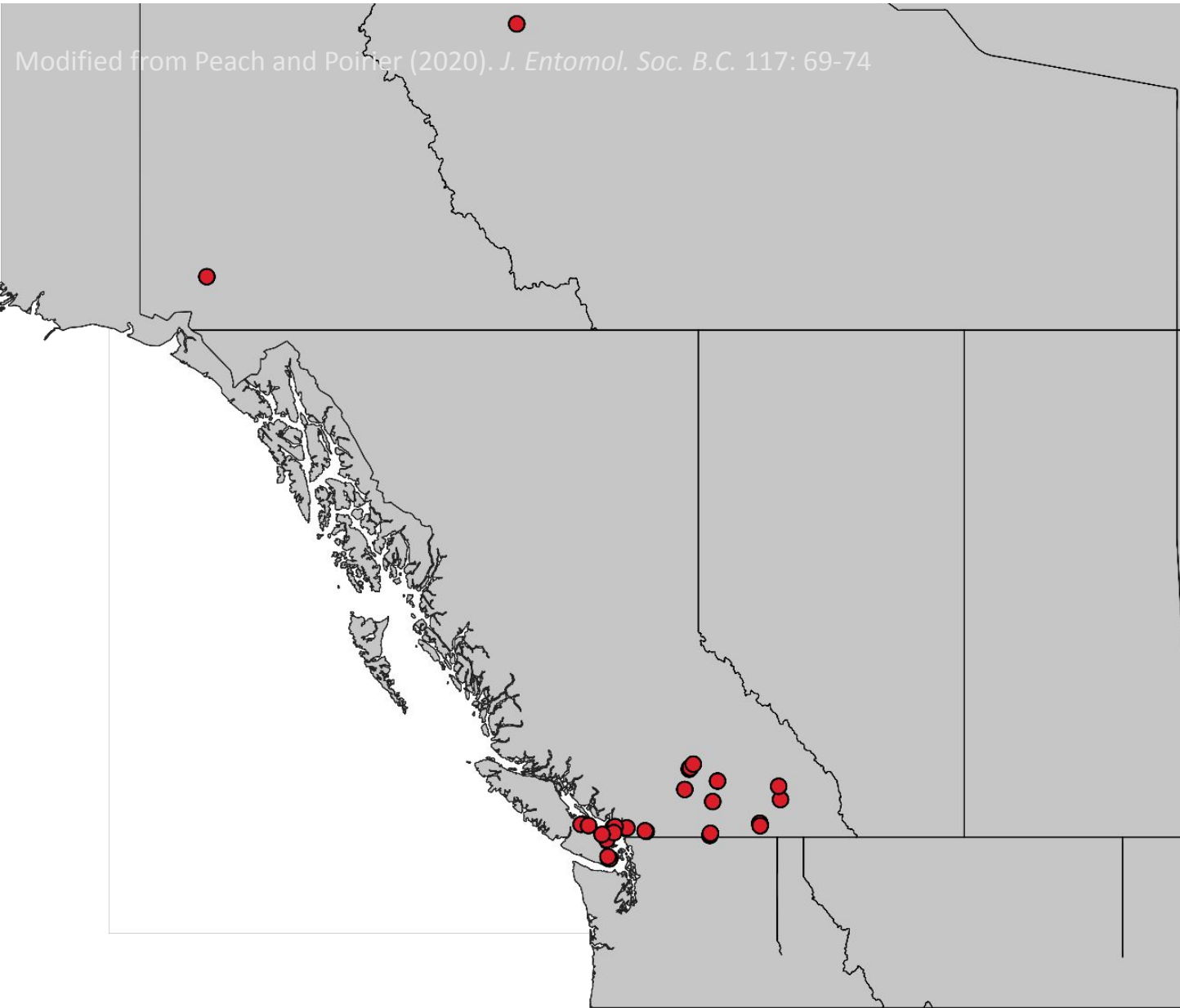
Modified from Peach and Poirier (2020). *J. Entomol. Soc. B.C.* 117: 69-74

Culex tarsalis, the western encephalitis mosquito

- Native species, but we never really had a handle on how far north its range extended.



Culex tarsalis occurrence records



Records of *Culex tarsalis* in BC, and the north. To what extent this species exists in between is unknown.

Culex pipens, the common house mosquito

- An invasive species that has been here a long time.
- Is it still spreading? Has its range been shifting?



Culex pipiens occurrence records

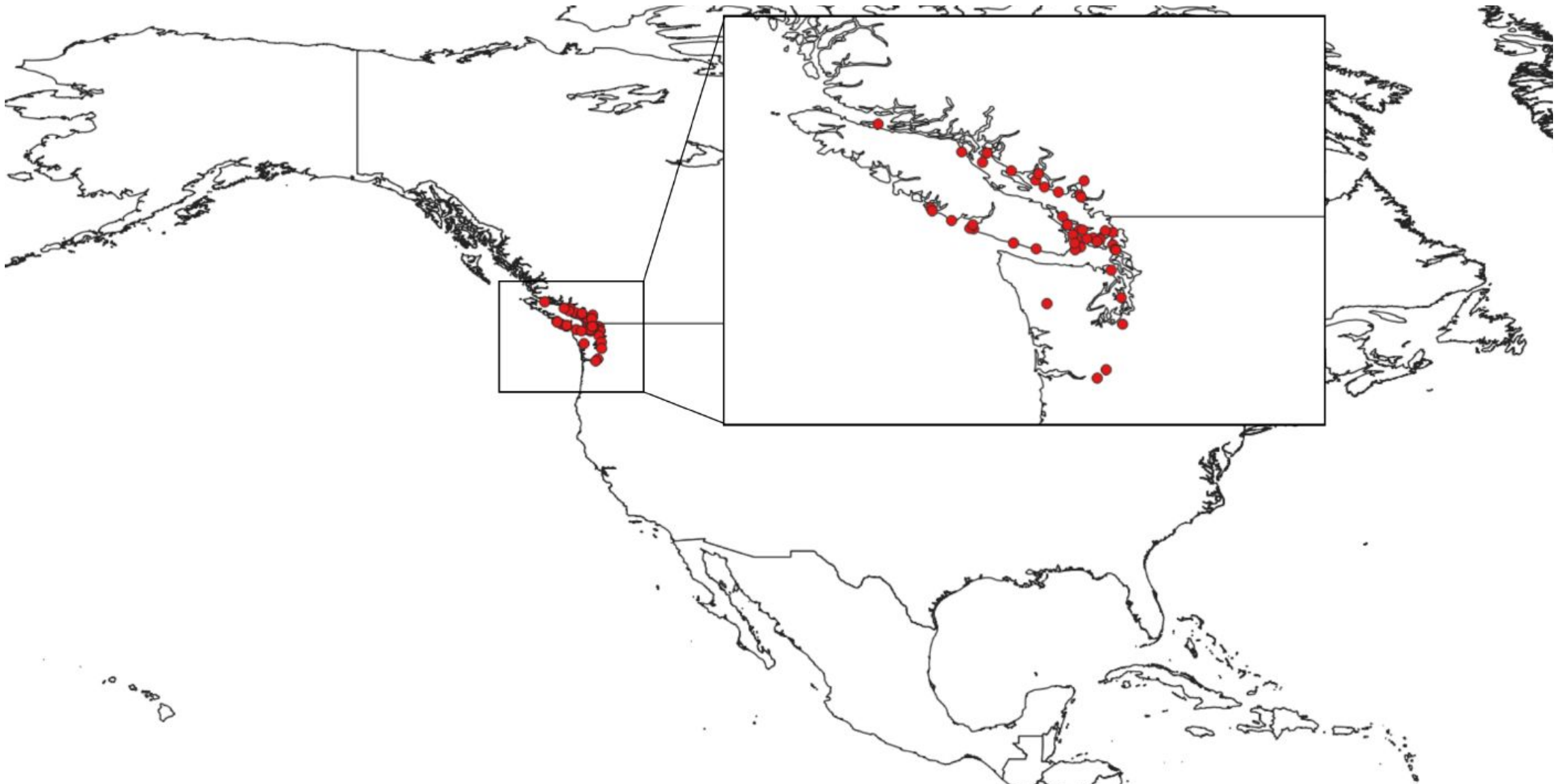


Aedes togoi, the coastal rock pool mosquito

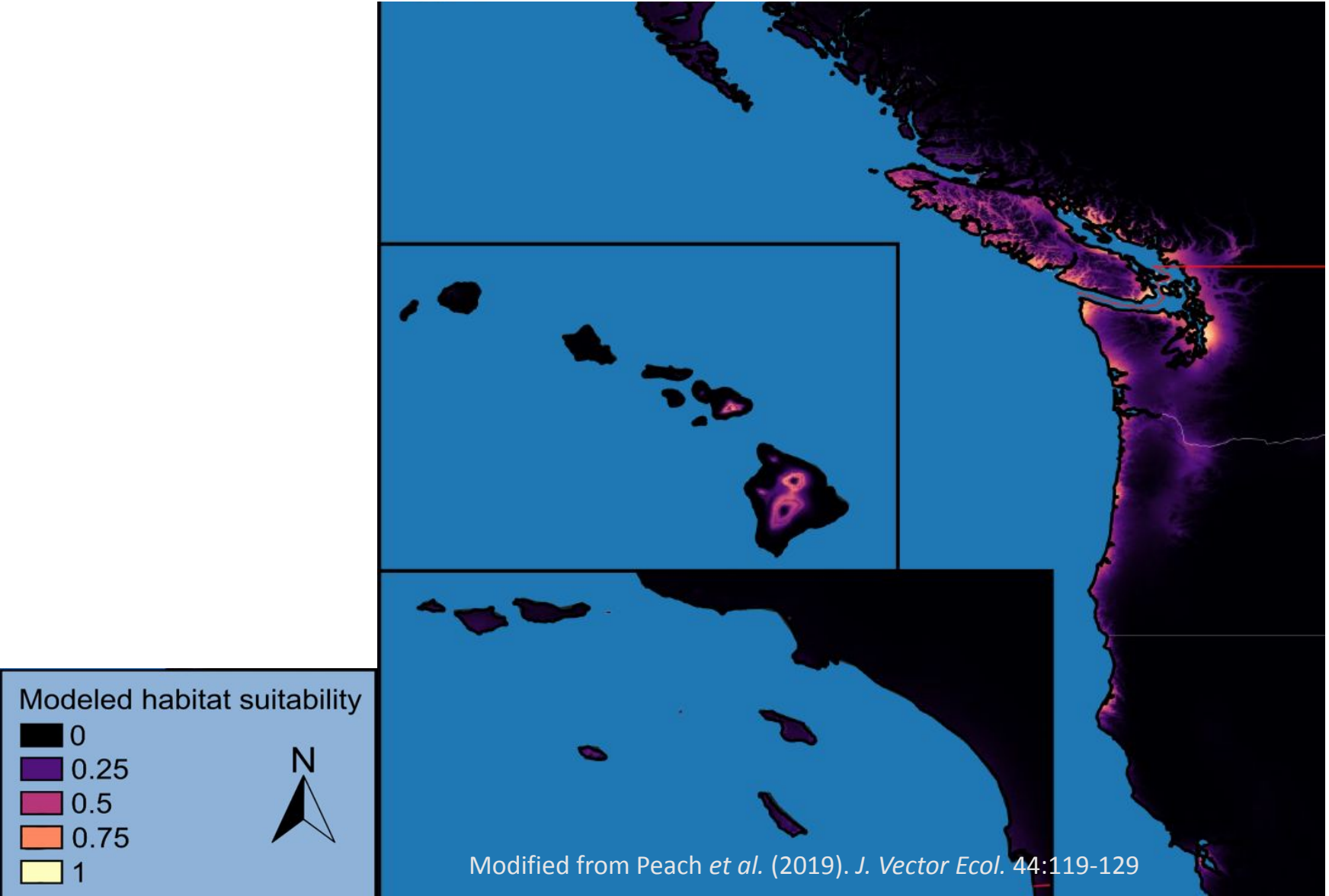
- Originally discovered in Asia in 1909.
- A specimen from Victoria was found, undated, in the Canadian National Collection in 1970.
- Native? Invasive? Where is it?



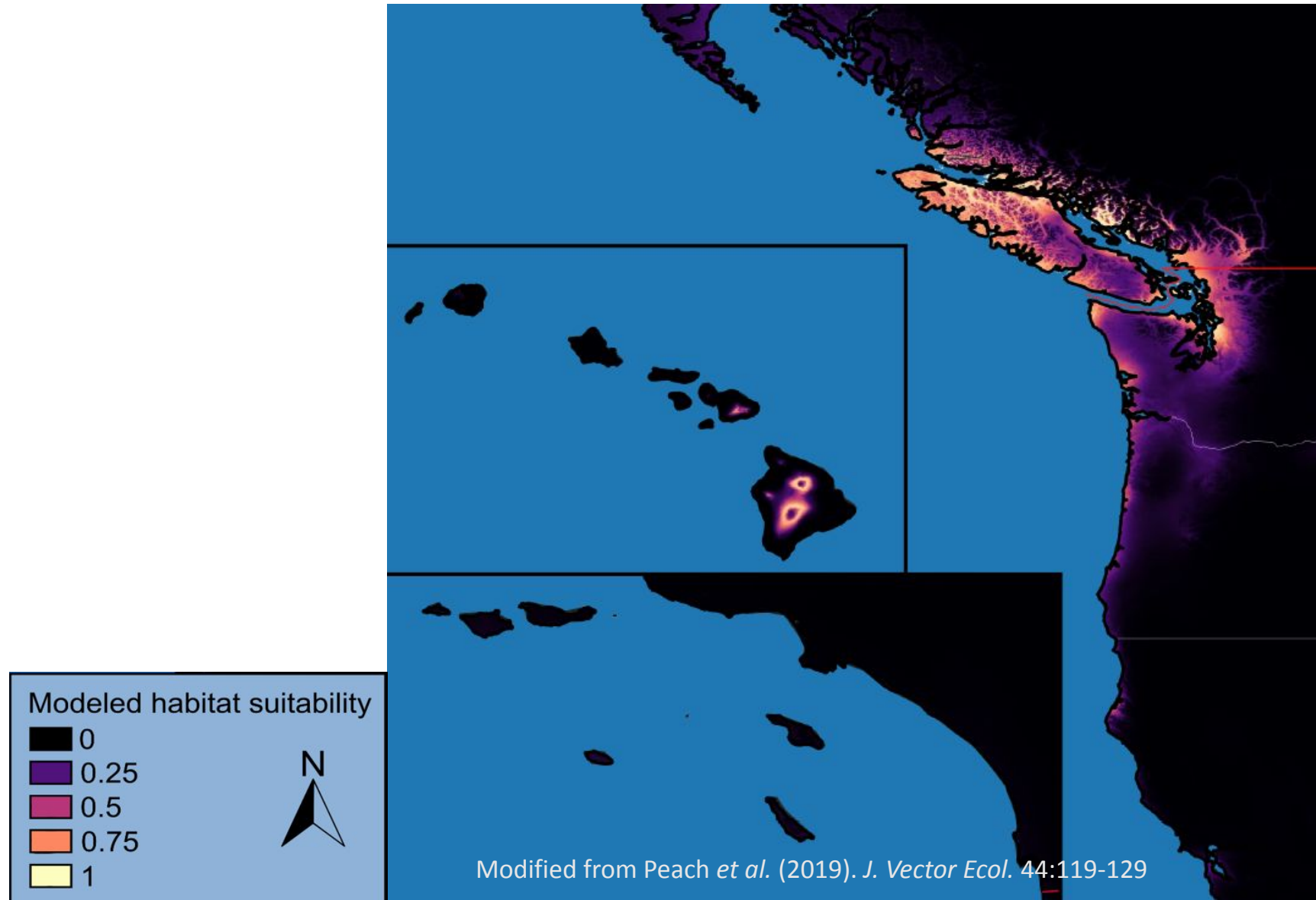
Aedes togoi occurrence records



Modeled current suitability for *Aedes togoi*



Modeled suitability for *A. togoi* under 2050 climate (moderate change)

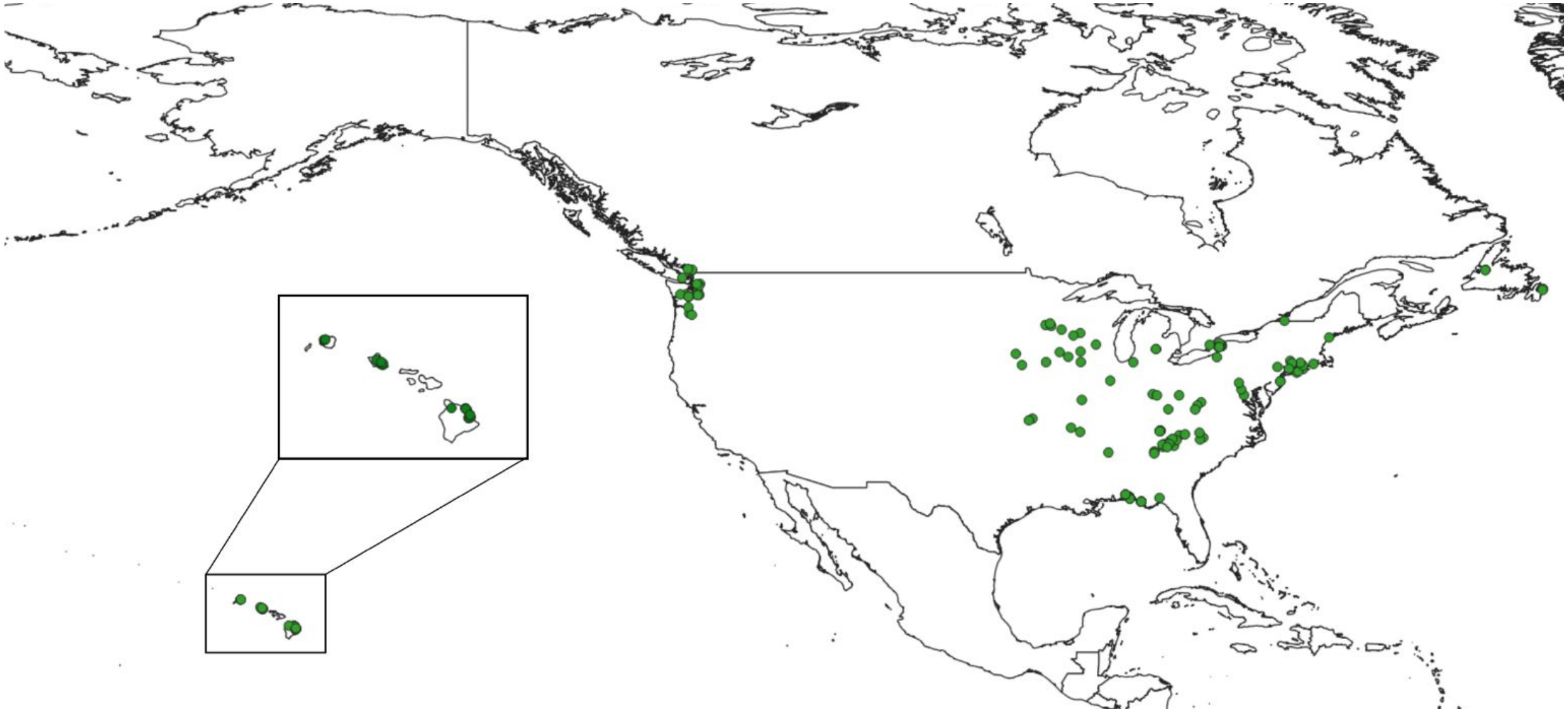


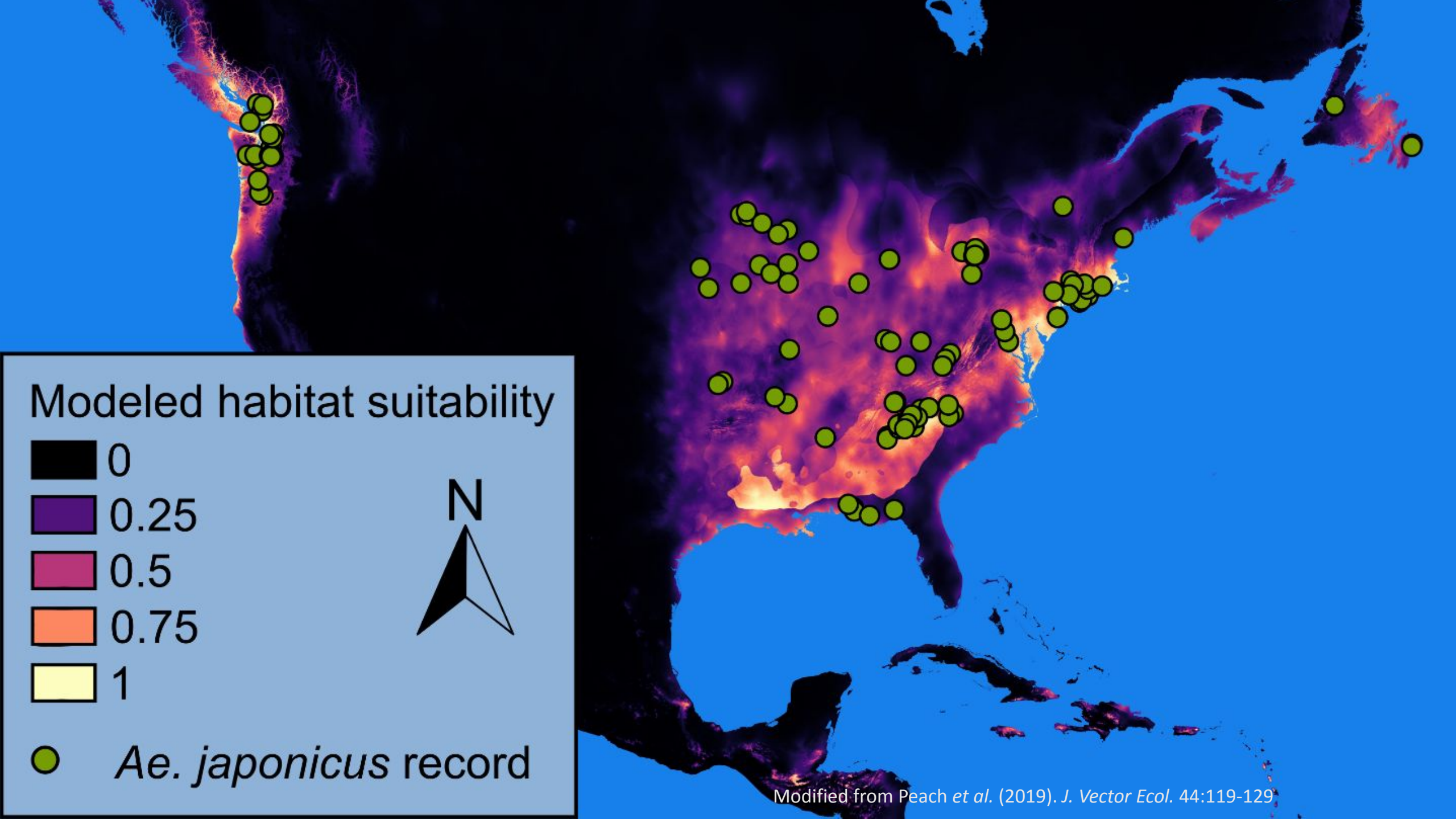
Aedes japonicus, the Asian bush mosquito

- First arrived in North America in 1998 in the northeast USA.
- First reported in BC in 2015 and likely still spreading.



Aedes japonicus occurrence records





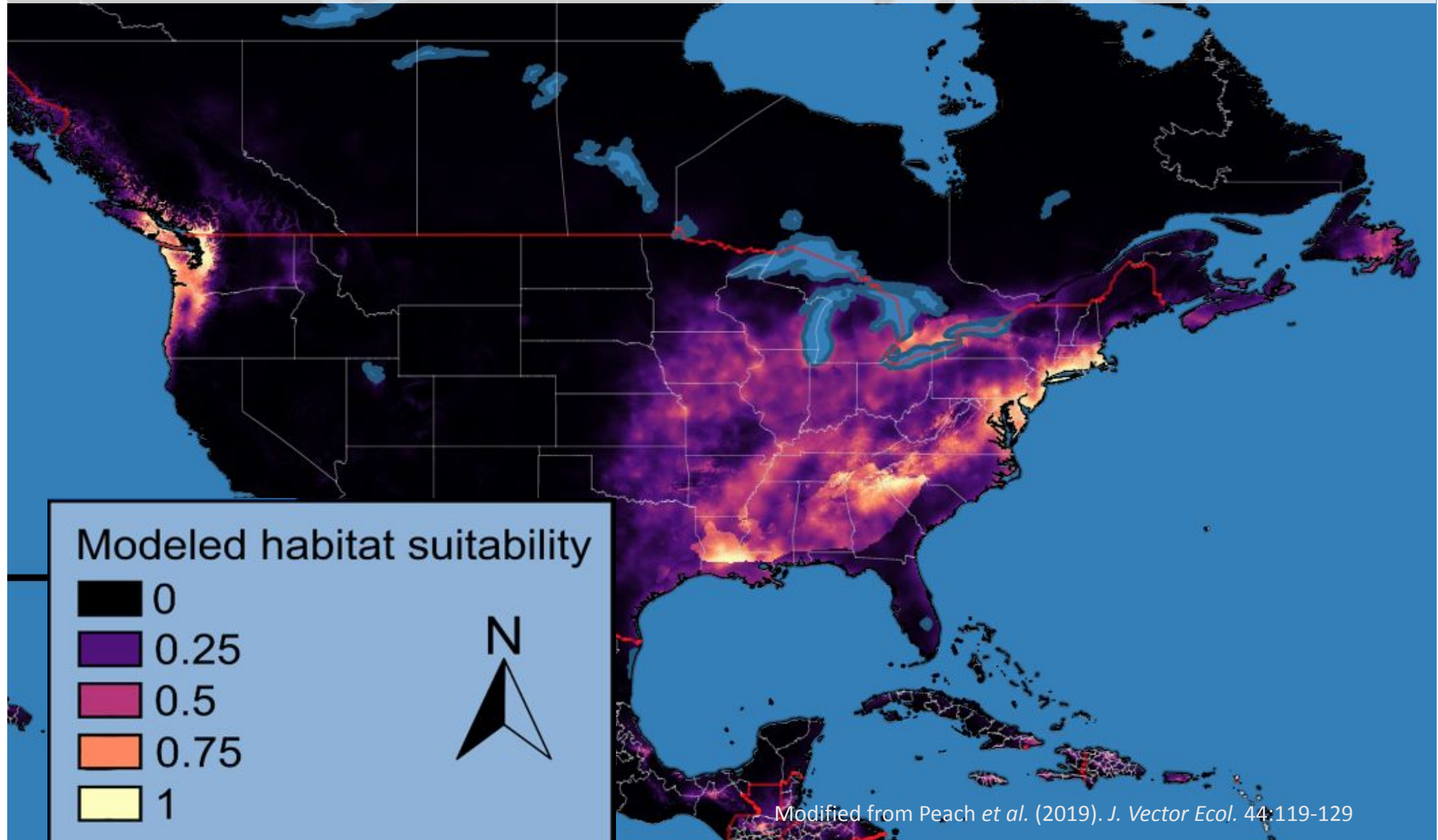
Modeled habitat suitability

- 0
- 0.25
- 0.5
- 0.75
- 1

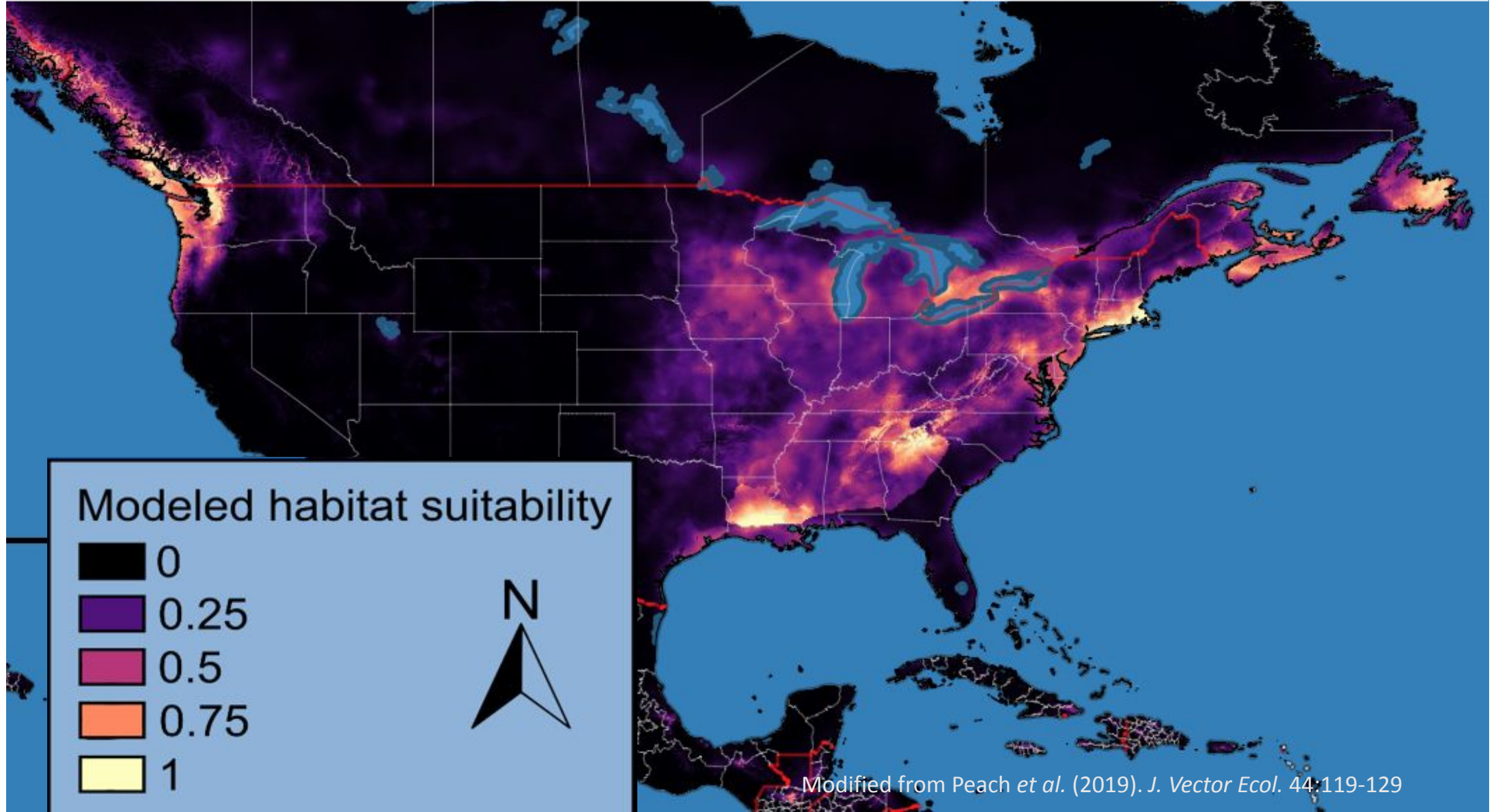


Ae. japonicus record

Modeled current suitability for *Aedes japonicus*



Modeled suitability for *A. japonicus* under 2050 climate (moderate change)



Barcoding and Citizen Science

CO1 and ITS2 barcodes of mosquitoes

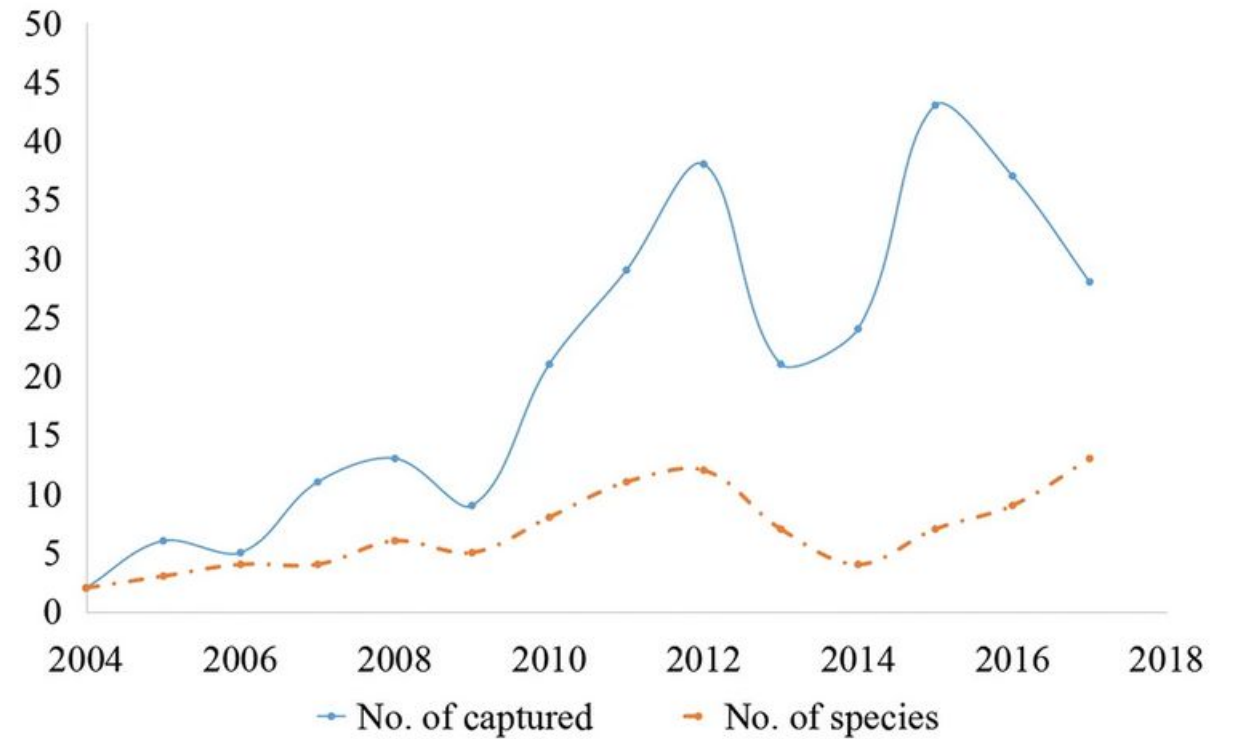
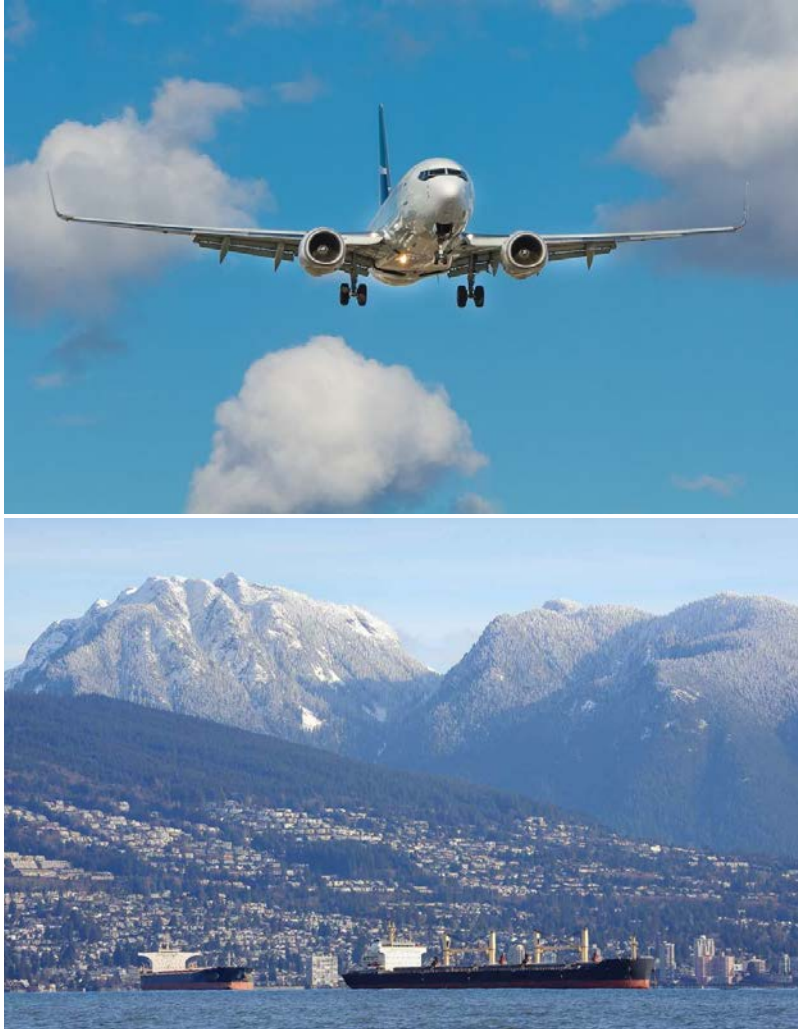
- Field-caught specimens
- Some potentially novel ITS2 barcodes

Novel ITS2 barcodes
<i>Aedes campestris</i>
<i>Aedes canadensis</i>
<i>Aedes flavescens</i>
<i>Aedes nevadensis</i>
<i>Aedes pullatus</i>
<i>Coquillettidia perturbans</i>

What just bit me?

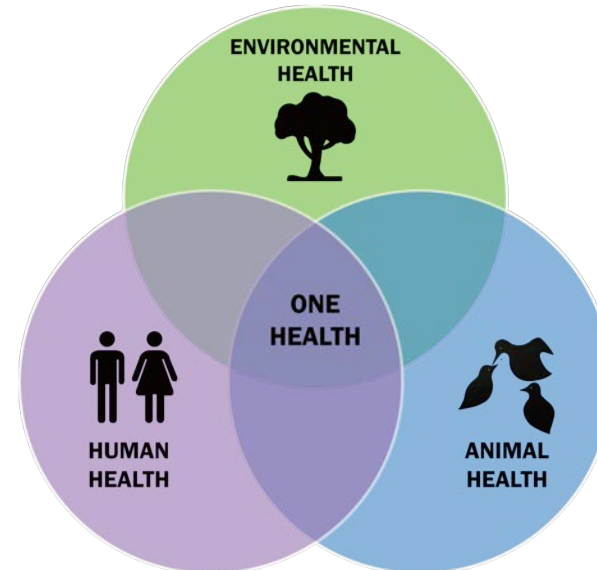
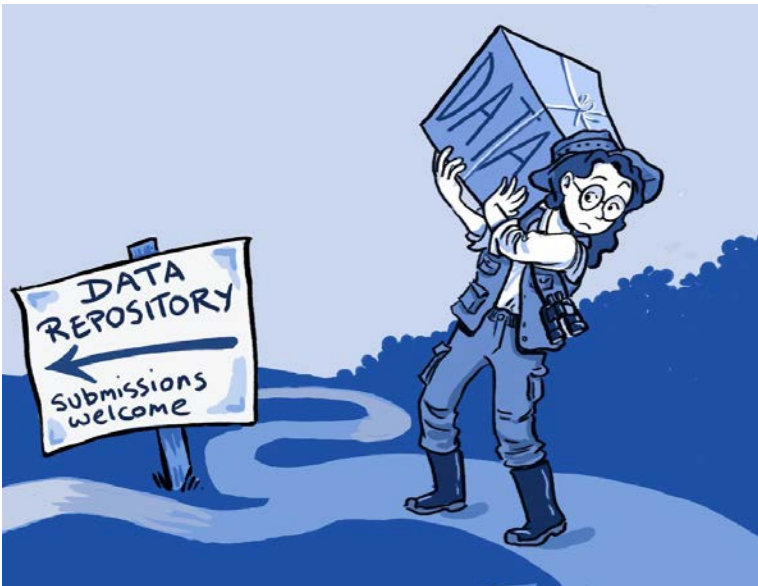
- Public mails in specimens with location
- Barcode to ID
- Use data to map and model distribution

Future considerations



Annual trends and species abundance of captured invasive mosquitoes at select sea and airports from in Zhejiang Province, China. Yang *et al.*, 2019

Future considerations



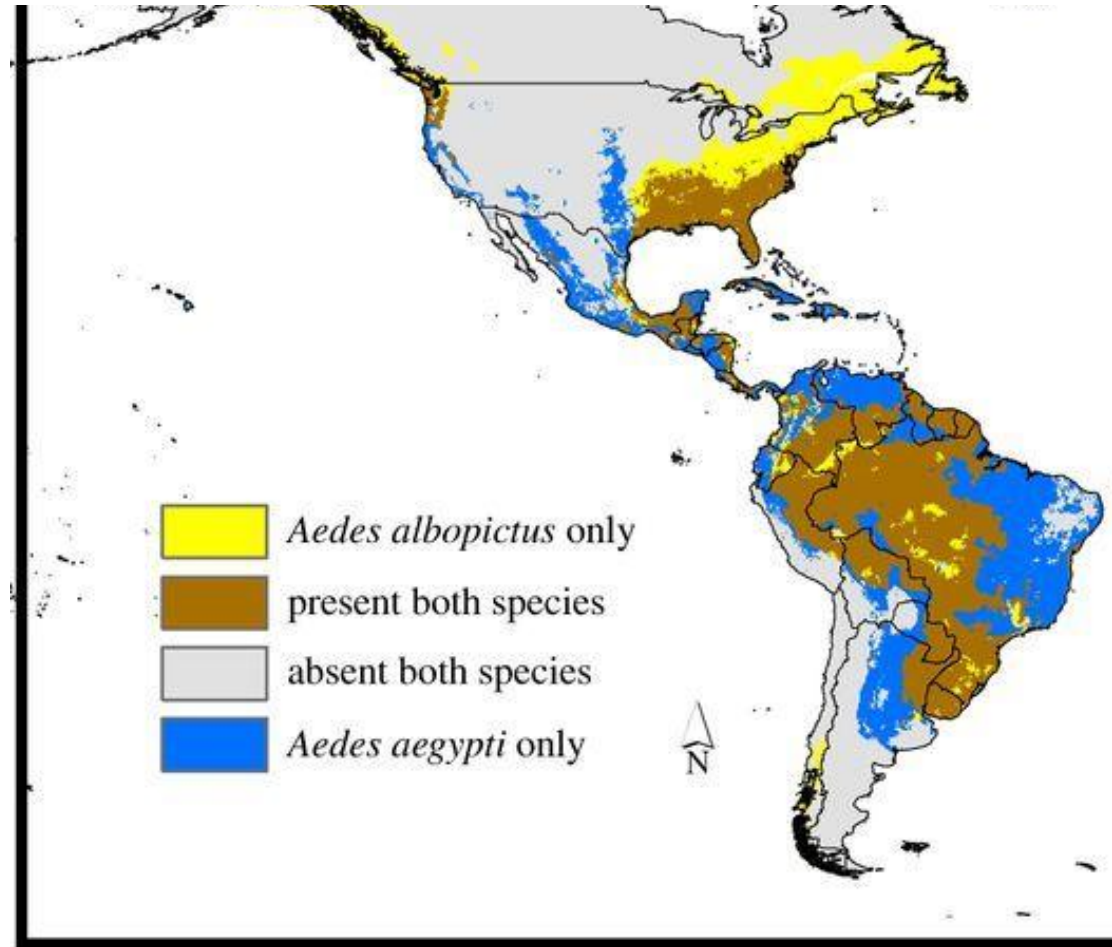
Culex stigmatosoma

- Breeds in high organic content water sources such as winery waste, sewage, cattle waste ponds, log ponds. Ornithophilic but will also bite humans (WNV vector).
- Scattered records in Washington. If it's not in BC already it likely will be at some point.



Aedes albopictus and *Ae. aegypti*

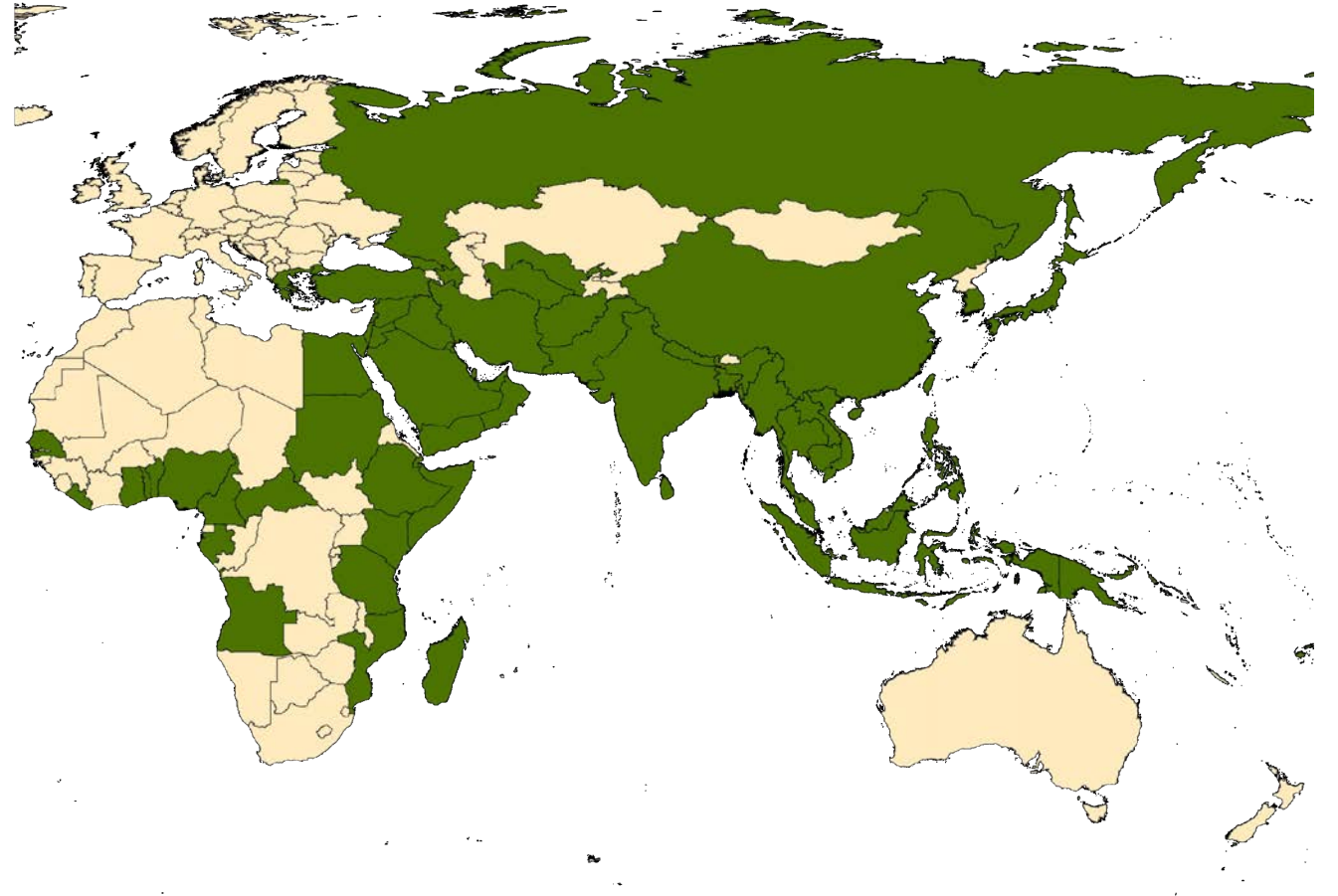
- *Aedes albopictus* recently established in southern Ontario. *Aedes aegypti* has been collected there but is not thought to be established.
- *Aedes albopictus* turned up in Seattle in the 1980's, but was eradicated.



Modelled future habitat suitability,
modified from *Campbell et al.*, 2015

Culex tritaeniorhynchus

- Native to SE Asia but has spread as far as Europe (Greece) and Africa.
- Primary vector of JEV.
- Breeds in containers and rice fields. Adults have also been found landing on container ships hundreds of kms offshore!



Walter Reed Biosystematics Unit

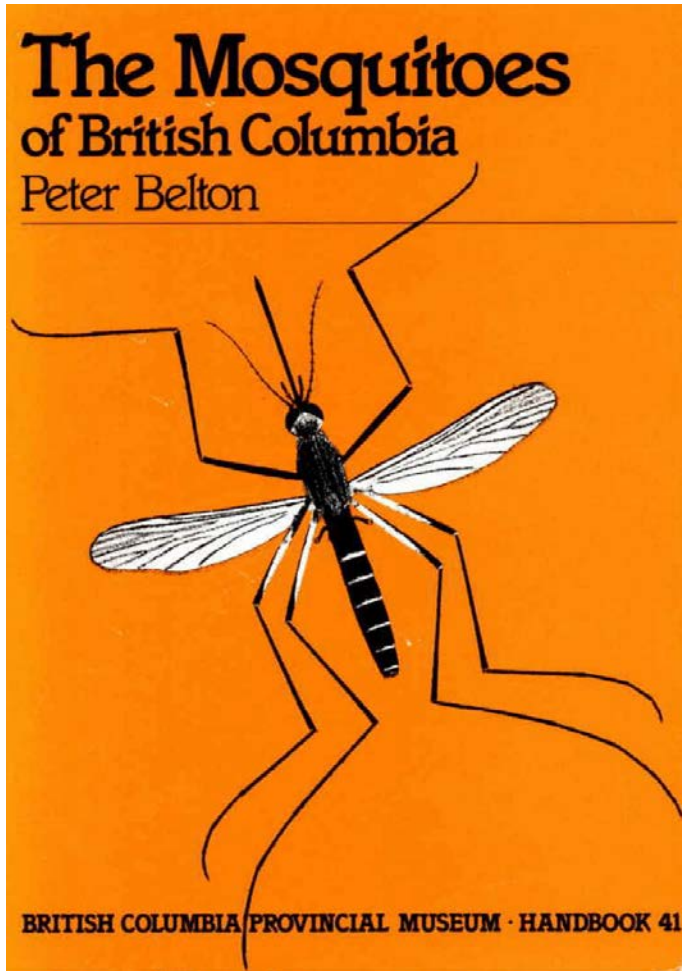
Japanese encephalitis virus (JEV)

- JEV is endemic in East Asia, including areas not too dissimilar from here, such as the Russian Far East. Rare imported cases in Canada.
- Pigs and wild birds serve as reservoirs, including some groups of wild birds that, rarely, accidentally migrate from Russia to North America.
- It's not just the effects of climate change here in BC that matters!



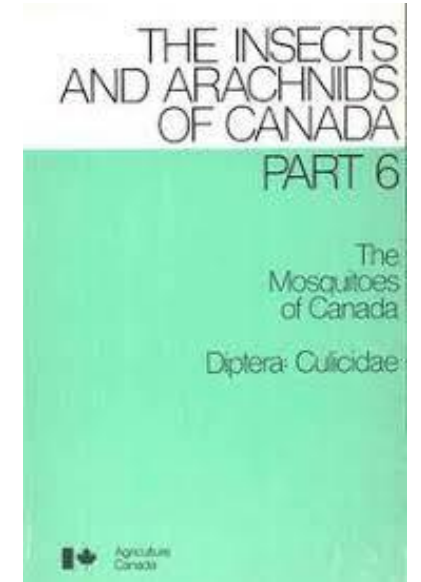
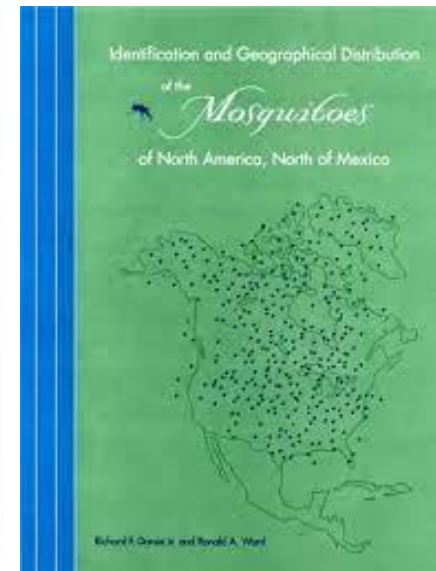
U.S. CDC

Mosquito reference material



A Guide to the Mosquitoes (Diptera: Culicidae) of the Yukon

Dan Peach, Sean McCann, and Peter Belton



Photographic Key to the Adult Female Mosquitoes (Diptera: Culicidae) of Canada

Acknowledgements

- Peter Belton
- Gerhard Gries
- Ben Matthews
- Karen Needham
- Joshua Chen

