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Fight the Bite - Applying Remote Sensing Technologies to Detect Mosquito Breeding Habitats

BIG Meeting

June 5th 2018

Sarah M Gunter, PhD, MPH

Mosquito-Borne Diseases

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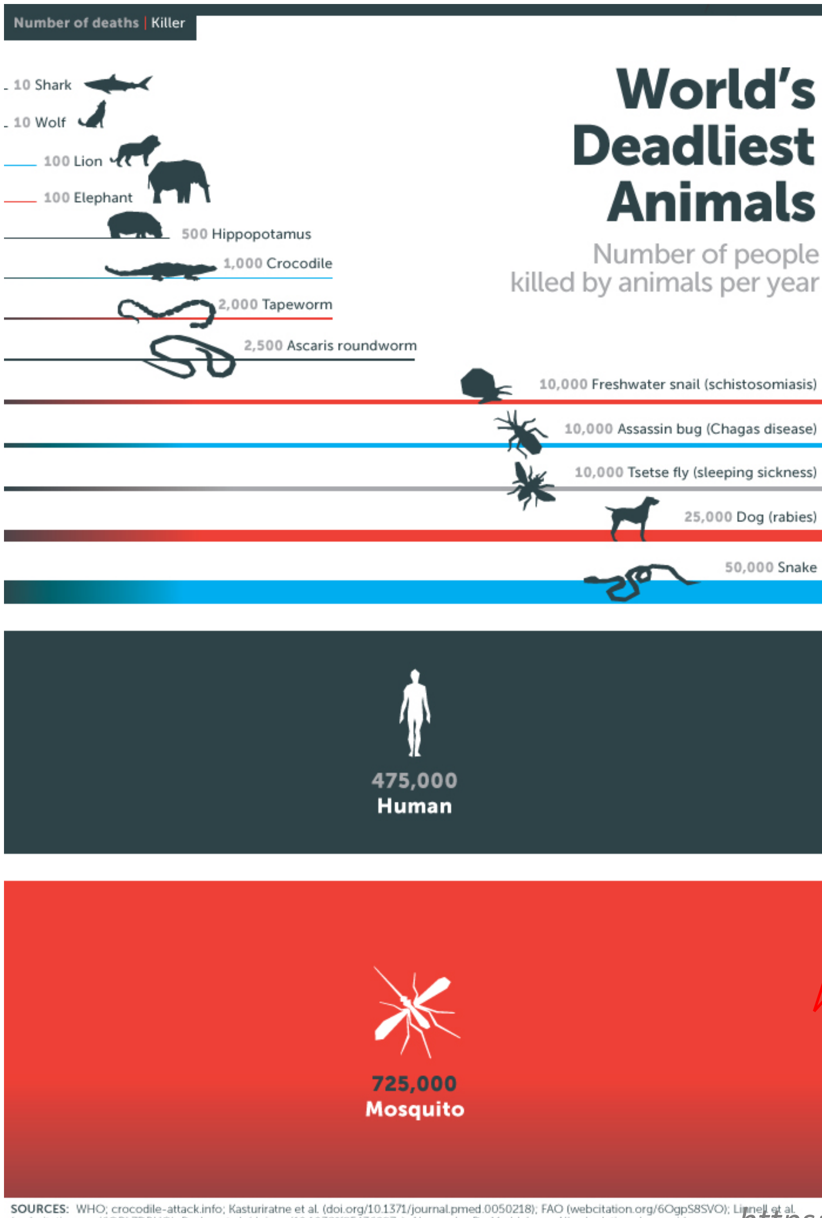

- ***Aedes spp.***
  - Chikungunya
  - Dengue fever
  - Lymphatic filariasis
  - Rift Valley fever
  - Yellow fever
  - Zika
- ***Anopheles***
  - Malaria
  - Lymphatic filariasis
- ***Culex***
  - Japanese encephalitis
  - Lymphatic filariasis
  - West Nile fever

https://www.gatesnotes.com/Health/Most-Lethal-Animal-Mosquito-Week

Major Limitations of Mosquito Borne Disease Prevention

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1. Majority of these diseases originate in infrastructure-poor, resource-limited countries
   I. Hard to predict spread of new Mosquito-Borne Diseases
      a. Arboviral mutations
         i. Unpredictable jump to new mosquito species-animal hosts
      b. Lack of surveillance
         i. Can't identify new epidemics
         ii. Can't track spread
         iii. Unaware of highest-risk populations

2. Globalization contributes to spread of disease

3. Paucity of available diagnostics, vaccines, and therapeutics

Development of BCM-ExxonMobil Collaboration

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MODELING/GIS, RISK ASSESSMENT, ECONOMIC IMPACT

Use of Remote Sensing and Geographic Information Systems to Predict Locations of *Anopheles darlingi*-Positive Breeding Sites Within the Sibun River in Belize, Central America

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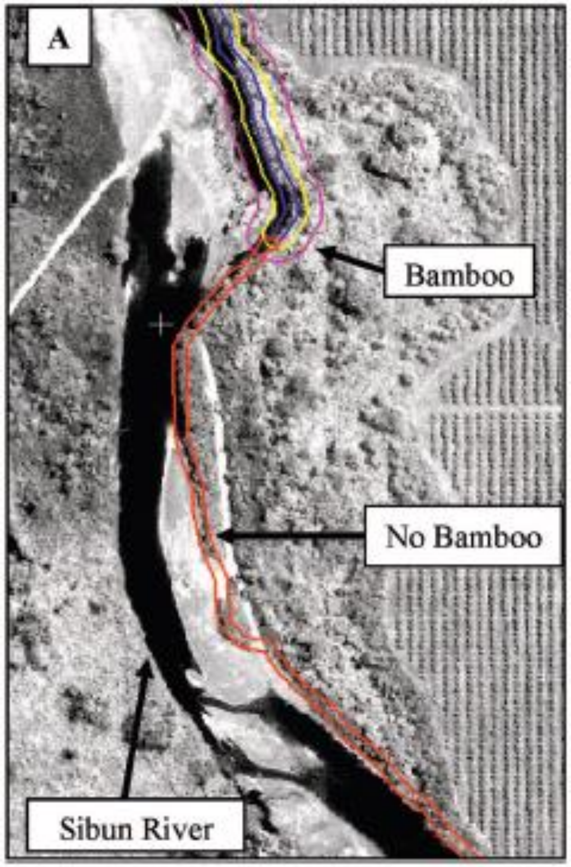

J. Med. Entomol. 43(2): 382–392 (2006)

to be made up of forest land cover (Table 5). Evaluation of the confusion matrix indicated a 75.9% accuracy rate by which all land cover categories were classified. Bare ground, forest, and pasture/low grass land cover categories had the highest accuracy rates with 98.8, 97.0, and 94.9% of the pixels being correctly classified, respectively. The orchard and sandbar land cover classes suffered from the worse classification confusion, with 58.8 and 58.6% of the pixels, respec-

Collaborative Project Goals

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1) Develop a image analysis workflow that can identify mosquito breeding habitats

2) Evaluate efficacy of our model with real-world validation

3) Determine public health impact with arboviral surveillance

Project Overview

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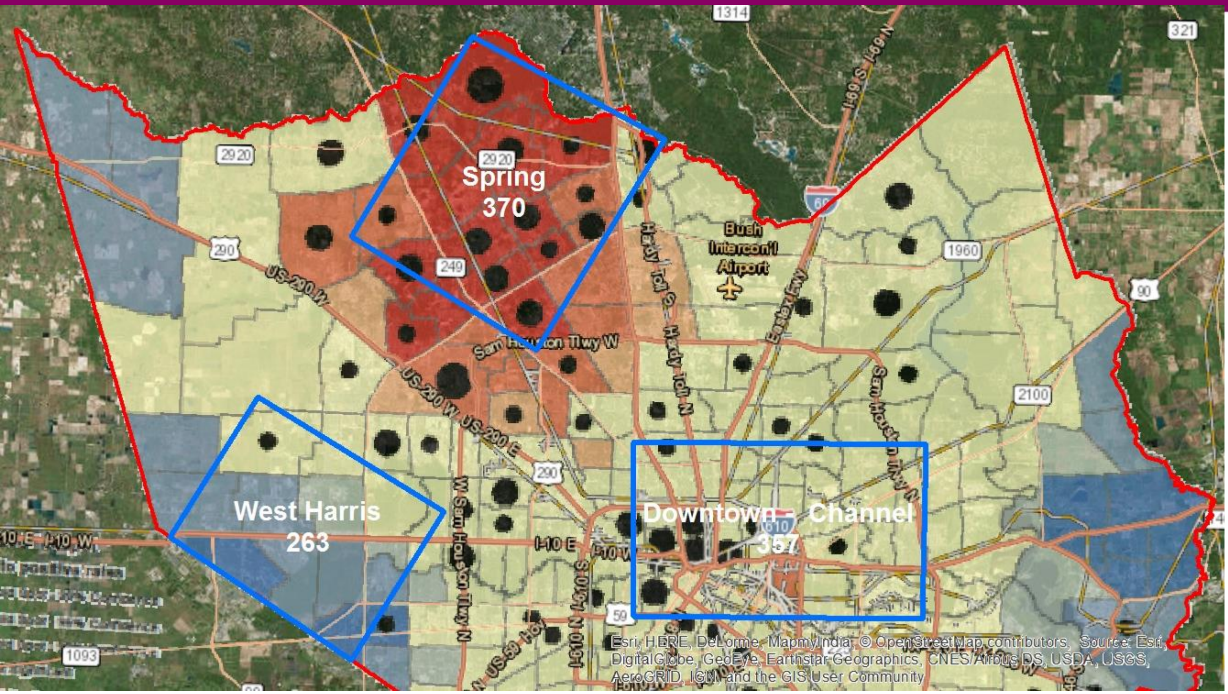
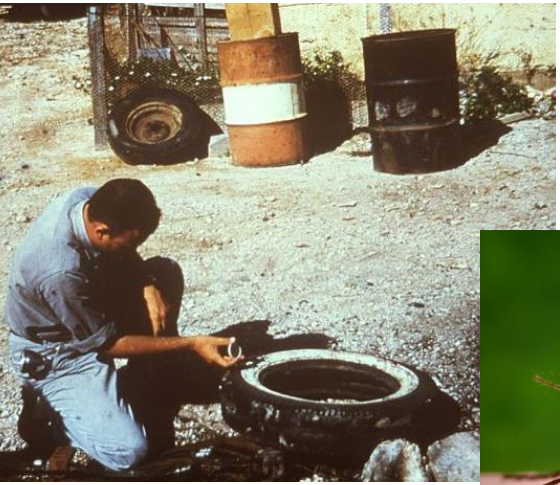


Spring– 370 sq.km.: High WNV + mosquito & High WNV+ human incidence 2014

West Harris – 263 sq.km.: "control" area, Low WNV+ mosquitos & human cases

Downtown/Ship Channel– 357 sq.km.: Mixed use areas (industrial & residential) which should provide a widest range of habitats



Phil.cdc.gov

Satellite Imaging Provider Selection

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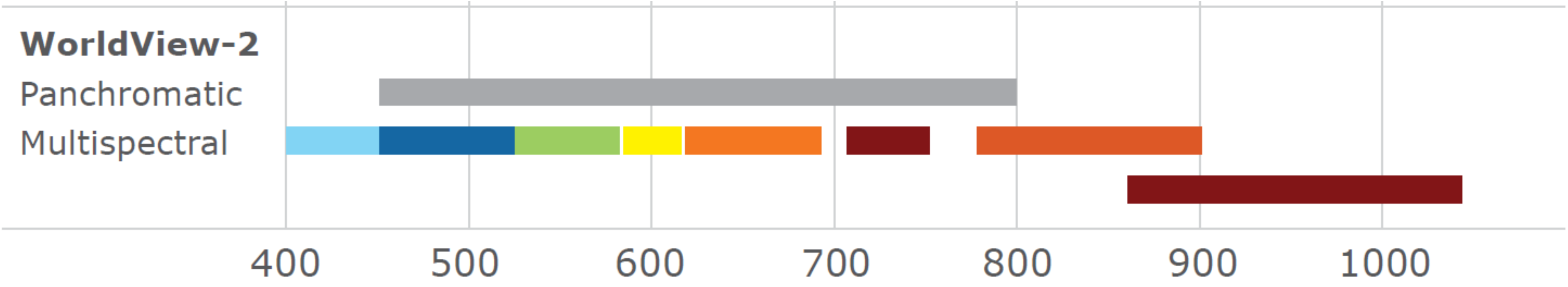
Satellite	Pixel Size (m)	# pixels that fit into a single Landsat-8 pixel	Number of Bands
WorldView-3	0.31	2341.3	16
WorldView-2	0.46	1063.3	8
QuickBird	0.65	532.5	4
SPOT-6	1.50	100.0	4
Sentinel-2	10.00	2.3	13
Landsat-8	15.00	1.0	11



WorldView-2 Image, Post Harvey. Courtesy DigitalGlobe

Image Analysis Workflows

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- **Visual Inspection:**
  - **Abandoned tires**: Look for ‘dark pixels” using automated classification refined by visual inspection of images and spectral readings
  - **OSSF:** look for clustering of permitted systems
- **Color Band Ratios:**
  - Normalized difference vegetation index (NDVI) to find areas with a high density of healthy vegetation
  - Normalized difference water index (NDWI) to find areas with standing water
- **Image Classification “object oriented”**:
  - If we know where good habitats for mosquito growth exist, we can use pixels from specific components of those habitats to predict where similar pixels exist
- **LIDAR**
  - Find roadside ditches and classify by depth

Mosquito Life Cycle

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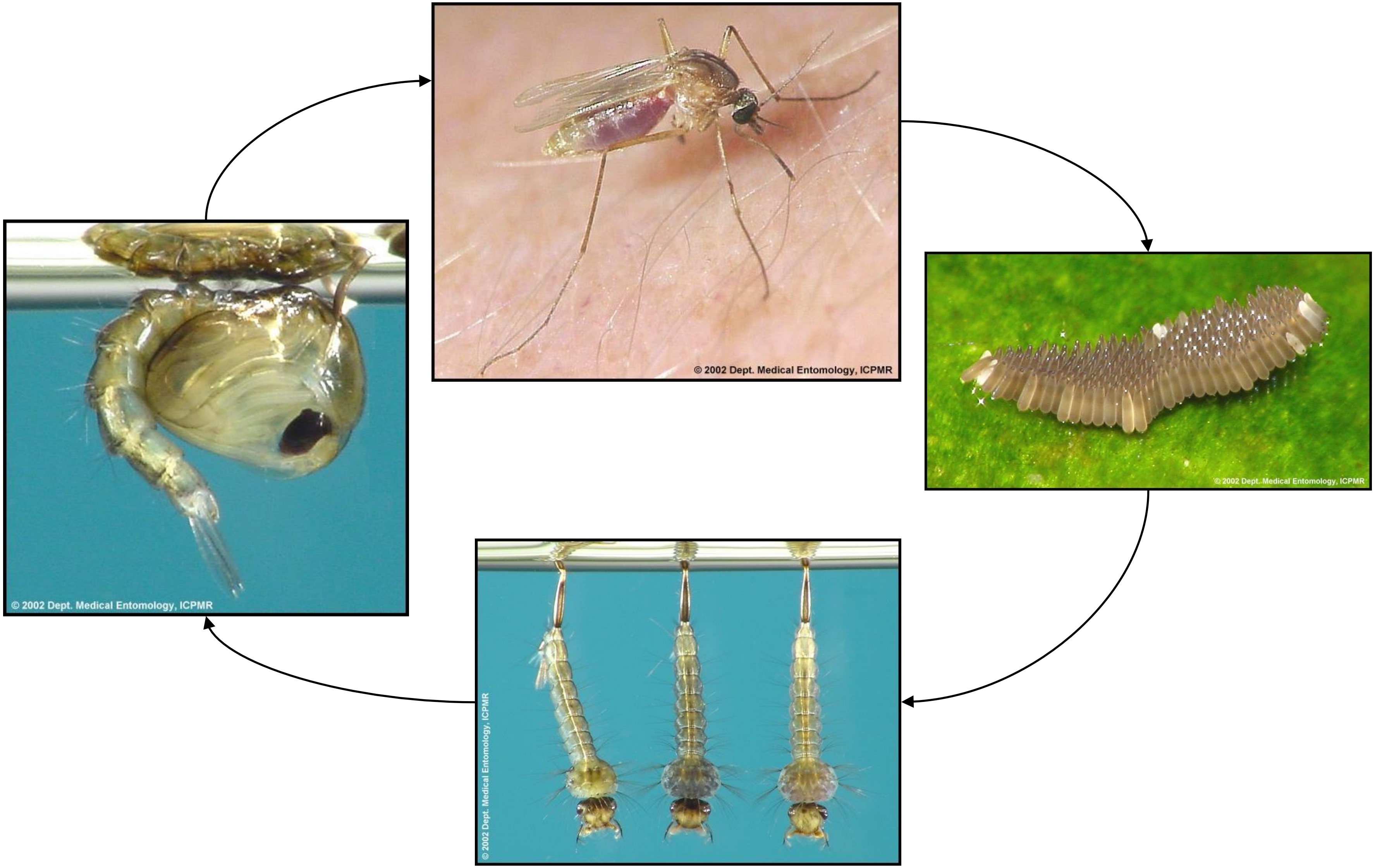

Department of Medical Entomology, University of Sydney and Westmead Hospital, Australia

Mosquito Breeding Habitats & Model Identification Plan

Culex quinquefasciatus

1. Drainage ditches
2. Septic leaks
3. Manhole covers
4. Vegetated stagnant water

Mosquito Breeding Habitats & Model Identification Plan

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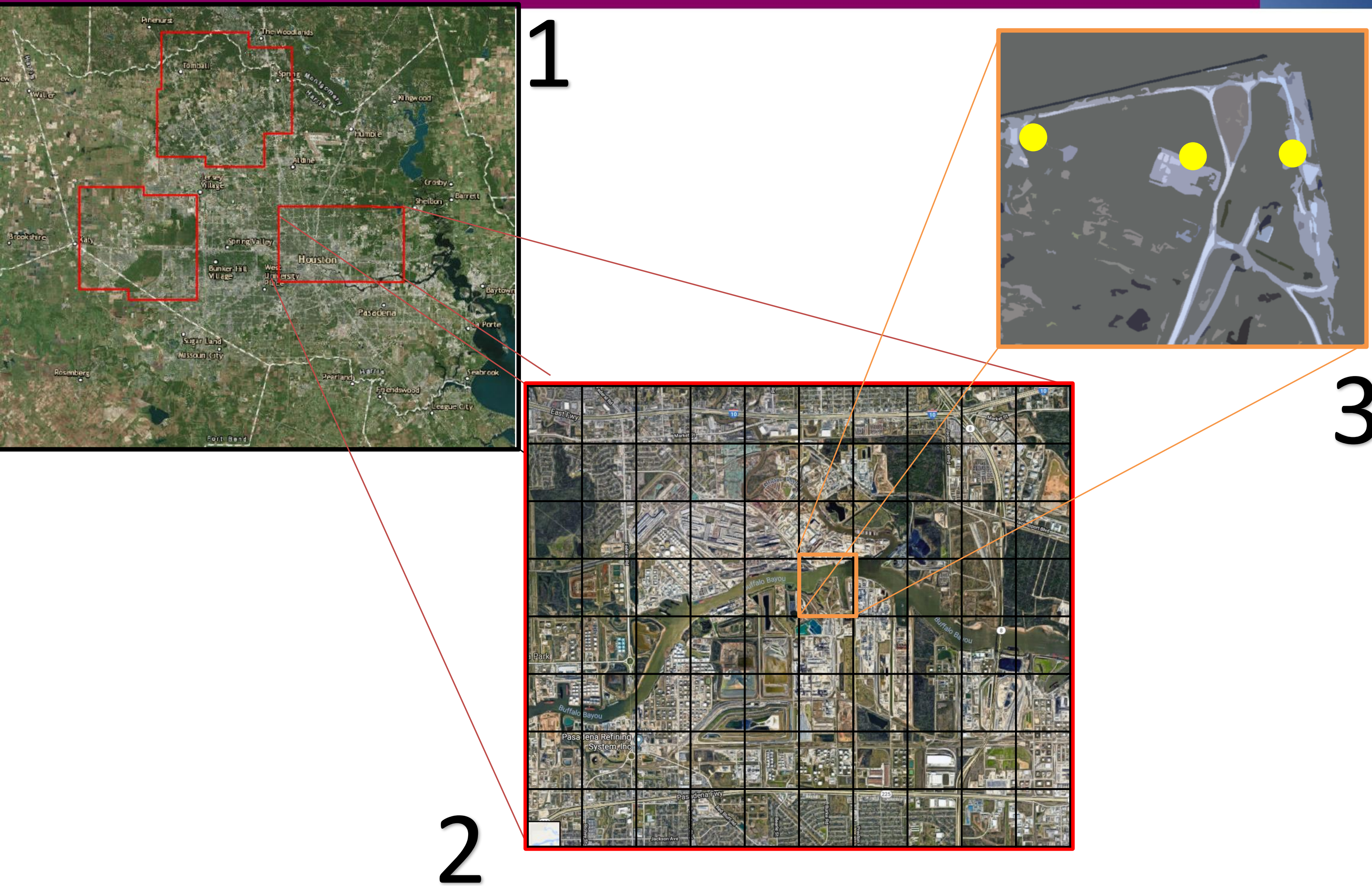
Aedes aegypti & A. albopictus

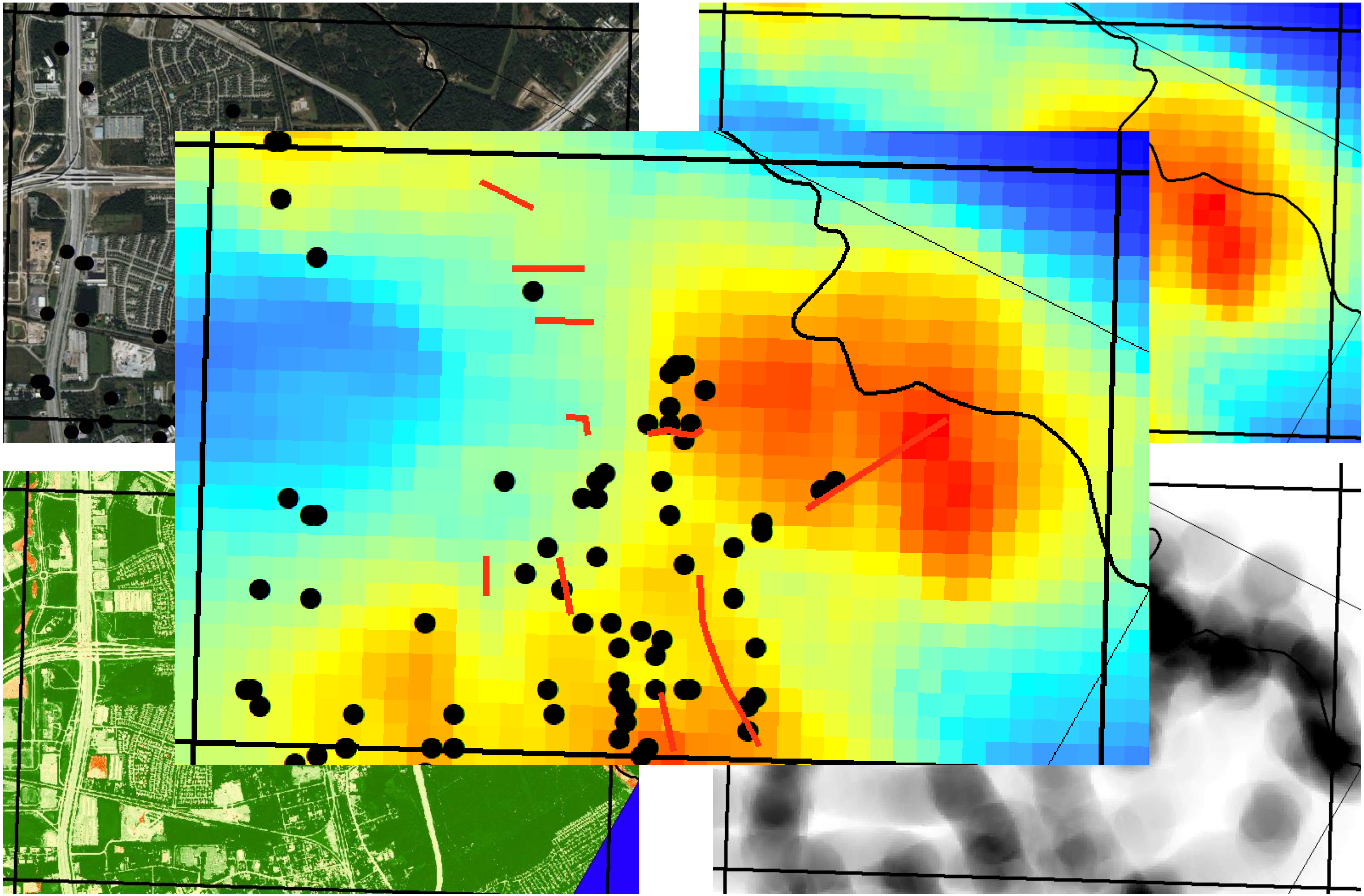
1. Tire grouping-*ASDI HandHeld2 spectroradiometer*
2. Trash/container index (junk)
3. Construction sites- *master plan communities*
4. Industrial yards
5. Cemeteries

Google Images 2018

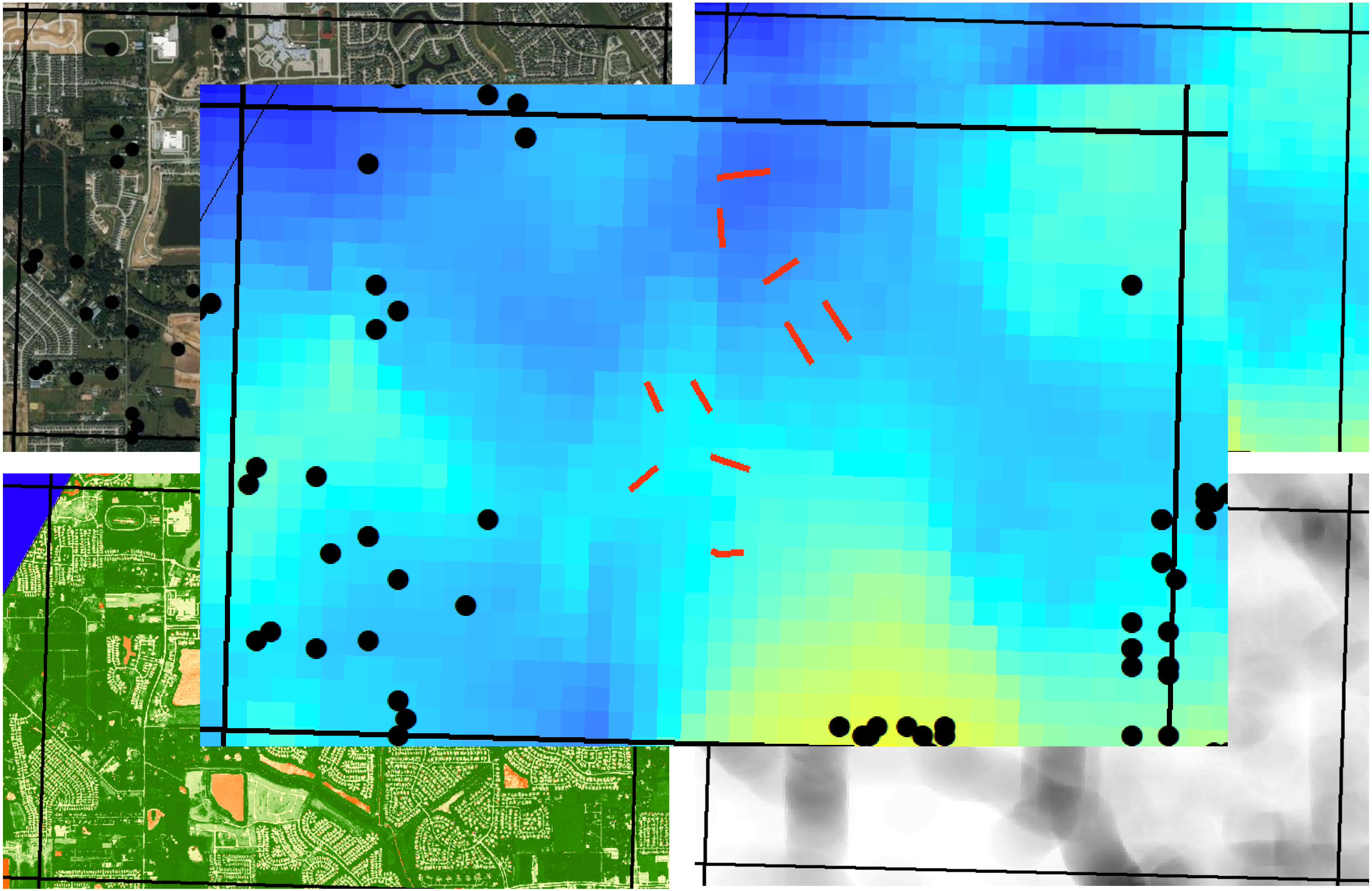
Public Health Relevance



Trap Locations



Trap Locations



Future Directions

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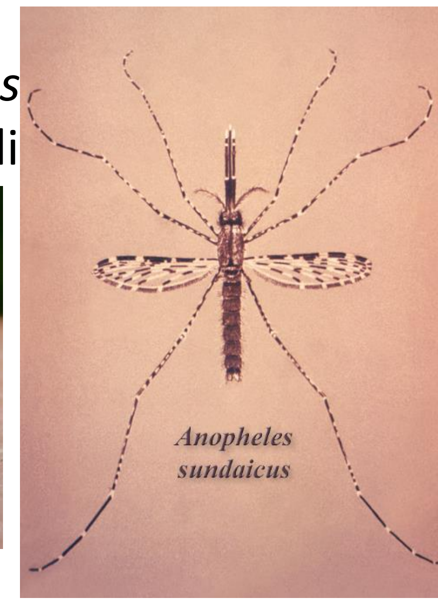
- **Refinement of Mosquito Breeding Habitat Model**
  - *Integration of Dog Detection as a Validation Measure*
  - *Artificial Intelligence (Neural network analysis), LiDAR data, Texture filters*

- **Habitat Prediction Models and Potential Applications**
  - Afghanistan/Iraq Sandfly (Leishmaniasis)-DoD
  - Africa *Anopheles* sp. Mosquito (Malaria)-Gates
  - Integrated Vector Management for *Aedes*, *Culex*, and *Ixodes* (Zika, Dengue, Chikungunya, West Nile, and St. Louis Encephali viruses, and Lyme disease)-NIH



CDC Public Health Image Library phil.cdc.gov

Acknowledgements

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