Seasonal variations are not uniform across all tropical regions or mosquito species; some areas experience extended periods of high mosquito abundance due to persistent favorable conditions. Modeling studies incorporating temperature and rainfall data from multiple African sites demonstrated that mosquito populations could peak once to multiple times annually depending on regional climate patterns. In locations with less pronounced dry seasons, such as parts of Ghana, mosquitoes maintain relatively high densities year-round, whereas other regions show prolonged low-abundance periods lasting several months (Baafi and Hurford, 2025). These findings emphasize the importance of local climatic context in shaping temporal population dynamics and suggest that vector control programs must be tailored to regional seasonal profiles for maximum effectiveness.

3.2 Effects of rainfall, temperature, and humidity on population fluctuations

Rainfall is a primary driver of mosquito population dynamics as it creates and replenishes aquatic habitats necessary for larval development. Accumulated precipitation in the weeks preceding sampling has been consistently identified as a significant predictor of adult mosquito abundance across diverse tropical settings. For instance, studies in Yucatan found that accumulated rainfall four weeks prior strongly correlated with increased captures of multiple species including *Culex quinquefasciatus* and *Aedes aegypti* (García-Súarez et al., 2024). However, excessive rainfall can sometimes flush out larvae or reduce habitat stability, indicating a nonlinear relationship between precipitation and mosquito populations.

Temperature influences multiple aspects of mosquito biology including development rate, survival, and biting frequency. Warmer temperatures generally accelerate larval maturation and increase adult activity but may also elevate mortality if exceeding optimal thresholds. Research from central Thailand coconut plantations showed that while meteorological variables did not always have statistically significant effects on Culex abundance individually, seasonal temperature variation was linked to changes in wing morphology indicative of phenotypic plasticity (Laojun et al., 2025). Relative humidity further modulates adult survival; higher humidity levels enhance longevity and feeding activity. Studies from temperate regions also highlight species-specific responses to weather variables such as diurnal temperature range affecting Culex species differently (Figure 2) (Baril et al., 2023). Together, these climatic factors interact dynamically to produce complex seasonal fluctuations in mosquito populations.

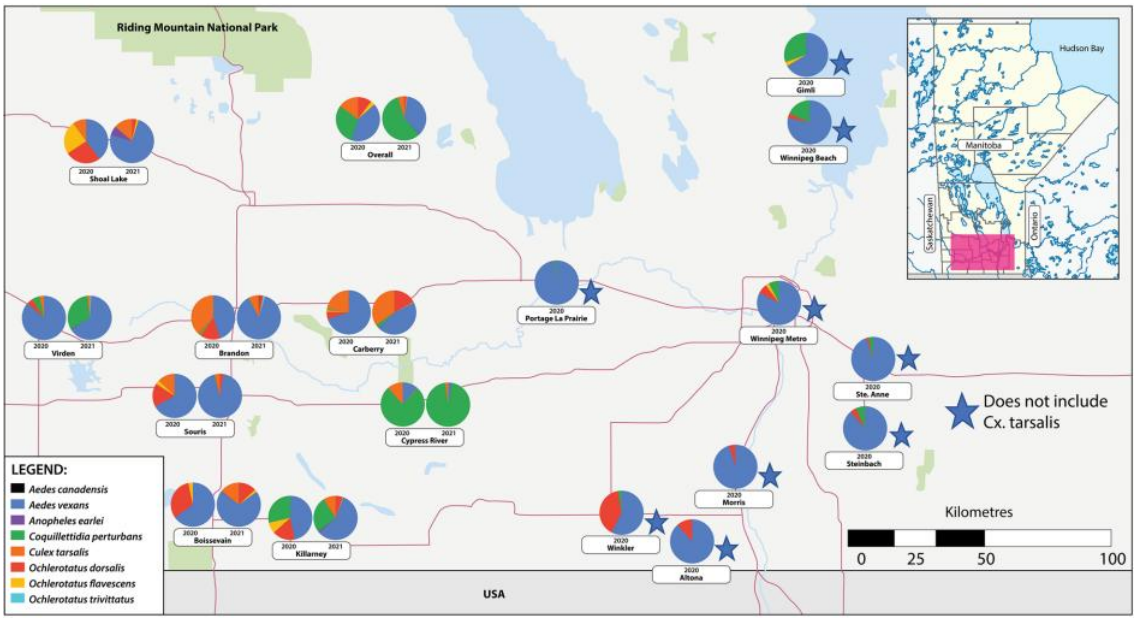

Figure 2 Relative trap counts for the eight most commonly found mosquito species in 2020 and 2021. Mosquitoes were captured on a weekly basis (May to September) from 17 sampling sites throughout Manitoba, Canada. *Culex tarsalis* counts are not included for all locations in the eastern part of the region (denoted with an asterisk*). *Ae. canadensis*, *An. earlei*, *Oc. trivittatus*, and *Oc. triseriatus* were not surveyed in 2020. We collected one *Oc. triseriatus* in 2021, which was not included on the figure (Adopted from Baril et al., 2023)