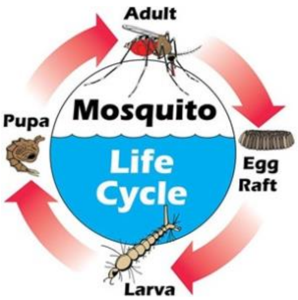
2025 Hampton Roads Datathon

Controlling and Reducing Disease-Causing Mosquito Culex Vector Population from Breeding Sites in Norfolk

Team: Byte and Bite (Zahra, Derek, Nana, Susan, Syed, and Sophia)



Our team discovered that a substantial 77% of the total mosquito population in Norfolk originates from the Culex species. Notably, the Culex species is the sole contributor to all West Nile Virus (WNV) disease cases reported in hospitals within Norfolk. Among the individuals infected with WNV, Caucasians exhibit a heightened susceptibility, resulting in a higher incidence of infection.

Marshy areas produce almost 50% of all mosquitoes – how can this number be reduced?

The Culex mosquito is one of the most prevalent mosquito genera in the United States and significantly contributes to the transmission of several severe diseases, including WNV.

Time series and seasonality analysis indicate a gradual increase in all mosquito species since 2020, with the Culex mosquito leading the trend. This significant rise in mosquito populations is expected to have a substantial impact on the number of WNV infections among the white race in Norfolk.

Approaches to control:

1. Given that a third of the mosquito breeding population resides in water, with marshy areas contributing approximately 50%, we propose the implementation of impregnated mosquito trap nets. These nets should be strategically placed over marshy areas, ponds, ditches, and water receptacles in homes and backyard gardens.
2. A weekly mosquito weather data report will be disseminated to the public and regulatory authorities, providing insights into mosquito population trends, similar to the pollen reports commonly found on weather applications.

References:

CDC Website. https://www.cdc.gov/mosquitoes/about/culex-mosquitoes.html

Norfolk Mosquito-born Diseae Testing, Norfolk Mosquito Trap Counts. data.norfolk.gov/stories/g2df-4vin

Savage, H., and B. Miller. 1995. House Mosquitoes of the U.S.A., Cules pipiens complex. Wing Beats, Vol. 6(2):8-9.

Weather API. https://open-meteo.com

Hampton Roads Itch Index (0–10)

A simple, UV-style mosquito nuisance signal for parks and green spaces

Datathon 2025 Submission **Team:** CDJ

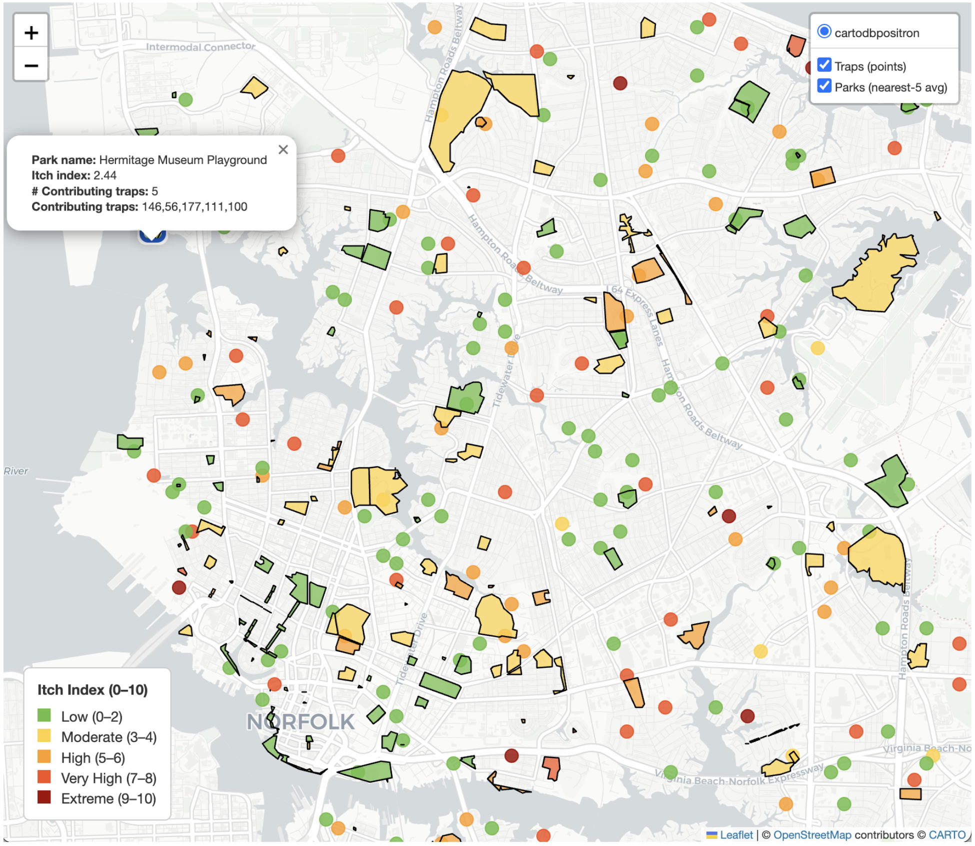


Figure 1: **Interactive Itch Map (click image). Full report can be found here.**

Why this matters

Mosquito nuisance is local and changes fast. Residents, Parks & Rec, and event planners need a clear, timely signal to choose protection & plan operations.

What we built

A stable, readable **0–10 Itch Index** derived from mosquito trap counts, published on a public, park-centric map. Different traps and species are normalized so the number is comparable across sites & wks.

What the number means

- **0–2 Low** — enjoy parks normally
- **3–4 Moderate** — repellent at dusk/dawn
- **5–6 High** — repellent + socks/long sleeves near vegetation
- **7–8 Very High** — avoid marsh-edge trails at dusk; caution for outdoor events
- **9–10 Extreme** — strong protection; consider advisories

Who uses it

- **Public:** simple daily guidance for parks and trails
- **Event organizers:** plan evening timing and patron messaging
- **Operations:** prioritize surveillance and treatment where risk stays high

Action statement

- **Publish weekly** Itch Index to Parks & Rec and event planners
- **Trigger ops:** prioritize sites that remain > 7 for two consecutive weeks
- **Targeted outreach:** emphasize daytime protection when day-biting species dominate

2025 HAMPTON ROADS DATATHON PROPOSAL
Team EpiAnalytics

Sushmitha Halli Sudhakara, Swati Mishra, Audrey Douglas-Cooke, Stephen Nkansah-Amankra

Project Title: SkeeterScan: Smart Detection for Healthier Communities

Background:
Mosquito-borne diseases remain a persistent and evolving threat to public health in Hampton Roads, Virginia. The region's diverse ecosystems, salt marshes, urban containers, and woodland pools, support over 30 mosquito species, notably Aedes albopictus (Asian Tiger) and Culex pipiens, which are established vectors for Zika, Dengue, and West Nile Virus. Traditional surveillance methods rely on manual species identification and delayed reporting, limiting the precision and timeliness of vector control. As climate variability and urbanization intensify mosquito proliferation; scalable, community-accessible tools are urgently needed to enhance surveillance, accelerate response, and foster public engagement.

Data and Definitions:
This AI driven mosquito species identification and real-time vector surveillance initiative utilizes publicly available entomological image datasets curated by global vector research consortia. Key operational definitions include:

- ***Vector Risk Classification:*** Mapping mosquito species to their associated disease transmission potential.
- ***Risk Level Indicator:*** A dynamic tiered system (High / Medium / Low) based on species, seasonality, and regional prevalence.
- ***Actionable Insight:*** Species-specific prevention and control recommendations aligned with CDC and Virginia Department of Health guidance.

Methods:
We deploy an innovative convolutional neural network (CNN) architecture, fine-tuned on annotated mosquito image datasets, to classify species from user-submitted images. The model is embedded within a lightweight, mobile-responsive application that enables:

- Image capture or upload via mobile or desktop interface.
- Real-time species prediction and vector risk assessment.
- Delivery of tailored public health guidance based on classification results.

Model training incorporates transfer learning and region-specific augmentation to optimize performance on locally relevant species. Evaluation metrics include classification accuracy, precision-recall, and latency benchmarks to ensure field usability.

Proposed Solution:
Our prototype bridges AI-powered analysis with public health communication. It empowers field teams to

- Rapidly identify mosquito species and associated disease risks.
- Receive immediate, species-specific prevention and control guidance.
- Contribute to decentralized surveillance through image-based reporting.

This viable and practical solution is designed for scalability, with future integration pathways including climate-based prediction models, sensor networks, and educational modules. It also fosters engagement among school-age students through interactive learning about mosquito species and their impact on human health. By automating entomological analysis and democratizing access to vector intelligence, SkeeterScan enhances outbreak preparedness, supports targeted interventions, and advances community-driven mosquito control.

Who Let the Buzz Out: Predictive Modeling of Mosquito Dynamics Through Feature-Engineered Data

Nishan Khatri and Suyog Dahal, Old Dominion University
Team: Lamkhute Binasak 2025 Hampton Roads Datathon

Overview

Mosquito-borne diseases pose a growing public health challenge, especially in coastal regions like Norfolk, Virginia, where warm temperatures, humidity, and diverse land features create favorable breeding conditions. To support proactive mosquito control and public health interventions, our project—*Who Let the Buzz Out?*—forecasts mosquito population density and identifies emerging hotspots using an integrated, data-driven approach.

Data Sources

We merged multi-source data spanning environmental, climatic, geospatial, and social dimensions, then engineered predictive features (lags, encodings, spatial metrics) and ranked them via correlation and model-based importance.

- **Mosquito Trap Counts** (target): Weekly species counts by trap location from Norfolk Open Data: data.norfolk.gov.
- **Weather (Open-Meteo API)**: Daily temperature, precipitation, humidity, and wind speed, aggregated to weekly (open-meteo.com).
- **Geospatial Features (OpenStreetMap)**: Land use (residential, park, wetland, industrial), *distance to nearest water body*, elevation, and neighborhood context (openstreetmap.org).
- **Service Requests (Citizen Reports)**: Mosquito-related complaints from MyNorfolk as a proxy for community-level activity.

Approach

Our process began with the integration of all available data sources. Through rigorous **feature engineering**, followed by correlation analysis and feature ranking, we distilled the dataset down to the most significant predictors of mosquito abundance. These key variables were subsequently used as inputs to a ***Prophet model***, an **AI-based** forecasting framework, to generate precise forecasts of mosquito counts for the specified location.

Results & Visualizations

- **Top Factors**: The feature ranking identifies top 10 important factors for predicting mosquito counts.
- **Dashboards**: Interactive time-series views with performance metrics.
- **Hotspot maps**: Predicted high-risk zones (emerging hotspots) guide targeted interventions.

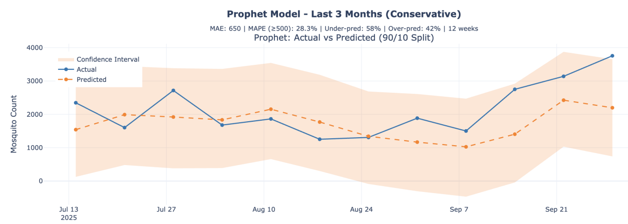


Figure 1. Actual vs Forecasted in Test data

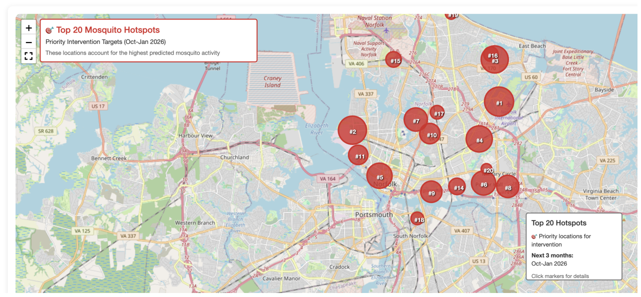


Figure 2. Predicted Hotspot Map

Impact and Use Cases

Our forecasting framework provides actionable insights for city planners and mosquito control teams:

- Anticipates mosquito population surges several weeks in advance, enabling timely interventions.
- Reduces unnecessary spraying by focusing only on predicted high-risk zones.
- Enhances operational efficiency by aligning manpower and resources with forecasted activity trends.
- Enables data-driven communication with the public about expected mosquito levels and safety precautions.
- Supports long-term planning through trend analysis and environmental impact assessment.

Future Directions

- Fine-tune and optimize models for higher forecast accuracy.
- Integrate live weather, satellite (NDVI), and IoT sensor data for real-time updates.
- Automate a weekly forecast pipeline with a web dashboard for easy visualization.
- Collaborate with Norfolk's mosquito control team to apply forecasts for timely field actions.
- Extend forecasts to predict disease risk indices.

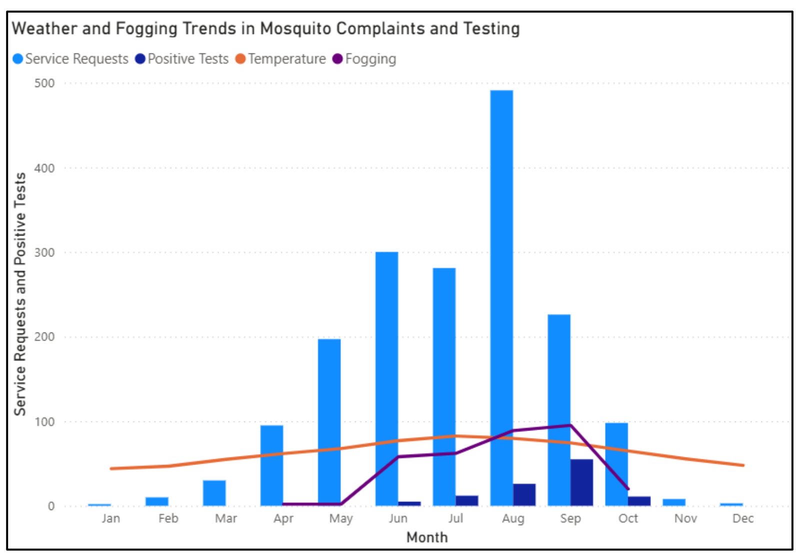
Team: Norfolk Buzz Killers

Swatting Away the Next Epidemic

History & Background: Historically, Hampton Roads, and specifically Norfolk, are no strangers to the effects of mosquitoes and the diseases they carry. As early as 1795, yellow fever outbreaks had occurred in the area; most notably, the 1855 epidemic, which reduced the population in Norfolk and Portsmouth by approximately one-third. Today, a gravestone memorializes the victims of this epidemic at Yellow Fever Park in West Ghent of Norfolk. The lessons gained from that experience and others have been shaped through technological progress. There is a vaccine now for yellow fever, but there are not for some of the other potentially fatal diseases that mosquitoes carry. This is why public health efforts to mitigate disease prevalence from these tiny creatures are a monumental task. We have also learned that a warming climate, flooding, and high population density can serve as a catalyst for the escalation of mosquito populations and disease transmission.

The goal of this project is to understand and assess the impact of mosquito vector control efforts on viral loads in the City of Norfolk.

Our purpose is to measure citizen complaints, fogging, climate, and weather trends, as well as positive vector testing, and human disease tracking, to determine the effectiveness of fogging against the mosquito viral load. We aim to utilize current data trends to better inform future vector control timing and strategies, thereby providing exceptional customer service that can reduce citizen complaints and also mitigate the spread of zoonotic diseases.



Findings & Solutions: Based on observations from currently available data, we recommend starting fogging schedules earlier in the season and increasing the applications targeting hot spots from historically high citizen complaint areas. In addition to increased fogging efforts, we also recommend implementing regular public education outreach efforts through neighborhood civic leagues.

Data Sources

Mosquito-borne Disease Testing – Norfolk Department of Public Health

Mosquito Control Product Options – Clarke

Address Information – City of Norfolk's Information Technology Department

Norfolk Vector Control ULV Fogging – City of Norfolk

VDH PUD Reportable Disease Surveillance Virginia Geography – Virginia Open Data Portal

Mosquito Trap Counts - Norfolk Department of Public Health

MyNorfolk - Norfolk Cares Center

Image Sources

Hafner, Katherine (2024, August 29), "A gravestone memorializes victims of the 1855 epidemic at Yellow Fever Park in West Ghent in Norfolk," *How yellow fever devastated Norfolk and Portsmouth in the summer of 1855*, WHRO, https://www.whro.org/arts-culture/2024-08-29/how-yellow-fever-devastated-norfolk-and-portsmouth-in-the-summer-of-1855

MosquitoWatch HR: Data-Driven Insights for Equitable Control in Hampton Roads

Team: NOVAMIND – Old Dominion University

Category: Data Analytics / Public Health / Environmental Equity

Abstract:

Mosquito-borne diseases and nuisance complaints continue to challenge public health teams in Hampton Roads. Our project, *MosquitoWatch HR*, offers an interactive dashboard that brings together open data from the City of Norfolk and other regional sources. The platform merges mosquito-trap counts, disease test results, and citizen service requests with weather and census data to help analyze mosquito distribution and fairness in control efforts.

The system uses local GIS boundaries and spatial methods to calculate a **Mosquito Risk Index based on** trap density, complaint frequency, and disease rates. This index is compared with neighborhood data like income, housing density, and demographics to highlight differences in mosquito problems and how well control measures work.

Developed entirely in Python with Pandas, GeoPandas, and Plotly, the prototype is deployed through Streamlit to provide:

- **Interactive maps** visualizing risk levels and equity gaps across neighborhoods.
- **Correlation analyses** linking socioeconomic factors with mosquito activity.
- **Temporal visualizations** illustrating the influence of rainfall, humidity, and temperature on mosquito trends.

In the future, we may add features like automated SMS alerts for high-risk areas and daily hotspot summaries powered by AI. This flexible, open-source tool is designed to help create fair, data-driven mosquito management plans and could be expanded to support wider environmental health monitoring in Hampton Roads.

Tools and Data: Python (GeoPandas, Plotly, Streamlit), Norfolk Open Data Portal, Visual Crossing Weather API, U.S. Census ACS data.

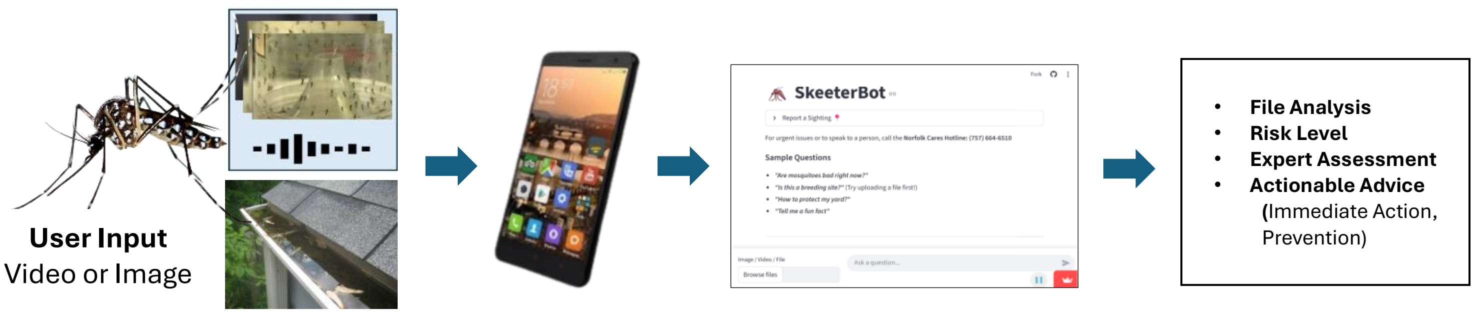
Expected Impact: Improved understanding of spatial disparities in mosquito exposure and a scalable framework for evidence-based, equitable vector-control decision-making.

AN AI IMAGE RECOGNITION AND GEOSPATIAL ANALYTICS PLATFORM FOR MOSQUITO DATA FOR CITY OF NORFOLK

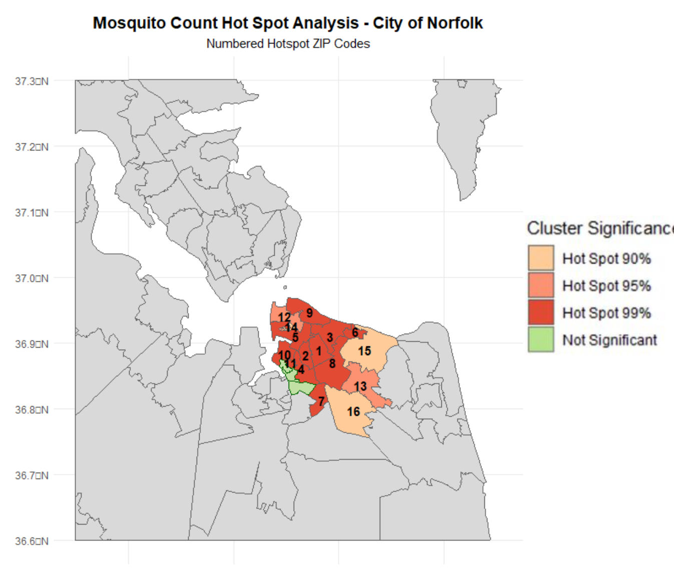
Team ODU CompSci: Sandeep Kalari, Brian D. Hanson, Chad Hargro, Heranga Rathnasekara
Old Dominion University

Mosquito-borne diseases remain a persistent public health challenge, demanding early detection, targeted interventions, and community engagement. This project integrates three components: Deep learning with AI, Geospatial Analytics, and Crowdsourced Data Collection to create a unified system for mosquito surveillance and public awareness in the City of Norfolk, Virginia.

Deep Learning: A deep learning-based AI image recognition system is developed to automatically identify mosquito species from field trap images or videos taken from smartphones. The model estimates mosquito counts and species composition using computer vision and machine learning techniques, enabling real-time analysis of mosquito populations. This model consists of risk level, expert assessment and actionable advice on the image/video as well. The following is a flow chart of the model and here is the link to the website: https://sandeep945-pixel-mosquitonet-datathon-app-skjq6r.streamlit.app/. The AI model titled as **SkeeterBot**.



Visualization: Using geospatial analytics, mosquito activity is visualized across Norfolk's ZIP codes. The system identifies hotspots of mosquito abundance and correlates them with environmental and socioeconomic factors, such as median household income and population density.



Education and Public Engagement: A crowdsourced data collection platform empowers the public to participate in mosquito surveillance. Residents can upload images, report mosquito sightings, and learn to recognize breeding sites and mosquito species directly from their smartphones. This participatory approach enhances community awareness and supports proactive control efforts.

Overall Impact: By combining AI-driven identification, spatial visualization, and community engagement, this integrated system provides a scalable, data informed approach to mosquito management. The goal is to assist public health officials in mitigating disease risks such as West Nile Virus and Eastern Equine Encephalitis, while fostering citizen science participation in environmental health monitoring.

Targeting the Tiger:

Predicting Aedes Albopictus Hotspots to Guide Sterile Insect Releases in Norfolk

By Team SpraySmart - Kamélia Marchand Vaudrin, Quhura Fathima, Reema Mahabooba)

The Problem

In Norfolk, the *Aedes albopictus* (known as the tiger mosquito) has become a persistent invader. It's an aggressive daytime biter that infests cluttered, container-filled yards and neighborhoods.

It currently accounts for nearly 25% of all local trap captures. Widespread pesticide use fails to curb its spread as the species grows increasingly resistant to common EPA-approved chemicals.

The Solution: Sterile Insect Technique (SIT)

Instead of chemicals, SIT releases sterile male mosquitoes that mate with wild females, producing no viable offspring and driving natural population decline. It's been proven globally and in the U.S. For example, a Lee County, Florida pilot achieved an approximate 80% reduction in adults and approximate 60% reduction in eggs.

Our Innovation: Deep-Learning Precision

We used a Multilayer Perceptron (MLP), a type of neural network that learns patterns between weather and mosquito counts. It analyzes years of trap data to predict where and when populations will surge. By training the model on historical weather cycles, it can forecast high-risk zones up to two weeks in advance - helping guide *where sterile males should be released first* for maximum impact.

By Scanning this QR Code you will be able to see how the model-predicted risk zones align with real observed trap data.

Tiger Tracks

Partnerships & Next Steps

- SIT vendors identified for potential sterile-male supply.
- Capture - Mark - Recapture pilot study planned to validate predictions.
- Advisors from Lee County's SIT program have expressed interest in continued collaboration and guidance.

Future impact

By combining biology and artificial intelligence, Norfolk can fight the mosquito that doesn't wait for nightfall. Our project delivers fewer bites, fewer sprays, and a cleaner environment. We made sure to create a model for sustainable mosquito control that can be scaled up to accommodate the larger Hampton area and offer predictions about multiple different species.

Data Sources:

1. ***Mosquito Trap Counts (2012-2025)*** **-** Norfolk Department of Public Health
2. **Weather Daily Summaries -** National Oceanic and Atmospheric Association (NOAA)

Tooling: Python (Pandas, NumPy, Matplotlib, Seaborn, Folium, Scikit-learn) on Google Colab.

Supporting Research Documents:

Biting rhythm and demographic attributes of Aedes albopictus (Skuse) females from different urbanized settings in Penang Island, Malaysia under uncontrolled laboratory conditions | PLOS One

Potential Roles of Environmental and Socio-Economic Factors in the Distribution of Insecticide Resistance in Anopheles gambiae sensu lato (Culicidae: Diptera) Across Togo, West Africa | Journal of Medical Entomology | Oxford Academic

Suppression of Aedes aegypti by the sterile insect technique on Captiva Island, Florida, USA from 2020 to 2022

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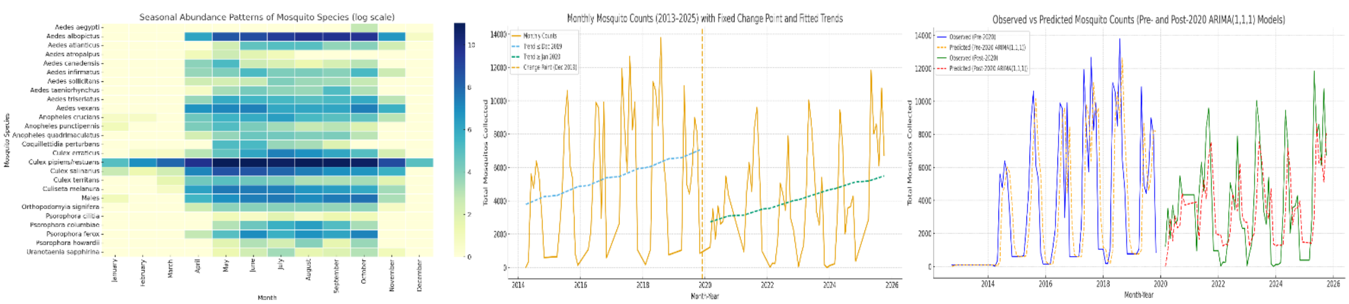
Norfolk Datathon 2025 – October 23, 2025

Team Super Acorn: Sam Winchester, Emaline Basye, Gordon Brown, and Norou Diawara

Mosquito Surveillance and Control: Data-Driven Insights and Solutions

The growing effects of climate variability and urbanization have heightened the need to understand the complex dynamics influencing mosquito populations. Statistical and time-series modeling provides a flexible framework for analyzing the multivariate dependencies among environmental and biological factors that drive mosquito abundance and distribution. However, identifying the most suitable models remains challenging, as existing goodness-of-fit (GOF) tests often lack consistency and power across varying sample sizes, spatial scales, and dependence structures.

In this study, we developed and analyzed an integrated time-series-based model selection approach to improve the accuracy of mosquito population forecasting in Norfolk, Virginia—a region sensitive to both coastal and climatic influences. Special emphasis was placed on the Culex pipiens/restuans complex, which dominates urban and suburban habitats and is closely linked to West Nile virus surveillance (Fig. a). Our findings suggest that mosquito population dynamics can be divided into two temporal phases—Pre-2020 and Post-2020—with a sharp post-2020 decline, possibly reflecting operational or environmental shifts (Fig. b). The trend also coincides with COVID-19-related effects in surveillance activities. Seasonal decomposition revealed consistent cyclic patterns, while predictive models effectively captured both long-term trends and seasonal fluctuations (Fig. c).



Figures: (a) Heatmap of species distribution (b) Change-point detection (c) Seasonal trend decomposition

The proposed framework combines multiple GOF tests with stratified cross-validation to enhance model robustness and selection precision. Future work will integrate marginal distribution fitting for key variables such as temperature, humidity, and vegetation index, along with sensitivity analysis to optimize spatial and temporal resolution. Further extensions may include Hierarchical Archimedean Copula models to capture complex multivariate dependencies among climatic and ecological drivers. Validation will be conducted through Monte Carlo simulations and applied to longitudinal mosquito surveillance data from Norfolk to evaluate predictive performance.

MosquitoWatch: Predictive Dashboard for Norfolk

Team Captains, Christopher Newport University School of Engineering and Computing

Smart Mosquito Surveillance: AI Classification and Community Awareness

Mosquito-borne diseases continue to pose significant health risks in the Hampton Roads region, where a warm and humid climate creates ideal breeding conditions. Current mosquito surveillance methods require trained specialists to manually identify species from trap images or samples. This process limits the speed and scale of data collection. As weather patterns and land-use changes influence mosquito populations, there is a growing need for data-driven tools that can anticipate mosquito activity and support more effective control strategies.

Our project combines deep learning and data visualization to address these challenges. We trained a deep convolutional neural network model capable of classifying mosquito species from image data, using supervised learning and fine tuning on a pretrained ResNet 34 architecture, selected due to its strong balance between accuracy and computation efficiency. We implemented this model into an interactive web application, where users can upload a mosquito image through our Mosquito Detector tool. The AI instantly identifies the mosquito species and provides information about the potential diseases that species is known to carry. This feature makes mosquito identification accessible to both the public and field researchers, transforming what is typically a specialized lab process into an interactive, real-time diagnostic experience.

Visit our interactive dashboard for our full project and results.

We then integrated weather and land-use data to build models that estimate mosquito population trends over time. Using ArcGIS, we visualize these patterns spacially, producing interactive heatmaps and forecasts that highlight likely hotspots across Hampton Roads. This dashboard helps vector control teams identify at-risk areas before outbreaks occur, improving the efficiency of surveillance and treatment planning.

Education and Community Engagement

Beyond analytics, our project includes an **educational component** designed to engage the public. Visitors can take an **interactive quiz** testing their knowledge of mosquito species, breeding habits, and local diseases that affect the Norfolk area. The goal is to make learning about mosquito-borne diseases approachable and relevant, fostering awareness that supports preventative behaviors like removing standing water or reporting mosquito activity.

Project Summary

Project Title: Assessing human West Nile Virus Outbreak Risks in the City of Norfolk, Virginia

Team: Hua Liu, Yin-Hsuen Chen, Kevin O'Brien, Tom Allen, George Mcleod, Christopher Davis at Old Dominion University, Norfolk, VA

West Nile Virus (WNV) is an arthropod-born virus with mosquitoes as vectors and birds as reservoirs. It first invaded the United States in 1999 and has been disseminating across the continents since then. For the state of Virginia, although most human WNV cases have been reported from Northern Virginia, Hampton Roads face a potential risk of human WNV infection due to its adequate climate and environment for transmission, e.g., high moisture, and frequent inundations. This project aims to evaluate the WNV outbreak risks among human in the City of Norfolk based on WNV surveillance data in mosquitoes, simulated mosquito populations, climate data, and tree canopy coverage.

The project method is innovative in nature by incorporating machine learning and geospatial analysis in evaluating human WNV risk based on public data from various sources.
Machine learning technology (Forest-based Classification and Regression analysis) was applied to predict the monthly mosquito abundance based on mosquito trapping data, and a set of environmental and socio-economic conditions (e.g., vegetation, water, moisture, resident's education level and household income). A spatial fuzzy model was applied to assess the human WNV outbreak risks (for all ages & for ages >= 65) by integrating WNV mosquito surveillance data, simulated mosquito population, tree canopy, daily max temperature, and precipitation.

The project outcomes include a story map capturing the details of project development and showcasing the results with a series of maps visualizing the simulated mosquito abundances and human WNV outbreak risks for the city, a poster highlighting the key components and findings of the project. WNV infections among seniors were assessed separately to facilitate the monitoring and control of the virus among elderly. Some neighborhoods constantly appear to face higher levels of risks for human WNV infections compared to the other ones in the city.

The WNV Risk Mappers successfully developed a robust machine learning spatial model to predict monthly mosquito abundance in Norfolk, VA (June-October). This model was essential for generating Human WNV Risk Map and opens the door to future analyses and interventions. Future Steps include incorporating more temporally dynamic predictors (e.g., drought condition & temperature), acquiring more spatially independent training data, and implementing spatial cross-validation to strengthen model generalization capabilities. More factors could be considered to improve the assessment of human WNV outbreaks (e.g., bird abundance).

The project offers a comprehensive, data-informed perspective on the WNV transmission suitability and outbreaks in humans in the City of Norfolk. Our results can provide informative background information for local mosquito controls and public health monitoring and management. The model approach is also transferable to other communities and scalable to larger areas, uses free and open-source data, and lays a foundation to identify future, emerging risks (changing climate, demographics, and mitigation.