

Wing Beats

of the Florida Mosquito Control Association



**Salt Lake City Mosquito Abatement District
Celebrates its 100-year Anniversary**

Vol 35, No 2

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Summer 2024

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Wing Beats

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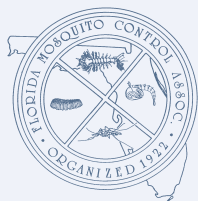
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About the Cover: Employees of SLCMAD gather for a group photo in 1951. Most of the equipment and vehicles were acquired through military surplus following WWII.

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This is the Place: Celebrating a Century of Mosquito Abatement in Salt Lake City, Utah

by Michele Rehbein, Sammie Lee Dickson, Christopher S. Bibbs,
Gregory White, Ary Faraji

The foundation for the mosquito control movement began in New Jersey early in the 20th century through the efforts of John B. Smith, an attorney and self-trained entomologist. Smith's research and legal training triggered the American mosquito control crusade (Patterson 2009). In addition to Smith's pioneering work on open marsh water management concepts was his realization that it was futile for one political jurisdiction to create mosquito abatement laws when the mosquitoes were developing and dispersing from habitats in another political entity. Smith's legal training paved the way for language authorizing the formation of the first mosquito commissions in New Jersey counties. New Jersey Governor Woodrow Wilson signed Smith's bill into law in 1912. California (1915), Utah (1923), and Florida (1925) soon passed similar legislation authorizing the formation of mosquito abatement commissions (Patterson 2009).

The Utah Senate (1923) passed Senate Bill 185 for forming and taxing a mosquito abatement district (MAD). When this bill was passed, a petition was signed by 8,100 registered Salt Lake City voters asking for the formation and operation of a mosquito abatement district to include all the territory within the boundaries of Salt Lake City (Cowen 1923). Thus, the Salt Lake City Mosquito Abatement District (SLCMAD), formed in 1923 and operational in 1924, was Utah's first mosquito abatement district and the second outside New Jersey. The district boundaries were defined to be the same as those of Salt Lake City at that time.

The SLCMAD is a local service district with its governing power vested in a five-member Board of Trustees appointed by the Salt Lake City Council. The Board establishes all SLCMAD policies and hires an executive director to run the daily operations. Funding

comes through property taxes with a certified tax rate. Although the district's jurisdictional boundaries match Salt Lake City's (~110 square miles), the district is also responsible for unincorporated regions of Salt Lake County, encompassing 63 square miles of freshwater wetlands surrounding the Great Salt Lake (GSL). These wetlands produce an abundance of *Aedes dorsalis* and *Culex tarsalis* mosquitoes, which impact surrounding residents. They are why SLCMAD and Utah MADs have long been among the leaders in advancing mosquito surveillance and control. Although a previous issue of *Wing Beats* was dedicated to mosquito control in Utah (Faraji 2020) and many of the stories individually highlighted (Dickson 2020, Patterson 2020), as we celebrate our 100th anniversary, we wish to share a few of the innovations and contributions that the SLCMAD has made to Integrated Mosquito Management.

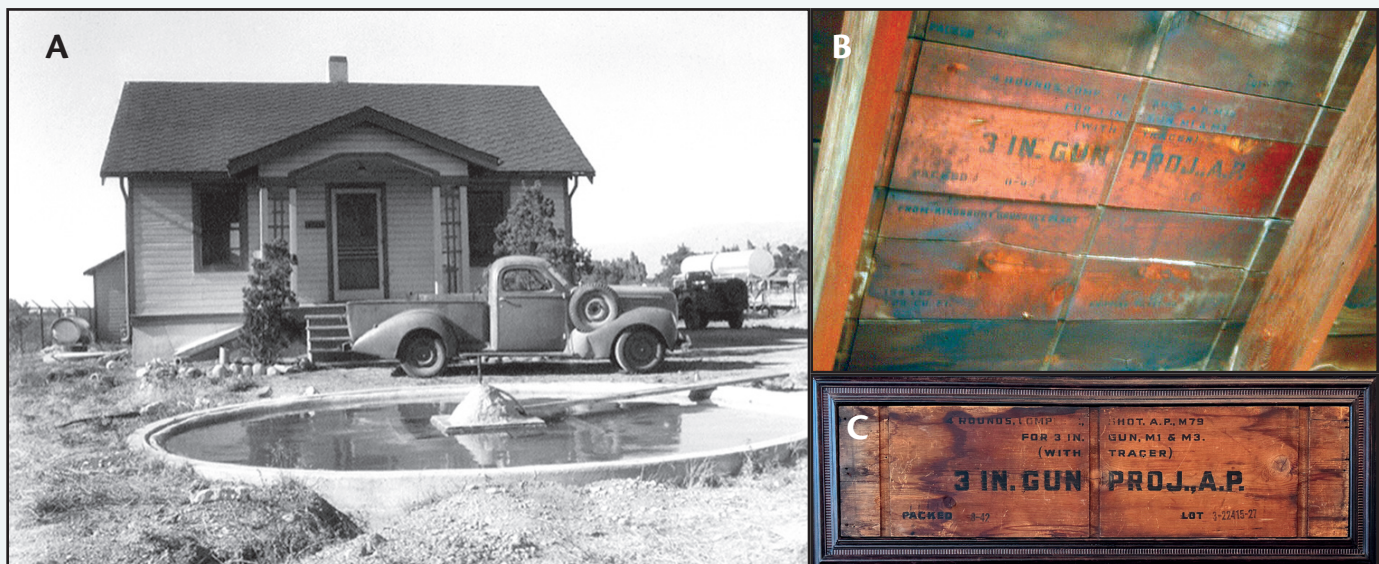


Fig. 1. One of the original homes of SLCMAD following WWII in 1946 (A). This modest 600 ft² building was built from surplus ammunition crate boards (B) and served the SLCMAD until 1993. Some of these ammunition crate boards were saved when the building was torn down and are currently displayed in the current facility.

One of the earliest homes of the SLCMAD was at a World War II Army Air Corps signal shack. This modest one acre of land and 600 ft² building were purchased as governmental surplus property in 1946 and used until 1993 (Fig. 1A). Due to a lack of building materials after WWII and the parsimony of the SLCMAD, the vehicle storage and shop were built from surplus military ammunition crates (Fig. 1B). The chemical storage 'building' was a container formerly used in equine encephalitis surveillance at the Tooele Army Depot. Some of these ammunition crate boards are displayed in the current facility as a reminder of our humble beginnings (Fig. 1C). Vehicles were acquired through military surplus following WWII.

A pond held *Gambusia affinis*, the western mosquito fish, first introduced by SLCMAD into the Salt Lake City area in 1933 for the biological control of mosquitoes. The mosquito fish became established in warm springs in the northeast part of the city, where thermal regulation prevented the water from freezing during the winter and killing the fish. The fish would be captured annually and introduced into ornamental ponds and abandoned swimming pools throughout the city. Other MADs in Utah and surrounding states adopted similar mosquito fish programs. This practice continued until concerns about the species as a non-native led to a memorandum of understanding between Utah MADs and the Utah Department of Agriculture and Food. The agreement restricted the continued usage of these agents only within confined habitats. The SLCMAD created outdoor fish-rearing ponds in 2009 and an indoor fish hatchery in 2019.

Since its establishment, the SLCMAD has been at the forefront of mosquito control tools, methods, and products. In 1955, when Glen C. Collett took over as Manager of the District, few effective mosquito control tools were available. These consisted primarily of mechanical control measures centering

around water flow/removal/ditching and harsh use of broad-spectrum chemical insecticides such as DDT and larvicidal oils. DDT had become the go-to product for all insect control after WWII, including mosquitoes. Collett was astute in observing the overuse of DDT in agriculture, as well as dwindling efficacy against mosquitoes from increasing resistance. He stopped its usage by the SLCMAD in the mid-1960s, shortly after Rachel Carson's 1962 *Silent Spring*, which presented concerns that pesticide usage was causing significant environmental damage, and before the Environmental Protection Agency (EPA) banned DDT in 1972. Fortunately, by this time, other active ingredients were being developed and becoming available for mosquito control. He was also instrumental in incorporating ultra-low volume cold aerosol techniques and using fixed-wing aircraft for mosquito control. Collett also created a paper chart system of over 100 maps containing all known larval habitats within the district, another innovation soon adopted by other regional MADs. These hand-drawn maps had to be mimeographed, as this was long before copiers and GIS, but this method laid the foundation for future databases still in use today.

When the first three-wheeler all-terrain vehicles became available, Collett adapted them to be used similarly to tracked vehicles. These vehicles became the "workhorse" of mosquito control in Utah, and were once again adopted by other local MADs (Fig. 2). Collett's fortitude and enterprising approach to mosquito abatement was using Integrated Mosquito Management long before the term was coined and adopted nationally. Collett's vision came from his involvement at national meetings and collaborations with others, which introduced new ideas, methods, products, and tools to challenge conventional wisdom.

With the elimination of organochlorine insecticides, mosquito abatement programs widely adopted organophosphates, including chlorpyrifos, fenthion, and malathion, for larval and adult control. Heavy reliance on these insecticides led to concerns about reduced efficacy due to resistance and negative impacts on arthropod diversity in the wetlands surrounding the GSL. Sammie Lee Dickson became SLCMAD manager in 1987. Dickson evaluated the efficacy of a granular formulation of *Bacillus thuringiensis israelensis* (Bti) and was exhilarated by its effectiveness and target-specificity



Fig. 2. Jason Hardman riding an ATV which has been modified and reinforced by the SLCMAD. They have been used since the 1980's for surveillance and control measures surrounding the Great Salt Lake.

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for mosquitoes. Dickson dropped all organophosphate larvicides in 1988 and switched primarily to *Bti*. This was another proactive decision to phase out a chemical (e.g., chlorpyrifos and temephos) long before any regulatory decision.

Another Dickson contribution was using bicyclists to routinely treat catch basins, gutters, and retention basins against *Culex pipiens* populations in response to the introduction of West Nile virus (WNV) in the mid-2000s. Dickson got the idea from an AMCA presentation about using motor scooters to treat catch basins. Due to maintenance and safety concerns, Maintenance Supervisor John Feragen was not keen on motorized scooters. He suggested bicycles. Other MADs and private industry have adopted the bike program.

Dickson was also responsible for the construction of a new SLCMAD facility in 1993. This new facility was sited on two acres and included 23,000 ft² of building space for SLCMAD operations. Highlights included a chemical storage building of concrete to minimize fire risk, double spill containment for all liquid pesticides, continuous ventilation, temperature control to maximize the life of biopesticide products, and loading docks for semi-trucks and field trucks. Indoor and outdoor mosquito fish-rearing spaces and holding ponds were constructed. A vehicle storage and maintenance

building was erected so vehicles could be repaired on-site to minimize chemical exposure to third-party mechanics. A laundry facility and locker rooms were built so employees could change into work uniforms, shower, and then change into civilian clothes to go home, thereby reducing a family's pesticide exposure. All uniforms were also laundered on-site to prevent third-party exposure. A laboratory provided a dedicated place for larval and adult identifications, bioassays, and other testing and a dedicated space for insectary and mosquito rearing. There was also a library with mosquito literature that doubled as a board meeting room and another room dedicated to document storage. The new facility raised SLCMAD's public presence, increasing our professionalism and accountability. During his tenure, Dickson grew the budget from \$282,000 to \$3.5 million and increased the full-time staff from three to eight individuals, including a biologist, GIS specialist, rural field supervisor, and urban field supervisor.

Growth has continued. Dickson hired Ary Faraji in 2014; by 2015, they had developed a five-year expansion plan. After Dickson's retirement in 2016, Faraji oversaw the annexation of many areas where SLCMAD was providing service yet were not within the district's taxing boundaries. This was mainly because the 1923 laws had aligned the SLCMAD boundaries with that of Salt Lake City and had not accounted for

city growth. Additionally, because of rapid changes in landscape, population growth, industrialization, service area, insecticide resistance, increases in travel/commerce/infestations, change in the workforce (no longer male-dominated), and other factors, it was evident that the SLCMAD must yet again proactively adapt for coming changes. The district had once more outgrown its facilities, and plans were made for constructing a new facility.

The new construction was completed at the end of 2019, with the facility strategically placed next to the Salt Lake International Airport. The facility is on 15 acres, with 62,000 ft² of building space, including a four-room dormitory with an attached laboratory, two vehicle storage buildings for the rural and urban programs, a pesticide storage facility, and a fish hatchery building. The main building includes an administration wing, training/conference room, vector surveillance laboratory, molecular laboratory, and two insectaries (Fig. 3A). The training and conference room, and facility overall, has served as a meeting space for the annual Utah Mosquito Abatement Association (UMAA) Spring Workshops. Phase II construction will begin at the end of 2024 for a heliport, hangar, jet fuel station, a pesticide bioassay laboratory building, adult bioassay cages, another laboratory, insectary, and larval bioassay vaults, adding 250,000 ft² to the operations (Fig. 3B).

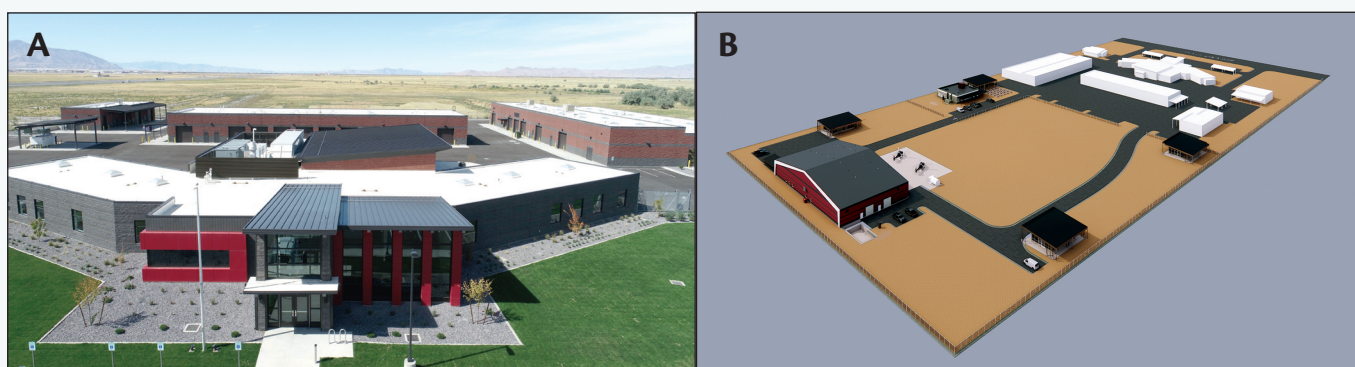


Fig. 3. Construction on the current SLCMAD facilities (A) were completed in 2019 and currently encompass 62,000 ft² of building space on eight acres of land. An additional seven acres is currently being developed (B) and will provide an additional 250,000 ft² of building space in the back of the original property.

Currently, the SLCMAD has an annual budget of over \$7 million and 12 full-time staff, including five PhDs. The district hires 40 to 50 seasonal employees and interns each summer, primarily students from local colleges. Furthermore, SLCMAD and Mosquito Abatement District-Davis employees participate in an annual MosquitoThon to increase camaraderie. Olympic-style competitions range from dipper exercises to bicycle team obstacles to identifications and more (Fig. 4).

SLCMAD participates in the University of Utah's Science Research Initiative (SRI) and Community Engaged Learning (CEL) student intern programs, and in 2023, was a host site for the Public Health Entomology for All (PHEFA) intern program funded by the Entomological Society of America and the Centers for Disease Control (CDC). The PHEFA program consisted of two undergraduate students for 10-week internships and one high school student for a two-week internship.

An unmanned aerial systems program was initiated in 2016 and now includes four drones. The district is involved

with collaborators nationally and internationally, including a malaria mosquito control project in Mali, Africa, in cooperation with the Ouelesseboungou Alliance, Anastasia Mosquito Control District, Clarke Mosquito Control, University of Bamako, and the Republic of Mali. In 2023, Greg White, SLCMAD Assistant Director, and Jason Hardman, Operations Supervisor, traveled to Mali to train, research, and conduct mosquito control operations in several rural villages (Fig. 5). SLCMAD participates in the newly formed Rockies and High Plains Vector-borne Diseases Center (RaHP VEC) with Texas Tech University, Colorado Department of Public Health and Environment, and the lead institution, Colorado State University. RaHP VEC aims to develop capacity to address established and future vector-borne disease threats in the intermountain region, including Colorado, Utah, New Mexico, Wyoming, and the Texas panhandle. RaHP VEC will increase training and professional development opportunities, establish and strengthen partnerships among academic

institutions, public health agencies, and vector control professionals, and evaluate the impact and efficacy of vector-borne disease prevention and control tools, strategies, and programs.

There are challenges with being located near an important and unique ecosystem such as the GSL and surrounding wetlands. Among the wetland habitats are private property, including duck hunting clubs, which flood their property to attract waterfowl. The mosquito surveillance traps consistently collect thousands of adults in this area, with one trap catching upwards of nearly 30,000 mosquitoes in one night. The traps are another recent innovation. SLCMAD has been at the forefront of using 3-D printers, including the rapid and economical creation of surveillance traps (Dewsnup et al. 2023b, Bibbs et al. 2024, Harker et al. 2024), blood-feeding devices, dippers, oviposition containers, and vial holders. View and download SLCMAD's 3-D models here: https://www.printables.com/@SLCMAD_1274322/models or <https://www.thingiverse.com/slcmad/designs> (Dewsnup et al. 2023a).



Fig. 4. Group photo of the 2023 SLCMAD championship team displaying the Golden Dipper Trophy Cup, after defeating Mosquito Abatement District-Davis during the annual MosquitoThon competitions. This competition was created in 2017 to increase camaraderie between the mosquito abatement districts.



Fig. 5. Jason Hardman (SLCMAD), Dr. Greg White (SLCMAD), and Dr. Muhammad Farooq (Anastasia Mosquito Control District), along with Siriman Samake (University of Bamako) in Mali, Africa initiate a western-style IMM program for surveillance and control of mosquitoes in a rural village.

We have made recent discoveries with sugaralcohols used in common artificial sweeteners for human consumption, which may hold mosquito abatement potential through methodologies similar to attractive-toxic sugar bait approaches (Baker et al. 2023, Maes et al. 2024, Nelson et al. 2024). Most of these publications were authored by our interns and students, where holistic training is central to their success and the advancement of our profession. Many of our students and previous employees have pursued successful careers in public health, academia, mosquito control, private industry, and the medical/veterinary sciences. The mentoring of these students to improve public health was a key reason why SLCMAD built a dormitory and encouraged the visitation and collaboration of many entities and individuals globally.

As we celebrate our centennial, we are reminded of the great innovations and contributions that our staff have made over the years and that if we have seen only a little further, it was by standing on the shoulders of the giants that came before us. None of

our accomplishments would have been possible without the dedication, passion, and professionalism of all the staff and the vision of the Board members throughout the years. The ability to adapt and evolve has been the only real constant within the organization, and we expect this to continue. We ponder what changes will occur in the next 100 years. We know change is coming; the question is how quickly? We may not know the answer, but we are already planning for the deployment of cutting-edge molecular and genetic control tools such as SIT, CRSPR, RIDL, and *Wolbachia*, which will change our operations once again. We will continue to serve the citizens of the Salt Lake Valley with the most economical, efficient, effective, and safe mosquito abatement efforts available.

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MOSQUITO CONTROL EVOLVED

Updates to GPS Mapping and Simple Job Management Using Tabula

by Mike McCraw and Katie Hare

Problematic Missions

"The flight department is ready for tonight's flight. The aircraft is prepped: spray systems calibrated, the crew is ready, and the GPS flight management system is good to go. I expect to brief you (the director) in the morning regarding a successful mission." It is rewarding for Mike McCraw, Chief Pilot at Manatee County Mosquito Control District (MCMCD), to be able to say such words before a night-time spray mission. On the other hand, it is miserable to report the following morning that the mission had to be canceled or was unsuccessful due to a three-dollar gasket that was no longer in stock or, even worse, due to a mission management technology breakdown like a GPS computer freeze. Some of these potential failures are easier to remedy than others. Gaskets and small parts are kept on hand to avoid surprises. However, GPS computers come with a different suite of challenges, especially when the system is outdated. We faced this situation at MCMCD until the summer of 2023.

For 20 years, we relied on the same spray system to assist in our GPS navigation for mosquito control missions. The system was simple to use, easy to maintain, and had good company backing when first used. Showing its age, this system used video cards for data transfer and ran on a Windows 98 operating system. As markets changed, the system became dated, budget cuts divested customer support, and the product became obsolete. Time passed, and our aging system was left to die on the vine with no tech support or replacement parts. The days and nights of failed

missions due to system crashes and faulty electrical connections increased until nearly two of every three aerial missions required extra time to pause, return to the District, swap out computer components, and then proceed as planned. Managing this system was no longer feasible, and it finally became time for us to update this system, which was, at the time, used in all three of our helicopters: two Bell 407s and one Hughes 500. At this point, we began searching for a replacement specifically tailored to mosquito control, just as the old one had been. While many agricultural systems had their advantages, they did not allow for the expansive drift model we rely on for adequate coverage of a spray area. Thus, the market had limited products, and we decided to turn in a more innovative direction.

Keeping It Simple

Unlike agricultural row-crop operations, we were not aiming to heavily apply chemical droplets to a target that was within feet of the spray booms. The goal of mosquito control ultra-low volume (ULV) aerial flight is to deliver an atomized product to an identified area using speed, drift, and swath width spacing. Less emphasis on hitting a specific bulls-eye target allowed us to keep things simple in how we approached our missions. One of the things we liked most about the old system was its simplicity. However, we had been controlling the mosquito population with the same system we had for decades, and automation was not a part of the equation. The components consisted simply of a tank, a pump, a switch, and spray nozzles with a stand-alone GPS flight



Fig. 1. The pump and valve setup currently used in MCMCD's chemical tanks.

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Fig. 2. The screen used to manually program a drift offset of 2,000 ft for mosquito control operations.

management system (Fig. 1). Overall, this system's simplicity worked well for our upper management and county residents, and it achieved acceptable kill rates for mosquitos. It just lacked efficiency as time went on.

Our pilots are more than capable of manually maintaining airspeed, following a course, and turning on and off the spray switch; we saw no need to incorporate a potentially more complicated automated system. Removing automation promotes simplicity because there is no need for the use of relays, sensors, and numerous other electrical components, which could lead to mission failures or delays. Our goal has never been only an effective kill rate, but also 100% mission performance reliability through robust hardware and software. It came down to either manual capability or a coupled (and more expensive) automated system. We decided to keep it simple and chose the former.

Help From the Land Down Under

Of the many innovations we encountered at the 2023 Helicopter Association International meeting in Atlanta, one stuck with us: a

GPS mapping system designed and operated in New Zealand. Tabula, formerly TracMap, was created to manage ground and aerial row-crop operations using Android-based tablets. Although they did not have the drift capability we needed, the company worked with us to develop the ULV profile we needed.

Our goal was to bring the new technology to meet GPS guidance and job management while keeping the operation simple. While Tabula's products could accommodate an automated system, they do not require it. Tabula's aviation product, AirVision, was promising for aerial larviciding, but to make it applicable specifically to a ULV adulticiding operation, it needed a significant drift offset capability. Before our input, the most drift that the product would allow was a spray boom width of approximately 30 feet due to the agriculture industry's preference to reduce drift for row crops.

Tabula's AirVision staff of designers was accommodating in adjusting their programming to allow the offset we required for effective mosquito control (Fig. 2). During many product development teleconferences between Florida and New Zealand, the

designers evaluated our requests and then quickly implemented them via the cloud. This allowed us to review the update promptly and provide feedback. Updates for our specific GPS devices were completed within a few days despite our two countries being a great distance apart!

Additional features that we capitalized on were hazard identification, hazard alerts, a laser altimeter, and night vision compatible hardware. Our helicopter flight profile for ULV is post-sunset at 150 feet and 105 mph. Therefore, tower and obstacle identification is imperative. Tabula's AirVision allows us to mark hazards such as power lines and towers that we identify during daylight hours so that we can avoid these during nighttime spray missions. Each hazard is not only marked on the moving map, but hazard warnings also illuminate on the fully customizable light bar (heads up display) (Fig. 3).

Further, the company quickly responded to our request for integrated laser altimeter capability to work alongside our radar altimeter. At the time of writing, the Federal Communications Commission (FCC) and Federal Aviation Administration (FAA) are working to manage the 5G network that has been interfering with aircraft radar altimeters. Until this is resolved, the laser altimeter will be a welcome backup device that can easily be displayed on the light bar.

Our final request was a friendlier night vision-filtered tablet and light bar so that pilots can safely use these functions without aggressive illumination even while they view the world through night vision goggles. Tabula responded quickly by sending us a new system with these filters, which we have found to be useful and effective.

Summer 2023

Working with Tabula, we assembled an operational product for the summer of

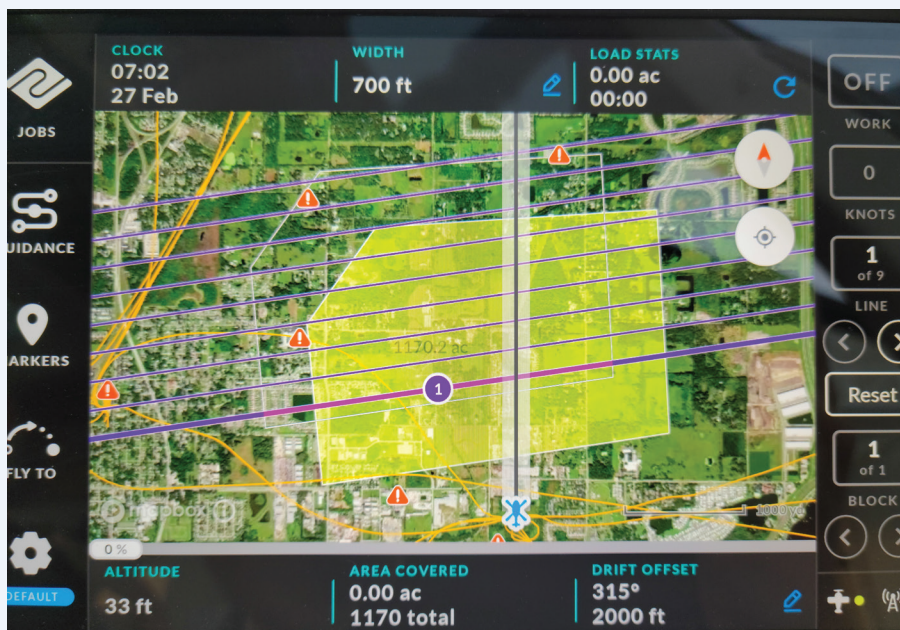


Fig. 3. A polygon map for an 1,170-acre mission with the treatment area in yellow. Spray lines show a 2,000 ft offset for winds from the Northwest. Hazards/towers are identified with red warning icons.

2023. After only a few flights, we were comfortable with the user-friendly programming and reliability. The system worked flawlessly with 100% of our missions accomplished in both aerial adulticide and larviciding. We credit this to not only new software and hardware but also a system that works seamlessly with the pilot and is easy to learn. One danger of night flying is a situation called “heads down” which means that the pilot is having to spend more time focusing on computer management than flying the aircraft. Fortunately, this new product allows us to focus on flying instead of troubleshooting. As we typically set up for a mission, wind direction is manually entered, and the appropriate edge of the spray block is selected to allow for drift as well as spray avoidance. We are responsible for maintaining airspeed, heading corrections, and spray management, which can be quickly controlled when approaching unannounced ballgames, public events, or other public hazards. This allows faster response and helps avoid the District receiving complaint calls the next morning!

We now have the capability to manage offset drift for ULV and record proof of application for both ULV and larvicides. In addition, we utilize Tabula’s live fleet tracking system for flight following by staff on the ground. Through the cloud, we can now send additional instructions directly to the aircraft instantly without USBs, video cards, or returning to base.

Updating Ground Operations

Like the aviation department, MCMCD’s ground department has been using the same aging hardware and software systems for truck ULV adulticide GIS guidance and record. Since our successful implementation of Tabula for aerial use, we have decided to continue updating our district by including the ground fleet as well. Upon our request, Tabula quickly addressed our need for a street map display in addition to the satellite and terrain views that were already available. Again, this was a simple update created in New Zealand and sent to each of our ground units, ready for implementation.

The Bottom Line

After switching to the updated system that put technology in the cockpit where it should be and still maintained full pilot control of the aircraft and systems, Manatee County Mosquito Control District had a successful 2023 season! Our previous rate of 67% of missions being slowed, failed, or hindered by an aging system has now been reduced to ZERO missions succumbing to the same fate. For every flight, we are now saving up to an hour of extra flight time previously caused by video card swaps. That is a reduction in fuel costs, overtime labor costs, and headaches. We are eager to begin the 2024 season. Simplicity of components, aggressive maintenance, standardization among flight crew, and robust new software systems have been fully and seamlessly implemented. Our adulticiding, larviciding, and job management efficiencies have never been better.



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What Happens When Honey Bees in Urban Environments Pose a Public Threat?

by Ed Freytag

The New Orleans Mosquito, Termite, and Rodent Control Board protects the residents of New Orleans from the three main pests:

- (1) mosquitoes that cause nuisance and disease transmission.
- (2) termites that damage buildings and trees.
- (3) rodents that transmit disease pathogens and damage structures and goods.

But we also respond to requests from city employees to control or minimize the impact of a wide range of other pests, including raccoons, opossums, birds, bats, ants, fleas, cockroaches, flies, spiders, wasps, and honey bees.

Honey bees are the most controversial pest we deal with in New Orleans. Most people recognize bees as beneficial, and do not immediately perceive them as a potential public health hazard. Homeowners also tend to believe the western or European honey bee, *Apis mellifera*, is federally protected, which is incorrect. The western honey bee is not native to North America but was imported by colonists from Europe in

the 1620s (Crane 1983). This honey bee, spread by humans for crop pollination and the production of honey and wax, originated in Africa or Asia and is now found on every continent except Antarctica (Crane 1983).

Honey bees are beneficial because they pollinate vegetables, nuts, fruit trees, and other important crops and produce honey. Honey has been used as a nutritional and sweetener since ancient times. Honey has also been used in traditional medicine as an alternative treatment for many ailments, such as bronchial asthma, ulcers, throat infections, gastrointestinal diseases, dressing wounds, etc. And honey shows antioxidant, antimicrobial, anti-inflammatory, antiproliferative, anticancer, and antimetastatic properties, to name a few (Samarghanduab et al. 2017).

Commercial beekeeping operations are usually located away from the city around farms. They can contain from a few to thousands of beehives that may be either maintained in one location away from cities or are for “hire-on-demand” and travel by truck across state lines to pollinate crops. Individual beekeepers in the city are usually hobbyists and may have just one or a few beehives in their backyard (Fig. 1). They keep bees in a hive box because they enjoy interacting with the bees and love sharing honey with their family and friends. The State of Louisiana (Revised Statute RS 3:2305) requires anyone who has a beehive to register it with the Louisiana Department of Agriculture and Forestry. The New Orleans Mosquito, Termite and Rodent Control Board will announce to the public via press release or social media that it will



Fig. 2. Feral honey bee swarm clustering on a private fence.

conduct mosquito spraying operations by truck or air. This allows beekeepers to protect their beehives from the spraying operations.

Honey bees kept in a bee box in a neighborhood are not a threat to the public because they are usually placed away from sidewalks and streets, and the beekeeper prevents them from swarming. The issue with honey bees that swarm (Fig. 2) from “wild” nests in the spring is that they aggregate on cars, buildings, trees, light posts, etc., looking for a place to build a permanent nest. Residents call us requesting the removal of the honey bees because their children cannot play outdoors for fear of getting stung. In many cases, nursing homes, parks, playgrounds, restaurants, city buildings, private buildings, schools, hospitals, utility workers, and lawn and landscape workers cannot operate because of fear of disturbing the nest and getting



Fig. 1. A beehive box in a private backyard in Metairie, LA.



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stung. We get involved because we want to prevent a stinging incident that may result in hospitalization and to save the honey bees. We try to remove the swarm cluster and relocate them to a safe place. There have been cases in New Orleans where inexperienced people attempted to remove a honey bee swarm in a public area, but this did not go well and ended up being aired by local TV reporters.

Honey bees will sting humans and pets in self-defense to protect their nests. Some colonies are more aggressive than others, but that does not mean they are "Africanized." We can test for suspected Africanized honey bees in our genetics laboratory. We do not presently have Africanized honey bees in Louisiana, which are usually much more aggressive and will follow a person long distances to protect their nest. Most honey bees react to loud noises and vibrations, such as lawn mowers and weed whackers, and will sting to defend their colony. Honey bee venom can produce different reactions in people (Fig. 3), ranging from temporary pain and discomfort to a severe allergic reaction called anaphylaxis. Stings can be life-threatening and require the use of an epinephrine auto-injector and, in cases of an anaphylactic reaction, a trip to the emergency room. Signs and symptoms of anaphylaxis include skin reactions, with hives, itching, and flushed or pale



Fig. 3. Extreme swelling of the author's hand caused by a single honey bee sting, requiring medical attention.

skin, difficulty breathing, swelling of the throat and tongue, a weak or rapid pulse, nausea, vomiting, diarrhea, dizziness, fainting, and possible loss of consciousness.

Honey bee swarms that cluster on a tree branch or other object are relatively easy to collect and relocate because bees do not aggressively protect wax comb with brood and honey. If the queen is inside the swarm, they can be gently moved to a bee box or a covered cardboard box. If a honey bee colony is established in a tree hollow or inside the wall of a building, it is usually difficult and expensive to remove and relocate. Some beekeepers specialize in removing a bee nest in a building, but it may require tearing out a wall and cleaning and repairing the damage after the bees are extracted. Depending on the difficulty and size of the bee nest, a removal may cost over \$800 in New Orleans. Our department is not specialized in the removal of honey bees in a structure, so we acquire the services of a beekeeper who cooperates with us free of charge, but this is possible only in city buildings (Fig. 4). We do not do removals on private property, so we refer owners to beekeepers or local pest control companies experienced with removals. When we receive requests for honey bee issues, we initially determine if it's located in a city building, city property, or private property – and that will determine our next steps. For private property, we will visit the site and talk to the homeowner, but the most we can do is remove a swarm from the property. If the bees are already established in the home, shed, garage, or tree, we refer them to a beekeeper. When a request is made from a city facility, state or federal building, or even a utility company, we must visit the site to determine if it's possible to remove and relocate the bees, ignore them, or eliminate them using an insecticide.



Fig. 4. Beekeeper removing honey bees from a city pump station in New Orleans.

Our protocol for dealing with honey bee issues is based on an assessment of health risks:

- No risk to human or animal health: no action.
- Some risk to human or animal health: place barricades, remove and relocate, or eliminate the colony.
- High risk to human or animal health: eliminate the colony.

Working with bees, even "friendly" swarms, is inherently risky to the operator and curious spectators. When we inspect honey bees on location generated by a call or email, we bring our honey bee equipment, which includes bee suits with leather gloves, duct tape, flashlight, ladder, binoculars, garden lopper, and "Warning" and "Do Not Trespass" tape. We must ensure the property is occupied, as we cannot enter private property without permission. Duct tape is essential to seal the bee suit around the ankles and sleeves to prevent bee entry. The loppers are great for carefully cutting a branch with the bee swarm and not causing distress to the bees. The barricade tape keeps the public away from the bees to prevent stinging incidents. We always work in teams of two for safety reasons.

When removing and relocating an established honeybee colony, we always bring our tools, but the beekeeper brings additional tools which include a specially designed low-suction bee box attached to a vacuum, an extra

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honey bee box, a plastic queen cage (to make sure the queen does not escape), a large knife and drywall handsaw, a bee smoker, spray bottles with lemon grass extract (attractant) and almond oil extract (repellent), and extension cords. The beekeeper does most of the work, and we assist. We have had unsuccessful attempts at removing honey bees from city buildings due to building obstructions, or the bees had already been partially killed with an over-the-counter pressurized can of insecticide (ant and roach) in a do-it-yourself attempt. The beekeeper usually keeps the honey bees that are successfully removed (with the queen) and relocates them to a farm or other production site.

Unfortunately, there are many occasions when we cannot remove and relocate the honey bees due to an inaccessible nest that also presents a high risk to public safety. For the honey bees that establish their nest inside the hollow of a tree, inside utility poles, in walls in city buildings, or in other unsuitable locations where we cannot remove them, we are forced to eliminate them with an insecticide application as a last resort. To treat a honey bee colony, we must first contact the Louisiana Department of Agriculture and Forestry (LDAF) to obtain their approval. Usually, we only need to call their office, but sometimes, they request a letter via email with details and pictures, followed by an in-person inspection of the site.

To treat honey bees inside a building wall or the trunk of a tree, we use a modified protocol that we developed to control Formosan subterranean termites: drill access holes to reach the honey bee nest and inject foam containing a mixture of liquid insecticide and foaming agent. We discuss with the state regulators (LDAF) what insecticides are appropriate to use. The application is conducted early in the morning, before dawn, before the bees leave the nest to forage for food, and because it's safer when there are few people on the sidewalks



Fig. 5. Using a Richway Pestifoamer machine to treat a honey bee nest inside a large oak tree near a New Orleans school.

(mostly joggers or dog walkers). Also, the schools are not open at that time. We drill holes with a half-inch drill bit and inject the termiticide inside the void using a foaming machine (Richway Pestifoamer® Model PF-5). For brick walls, we drill the holes using a rotary hammer drill, and for trees, a cordless drill with a wood-boring ship auger. The foaming machine should be calibrated to produce approximately 15 gallons of foam from each gallon of water or foamer mix. The insecticide is added according to the label and mixed to create a homogeneous solution. The solution is injected until the foam has saturated the nest cavity, and no honey bees are leaving the cavity (Fig. 5). The drill holes are covered with plastic half-inch plugs. Care should be taken to reduce foam spilling outside the cavity.

This information was presented at the Louisiana Mosquito Control Association (LMCA) meeting in December 2023. I asked the audience if other mosquito abatement districts were involved with honey bees as health hazards. Not a single district present was collecting, relocating, or eliminating honey bees in their area. Hopefully, this information can serve as a template for dealing with honey bee issues in urban environments.

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ADDITIONAL RESOURCES

- Rutter, B. 2022. Urban beekeeping: history, challenges, benefits & best practices <https://bestbees.com/2022/02/16/urban-beekeeping/>



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Mosquito Control

The History of Mosquito Control in Connecticut

by Roger Wolfe

Connecticut (CT) has a history of vector-borne disease epidemics. Yellow fever epidemics were associated with maritime trade from the West Indies and were introduced through infected crew and slaves, and water cisterns carrying *Aedes aegypti* larvae. Outbreaks occurred in New Haven (1743, 1794, 1805), Middle Haddam (1796), New London (1798), Hartford (1799), Middletown (1820), and a probable outbreak in 1794 in native Mohegans living along the Thames River. Malaria also caused sporadic deaths in CT since the mid-1600s but was not considered epidemic until it broke out during the 1860s in the southwestern portion of the state and spread eastward. Soldiers returning from the Civil War were infected, and by 1882, practically every Connecticut town had cases of malaria. The number of statewide malarial deaths averaged 125 per year between 1894-1904. Open cisterns and hundreds of dams built for powering mills created ideal habitat for vector *Anopheles* mosquitoes.

The CT Agricultural Experiment Station (CAES) was founded in 1875 in New Haven for "the purpose of promoting agriculture by scientific investigation



Fig. 1. Dr. Wilton Britton, CT's first state entomologist.

and experiment" and is recognized as the nation's first state agricultural experiment station. It was not long before mosquitoes were determined to be a major pest and public health threat. In January 1901, the CT Gen. Assembly passed "An Act Concerning Insect Pests" and established a Board of Control. Dr. Wilton Everett Britton was appointed Connecticut's first State Entomologist in 1894 (Fig. 1). In 1904, Britton and B.H. Viereck published a "Report on Mosquito Investigations in Connecticut", identifying the breeding locations of malaria mosquitoes in salt marshes. The report stated that 50% of CT marshes (22,264 acres at that time) had been ditched for salt hay farming and were now holding water and producing mosquitoes.

In 1902, John B. Smith from New Jersey noted that "the killies (*Fundulus*) that swarm in every ditch are very good wriggler eaters," and that "more permanent improvements should be the objective, as opposed to surface oil which is a temporary expedient." Without state funding, but with concerns of preventing malaria, individual towns began to hire workers to dig trenches to drain the soils and to allow killifish access to these stagnant areas. Britton recommended narrow (10"), deep (24-30") ditches, 100-150' apart to provide adequate drainage and greater longevity than farming ditches.

In 1912, the Commission on Mosquito Extermination drafted two legislative bills to: 1) declare mosquito breeding a nuisance which gave health officers more authority, and 2) to provide for the drainage of marshlands under state control. In 1913, the state legislature approved, and Governor Baldwin signed into law that "any accumulation

of water in which mosquitoes are breeding is hereby declared to be a public nuisance." This also gave health officers the enforcement power to treat or eliminate breeding places. By 1919, ditch maintenance on approximately 5000 acres was continued by CAES field workers at a cost of \$7.35 – \$10.50 per acre or \$0.02 per foot.

New technologies and techniques were tried and incorporated into the state's program over the next few decades. In 1926, Robert C. Botsford patented the Botsford Spade – a lightweight,



Fig. 2. The Botsford spade was patented to dig ditches more efficiently than with hand shovels.

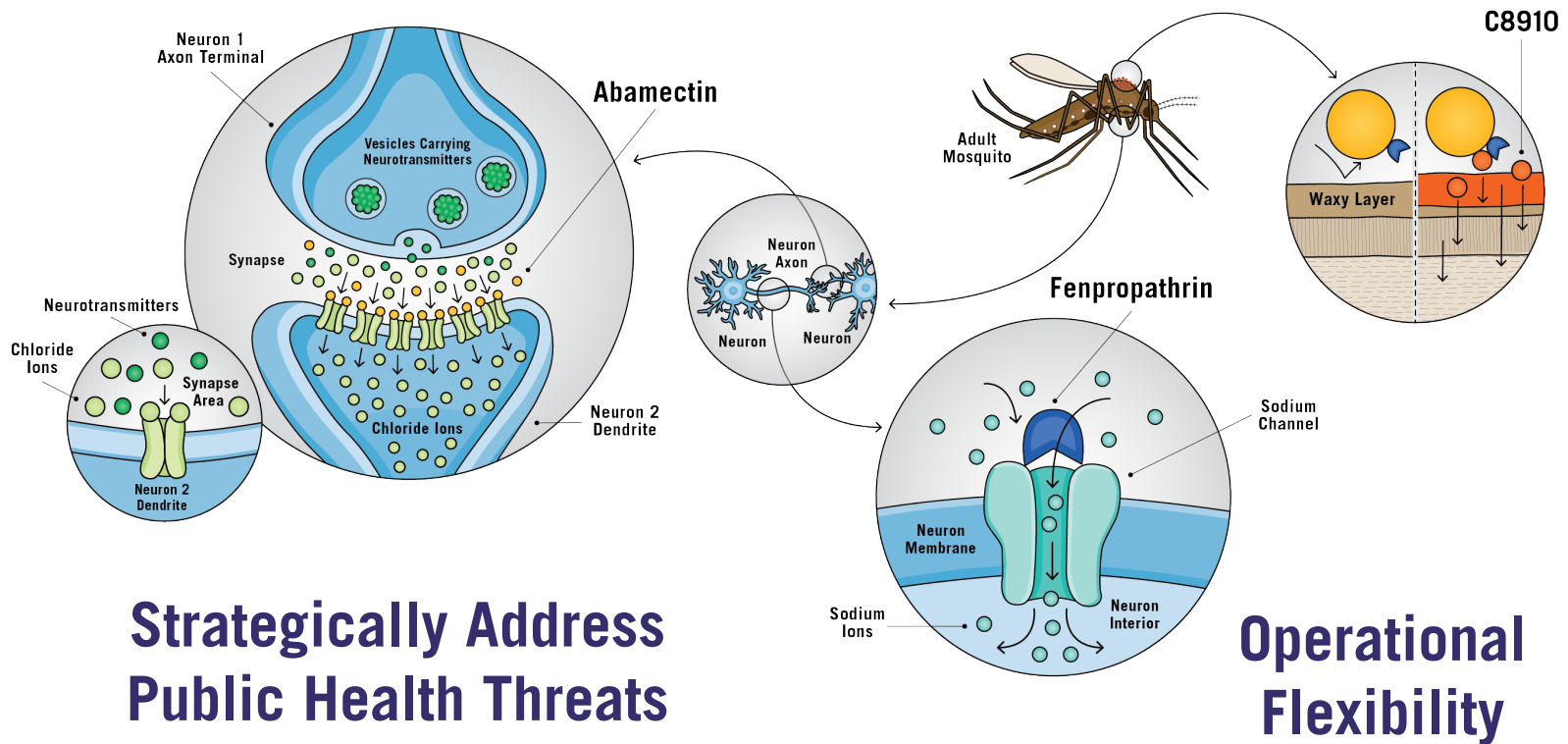
double-spaded, two-handled shovel capable of cleaning a ditch much faster than with a hand shovel (Fig. 2). Other forms of habitat modification included creating ponds for fish by blasting "champagne pools" with dynamite, digging blind (closed) ditches, and creating impoundments for salt hay production, waterfowl habitat, and mosquito control. Ditching continued throughout the northeast and mid-

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Atlantic. By 1950, more than 90% of tidal marshes from ME-VA had been ditched (Bourn and Cottam 1950).

Oiling marshes using diesel oil or kerosene for larval control was also practiced. Later, pesticides like pyrethrum were added. Fieldwork consisted of surveillance to find breeding places, oiling standing water areas, and maintaining the ditches that had been dug.

The state program maintained an increasing ditched area – from 5,065 acres in 1928 to 10,129 in 1930. The biannual budget grew from \$25,000 to \$30,000 and employed 12 men. In 1932, however, due to fiscal restraint during the Great Depression, the budget was cut to \$6,247, and the crew was reduced to ten men. For the first time, mosquito and pathogen surveillance was initiated. Two New Jersey light traps were used to capture mosquitoes for identification and to test for malarial parasites at the CAES.

The Civilian Conservation Corps (CCC), created in 1933, was the nation's largest peacetime mobilization of men. It provided labor for the CAES to complete the ditching of the state's remaining salt marshes.



Fig. 3. CCC workers maintaining ditches.

By January 1934, the CCC mosquito ditching program employed 1,056 men, including 360 laborers, 19 field supervisors, 2 blacksmiths, 4 administrators, 7 engineers, and 112 employees paid with individual towns' relief funds. More than \$287,000 of federal funds had been spent on wages, with state and individual towns adding another \$34,730 for ditching. A total of 1,478,756 feet of ditches had been installed and maintained since the beginning of the century, as well as repairs to tide gates and dikes, and freshwater drainage work in many towns where malarial mosquitoes were still found. Every shoreline town from New Jersey to Rhode Island had ditched marshes. This was often done without notice or consultation with the State Board of Fish and Game, resulting in escalating conflict.

The CCC was terminated in 1942, with federal funds reappropriated to the war effort. By 1945, the state program had dwindled to only three laborers and four working foremen who continued ditch maintenance work. (Fig.3). Around this time, the Department of Entomology at CAES began testing chemical insecticides, including dichlorodiphenyltrichloroethane or DDT. DDT at a rate of 1 lb to a quart of xylene and three quarts of kerosene was applied with a thermal fogger at the Yale Bowl prior to six outdoor concerts (Fig. 4). The treatments were reported to make the concerts "more enjoyable, with no mosquitoes found in the Bowl for five days thereafter."

Public Act #7 dissolved the State Board of Mosquito Control in 1949, and the program was placed under the State Department of Health. Rolling the program into a state department provided a more consistent funding avenue. Robert Botsford, formerly



Fig. 4. Mist blowing DDT before a concert at Yale Bowl, 1945.

Superintendent of the Board, became Chief of the Division of Mosquito Control (DMC). For the first time, formal agreements between towns and the state program were written. Sixteen towns had ongoing state projects in their marshes, totaling over 8,000 acres. The program's equipment consisted of two cars, two pickup trucks, two ditch-cleaning machines, one suburban vehicle, and one platform truck. By 1959, the new Chief, Julius Elston, reported that the program maintained 9,292 ac. of marshlands, 14 tide gates, 18 beach outlets, two dikes, and one sea wall. Approximately 1,800 acres of marsh had been filled, and 4,181,400 feet of ditches completed during the decade. Larviciding with pyrethrum solutions continued. DDT was used for ground and aerial spraying until it was banned in 1965. The Yale Arbovirus Research Unit was created in 1964 as a continuance of the Rockefeller Foundation Virus Laboratories.

By the late 1960s, it was apparent that the destruction of coastal wetlands had gone on long enough. The Tidal Wetlands Act (1969) regulated activities to preserve tidal wetlands. There was no provision, however, for restoring degraded wetlands, although there was an exemption for mosquito control. On January 1, 1980, the Coastal Management Act prioritized wetland restoration for the CT Coastal Area Management (CAM) Program of the Department of Environmental

Protection (DEP). Dr. William Niering and others at Connecticut College were asked to study 15 degraded tidal wetlands and make restoration recommendations. From their findings, a minimalistic approach to restoration was adopted, which would put degraded wetlands on a trajectory toward sustained restoration. The state and the Army Corps of Engineers (ACOE) concluded that continued ditching was detrimental to the marsh ecosystem. In 1983, ditch maintenance was discontinued.

In 1985, the DMC and the CAM Program applied for a Sec. 404 permit from the ACOE to continue mosquito control activities. Ditch maintenance was abandoned, and the site-specific Open Marsh Water Management (OMWM) technique was adopted. Studies also found that tidal flow restoration through replacing undersized culverts and manipulating tide gates reduced mosquito breeding, invasive Phragmites cover, and other tidal wetland functions. Marsh inspections and larvaciding (using biorationals like Bti and methoprene) continue along most of the shoreline's coastal marshes, with adulticiding of shoreline communities done as requested.

The next several years were tumultuous for mosquito control. In 1991, due again to state budget constraints, summer staff was not hired, and on November 1st, the four-man crew was laid off, leaving only the Section Chief, Paul Capotosto. In January 1992, the staff was reinstated, but in April, three of the crew were notified again that their positions would be terminated. Fortunately, their efforts in saltmarsh restoration had not gone unnoticed. The state legislature passed "An Act Concerning Mosquito Control", which allowed saltmarsh restoration projects to be funded by Long Island Sound Clean Up Account funds. On June 30, 1992, an agreement was signed between the Mosquito & Vector Control Section of the Dept.

of Health Services and the DEP Office of the Long Island Sound Programs, with \$308,000 allocated for wetland restoration projects (not mosquito control). The termination notices were rescinded that same day, and the mosquito control crew found a new home in the CT DEP as the Wetlands Restoration Unit.

The newly formed DEP Wetland Restoration Unit continued with coastal restoration efforts, but it was not authorized to do mosquito control. Coastal communities suffered from unchecked hordes of biting saltmarsh mosquitoes. Coastal state parks issued "no refund" policies due to mosquitoes. A few private companies emerged out of demand and necessity as the state was no longer in the mosquito control business.

This continued until an Eastern Equine Encephalitis (EEE) outbreak in 1996 occurred in the state's southeastern quarter. A public health emergency was declared by Governor Roland, who ordered aerial spraying to reduce mosquito populations in the affected area. Later that same year, Pub Act 97-289 was passed, specifically targeting the public health threat of EEE. Additional staff were hired at DEP and CAES to increase mosquito surveillance and testing, and operational mosquito control was added to the state budget. Together with the CAES, Dept. of Public Health, Dept. of Agriculture, and the University of Connecticut, the DEP was now part of the statewide Mosquito Management Program. Using OMWM and other wetland restoration techniques, the DEP now employs the more holistic approach of Integrated Marsh Management for coastal marsh restoration and provides technical assistance to towns and the public on mosquito control. The future of this arm of the state's program is uncertain, as the current staff consists of three employees to provide operational control.

The CAES initiated arbovirus surveillance in 1966, with mosquito

pathogen testing done at Yale. With the closure of the Yale Unit, CAES established its own arbovirus testing facility in 1999 and increased its trapping efforts from 36 to 73 statewide trap sites. The CAES was the first to identify West Nile virus (WNV) in the U.S. in 1999. Since its discovery, they have increased their staff and surveillance efforts to 108 trap locations. In 2005, they established a Bio-Safety Level 3 (BSL-3) laboratory to test for an array of vector-borne pathogens. Today, the CAES participates in the Northeast Regional Center for Excellence in Vector-Borne Diseases (<https://www.neregionalvectorcenter.com>).

Diseases like yellow fever and malaria may no longer be of epidemic proportions in the Northeast. Yet, other arboviruses like WNV, EEE, and tick-borne pathogens will be with us for the foreseeable future. The public's health, safety, and quality of life demand that we remain diligent in our efforts, and thus, there is a continued need for mosquito control.

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Mosquito Control Across the Pond: How Fighting Mosquitoes in Europe is Being Shackled by EU Regulation-Driven Diminishment of the Tools to Fight Them

by Robert "Bob" Hancock

Author's Note

My unlikely education and interest in European mosquito control began in November 2023 when I attended the 11th Conference of the European Mosquito Control Association (EMCA) in Palma de Majorca, Spain. I was unknown to the 287 attendees until my presentation on the impact of the epic May/June rainfall on mosquito/West Nile virus surveillance along Colorado's front range. This conference spawns and grows conversations as it is a one-room event with lunches provided each day and scheduling that maximizes the interconnectivity of attendees. All talks are followed by Q&A, and I cannot recall a single speaker who was not asked at least one stimulating question. My operational talk was well received, and many conversations and associations followed. My first break-time conversation began with a provoking, if not aggressive, question: "So do you even have any insects flying around at all?" I quickly answered "yes," but I briefly felt like a "spray jockey" at the height of the DDT era. This question aroused my curiosity about chemicals and mosquito control in Europe.

Where are the Adulticides?

Through the conference, there was an abundance of papers on the metastasizing invasion of *Aedes albopictus* on the European subcontinent and the active and multifaceted (but NOT chemical) research in advanced modeling, citizen science, community campaigns ("fight the bite," etc.), lethal trapping, and others. Lacking was the chemical side. Adulticide vendors were essentially absent, as well as posters and presentations involving adulticiding. On the other hand,

Bacillus thuringiensis israelensis (Bti) was well represented in presentations, demonstrations, and vendors. There was turbulence in the membership concerning chemical control and its policy-driven diminishment, with one extreme embracing harsh restrictions and the other lamenting the loss of tools to do their jobs and fight vector-borne diseases with knockdown force. In a featured panel discussion, an association leader and journeyman mosquito controller reflected on his introduction several years ago to the American Mosquito Control Association's (AMCA) active lobbying in the US. He proclaimed, "Like the AMCA in Washington, we need to be in Brussels."

European Chemical Regulations in the 20th Century

The dramatic restrictions enforced on chemical use in Europe today are deeply rooted in the history of industrial chemistry. As in other global industrial centers in the 20th Century, pre-European Union (EU) chemical concerns were elevated in the 1960s when, around the world, harmful effects caused by chemicals to humans, animals, and the environment were being brought to public attention by authors like Rachel Carson - Silent Spring (Carson 1962). In Europe in 1967, a Dangerous Substances Directive (DLP) enforced Hazard Assessment and a Classification, Labeling and Packaging (CLP) system (Dir. 67/548/EEC, 1967). In the 1970s, restrictions on marketing and use were introduced (Dir. 76/769/EEC, 1976). The year 1993 was transformative in that not only was the EU established, but regulations were introduced requiring data collection on existing substances and risk assessment of new and existing substances.

European Chemical Regulations in the 2000s: REACH and the Global Harmonized System

As the EU reached its full stride, its powerful and multinational policymakers created the Registration, Evaluation, Authorization and Restriction of Chemicals program (REACH) (Reg. 1907, 2006). They implemented the Test Methods regulation (Reg. 240, 2008) and, most importantly, a Global Harmonized System (GHS) (Reg. 1272, 2008) for CLP. I will say more about REACH and GHS later. Chemicals in Europe have been under scrutiny for years and with progressively restrictive regulations.

European Chemical Regulations Now: Existing Active Substances, New Active Substances, Startups, and Dossiers

Current (2024) European chemical regulations are rooted in legislation from May 4 2012, when the European Parliament and the Council of the European Union instated Regulation No. 528 (Reg. No. 528, 2012). This document acknowledged a need for biocides to control harmful organisms, but emphasized that due to harmful effects (including persistence, bioaccumulation, toxicity, and endocrine disruption) on humans, animals, and the environment, their use and availability must be in accordance with this regulation. A distinction is made between "existing active substances" on the market before May 14 2000, and "new active substances" that were later introduced. Active substances used for Mosquito Control fall under Product Type (PT)18. Existing substances can be used until three years after their approval Regulation (EU) No 1062/2014,

whereas new active substances must be approved by passing a multistep process that involves creation/assembly and rigorous evaluation by an EU Biocidal Products Committee. Not surprisingly, many firms have popped up offering services to get new active substances approved, including project management, product testing, risk assessment, and full dossier development (an internet search for “biocide dossier company” will pull up many such companies). Through its 97 articles, the regulation spells out policies and procedures that teeter on a balance between protecting health and the environment and protecting the market. The most important and repeated elements are the procedures and standards for substance authorization and the procedures for introducing, keeping, or removing substances on the list of approved active substances. Like most legislative documents, this is a cumbersome read.

REACH and How Chemicals are Excluded

As a professor with expertise in the toxicology of insecticides, I was especially interested in the “Exclusion Criteria,” which comprise the heart and soul of REACH. Active substances that exhibit the following exclusion criteria will not be approved if they are: 1) carcinogenic, mutagenic, or reprotoxic; 2) endocrine disruptors; 3) persistent, bioaccumulative, or toxic; or 4) persistent and bioaccumulative (European Chemicals Agency, 2024). There are conditions for active substances for which suitable substitutions cannot be found to continue with an exemption for up to five years. Simply put, these criteria are leading to the disapproval of active ingredients previously used in Europe.

Us and Them Act 1: Comparing Mosquito Adulticide Restrictions Between the US and Europe

As I navigated the complexity of regulatory documentation, I discovered that many adulticides we routinely use in the US are no longer approved by the EU or the European Chemicals Agency

(ECHA) (Table 1). Note that approval for currently “ECHA Approved” substances expires in the next two years. Evaluating insecticide impacts on human health has intensified, especially in their function as endocrine disruptors. During the expert panel and personal conversations at the EMCA, my new European colleagues predicted that adulticides would be banned in Europe within a couple of years. Evolving exclusion criteria and growing regulation from an ebb and flow: pesticide designers make better products with improved pesticidal action, while regulatory science effectively counters with better protocols to measure biological and ecological impacts.

Us and Them Act II: The Global Harmonized System and Pesticides

Initially proposed in 1993 at the Earth Summit in Rio de Janeiro, the GHS is a CLP that, at its core, boldly and simply communicates hazard information using hazard pictograms consisting of black and white figures in red diamonds, plus signal words like “Danger” and “Warning” with a hazard statement. The EU holistically adopted this system (including for PT18 chemicals) in 2008 (Reg. (EC) 1272). US adoption is less clear. The US Environmental Protection Agency has not adopted GHS despite touting its benefits for years. However, like many countries, the US Occupational Safety and Health Administration has selectively adopted the GHS.

Us and Them Act III: Will Endocrine Disruption be the Final Nail in the “European Pyrethroid Coffin?”

Etofenprox and pyrethrins are currently being evaluated as endocrine disruptors, one of the REACH exclusion criteria listed above. There is a powerful wave of research worldwide on pesticides and endocrine disruption. The range of approaches is broadly anchored in clinical studies, field studies, and intensive laboratory studies using a diverse range of model systems (zebrafish, rodents, and human cell lines, to name a few). As

science marches forward, more active ingredients are expected to be evaluated as endocrine disruptors.

The Silent Partners

European attention has focused on two phenomena undermining the need for adulticides: the *Ae. albopictus* invasion, and resistance of mosquitoes to insecticides. *Ae. albopictus* is a diurnal container breeder for which adulticides have limited efficacy and are rarely used. Mosquitoes in Europe are increasingly exhibiting resistance to insecticides in multiple modes, thus shifting the insecticide argument from regulation because of their harmful effects to limiting use because of the decline in efficacy. Effectively, the message is that adulticides are less needed and that the diminishment of chemical controls is somehow less noticeable or less concerning. Non-chemical controls were commonly discussed at the EMCA conference. There were many presentations on control tactics involving various traps, and they seem poised to embrace them, including sterile insect techniques, *Wolbachia*, attractive toxic sugar baits, genetic methods, autodissemination, and spatial repellents. Note, however, that repellents are also under regulatory evaluation by the EU and ECHA as active ingredients.

A Crystal Ball for Mosquito Control in Europe?

Based on my discussions with EMCA members and my deep dive into the published regulatory legislation of the EU and the ECHA, I predict that adulticides will be banned for mosquito control in Europe. The use of larvicides will also decrease, although *Bti* appears to have a long future. Passive adult controls, like traps and bait stations, will likely increase in prevalence due to technological advances and the deployment of more units of long-established hardware. Invasive mosquitoes will continue to expand their footholds, vector-borne diseases will continue to threaten, and multifaceted mosquito resistance will be a continuous problem.

The question for mosquito control in the US is simple: What can we learn from this?

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European Chemicals Agency. Search for chemicals. <https://echa.europa.eu/information-on-chemicals>



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Table 1. US-Registered active substances used in mosquito control and approval status in Europe (EU and ECHA).

Active substance (and US application*)	US Registered?[1]	EU Approved?[2] (end date)	ECHA Approved?[3] (end date)
Deltamethrin (gru, aer) **SS	YES	YES (15/08/2026)	YES, renewal in progress (31/03/2026)
Etofenprox (gru, grth, aer) **ED	YES	YES (31/03/2027)	YES, renewal in progress (30/06/2025)
Permethrin (gru, grth, aer) **SS	YES	NO	YES, renewal in progress (30/06/2025)
Pyrethrins (gru, grth, aer) **ED, SS	YES	YES (15/06/2026)	NO
Sumithrin (gru, aer)	YES	NO	NO
Prallethrin & Sumithrin (gru, aer)	YES	NO	NO (initial application in progress)
Sumithrin/Phenothrin (grth)	YES	NO	NO
Malathion (aer) **SS	YES	YES (31/07/2026)	NO
Naled (aer)	YES	NOT REGISTERED	NOT REGISTERED
Methoprene (grlv, aerlv)	YES	NO	YES, (31/08/2025)
Pyriproxyfen (grlv)	YES	YES (31/07/2035)	YES, renewal in progress (31/01/2025)
<i>Bacillus thuringiensis israelensis</i> (grlv, aerlv)	YES	YES (30/06/2038)	YES, (31/01/2025)
<i>Lysinibacillus sphaericus</i> (grlv, aerlv)	YES	NO	YES, (31/01/2025)
<i>B.t.i. & L. sphaericus</i> (aerlv)	YES	NO	YES
Spinosad (grlv, aerlv)	YES	YES (15/03/2025)	YES, renewal in progress (30/04/2025)

*Key for US application type: Ground ULV = gru, Aerial = aer, Ground Thermal aerosols = grth, Ground Larval = grlv, Aerial Larval = aerlv

**Properties of concern: SS = skin sensitizing, ED = endocrine disruption

[1] EPA. Active Pesticide Product Registration Informational Listing (APPRIL)

[2] EU. Search for active substances, safeners and synergists.

[3] ECHA. Search for chemicals.

The (not so) Secret Life of *Mansonia* Mosquitoes: Understanding Their Behavior to Target Their Control

by Mollie M. Davies

Introduction

Invasive plants can be detrimental to the health of aquatic ecosystems. In addition to clogging waterways, plants like water hyacinth (*Eichhornia crassipes*) and water lettuce (*Pistia stratiotes*) serve as host plants for immature stages of mosquitoes in the genera *Mansonia* and *Coquillettidia* (Burton 1965). Larvae of these species have modified sclerotized siphons to pierce the roots of aquatic plants, helping them to hide and avoid predators like dragonfly and damselfly naiads. They are also a challenge to control (Bosak and Crans 2002). Because they occupy a lower space in the water column than other mosquito larvae that typically rest at the surface of the water, conventional larvicides are less effective at controlling *Mansonia* and *Coquillettidia* species. Using mechanical control to remove host plants can reduce *Mansonia* and *Coquillettidia* populations, but because

these species use more than one plant for oviposition and potentially for their different life stages (Saraiva et al. 2023), they might easily adapt to this change in their environment. My study recorded the abundance of *Mansonia* egg masses at a field collection site in Madisonville, LA, from August to November 2023.

Field Site Collection

Adult *Mansonia* mosquitoes were surveyed using Centers for Disease Control and Prevention CO₂ traps with no light. We also monitored for oviposition and collected *Mansonia* eggs by sampling *Salvinia minima* and *Lemnoides* species throughout the season. In our area, *M. titillans* dominates over *M. dyari* in trap counts, so we anticipated collecting mostly *M. titillans*. *Mansonia* oviposits onto the underside of a variety of aquatic plants, including *Salvinia minima*, *E. crassipes*, and *P. stratiotes* (Chandra et al. 2006,

Chiang et al. 1985, Saraiva et al. 2023) so we were interested in collecting both egg masses and adults from the field populations.

Field Collection, Rearing, and Maintenance

In four months of surveillance for *Mansonia* egg masses, we collected 112 egg masses on the leaves of *S. minima* and *Lemnoideae* (duckweed) species, 93 of which were found on *S. minima* and 19 on *Lemnoideae* spp. We noticed through collecting egg masses and through surveillance of *Mansonia* adult females throughout the mosquito season, that the generation time was approximately a month. This was indicated by a greater number of adult females collected in host-seeking traps in months where average egg mass collections were fewer (Fig. 1). In the laboratory, field-collected and laboratory-oviposited *Mansonia* also took about a month to become adults.

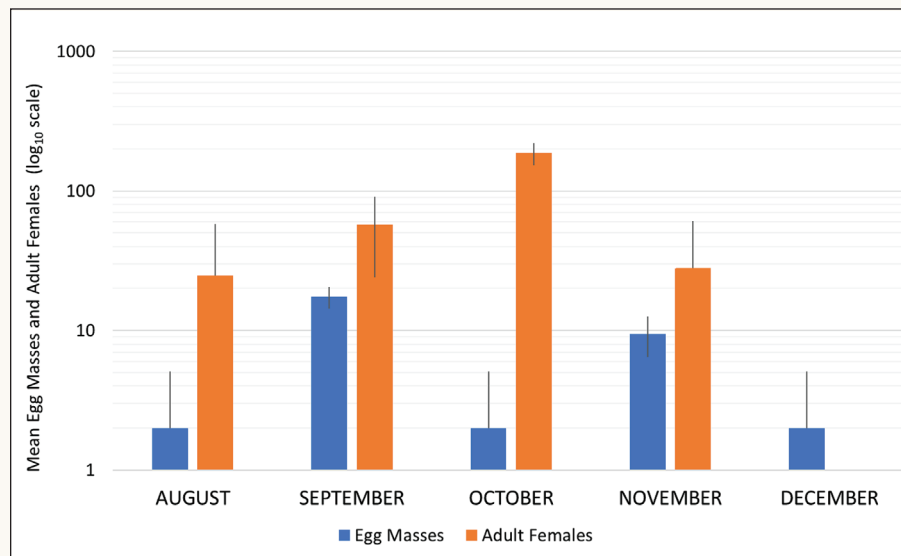


Fig. 1. Mean *Mansonia titillans* egg masses and adult females collected per surveillance trap in August-December 2023. Adult females were collected from several surveillance traps. Egg masses were collected at a productive *Mansonia* field site in Madisonville, LA.

Mansonia titillans were successfully reared under laboratory conditions from egg to adult from field and laboratory oviposited eggs (Fig. 2). Egg masses oviposited by field-collected females that were blood-fed in the laboratory eclosed 4-5 days after oviposition and pupated, on average, 30 days later. Although we are unsure of when field egg masses were oviposited, mosquitoes from such egg masses developed at the same rate as F1 individuals originating in the laboratory. We saw high mortality among pupae originating from both field-collected and laboratory-oviposited eggs, with only a small number of mosquitoes successfully emerging as adults.



Fig. 2. *Mansonia titillans* field collected and blood-fed in the laboratory ovipositing on *Salvinia minima* in a petri dish of water.

Mosquitoes in the *Mansonia* genus thrive in complex aquatic habitats, which makes their survival difficult to predict in the field and the laboratory. Although we found *Mansonia* egg masses on *Lemna minor* and *S. minima*, maintaining healthy plants under insectary conditions is challenging. *Pistia stratiotes*, *S. minima*, *E. crassipes*, and *L. minor* all deteriorated rapidly in the laboratory, which might be the reason we saw high mortality in later instars and pupae. High mortality due to plant decay has previously been an obstacle in rearing *Mansonia* mosquitoes, so artificial attachment substrates like polystyrene are often preferred (Breeland et al. 1981). While it is suggested that immature *Mansonia* mosquitoes require macrophytes to breathe (Johnson and Russell 2019), we noticed that early instars survived without plant attachment, remaining at the surface of the water for days. However, later instars did not survive for more than a few hours without attaching to a host plant and died if attached to decaying plant material.

Larval attachment to macrophytes may only be beneficial with healthy plants. We noticed later instars would remain attached to free-floating, decaying roots of *P. stratiotes*, resulting in larval mortality. The oxygen-rich

aerenchyma of *E. crassipes* helps immature *Mansonia* survive (Amorim et al. 2022), but this support system slowly breaks down as the plant decays. Although immature *Mansonia* have been found to tolerate low dissolved oxygen levels (Sérandour et al. 2011), having access to a sufficient oxygen source is imperative to their survival. Plant health seemed to be a crucial factor in the oviposition and immature health and development of *Mansonia* species.

The health and size of host plants might dictate the health and abundance of the *Mansonia* mosquitoes they support. At the field collection site, younger *S. minima* seemed to have more egg masses than decaying or mature plants. In addition, we only found egg masses on smaller macrophytes like *S. minima* and *Lemna* species. Oviposition by *Mansonia* on smaller plants might be due to the leaf surfaces coming in complete contact with the water, ensuring complete submersion of eggs, but is something that we would like to investigate by surveying a greater variety of plants in the future. Larger plants with leaves extending above the water surface, including *E. crassipes* and *P. stratiotes*, may be less favorable for oviposition. Early instars in the field may use small

macrophytes for oviposition and initial larval attachment and migrate to larger host plants as later instars. Similar studies have hypothesized that *Mansonia* might use smaller plants for oviposition with the larvae transitioning to larger host plants with more extensive root systems and a more oxygen-rich environment (Saraiva, 2023). Later instars and pupae might benefit from larger root systems for more suitable attachment sites, oxygen availability, and because the roots conceal larvae from predators. Larvae attached to large macrophytes blend in as root hairs (Fig. 3) and egg masses themselves closely resemble the hairs on the underside of *Salvinia* leaves (Fig. 4). The survival of *Mansonia* seems to rely on more than one adaptation to avoid predators and other threats including mosquito control practices.



Fig. 3. *Mansonia titillans* larvae attached to *Pistia stratiotes* (water lettuce) root.



Fig. 4. Egg mass of field-collected *Mansonia titillans* on the underside of a *Salvinia minima* leaf in the laboratory, resembles the hairs on the underside of the aquatic plant.

Mansonia mosquitoes are challenging for traditional mosquito control techniques and a nuisance to the public's quality of life. We focused on the collection of individuals to establish a laboratory colony and observation of the behavior of immature mosquitoes. In the future, we hope to conduct site attractiveness oviposition assays, further investigate their life history traits to better understand their seasonality, and measure resistance in our populations. We plan to continue to survey new field sites in addition to our original collection site to better understand the associations of *Mansonia* with their host plants and their prolific nature.

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Using Veterinary Medicine to Control Mosquito-Borne Disease: A One Health Approach

by Amy Bunch

Over 17% of all infectious diseases are vector-borne. Unsurprisingly, individuals worldwide risk contracting diseases transmitted by ticks, mosquitoes, fleas, and other blood-feeding vectors. Global travel, urbanization, and changing climate and vector ranges contribute to the spread and emergence of vector-borne diseases (VBD). For example, West Nile virus is now a regularly occurring and firmly established disease in much of the US. There is a growing threat from invasive viruses like dengue, chikungunya, and Zika. The control and prevention of these diseases pose significant challenges, especially given the limited availability of vaccines.

Our ability to control VBD relies on detecting, preventing, and responding to these threats. According to the Centers for Disease Control and Prevention (CDC) report *A National Framework for the Prevention and Control of Vector-Borne Disease in Humans*, some challenges to VBD control and prevention include inadequate and stressed surveillance systems, limited diagnostic capabilities, restricted options for vector control at the individual level, and the absence of vaccinations for many mosquito-borne diseases of concern.

A partnership between animal health, environmental management, and public health is increasingly crucial in addressing the complex challenges posed by mosquito-borne and other arboviral diseases. The One Health concept is at the forefront of this multidisciplinary approach, recognizing the interconnectedness of people, animals, plants, and their shared environment. This collaborative strategy aims to optimize health outcomes by acknowledging the

interdependence of human health, animal health, and environmental health. Including veterinarians and other veterinary health professionals as partners in a multidisciplinary team can help mitigate some of the challenges of addressing VBD. This cooperation can span multiple areas, such as surveillance, research, education, prevention, and vector control, and offers opportunities to use their unique skill sets and perspectives.

Surveillance

Veterinary medicine plays a crucial role in disease surveillance, with veterinarians optimally positioned to detect zoonotic diseases in animals due to their extensive contact with diverse species, ranging from companion animals to livestock, laboratory animals, and exotic species. Their engagement with farmers, ranchers, pet owners, zoos, and animal shelters facilitates collecting samples and reporting illness cases from various environments. Their routine public health work includes health examinations, vaccinations, and parasite control programs, contributing to a population-level perspective on disease control, vector control, and prevention strategies.

Reporting

Beyond diagnosis, prompt reporting of arboviral illnesses by veterinarians to local or state public health agencies, mosquito control agencies, and agriculture departments is imperative. Reporting facilitates swift responses from human health and other pertinent agencies, enabling targeted vector control or other public health interventions. Reporting findings and sharing data also contribute to the collective understanding of disease patterns and prevalence.

Diagnostic Testing and Risk Assessment

Diagnostic testing on animals is instrumental in confirming disease presence, aiding in early detection, and is vital for assessing the risk of transmission. Datasets from veterinary diagnostic laboratories, large corporate practices, and pet insurance companies can be integrated with location information to map the incidence and potential risk of diseases, help localize hot spots, or find areas with previous increased risk. Veterinarians in research, industry, government, and laboratories are all integral to developing and implementing diagnostics for animal use.

Prevention and Control

Veterinarians play a pivotal role in disease and vector control by advising owners, facilities, institutions, or producers on preventive measures such as vaccinations, mosquito repellents, and integrated pest management strategies. While vaccines for WNV and EEE are not yet available for humans, horses have good vaccinations for both viruses. Appropriate vaccination of animals and education on reducing animals' exposure opportunities will reduce the overall disease burden in an area, reducing transmission risks. Additionally, veterinary organizations and groups can use their voice and platform to advocate for policies supporting integrated mosquito control programs, research funding, and collaborative efforts between health sectors.

Education and Awareness

Educating and informing owners and the public about VBD is a key responsibility shouldered by veterinarians. Opportunities include

distributing informational materials at veterinary clinics and educating students about protection from vector species during school presentations. Veterinarians are in a favorable position to promote One Health concepts and ideas. Demonstrating the impact of VBD on human and animal populations can motivate a broader audience to engage in preventive measures.

Research

There are opportunities for collaboration between veterinarian researchers and those in other disciplines in many research areas, including vaccine development, epidemiological studies, vector-host interactions, and others.

Collaboration

Effective control of VBD requires close collaboration between stakeholders, including mosquito control agencies, universities, public health agencies, wildlife agencies, private businesses, and veterinarians. With their scientific training and distribution among many sectors of government, industry, public health, and animal care, veterinarians

can play a crucial role in collaborative efforts.

How to Reach Out

The integration of veterinarians into vector control efforts can be achieved through targeted outreach efforts, including engagement with professional associations, collaborative workshops and seminars, and online platforms. Participation in veterinary conferences and research initiatives and collaboration with veterinary schools and hospitals provides many opportunities for engagement and cooperation. Appoint professional liaisons or contact persons within vector control agencies specifically responsible for engaging with veterinarians. A designated point of contact can streamline communication and foster a stronger working relationship. Finally, collaborate with government health departments that oversee human and animal health. These departments can serve as intermediaries and facilitate communication between mosquito control agencies and veterinarians.

In conclusion, the involvement of veterinarians in mosquito-borne

disease control is not just a beneficial addition; it is a strategic imperative. Their unique skills, extensive networks, and existing contributions to public health make them invaluable One Health partners in the collective effort to combat vector-borne diseases.

REFERENCES CITED

Centers for Disease Control and Prevention. 2020. A National Public Health Framework for the Prevention and Control of Vector-Borne Diseases in Humans. Atlanta, Georgia. <https://www.cdc.gov/nceid/dvbd/framework.html>



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From Where I Roam: AMCA has Developed Educational and Training Materials for All Vector Control Programs

by Daniel Markowski
AMCA Technical Advisor

The American Mosquito Control Association, as a leading authority in the vector management workforce, has worked with multiple partners to create a new standard of care for protecting public and environmental health through training and advocacy. To accomplish this goal, we have developed several materials to aid applicators, students, and vector control professionals. In 2023, we developed a comprehensive online course designed to complement our recent Best Management Practices (BMP) manual update (Fig. 1). This work was funded with grants from the Centers for Disease Control and Prevention (CDC) and to date 751 participants enrolled in the course.

AMCA's Virtual Training Course consists of 13 modules or videos that cover each chapter of our BMP Manual. Upon completion of the full program, participants receive a Certificate of Completion. The training course can be found online at AMCA's website and is free for all participants. We hope everyone enjoys it, learns something, and provides feedback on how we can improve it in the future! AMCA's Best Practices for Integrated Mosquito Management Virtual Training Program (<https://amca.ce21.com/item/best-practices-mosquito-management>) can be found on AMCA's website.

While we hope everyone finds our virtual training course useful, we also hope users will check back regularly for updates and improvements. One of the advantages of a virtual program is modules can be updated as new information becomes available or as participants provide feedback for

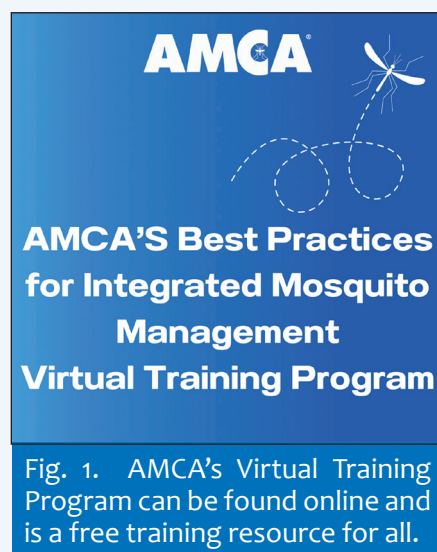
improvements. Also, we have plans to expand the training modules with content from AMCA's Emergency Response BMP. Furthermore, we have plans to develop content related to Unmanned Aircraft System Operations, Endangered Species Act (ESA) Mitigations, and more. In short, this is the first step, but it is by no means our last!

In addition to the virtual training program, I have worked with the North American Pollinator Protection Campaign (NAPPC) to develop pollinator positive messaging that we hope will be useful to both the public and applicators. We have developed educational flyers and cards that can be downloaded at (<https://www.pollinator.org/nappp/pesticide-education>). The first flyer developed was designed to educate applicators on each of the key bee safety messages that applicators would find on a pesticide label (Fig. 2). The flyer also includes additional steps to protect pollinators.

In addition to this flyer, we developed VectorControlcardsdesignedtoreduce non-target impacts on pollinators that can result from control efforts of pests of public health importance, such as ticks and mosquitos. Three cards were developed, each with a similar message, but with slight differences designed for different target audiences - the homeowner, multi-family and large housing managers, and mosquito control professionals (Fig. 3). I encourage people to visit the NAPPC website, download these materials, and distribute them to residents and applicators in their jurisdictions. These items are also free to download and post online or distribute as printed versions at any mosquito control awareness or pollinator protection event.

I hope that these materials represent just the beginning of a broad initiative to set a new national standard for the training and recruitment of vector management professionals. A national standard for training our vector control workforce is integral to the AMCA's core mission of providing leadership and education to our members and the larger vector control workforce. I hope that our virtual training course and supplemental flyers, such as the NAPPC materials, not only enhance the capabilities of applicators and professionals in the field but also contribute to broader public health initiatives and collaboration.

Acknowledgments. Jennifer Gordon of Bug Lessons Consulting, LLC, was instrumental in the development and completion of AMCA's Virtual Training Program.



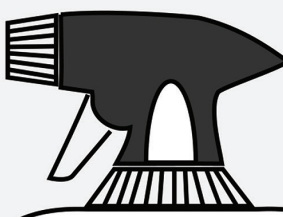


PROTECT POLLINATORS READ PESTICIDE LABELS

Four steps to reading a pesticide label to reduce risk to pollinating insects



1. OPEN THE LABEL.
STEP 1 - See if product is toxic and has more than 8 hour residual contact toxicity in the **ENVIRONMENTAL HAZARDS** statement.
STEP 2 - Look for general and crop-specific directions under **DIRECTIONS FOR USE**.



2. BEE TOXIC PESTICIDES will be indicated by the phrase **"TOXIC"** or **"HIGHLY TOXIC TO BEES"**. If toxic:


→


don't spray when in bloom wait until over 80% of petals fall

ENVIRONMENTAL HAZARDS

This pesticide is toxic to mammals, birds, fish and aquatic invertebrates.

This product is **highly toxic** to bees exposed to direct treatment or residues on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops if bees are **actively foraging** the treatment area.

DIRECTIONS FOR USE

Protection of Pollinators
 APPLICATION RESTRICTIONS EXIST FOR THIS PRODUCT BECAUSE OF RISK TO BEES AND OTHER POLLINATING INSECTS.

Tree Nuts (Crop Group 14-12)

Pest	(oz/acre)
Aphids	0.75 - 1.5 (0.023 - 0.047 lb/acre)
San Jose scale	2.75 (0.086 lb/acre)

Advisory Pollinator Statement: Notifying known beekeepers within 1 mile of the treatment area 48 hours before the product is applied. The RT25 for this product is less than or equal to 3 hours.

Restrictions:
 - Do not apply this product any time between 3 days prior to bloom and until petal fall.

3. Some bee-toxic pesticides BREAK DOWN IN A FEW HOURS. Learn if these pesticides can be applied at bloom in the evening:



1. "FORAGING" or "VISITING" = remains toxic for more than 8 hours. **DON'T APPLY TO FLOWERING PLANTS!**



2. "ACTIVELY FORAGING" or "ACTIVELY VISITING" = remains toxic for less than 8 hours **ONLY APPLY IN THE EVENING WHEN BEES ARE NOT ACTIVE!**

4. GENERAL AND CROP-SPECIFIC USE DIRECTIONS
 Newer labels have **additional precautions** for using products around honey bees. Here you will find what practices to follow to keep bees safe and/or **restrictions around whether a pesticide can be applied around crop bloom time**. Instructions **may apply to all crops, or include crop-specific restrictions**. The label may also specify a value **RT25**, a measure of the time that field weathered residues remain toxic to bees on contact with foliage.

www.pollinator.org/pesticide-education

Graphic by Iris Kormann and Andony Melathopoulos - Oregon State University; Rose Kachadoorian and Gilbert Uribe - Oregon Department of Agriculture
 Text on reverse of card by the NAPPC Pollinator Health Task Force

Fig. 2. NAPPC's Reading Pesticide Labels flyer was developed to be an accompaniment for continuing education programs for certified pesticide applicators.



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Tips for vector control professionals

Pollinator-Friendly Vector Control

You can Protect People and Pollinators with Local Vector Control Agency and Pollinator Expert Partnerships.



Pesticides

Pesticides can impact survival, growth, reproduction and/or behavior of pollinators.

Use targeted applications as part of a full IPM Program:

- Make applications when pollinators are least active (e.g., late afternoon/early evening).
- Avoid direct application to blooming plants
- Consider the environmental fate of products and their acute (e.g., LD50) and chronic (e.g., NOAEL) toxicity to pollinators
- Granular and ultra low-volume (ULV) formulations are preferred
- Use host-targeted techniques (e.g., tick tubes) to minimize broadcast applications and only make applications based on action thresholds (i.e., avoid prophylactic use of pesticides)



Habitat Modification

Removing mosquito and tick habitat can be effective but can impact pollinators.

- Consult local pollinator experts; use targeted practices to avoid removing pollinator habitat
- Dump, drain, or remove sources of standing water and encourage the public to do so
- Remove leaf litter, invasive plants that harbor ticks, and clean trail edges
- Remove brush piles and rodent harbourage sites



Biological Control

- Consider local predators, fungi, and parasitoids
- Biorational larvicides minimize pollinator impacts
- Consider alternative methods (e.g., SIT, host reduction)



Surveillance

- Routine surveillance for each vector life stage is fundamental
- Establish abundance and infection rate-based action thresholds
- Use surveillance data to time applications and target focal geographies or hosts

Fig. 3. NAPPC's Vector Card is ideal for distribution at Pollinator Protection Week events in your area.

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- ♦ Graphics may be included in your Word document but **must** also be sent as separate files.

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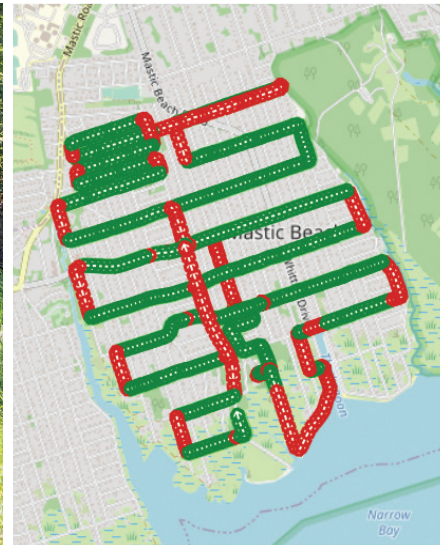
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