

Black-legged tick phenology and warming climate in Maine, USA

Susan Elias, MS^{1,2,3}, Sean Birkel, PhD², Kirk Maasch, PhD^{2,3}, Norman Anderson⁴, Charles Lubelczyk, MPH¹, Rebecca Robich, PhD¹, and Robert Smith, MD, MPH¹

¹Maine Medical Center Research Institute Vector-borne Disease Laboratory. Scarborough, Maine, USA

²University of Maine Climate Change Institute, Orono, Maine, USA

³University of Maine School of Earth and Climate Sciences, Orono, Maine, USA

⁴Anderson Environmental Health, Winslow, Maine, USA

Background: Lyme disease incidence in Maine, USA, has coincided with the state's northwestward range expansion of blacklegged ticks (*Ixodes scapularis*). Migrating birds are the primary long-distance mover of ticks, but completion of the life cycle is dependent on the correct mix of hosts, habitat, and climate. For deer tick females to lay eggs (in May), and for those eggs to hatch, about ~1,240 degree days over 6°Celsius (21°F) must accumulate. Until ~2010, this threshold has not been attained in Maine's northern tier. We now appear to be crossing that threshold in the northern tier and by 2040-49, degree day accumulation will likely be sufficient for tick egg hatch in all but the highest elevations. We asked whether recent shifts tick phenology could reflect climate warming in Maine.

Methods: From 1990-2013, a statewide tick identification program was run at the Maine Medical Center Research Institute. Data included tick species and stage, "found-on" host and date, and town where tick was acquired. We calculated ticks per capita to adjust for county populations, then divided the data by northern vs. southern tier. We then looked for uptrends in annual abundance, downtrends in peak week, and increase in season length (# of weeks) on the premise that warming of Maine's climate has extended the spring and fall questing seasons.

Results: The program identified 1,825 nymphal and 16,256 adult *I. scapularis* on humans (65%), dogs (24%), cats (11%), 1990-2013. Uptrends in the northern tier were evident for nymphs and fall and spring adult tick cohorts. But in the southern tier, the uptrend leveled off in the early 2000's. Peak week of nymphal and adult tick abundance has not advanced to earlier weeks, but the length of the tick season has increased in both tiers (stable for the southern tier, and still increasing in the northern tier). Increasing length of season was due to earlier spring submissions, and even more so, later fall submissions. White-tailed deer are the primary reproductive host for adult blacklegged ticks, but deer abundance in the northern tier has been quite low (2-9/mi² compared to ~25/mi² or more in the southern tier) due to dearth of wintering habitat.

Conclusion: Uptrend of more nymphs and adults in the northern tier (and increasing length of questing season) could reflect earlier accumulation of degree days and larval hatch and survival in the northern tier of Maine.