

# SALT LAKE CITY MOSQUITO ABATEMENT DISTRICT

## Executive Director's Report

January 2024

### 1. Personnel:

Personnel	
Staff	Seasonal
12	4

Type of Work	2024	3 - Year Average
Adulticiding	0.00	0.00
Wetlands / Rural	5.00	0.67
Fish Culture	25.25	32.83
Catch Basins / Gutters	0.00	0.00
Tree Holes	0.00	0.00
Prison	0.00	0.00
Service Request	0.00	0.00
Traps	0.00	27.33
Laboratory	357.25	162.92
Office / Administration	816.50	665.25
Equipment Maintenance	210.50	227.17
Facility Maintenance	65.75	147.75
Training	25.00	31.00
Education	78.00	17.83
Unmanned Aerial System	14.00	0.67
CSU Grant	170.50	0.00
Other Grants	0.00	0.00
Other / Errands	76.50	137.17
Comp. Time Used	217.75	109.67
Vacation	287.25	138.67
Additional Hours	0.00	11.83
Holidays	184.00	178.67
Sick Leave	72.25	52.42
<b>Total</b>	<b>2,605.50</b>	<b>1,941.85</b>

### 2. Office Activities:

- Executive Director Faraji met with Dr. Jessica Brown from UU regarding potential collaborations and training of postdocs on 3 January 2024.

- Executive Director Faraji and Assistant Director White attended the weekly Rahp Vec meetings on 3 January 2024.
- Education Specialist Rehbein created a LinkedIn page for SLCAMD on 3 January 2024.
- Assistant Director White attended a State Purchasing Pesticide Bid contract meeting on 4 January 2024.
- Executive Director Faraji and Assistant Director White conducted their annual SLC International Airport badging requirements on 5 January 2024.
- Laboratory Director Bibbs assisted Dr. JR McMillen from TTU on mosquito husbandry on 5 January 2024.
- Assistant Director White and Education Specialist Rehbein met with a representative from Aramak on 4 January 2024.
- Education Specialist Rehbein attended a Primetime Safety webinar with ULGT on 8 January 2024.
- Members of staff met with representative from CoDiagnostics regarding collaborations on 8 January 2024.
- Laboratory Director Bibbs attended a conference call with Dr. JR McMillen regarding mosquito colonies on 9 January 2024.
- Assistant Director White attended a Cross COE CDC call on Insecticide Resistance on 9 January 2024.
- Members of staff attended a weekly Rahp Vec meeting on 10 January 2024.
- Members of staff met with representatives from Pestie Pest Control Solutions on 10 January 2024.
- Executive Director Faraji and Assistant Director White attended the weekly Rahp Vec meetings on 10 January 2024.
- Executive Director Faraji attended a conference call with Mike Banfield regarding grants from Banfield Biologics on 10 January 2024.
- Education Specialist Rehbein continues working on the 100 Year Anniversary newsletter/magazine on behalf of the District.
- Education Specialist Rehbein submitted an application for the Utah STEM Best Practices conference for June 2024.
- Education Specialist Rehbein submitted a presenter application for the Utah Public Health Association conference in April 2024.
- Education Specialist Rehbein attended an onboarding call with Executive Director MacNee from the AMCA as her new Social Media Coordinator role on 12 January 2024.
- Laboratory Director Bibbs attended a conference call with the University of Central Florida regarding an AMCA RF grant on 12 January 2024.
- Laboratory Director Bibbs attended a video conference call with Igra Saif, a PhD candidate and potential intern from Pakistan on 15 January 2024.
- Members of staff met with and provided a tour to Nate Hill from Valent Biosciences and Larry Heller from Azelis on 16 January 2024.
- Executive Director Faraji and Assistant Director White met with Dick Loomis and Anounou from the Ouelessebougou Alliance regarding the Mali Mosquito Control Project on 16 January 2024.
- Executive Director Faraji, Assistant Director White, CFO Fairbanks, and Trustee Barth conducted interviews for a Financial Advisor on 17 January 2024.
- Executive Director Faraji, Urban Field Supervisor Sorensen, and Assistant Director White attended the weekly Owner/Architect/Engineer meetings on 17 January 2024.
- Education Specialist Rehbein met with Megan MacNee and Hanna Paige from the AMCA regarding social media outreach on 17 January 2024.

- Education Specialist Rehbein participated in Utah's Wasatch 2024 City Nature Challenge meeting that will take place in April on 17 January 2024.
- Education Specialist Rehbein met with Ellen Erickson from the NHMU to discuss upcoming Mosquito DNA Barcoding Workshop on 18 January 2024.
- Laboratory Director Bibbs worked with Dr. Ingrid Chen from UCSF on crowd sourcing repellent ingredients and testing methodologies on 19 January 2024.
- Assistant Director White attended the annual MVCAC conference on 21-24 January 2024.
- Members of staff participated in a field photo shoot for Kuhl clothing gear on 23 January 2024.
- Education Specialist Rehbein met with Nicole Codd, a potential intern, on 23 January 2024.
- Education Specialist Rehbein, Molecular Biologist Byers, and Operations Supervisor Hardman participated in the Reid School Science Fair as judges on 24 January 2024.
- Executive Director Faraji, Urban Field Supervisor Sorensen, and Assistant Director White attended the weekly Owner/Architect/Engineer meetings on 24 January 2024.
- Executive Director Faraji and Assistant Director White attended the weekly Rahp Vec meetings on 24 January 2024.
- Members of staff visited and participated in a tour of the new science buildings at the Waterford School on 25 January 2024.
- Executive Director Faraji conducted his Ogden Airport badging on 25 January 2024.
- Education Specialist Rehbein attended an AMCA Committee Chair meeting on 26 January 2024.
- Education Specialist Rehbein met with Hannah Paige from the AMCA on 26 January 2024.
- Education Specialist Rehbein met with ESA PHEFA intern Gavin Maes on 26 January 2024.
- Education Specialist Rehbein and Molecular Biologist Byers participated in and presented a tour of the District for the NHMU Mosquito DNA Barcoding workshop on 27 January 2024.
- Education Specialist Rehbein and Executive Director Faraji met with Senator Escamilla and staff member Isabella Durham at the Capitol on 29 January 2024 where she co-presented on a mosquito education campaign to members of the Senate.
- Executive Director Faraji and Assistant Director White attended the weekly Rahp Vec meetings on 29 January 2024.
- Education Specialist Rehbein presented a tour of the District to Dr. Rachel Forrest from Westminster University and three of her students from the Environmental Health class on 30 January 2024.
- Members of staff met with Dr. Dan Peach from the University of Georgia regarding collaborations on 30 January 2024.
- Members of staff met with David Nielsen and Moriah Garrison from Carrol-Loye Biological Research regarding wind tunnel experiments on 31 January 2024.
- Molecular Biologist Byers continues work with Dr. Crystal Hepp from AZ, Kristy Burkhalter from the CDC, and Aurelie Kapusta from ID by DNA on various projects during January.
- Laboratory Director Bibbs and Molecular Biologist Byers continue work with interns and SRI students.
- Nick Delisi, Assistant Director of the St. Tammany Parish Mosquito Control District in Louisiana (also a previous intern of SLCMAD), and three members of

his staff visited and stayed at the SLCMAD dormitories on 31 January to 2 February 2024.

### 3. Shop/Field/Lab Activities:

- Trap maintenance and fabrication continues.
- Operations Supervisor Hardman has been handling maintenance related issues at the Ogden Hangar on behalf of DSLASA.
- Equipment and vehicle maintenance continues.
- General winter maintenance activities continues in all buildings and grounds.
- New ATV was picked up from Young Powersports.
- New vehicles (two trucks and an SUV) were picked up or delivered.

### 4. Weather:

January's weather was warmer (by 3.4°) and drier (by 0.15") than normal.

#### Temperature:

	Monthly Avg.	Normal	High	Low
December	36.5°	32.2°	57°	20°
January	34.8°	31.4°	62°	14°

<https://w2.weather.gov/climate/index.php?wfo=slc>

#### Precipitation:

	Total for Month	Normal	Most in 24 hours
December	0.94"	1.40"	0.56" on 3 <sup>rd</sup>
January	1.28"	1.43"	0.36" on 17 <sup>th</sup>

<https://w2.weather.gov/climate/index.php?wfo=slc>

#### Great Salt Lake (elevation in feet above sea level):

	December 1	January 1	February 1
2022-2023	4,188.8	4,189.4	4,190.0
2023-2024	4,192.3	4,192.6	4,192.8

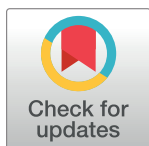
<https://waterdata.usgs.gov/monitoring-location/10010024/#parameterCode=6214&period=P7D>

## RESEARCH ARTICLE

## Do it yourself: 3D-printed miniature CDC trap for adult mosquito (Diptera: Culicidae) surveillance

Christopher S. Bibbs<sup>\*</sup>, Nadja Reissen, M. Andrew Dewsnap, R. Bradley Sorensen, Ary Faraji, Gregory S. White

Salt Lake City Mosquito Abatement District, Salt Lake City, UT, United States of America

<sup>\*</sup> [chris@slcmad.org](mailto:chris@slcmad.org), [csbibbs@outlook.com](mailto:csbibbs@outlook.com)

## Abstract

The central component of mosquito and vector surveillance programs globally is the adult mosquito trap, which is intended to collect host-seeking mosquitoes. The miniature CDC trap is a widely distributed trap style in part due to its relative affordability and compact nature. Despite already being a simple trap, in-house production methods, such as 3D printing, could improve the accessibility of the CDC trap by eliminating some of the supply chain variables. We present here several trials with the Salt Lake City (SLC) trap, a three-dimensional (3D) printed trap design. Functional assessments were made on secondary components and found no statistically significant differences when comparing CO<sub>2</sub> line height (above vs. below fan), battery types (sealed lead acid vs. USB battery pack), and trap body collection shape (funnel body vs. simple/straight body). The SLC trap was compared directly to a commercial equivalent, the ABC trap, with comparative assessment on species diversity and evenness in collections and found to be statistically equivalent on all metrics. Methods also detail an accompanying optional transport system for a pressurized CO<sub>2</sub>/regulator set-up, should a practitioner elect not to use dry ice. Our final design is presented here with the publicly published stereolithography (STL) files and a detailed outline of the transport container system. Alternative models are available for in-house manufacture of mosquito traps, and we contribute these designs in an effort to stimulate further growth in vector surveillance.

## OPEN ACCESS

**Citation:** Bibbs CS, Reissen N, Dewsnap MA, Sorensen RB, Faraji A, White GS (2024) Do it yourself: 3D-printed miniature CDC trap for adult mosquito (Diptera: Culicidae) surveillance. *PLoS Negl Trop Dis* 18(1): e0011899. <https://doi.org/10.1371/journal.pntd.0011899>

**Editor:** Philip J. McCall, Liverpool School of Tropical Medicine, UNITED KINGDOM

**Received:** June 7, 2023

**Accepted:** January 3, 2024

**Published:** January 10, 2024

**Copyright:** © 2024 Bibbs et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

**Data Availability Statement:** Access this dataset on Dryad: <https://data.dryad.org/stash/share/SOht7FNgFkSk8l6ldZeR7fSuHX-qSKcS9uloNS9uTbA>.

**Funding:** The author(s) received no specific funding for this work.

**Competing interests:** The authors have declared that no competing interests exist.

## Author summary

Mosquitoes are among of the most commonly encountered public health pests when discussing zoonotic infectious diseases. Several specific tools exist to collect host-seeking mosquitoes from the field. The miniature CDC trap is a widely distributed, compact trap type that is best used when baited with carbon dioxide, such as through dry ice or pressurized gas. Even if the miniature CDC trap is among the more accessible variants of host-seeking mosquito traps, there can still be barriers to entry for small/local programs needing to trap, learn about, and make management decisions against their local mosquito species. To facilitate this, the Salt Lake City Mosquito Abatement District (SLCMAD)

## DO IT YOURSELF: A MODERNIZED GRAVID TRAP DESIGN FOR MOSQUITO SURVEILLANCE

M. ANDREW DEWSNUP, THOMAS D. WIDMER, ELLA J. BRANHAM, ARY FARAJI,  
GREGORY S. WHITE AND CHRISTOPHER S. BIBBS<sup>1</sup>

Salt Lake City Mosquito Abatement District, 2215 North 2200 West, Salt Lake City, UT 84116

**ABSTRACT.** Gravid traps have become a common and frequently essential surveillance tool for parous *Culex* spp. vectors of West Nile virus and other encephalitis-causing pathogens. The recent closing of BioQuip Products Inc., an entomological supply company, has jeopardized the commercial availability of gravid traps. The Salt Lake City Mosquito Abatement District presents herein a template for making your own gravid trap, but with some modernizations for quieter fans and longer lasting, light weight, lithium battery packs. At the time of writing, the materials cost for the fan (\$14 USD), toolbox (\$13), cables (\$9), ABS pipe (\$2.50), aluminum brackets (\$10), catch container with lid (\$9), trap net (\$10), USB battery pack (\$35) and the negligible amount of 3D-printed filament (\$2), is approximately half the cost (not including labor) of the formerly available commercial model. Additionally, performance validation in the laboratory ( $t_{4.9} = 0.1191$ ,  $P < 0.9109$ ) and within two field sites ( $\chi^2 = 0.107$ ,  $P < 0.744$ ) demonstrated no significant differences in collections of gravid *Culex pipiens*. We do not present an overhaul of the previous gravid trap blueprint, but the quality-of-life updates to the trap design, the feasibility of in-house manufacture, and the mirrored collection efficacy to the commercial model can allow improved maintenance of gravid trap surveillance networks without a commercial supplier.

**KEY WORDS** *culex*, mosquitoes, surveillance, traps, vector, 3D printing

### INTRODUCTION

The Reiter-Cummings style gravid trap (RCGT) is a common tool for surveillance of *Culex* spp. vectors (Allan and Kline 2004). The Reiter-Cummings modification to the original Centers for Disease Control and Prevention (CDC) gravid trap was intended to allow a more compact, easier to transport trap for daily use (Allan and Kline 2004). After improvements to housing and airflow, the RCGT trap has become a tight contender to the originally developed gravid traps (Braks and Cardé 2007) and serves as a staple in many mosquito surveillance operations. The RCGT was available through the now defunct entomological supply company BioQuip Products, Inc. until their closure in 2022, effectively taking prefabricated RCGTs out of circulation. The loss of a major supplier for this trap is reminiscent of the loss of another entomological supply company American Biophysics (Schneider and Hall 2011) and their MM-X counterflow geometry trap (Kline 1999), which was a unique type of research and surveillance tool for gravid (Mboera et al. 2000) and host seeking mosquitoes (Njiru et al. 2006). Subsequent concern about continued service of the RCGT without the originating manufacturer could possibly be resolved with modern tools and e-commerce for in-house fabrication so as not to repeat the loss of additional surveillance tools.

Self-manufacturing is more accessible than ever before (Hoshi et al. 2019, Hiscox and Takken 2021, Wasson-Reinbold and Reiskind 2021) with increasingly

simplified trap designs and in-house tools such as laser cutting and 3D printing (Hoshi et al. 2019; Hiscox and Takken 2021). As with virtually any mosquito surveillance tool, resource barriers with shipping, construction/assembly skills, and the lost availability of original parts all limit the long-term operation of any given trap. To help empower programs to continue using the known and useful RCGT, the Salt Lake City Mosquito Abatement District (SLCMAD) has modernized the parts list for the BioQuip RCGT and proposes a design for low-cost upkeep through in-house manufacturing. This enhanced surveillance tool, the Salt Lake gravid trap (SLGT), is easy to manufacture, economic, efficacious, and the design is readily available to all through free-of-charge online 3D modeling programs.

### MATERIALS AND METHODS

#### Design and Construction

The main template for manufacture of the SLGT was the Reiter-Cummings style gravid trap (RCGT) from the now defunct BioQuip (Royce Cummings 2800 series, BioQuip Products, Inc., Rancho Dominguez, CA) equipped with a 6 v, 12 ah sealed lead acid battery (UB6120 AGM type, Universal Power Group, Inc., Coppell, TX). The main physical constraints are matching dimensions for the interior of a toolbox and the mosquito collection container such that everything can be packed within the toolbox. For the SLGT model, we selected a 40.6 cm (16 in) black plastic portable toolbox with metal latches (Husky, The Home Depot, Inc., Atlanta, GA). The interior dimensions of this toolbox are 35 cm × 17.15 cm × 16.5 cm (13.75 in × 6.75 in × 6.5 in) and is paired

<sup>1</sup> To whom correspondence should be addressed.

## EVALUATION OF MODIFIED AUTOCIDAL GRAVID OVITRAPS FOR CONTROL OF *Aedes aegypti* IN ST. AUGUSTINE, FLORIDA

DANIEL DIXON,<sup>1</sup> CHRISTOPHER S. BIBBS,<sup>1,3</sup> DENA L. AUTRY,<sup>1</sup> MICHAEL BANFIELD<sup>2</sup> AND RUI-DE XUE<sup>1,4</sup>

**ABSTRACT.** *Aedes aegypti* is an anthropophilic mosquito that vectors dengue, chikungunya, Zika, and yellow fever viruses. The US Center for Disease Control and Prevention (CDC)'s autocidal gravid ovitraps (AGOs) may facilitate the control of container-inhabiting *Aedes* mosquitoes and curb arbovirus outbreaks by taking advantage of oviposition-seeking behavior using pesticide-free technology. The AGOs, manufactured by SpringStar Inc., were tested during the summer of 2018 in St. Augustine, FL. A total of 1,718 AGOs were deployed for study in 3 different 40-acre (~18.2 ha) plots at a density of 5–7 AGOs per house and a coverage of >90% for all AGO test sites. The AGOs were modified using tap water instead of infusion water to reduce the capture of nontarget organisms. Each intervention and reference area was monitored weekly using BioGents Sentinel traps and Sentinel AGOs. Generalized linear mixed models showed that changes to *Aedes* mosquito populations were more seasonal than treatment driven. Homeowners expressed positivity about traps and believed the traps were both effective and had directly contributed to increased quality of life.

**KEY WORDS** Autocidal gravid ovitrap, container, mosquito, oviposition, surveillance

### INTRODUCTION

*Aedes aegypti* (L.) is a nuisance and disease vector mosquito that readily feeds on humans. They live near and deposit eggs in artificial containers found throughout peridomestic environments, such as bird baths, bottles, and buckets (CDC 2017). Container-inhabiting *Aedes* mosquitoes can be controlled by discarding, draining, modifying, and pesticide treating artificial containers that hold water. However, container-inhabiting *Aedes* disperse offspring across sites that are often hidden from mosquito control personnel (Faraji and Unlu 2016). In addition, *Ae. aegypti* (Koou et al. 2014, Estep et al. 2018) has documented tolerance or resistance to conventional adulticides and larvicides in the state of Florida. To more effectively control mosquito populations and reduce mosquito-borne arbovirus transmission, nonchemical approaches that target *Ae. aegypti* are being developed for integrated mosquito management.

Among the tools available for mosquito management, lethal ovitraps take advantage of the oviposition behavior of gravid, container-inhabiting mosquitoes in an attract-and-kill strategy using lethal pesticide strips (Williams et al. 2007), sticky capture cards (Cilek et al. 2017), or entomopathogenic biopesticides (Buckner et al. 2017). Sticky ovitraps, such as the Centers for Disease Control and Prevention's (CDC's) autocidal gravid ovitrap (AGO), are preferred because their killing agent is pesticide-free, requires minimal maintenance, and is more cost effective than other styles of lethal ovitrap (Ritchie et al. 2003, Acevedo et al. 2016).

The CDC AGO was tested in Puerto Rico and reduced the population of mosquitoes by 53–70% in areas where AGOs were deployed at a high density (Barrera et al. 2014a). Considering Puerto Rico with hard barriers to mosquito movement as an island, the effectiveness of lethal ovitraps for *Aedes* mosquito control may differ on the mainland USA.

The CDC AGOs work by using odorous plant-based infusion water within the bucket reservoir to attract gravid mosquitoes to the trap where they die on the fatal sticky capture surface. Mackay et al. (2013) showed that infusions using packets with 3.8 g of hay (*Cynodon nlemfuensis* Vanderyst [Bogdan]) per 1 liter of water caught 1.6-fold more *Ae. aegypti* in the field, compared to traps with water only. In addition to capturing *Ae. aegypti*, CDC AGOs also capture a large abundance of nontarget organisms across multiple insect orders based on previous experience with their use in St. Johns County, FL (Autry 2019, Khater et al. 2022). A study conducted in parallel to this one by Mullin et al. 2020 tested different AGO infusion water substrates compared to a tap-water-only control to reduce the number of nontarget organisms captured by AGOs. The infusion water types tested were Orchard grass (*Dactylis glomerata* L.), Alfalfa hay (*Medicago sativa* L.), and CDC AGO-provided hay (*Cynodon nlemfuensis* Vanderyst [Bogdan]). The traps with infusions caught more nontarget organisms and were not significantly more attractive to *Ae. aegypti*, compared to the tap-water-only control in St. Augustine, FL (Mullin et al. 2020). To minimize the impact AGOs have on nontarget organisms and streamline the workload associated with AGO deployment and maintenance, the trap protocol was modified to omit the hay infusion and use tap water only in the bucket reservoir based on the results of Mullin et al. (2020). The following efficacy study details the collaborative investigation of AGOs for the area-wide control of *Ae. aegypti* in St. Augustine.

<sup>1</sup> Anastasia Mosquito Control District, 120 EOC Drive, St. Augustine, FL 32092.

<sup>2</sup> BanfieldBio Inc., P.O. Box 2622, Woodinville, WA 98072.

<sup>3</sup> Present address: Salt Lake City Mosquito Abatement District, 2215 N 2200 W, Salt Lake City, UT 84116.

<sup>4</sup> To whom correspondence should be addressed.