5 Driving Mechanisms of Environmental Factors on Populations and Habitats

5.1 Relationships between climatic factors and mosquito life cycles

Climatic factors such as temperature, rainfall, humidity, and photoperiod play critical roles in regulating mosquito life cycles by influencing development rates, survival, reproduction, and behavior. Temperature affects the speed of larval development and adult activity; warmer conditions generally accelerate growth but can increase mortality if exceeding species-specific thresholds. For example, accumulated rainfall in the weeks preceding sampling strongly correlates with increased mosquito abundance by creating suitable aquatic habitats for larvae, while diurnal temperature range influences species like *Culex quinquefasciatus* and *Aedes aegypti* differently (García-Súarez et al., 2024). Additionally, humidity modulates host-seeking and oviposition behaviors, with higher humidity enhancing adult survival and feeding activity (Meuti, 2025). Photoperiod cues induce diapause or arrested development in temperate mosquitoes to survive unfavorable seasons, though tropical species may respond differently due to less pronounced seasonal changes (Meuti, 2025).

Interactions among these climatic variables create complex temporal patterns in mosquito populations. Nonlinear relationships have been observed where extremely high temperatures reduce abundance despite otherwise favorable conditions (Ferraguti et al., 2024). Rainfall not only provides breeding sites but also interacts with urban environmental factors to influence local mosquito distributions (Wouters et al., 2024). Seasonal peaks in mosquito populations often coincide with periods of optimal temperature and sufficient precipitation, but these patterns vary by species and location. Understanding these multifactorial climatic influences is essential for predicting population dynamics under changing climate scenarios and for timing vector control interventions effectively (Blanco-Sierra et al., 2024; García-Súarez et al., 2024).

5.2 Impacts of human activities on habitat formation

Human activities profoundly shape mosquito habitats by altering land use, water management, and urban infrastructure. Urbanization creates artificial breeding sites such as water containers, drainage systems, and abandoned infrastructure that support container-breeding species like *Aedes aegypti* and *Aedes albopictus* (Little et al., 2017; Wouters et al., 2024). Studies show that infrastructural decay combined with vegetation presence increases mosquito abundance in urban neighborhoods; abandoned blocks with more vegetation harbor larger populations due to increased habitat availability (Little et al., 2017). Moreover, impervious surfaces associated with urbanization influence microclimates by increasing temperatures (urban heat islands) which can accelerate mosquito development rates (García-Súarez et al., 2024; Vandergiessen et al., 2025).

Anthropogenic stressors such as eutrophication and salinization of water bodies also affect mosquito population parameters by modifying survival rates, development times, and reproductive behaviors. Experiments demonstrate that increased nutrient pollution enhances larval survival and egg-laying behavior while salinity negatively impacts survival at higher temperatures (Boerlijst et al., 2022). These human-induced environmental changes often interact synergistically with climatic factors to promote mosquito proliferation. Consequently, human-driven habitat modifications are key drivers of spatial heterogeneity in mosquito populations and must be integrated into vector control strategies to address disease risks effectively (Little et al., 2017; Boerlijst et al., 2022).

5.3 Biological factors

Biological interactions including predation and interspecific competition significantly influence mosquito population dynamics within their habitats. Predators such as fish, aquatic insects, and other invertebrates regulate larval densities by consuming immature stages, thereby affecting overall population size and species composition. The presence or absence of natural predators varies across habitat types; artificial containers often lack predators compared to natural water bodies, allowing some species like *Aedes aegypti* to thrive in urban environments (Wouters et al., 2024). Interspecific competition among co-occurring mosquito species can lead to niche partitioning or competitive exclusion depending on resource availability and environmental conditions.

These biological factors interact with environmental variables to shape community structure; for instance, habitat heterogeneity created by human activities may alter predator-prey dynamics or competitive relationships among