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OPERATIONAL NOTE

TO CATCH A TIGER IN A CONCRETE JUNGLE: OPERATIONAL CHALLENGES FOR TRAPPING *AEDES ALBOPICTUS* IN AN URBAN ENVIRONMENT

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ABSTRACT. We have been using BG-Sentinel™ (BGS) traps to monitor populations of *Aedes albopictus* as part of an area-wide project for management of this species. Although BGS traps are very effective for collecting adult *Ae. albopictus*, the device is expensive and must be properly maintained to be effective. The trap also poses a challenge for mosquito control personnel because secure locations free from the risk of vandalism or pet damage during surveillance efforts are scarce. Additionally, acquiring access to private property or finding suitable shaded habitats to place traps can be difficult. Here we summarize a protocol for BGS trap surveillance of *Ae. albopictus* in a highly urbanized environment during an active mosquito season.

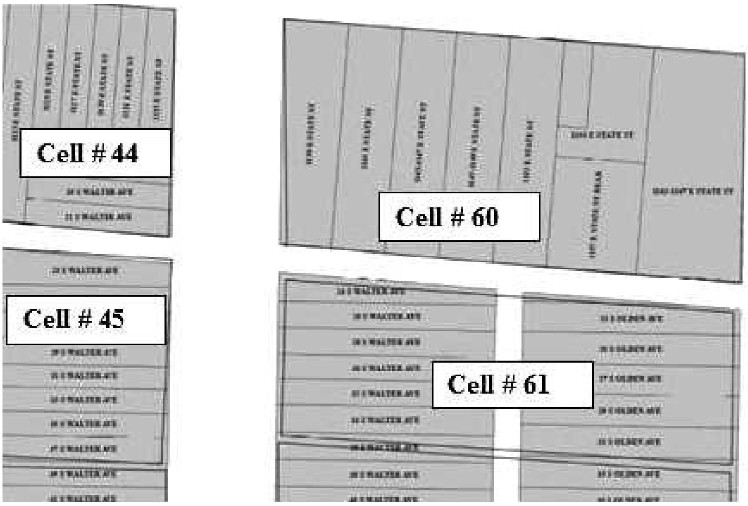
KEY WORDS BG-Sentinel™ trap, trap placement, surveillance, New Jersey

Aedes albopictus (Skuse) is highly invasive and a major concern for mosquito control personnel because it 1) adapts quickly to peri-domestic environments, 2) poses a threat to public health as an efficient vector of arboviruses (Gratz 2004), 3) thrives in artificial containers that are ubiquitous throughout its range, and 4) is not readily collected efficiently in conventional traps used in mosquito control programs.

The New Jersey light trap (NJLT) has long been considered the gold standard for monitoring adult mosquito populations (Slaff and Crans 1979). In the 1960s the Centers for Disease Control and Prevention (CDC) miniature light trap was also developed as a highly efficient trap for collecting host-seeking female mosquitoes (Sudia and Chamberlain 1962). The standard NJLT and the CDC miniature light trap have been widely used for arbovirus surveillance in the USA for several decades (Reiter 1983). The NJLT and the CDC miniature light trap are not effective at trapping *Ae. albopictus* for 2 reasons. First, the species is diurnal and is not attracted to the light sources from these traps. Second, these traps are usually placed at least 1.5 m above the ground and *Ae. albopictus* primarily seeks hosts at ground level (Robertson and Hu 1935). Reiter (1983) introduced a portable, battery-powered gravid trap, which is also utilized by mosquito control programs nationally. However, gravid traps do not capture significant numbers of *Ae. albopictus* (Farajollahi et al. 2009), because the highly organic hay or grass infusion that is used to attract ovipositing females is not effective for *Ae. albopictus*, which prefers less eutrified larval habitats. Although light and gravid traps capture small numbers of *Ae. albopictus* (Farajollahi et al. 2009), substantially more individuals are necessary to accurately assess population sizes or distribution. The recent invasions, range expansions, and reemergence of *Ae. albopcitus* has created a high demand for an efficient surveillance trap to assess population dynamics of this species and gauge the efficacy of control strategies.

The BG Sentinel™ (BGS) trap (Biogents AG, Regensburg, Germany) was originally designed to capture *Aedes aegypti* (L.) (Krockel et al. 2006). The BGS trap uses contrasting black and white colors and a human scent lure (BG-lure) to attract *Ae. aegypti* and other diurnal species like *Ae. albopictus*. This trap has been effective at trapping temperate populations of *Ae. albopictus* (Farajollahi et al. 2009), and has proven useful in residential areas (Unlu et al. 2011, Fonseca et al. 2012). However, other difficulties within heavily populated areas may exist when conducting surveillance, and we hope to categorize those topics and provide suitable recommendations. Some issues include selecting a site for initial trapping, access to trapping location, security of trapping location with respect to vandalism by humans or damage by animals, safety of mosquito inspectors in trapping areas, atmospheric conditions such as heavy rain, and lack of shaded habitats in heavily urbanized and socioeconomically depressed areas.

To expedite selection of trapping locations during an area-wide project for suppression of *Ae. albopictus* in 2008 (Unlu et al. 2011), we selected 4 sites (3 in the city of Trenton and 1 in Hamilton Township) for surveillance. These sites were chosen because of past requests for service related to *Ae. albopictus* and abundance during routine disease and nuisance surveillance. Each site was approximately 0.6 × 0.6 km and they were at least 0.5 km apart, which also included about 1,000 individual parcels (Unlu et al. 2011).



Target cell #s for the week	Backup cells
2	56
45	98
105	73
21	
89	
16	
19	
133	
9	
55	

Fig. 1. An example of a map (a close-up of a target cell for trapping, 9 maps per site, 36 maps per week) provided to Mercer County field crews in order to accomplish the set trapping protocol for each week. The 1st 9 randomly generated numbers (using Excel) were selected per each site and assigned as trapping locations.

Each established site was separated into grid cells using natural boundaries and assigned a unique identification number (Fig. 1). The mean number of parcels in each cell was estimated with aerial imagery and a parcel layer in ArcMap 9.2™ (ESRI, Redlands, CA). We sampled randomly and weekly across a predetermined grid of cells that included several parcels (residential home and accompanying yard). This protocol allowed us to utilize the BGS traps within the entire sampling site and estimate the abundance of *Ae. albopictus* in each study site. Each week, we used an Excel™ (Microsoft® Office 2007, Mountain View, CA) random number generator to select cells for sampling (Fig. 1). The 1st 9 randomly generated numbers were assigned to trapping locations at each site (4 sites $\times$ 9 traps). The number of available traps determined how many cells were sampled each week within each site. The cells were displayed on the parcel layer so an address for each parcel and features (e.g., roads, schools, and parks) that served as visual limits for the trapping location and cells could be properly identified by field crews (Fig. 1). The method of predetermining trapping site locations outlined above allowed our inspectors to locate trapping sites and alternatives quickly and accurately.

Access into residential parcels to deploy traps in urban environments is often difficult because residents are not home during the day, parcels are locked or gated, residents own guard dogs or others pets, or residents are apathetic toward government employees; parcels may be abandoned and pose physical structural hazards or harbor free-range humans who may be squatting within the plot. Based on these issues, we acquired permission from residents before BGS traps were placed. This required gaining permission from at least 36 residents each week. A notice with a detailed explanation about our surveillance efforts and contact information was placed for residents who were not home during the pretrapping site visit. We experienced a low rate of refusal (<5%) in the city of Trenton. To increase contact with residents who may have been at work between 7:30 a.m. to 3:30 p.m., 2 of our staff worked from 4:00 p.m. to 8:00 p.m. Residents were also asked to leave their property unlocked and to keep pets indoors during the sampling period. Although compliance was high, if residents did not grant us permission, another nearby parcel was quickly chosen. Social apathy or refusal based on government affiliation was not a major concern during our surveillance (Bartlett-Healy et al. 2011). In general, residents welcomed attention in lower socioeconomic areas. In fact, several residents became interested in the project and regularly asked about the mosquito counts in their own yards and community. Abandoned parcels posed an issue during our investigations. Neglected and vacant parcels often were dangerous for field crews because of falling structures and other physical hazards, and high rates of squatting by free-range humans increased the rates of trap vandalism. To avoid losing data and expensive BGS traps (>US$300 in 2008), we placed traps only within occupied parcels.

Heavily urbanized locations may have less shaded habitats compared to suburban neighborhoods. Most mosquitoes avoid direct sunlight and wind, so BGS traps should be placed in shaded and sheltered areas (Biogents 2012). Temperature and humidity also affect success, so if a parcel did not have a suitable location for trap placement, an alternative parcel was used. If a parcel did not include shade from vegetation, we often placed traps in shade created by infrastructure such as an

Fig. 2. Placement of BG-Sentinel (BGS) traps within urban habitats. (A) A BGS trap is placed within close vicinity of the only shaded and vegetated habitat available within a typical urban backyard; (B) placement of a BGS trap within the backyard of a shaded and protected alcove between 2 adjoining row homes. Note abandoned and boarded up residential home on the right.

alcove between adjoining duplexes or row homes (Fig. 2). Additionally, because the BGS trap attracts *Ae. albopictus* visually as well as with the lure during operation (Farajollahi et al. 2009), we did not cover the trap (from rain) during sampling. Traps were operated weekly for 24-h periods, depending on weather conditions. On the whole, mosquito inspectors located suitable shaded habitats within most preselected parcels and rainfall did not affect trapping surveillance (Fig. 2).

In summary, we achieved and maintained a successful surveillance program using BGS traps in the heavily urbanized areas of Mercer County. Residents of these urban sites were heavily afflicted by biting populations of *Ae. albopictus* and were ecstatic that surveillance and control measures were being implemented. In general, residents were very supportive of mosquito control personnel and provided logistic assistance and access. Without this understanding and compliance, locating suitable places for our trap locations would have been very difficult. No safety related incidents were reported by any member of our crews during the course of these investigations. It was essential to maintain good public relations during surveillance efforts, because BGS traps should be located within private property for safety and easy access. During the initial weeks of our investigations, 3 BGS traps that were placed in public access alleys were vandalized or stolen, resulting in a substantial loss of property and data.

Aedes albopictus is a very aggressive daytime biter that has been a major problem in urban areas of Mercer County since 2003 (Farajollahi and Nelder 2009). Mosquito control personnel did not possess an effective trapping device to survey this species before the BGS traps were commercially available. Although this trap is expensive and needs routine maintenance, it does provide very important information on *Ae. albopictus* population dynamics. Integrated mosquito management relies on abundance and distribution data, which determine thresholds for action and gauge the efficacy of control measures. The simple recommendations outlined above will enable vector control agencies in urban environments to implement an effective surveillance program for *Ae. albopictus*.

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