



A model-based tool to evaluate spatially explicit mosquito-borne risk in the US Southern High Plains



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Introduction

- Quantifying mosquito-borne risk is challenging
 - Complex life cycle of mosquitos
 - Heterogeneous distribution of habitat across landscape
 - Mosquito population feedbacks with mosquito control and temporally varying weather
 - Heterogeneous distribution of human population
- Simulation-based population modeling may allow for:
 - Prediction of population distribution under a variety of conditions
 - Quantification of spatially explicit relative exposure risk
 - Evaluation of different management schemes

Focus Area: US Southern High Plains

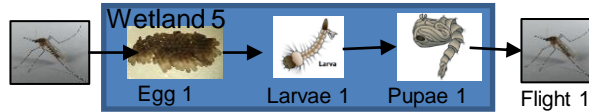
- Species of interest: *Culex tarsalis*
- Utilizes widely distributed plays lakes to breed
- Can have long distance dispersal
- Vector for WNV and WEE

Model Description

- Agent-based, stochastic, spatially explicit model that simulates mosquito population dynamics
 - Developed based on Lubbock County, TX
 - Written in program NetLogo
 - Freely available software
 - Built-in visual interface
- Population model based on mosquito physiology/ecology
- Real-world spatial and temperature information
- Surveillance and Control Modules
 - Quantify metrics of spatially explicit risk
 - Evaluate different control strategies under different conditions versus no treatment

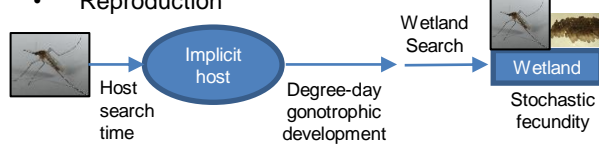
Model Modules

- Environment:** daily temperature, landcover, wetland location data, human population
- Aquatic Phase**
 - Egg, larvae, pupae age-based cohorts in wetlands
 - Degree-day model of development
 - Stage-based, individual survival rates



Adult Phase

- Adult cohorts: Flights of fixed size
- Landcover-based probabilistic dispersal model
- Reproduction



Surveillance and Control (currently only larvicide)



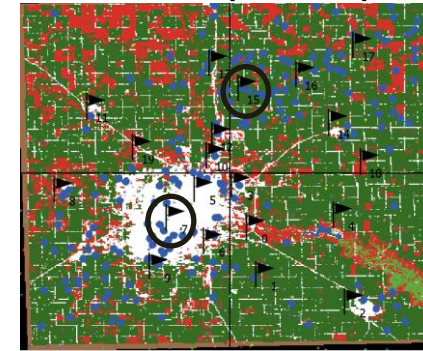
• Adult population sampled weekly at stationary light trap sites



• Larvae population sampled at wetlands

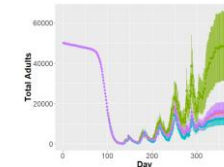
- Simple exposure risk index calculated at trap sites: Human Population + Mosquito Sample
- Wetlands to treat prioritized by management priority: e.g.: reduce overall population or relative risk metric
- Treated wetlands influenced by resource limitations: number of wetlands possible to treat per day

Simulation Output Example

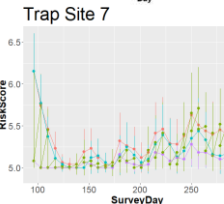


Lubbock County, TX

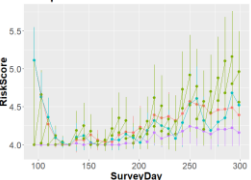
- Surveillance and treatment operated in 7-day periods
- Treatment prioritization scenarios considered
 - Random
 - Total adult population
 - Human contact risk
- Model simulated over a year: 50x per scenario
- Adults sampled at 20 light traps (example locations shown)



- All treatment scenarios result in reduction of total population over no-treatment scenario
- Total population approach often reduces risk metric the most relative to no treatment at all



Trap Site 15



Next Steps

- Variable habitat (drying, filling wetlands) and adulticiding
- Incorporation of arboviral disease transmission risk module
- Calibration of population model with surveillance data
- Adaptation to other systems and species

*For questions, feedback or updates, please email: daniel.dawson1081@gmail.com