USE OF CENTERS FOR DISEASE CONTROL AND PREVENTION GRAVID TRAP IN CATCH BASINS: PROOF-OF-CONCEPT TRIALS

NICHOLAS MILLER,¹ ROBERT C. METTELMAN,¹ SUSAN C. BAKER¹ AND JUSTIN E. HARBISON²,³
OPERATIONAL NOTE

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ABSTRACT. Gravid traps are commonly used by mosquito control agencies to collect local populations of Culex pipiens, which are then tested for the presence of West Nile virus. Culex pipiens adults disperse a relatively short distance (~2.5 km) from their breeding site, so it can be challenging to position a sufficient number of gravid traps to accurately monitor these mosquitoes in large urban areas. As placement of these traps is often limited to locations out of public view, the potential for placing these traps belowground in commonly found storm-water catch basins was investigated. We compared the numbers of mosquitoes isolated in the Centers for Disease Control and Prevention (CDC) gravid traps placed aboveground with various types of CDC gravid traps placed in nearby catch basins. We found that the gravid traps placed in catch basins collected significantly fewer Culex pipiens females as compared to the aboveground traps. However, the 2 types of catch basin traps continued to function and collect mosquitoes despite heavy rainfall and runoff, demonstrating their utility for sample collection in an urban setting. The potential advantages and disadvantages of using catch basins for the placement of CDC gravid traps are discussed.

KEY WORDS Gravid trap, catch basin, mosquitoes, Culex pipiens

Trapping of gravid mosquitoes is a common method employed by mosquito control agencies nationwide to monitor local populations of Culex pipiens L. complex (Reiter 1983) and collect samples for subsequent West Nile virus testing. A challenge in monitoring these mosquitoes is that they tend to disperse only a short distance (~2.5 km) from their larval habitat (Hamer et al. 2014) and as such, a greater number of gravid traps are needed to accurately estimate local populations across larger operational areas. However, placement of gravid-mosquito traps in urban areas is generally limited to locations out of public view to prevent tampering or disturbance. As a result, many agencies tend to locate their traps in more secluded and/or wooded areas of public parks and other right-of-way facilities instead of placing them within residential areas (e.g., next to single- or multi-family dwellings) that may ultimately provide a better estimation of human infection risk. Because storm-water catch basins are commonly found within residential areas (often only meters from residences), they are sources of Cx. pipiens, and provide isolation from potential tampering, it was desired to test the function of gravid traps placed within these structures. This concept of using catch basins to increase trap density and enhance disease surveillance in urban areas is not a new one; a similar methodology was employed by Anderson et al. (2006). This group placed Centers for Disease Control and Prevention (CDC) miniature light traps baited with dry ice in catch basins in Connecticut and determined that nearly 60% of collected females were gravid. Therefore dry-ice baited CDC miniature light traps can, in a sense, be considered to be “gravid traps” in situations where these predominately collect gravid females.

However, the use of dry ice as a trap attractant varies among mosquito control agencies, as this resource must be regularly purchased throughout a mosquito season, often on a weekly or biweekly basis. As many agencies already use standard gravid traps, such as the CDC Gravid Trap Model 1712, and have the supplies necessary to create their attractant-infused water it may be more straightforward to modify existing catch-basin traps (i.e., CDC miniature light traps) to utilize attractant water instead of dry ice. We therefore sought to determine if the use of liquid attractant-based traps housed within catch basins could 1) capture gravid Cx. pipiens and 2) continue to function with the inflow of runoff into these basins.

All trials were conducted from June to October 2014 on the Loyola University Chicago Health Sciences Campus in Maywood, IL, located approximately 16 km (10 miles) west of downtown Chicago. Two models of mosquito traps were evaluated for use in catch basins as gravid-mosquito traps: the rug-edized storm sewer light trap (Model 519.55, John W. Hock Company, Gainesville, FL) and the CDC gravid trap (Model 1712, John W. Hock Company, Gainesville, FL). The liquid attractant used in all trials was made by fermenting 280 g of alfalfa (Kay-tee Supreme Fortified Daily Blend Rabbit Chow, Chilton, WI) per 75 liters of water for 6–10 days. All traps were placed within 370 m of each other and collections were made 1 to 3 times per week for collection periods of 24–72 h. All captured mosquitoes were identified to species and the female gonotrophic status (i.e., gravid) was determined.

1 Department of Microbiology and Immunology, Loyola University Medical Center, 2160 S First Avenue, Maywood, IL 60153.
2 Department of Public Health Sciences, Loyola University Medical Center, 2160 S First Avenue, Maywood, IL 60153.
3 To whom correspondence should be addressed.
Initially, trials began in the 1st week of June. Three light traps were hung belowground from the underside of the circular manhole grate of 3 catch basins (approximately 112 cm [44 inches] diam and 229 cm [60 inches] deep) located in the turf landscaping or in a parking area of the campus. Additionally, 3 Model 1712 gravid traps were placed aboveground next to 3 separate buildings for use as controls to assess whether gravid females were seeking oviposition sites in the area. In these 1st trials no modifications were made to any traps and all traps were run utilizing only their designed attractants (belowground traps using light, and aboveground traps using liquid attractant). After 1 wk, a total of 12 *Culex pipiens* females were collected in all aboveground traps and no mosquitoes were collected in the belowground traps. Belowground light traps were then modified to incorporate liquid oviposition attractant by attaching 3 plastic petri dishes (100 mm diam × 13 mm deep) containing liquid attractant to the top of each lid. Following a 2-wk trial using this design, the aboveground traps collected 41 *Cx. pipiens* females while the belowground (petri dish) traps collected only 2 females.

In the 3rd iteration of trials, 5 perforated 50-ml conical tubes were filled with the liquid attractant and were attached to the lid of each light trap. These modifications were made to reflect the trap design employed by Dees et al. (2012). The “test tube modification” was tested for 1 wk during which time the aboveground traps collected a total of 176 *Cx. pipiens* females and the belowground traps collected none. Because light traps placed within the test catch basins captured few to no female *Cx. pipiens*, these traps were removed from further evaluation. No statistical analyses were performed on the data generated from these 3 sets of trials as belowground light traps collected so few mosquitoes in relation to the aboveground traps.

For the final set of trials, one Model 1712 gravid trap was left aboveground, one was placed in a catch basin (approximately 120 cm deep) that was designed to quickly drain runoff and thus remained dry during trials, and one modified to float was placed in the water captured in the sump of another catch basin (Fig. 1). This floating gravid trap was developed by removing the attractant pan and attaching the updraft fan and net portion to the top of a 5-gallon plastic bucket with bungee cords. A ring of 2-cm-thick expanded polystyrene (Insulfoam, LLC, Mead, NE) was glued to the top outer perimeter of the bucket to stabilize the trap and prevent spilling and the liquid attractant was placed within the bucket. This design was similar to the belowground ovitraps used in Harbison et al. (2010, 2011), although these did not have adult traps attached to the tops.

Sampling began in the 3rd week of July and extended over 12 wk into October. Over this sampling period a total of 20 collections at 24- to 72-h intervals were taken. All traps were turned off and left in their respective locations when not collecting. Over this time period, the Model 1712 gravid trap placed aboveground captured a total of 331 *Cx. pipiens* females (233, or 70.4%, gravid), the trap placed in the dry catch basin captured 62 (36, or 58.1%, gravid), and the trap floated in sump water captured 44 (23, or 52.3%, gravid; Fig. 2). Using a 2-sample *t*-test, we determined that the aboveground trap collected significantly more *Culex* females per day (\( \bar{x} = 11.16, SD = 6.78 \)) than either the trap placed in the dry basin (\( \bar{x} = 1.94, SD = 2.41, t = 5.72, df = 37, P < 0.001 \)) or the trap floated in sump water (\( \bar{x} = 1.23, SD = 1.81, t = 6.18, df = 36, P < 0.001 \)). No significant difference was observed between the trap in the dry basin and the floated trap (\( t = 1.04, df = 37, P = 0.3 \)). Precipitation data were collected from a nearby weather station of the National Oceanic and Atmospheric
Administration Weather Service Forecast Office located at the Chicago O’Hare Airport, IL. During the 83 days encompassing this final trial, it rained 29 days for a total of 29.87 cm and a single-day high of 7.01 cm. Precipitation during August and September of the trials was the highest observed during the past 5 years.

Both belowground traps continued to collect mosquitoes and function normally despite relatively heavy and consistent rainfall and associated runoff directed into basins. Therefore, the risk of belowground trap disturbance as a result of runoff may be negligible. Compared to the belowground traps, it is clear that the CDC gravid trap placed aboveground was a more effective method of attracting and capturing gravid \textit{Cx. pipiens} females. It is unknown whether this difference may be due to site-specific differences unrelated to the trap function, as each of the 3 traps were evaluated in a single unique location. As the floating bucket did not incorporate the wider black plastic basin that is typically part the CDC gravid trap, this design may have hindered the approach of ovipositing mosquitoes. Reiter (1983, 1987) emphasized the need for ovipositing mosquitoes to have an open approach to the liquid attractant and, in general, this may be a significant challenge when placing any kind of gravid trap design belowground as gravid females must navigate through grates into the confined space of the catch basin.

However, ovitraps placed in approximately 30 belowground storm-water sumps in Southern California (Harbison et al. 2010, 2011) generally collected low numbers of \textit{Cx. quinquefasciatus} Say egg rafts (daily mean of 5 or less), suggesting that females of this species complex may preferentially oviposit aboveground and/or have difficulty detecting olfactory cues from the liquid attractant belowground. Additionally, the use of the bucket as a substitute for the standard Model 1712 liquid attractant tray may have limited mosquito access in comparison to the unmodified Model 1712 traps placed aboveground and in the dry catch basin. More study is needed to clarify the potential for buckets to limit mosquito access as no difference was observed between both belowground traps (one using a bucket and one with the standard tray) in these trials.

As the objective of these proof-of-concept trials was to determine if liquid attractant gravid traps could function in belowground catch basins, the use of CDC gravid traps within these structures does appear to be a potential option for mosquito control agencies. Although collections were comparatively lower than in aboveground traps, our study provides experimental evidence demonstrating the utility of a belowground mosquito sampling method that allows for a more broad collection area and increased West Nile virus surveillance in an urban setting.

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