PROJECT TITLE: Controlling the invasion and spread of *Aedes albopictus* in the Los Angeles Basin

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PROGRESS REPORT FOR YEAR 1 (2012)

BACKGROUND AND SIGNIFICANCE (see more detailed background in year 2 proposal)

Aedes albopictus is a vector of global health concern because it bites humans and is a competent vector of many arboviruses, including dengue, West Nile virus, and chikungunya[1]. This species invaded California repeatedly during the last four decades[2, 3, 4, 5], including a recent infestation detected during late 2011 in the El Monte and South El Monte area of Los Angeles County, and it has already established populations in similar climates in southern Europe [6, 7, 8, 9, 10]. This project focuses on development of spatial models that simulate adult mosquito reproduction and movement between locations, aspects that are particularly important for targeting control of *Ae. albopictus* or other invasive species because of the potential for spread beyond the containment area or repopulation from neighboring areas following successful local control [11]. In this progress report, we focus on our work during 2012. More detailed background and justification for the work are presented in our proposal for year 2.

GOALS AND OBJECTIVES

This project uses dynamic modeling to inform the ongoing response to this invasion, with the following objectives:

1. Enhance our initial model to include realistic mosquito biology;
2. Estimate the likely time since *Ae. albopictus* was introduced and expectations for future spread based on modeled spread rates and local districts' collection data;
3. Compare the efficacy of larval and adult control measures for containment and eradication of *Ae. albopictus* or other invading container-breeding mosquitoes.

PROGRESS, 2012

This project overlaps 2012 and 2013, and is proposed to run from summer 2012 through 9 months (2 academic quarters and summer) of 2013 as originally proposed. During June 2012, C. Barker and M. Danforth visited SGVA and GRLA to discuss the project's goals and visit the sites of infestation. From the tour of known *Ae. albopictus* habitats, it was clear that predicting the receptivity of individual real estate parcels for this species would be a challenge when applied in a broad-scale model. In the 4 months since the visit, we have focused our efforts on 2 areas that accomplished project **Objective 1** to enhance our preliminary model to include realistic mosquito biology. These were: **(1a)** to define spatial factors that could affect the spread of Ae. albopictus to new locations, and **(1b)** to construct a model that represents the aquatic development and adult female reproductive cycles, as well as their movements between residences.

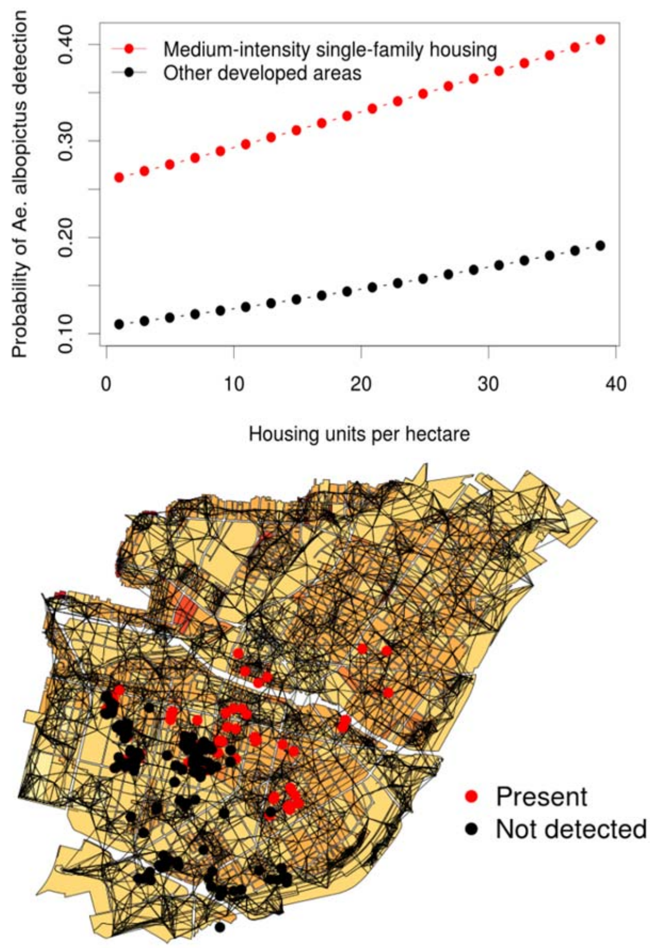

Fig. 1. Top: Modeled probabilities of finding Ae. albopictus at a house based on housing density and land cover. **Bottom:** Mapped probabilities of Ae. albopictus detection for El Monte and South El Monte, overlaid with a movement network with links indicating possible pathways for movement between census blocks.

1a. Spatial factors affecting spread.

The extreme number of real estate parcels, even in the affected cities of El Month and

South El Monte (approx. 26,000 parcels), make this fine scale computationally impractical for model development. As a result, we have focused on census blocks (generally equivalent to city blocks), which allowed us to use underlying data from the US census on housing and population density, demographics, and socio-economic status. We have considered several possible models and selected the best-fitting model for the probability of *Ae. albopictus* occurrence based on the available collection data from SGVA and GRLA, combined with census demographic data and land use at 30-m resolution (http://mrlc.gov). Graphical and mapped model predictions are presented in Fig. 1 above.

1b. Modeling spatial and temporal dynamics.

At the start of the project, we developed a spatial simulation model using realistic spacing of real estate parcels in Los Angeles County. This model reasonably reproduced the results of mark-recapture studies over a similar one-week time period [12, 13]. During the past few months, we have redefined a more realistic model for movement that allows for mosquito reproduction as they move, alternately laying eggs and seeking hosts[14], because these behaviors and the development and emergence of offspring will affect the potential for the mosquitoes' spread. We have employed the matrix modeling approach described by Caswell[15], in which movements are evaluated daily and space is divided into discrete units (city blocks) to which mosquitoes may move. Movement of *Ae. albopictus* among city blocks is defined by proximity of the blocks (closer = more likely) and the "receptivity" of each block defined by our spatial modeling of the districts' collection data described in section 1a above. Reproduction is also included in the model, with egg-laying frequency defined by the length of the gonotrophic cycle.

Fig. 2. Single model simulations over 4 weeks based on introduction of a container with 20 female eggs (left panel) or a single female adult *Ae. albopictus* (right panel). The colored regions show the extent of the infestation at 1-week intervals following the introduction.

All events in the model are defined by biological parameters, with realistic random variation in reproduction and movement based on probability distributions informed by the parameters. This randomness adds to the realism and allows us to evaluate the probabilities of establishment under various scenarios for introduction via containers or transport of individual adult mosquitoes (e.g., Fig. 2). Because of the random nature of mosquito survival, the model shows that many introductions of single adults fail to establish and introduction of an egg batch via a single container results in much higher probability of spread. We are continuing to evaluate these scenarios, and results for Objective 1 will be presented at MVCAC's annual meeting. This model will form the basis for achieving the remaining surveillance and control-oriented objectives presented in our separate proposal for year 2 (2013).

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