ADA COUNTY
MOSQUITO ABATEMENT DISTRICT

2019 Annual Report

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12/31/2019

Contents

Mission Statement

The mission of Ada County Mosquito Abatement District is to control mosquitoes that are both a nuisance and potential vector of disease to Ada County residents using the best available data and sound science practices through Integrated Mosquito Management (IMM).

District History

Ada County's original Mosquito Abatement District (MAD) was the Three-Mile Creek District established in 1974, which included 12 square miles between Cloverdale and Cole Roads and Franklin and Columbia Roads. There were several district annexations made over the next few decades, and in 2004, Ada County Board of County Commissioners agreed to incorporate and operate what was then called the Southwest Ada County Mosquito Abatement District. Today, the district is known as Ada County Mosquito Abatement District (ACMAD) and covers 406 square miles, with the majority of the district covering major residential and urban areas.

ACMAD Management and Staff

Adam Schroeder, Director
Desireé Keeney, Deputy Director
Rachel Pollreis, Division Coordinator
Diana Beahm, Administration Specialist II
Additional Staff: four full-time field employees, and up to 16 seasonal employees; one full-time GIS Analyst (shared with Weed and Pest departments); four full-time administration staff (shared with Weed and Pest departments).

Training and Education

ACMAD works hard to train and educate all staff members as to best and most current management practices and methodologies in mosquito control. All staff members who recommend or apply pesticides are required by ACMAD to hold and maintain an Idaho Professional Applicator license. Most of the education provided by ACMAD to the applicators and staff members qualifies for continuing education certification credits (as regulated by the Idaho State Department of Agriculture). Listed below in *Table 1* are the training seminars which ACMAD staff attended prior to and during the 2019 season.

2019 Seminar/Training	People Sent	Hours	Total Hours
AMCA Washington Days, DC Meeting	1	30	30
AMCA Annual Meeting	2	32	64
NWMVCA Spring Workshop	1	16	16
NWMVCA Fall One-Day Conference	13	8	104
NWMVCA Fall Conference	3	24	24
ECA of Idaho	1	4	4
SWIWCA Fall Seminar	10	8	80
Total Hours in Training			**323**

Table 1: *External training in seminars and conferences for full-time and seasonal staff in 2019.*

Memberships, Affiliations, & Grants

ACMAD is an active member of several professional vector control associations. These memberships help to increase professional knowledge base by keeping ACMAD up-to-date on new abatement methods, best available science practices, and knowledge of potential legislation that will affect ACMAD operations and/or residents.

ACMAD is proudly affiliated with the following organizations:

- Idaho Mosquito and Vector Control Association (IMVCA)
- Northwest Mosquito and Vector Control Association (NWMVCA)
- American Mosquito Control Association (AMCA)

ACMAD also receives grant funding from the Idaho Department of Health and Welfare (IDHW) for the purpose of pursuing a mutual goal of mosquito control, surveillance, and disease transmission reduction. A total of $7,000.00 in grant funding was used for mosquito disease testing in 2019.

Integrated Mosquito Management (IMM)

ACMAD follows an) IMM program which is designed to benefit and to have minimal adverse effects on people, wildlife, domestic animals, and the environment. An IMM program includes education and prevention, cultural, physical and mechanical controls, biological control, and chemical control of mosquitoes and mosquito development sites. We recognize that not all mosquito populations can be controlled using these methods, and there is no one way to use these practices due to variations in the mosquito population abundance, species diversity, time of year, development habitats and environmental conditions. ACMAD considers all controls carefully, using the aforementioned techniques as well as cost-versus-benefits analysis, efficacy, potential health effects and ecological impacts, including exposure risk potential for vector-borne diseases.

Public Education

Public education is a primary objective of any IMM program. Through public education and outreach we can work to better inform the residents of Ada County about the best forms of protection and control options against mosquitoes, which might help to limit the interactions between mosquitoes and people, reducing the potential spread of WNV and other vector-borne diseases.

Listed below are some examples of public education and outreach conducted in 2019:

- ACMAD web presence: Online Mosquito Tracker, social media, and Ada County website
- Booth at the Western Idaho Fair
- KTVB interview discussing local WNV+ presence and citizen control methods
- Fishin' with the Commission event
- Children's coloring contest for National Mosquito Control Awareness Week
- Education Trailer at multiple municipal parks for National Mosquito Control Awareness Week
- Laboratory tour of primary STEM educators facilitated through Boise State University
- The many face-to-face interactions between field staff and the public when working on a daily basis during the mosquito season, especially during WNV positive outbreaks.

History of WNV in Ada County

West Nile virus (WNV) was first detected in Ada County in 2005, and in 2006, Idaho led the nation in human cases of WNV, with over 1,000 reported cases resulting in 23 WNV-related deaths. Nearly every year since then, mosquitoes infected with WNV have been collected by ACMAD. WNV is an arthropod-borne flavivirus (arbovirus) disease passed between birds and mosquitoes in a cyclical fashion. Mammals can also be infected with the disease, but are considered "dead-end hosts "or "incidental hosts" of the virus, and are unable to pass the disease any further; however, mammals can contract the virus and become ill (*Fig. 1*). On average, 80% of those infected with WNV may not show symptoms, or show only mild symptoms. Some of the most commonly reported symptoms are fever, headaches and fatigue, and 1% of those who are infected develop severe neurological symptoms (such as encephalitis), which may result in paralysis or death (CDC, 2019).

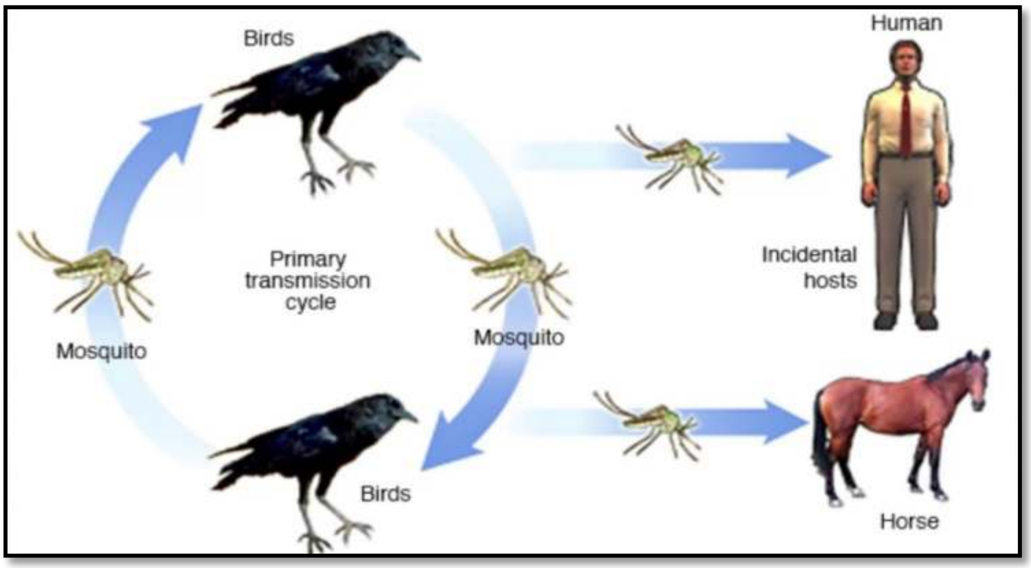

Figure 1. The transmission cycle of WNV, the most prevalent arbovirus in Ada County. Adapted from Mayo Foundation for Medical Education and Research. (https://www.mayoclinic.org/diseases-conditions/west-nile-virus/multimedia/west-nile-virus-transmission-cycle/img-20006044).

The Idaho Health and Welfare Department (IDHW) reported that there were 11 human cases of WNV in Idaho as of November 7, 2019, with no cases resulting in death (IDHW, 2019). Nationwide, 2019 has seen 731 cases of WNV with 37 cases resulting in death (CDC, 2019).

Mosquito Surveillance Operations

Ada County mosquito surveillance operations began May 6, 2019 and continued through September 20, 2019 for a total of 20 weeks (weeks 18-37) shown in *Fig. 2*.[1] The most commonly-used trap was carbon dioxide (CO_2)-baited Encephilitis –Virus-Surveillance (EVS) light traps, which, on average, ran for 10 hours a night, using up to four lbs. of dry ice as an attractant. ACMAD placed a total of 2,251 mosquito surveillance traps during the 2019 season (n_{EVS}=2,192, n_{Gravid}=52, n_{BG}=16 and $n_{Rotational}$=4). Historically, a cumulative total of 514

[1] A list of all week numbers with corresponding dates can be found in Appendix 1.1.

trap locations have been used in Ada County; 149 locations were used for WNV surveillance during 2019.[2] Two surveillance crews were deployed every weeknight. The crews placed an average of 113 mosquito traps per week; which was an increase in weekly mosquito trapping by over 18% as compared to the previous three-year average. The trap failure rate was 6.63% (n=149) in 2019, which was much lower than 2018's failure rate of 13.33% (n=304).

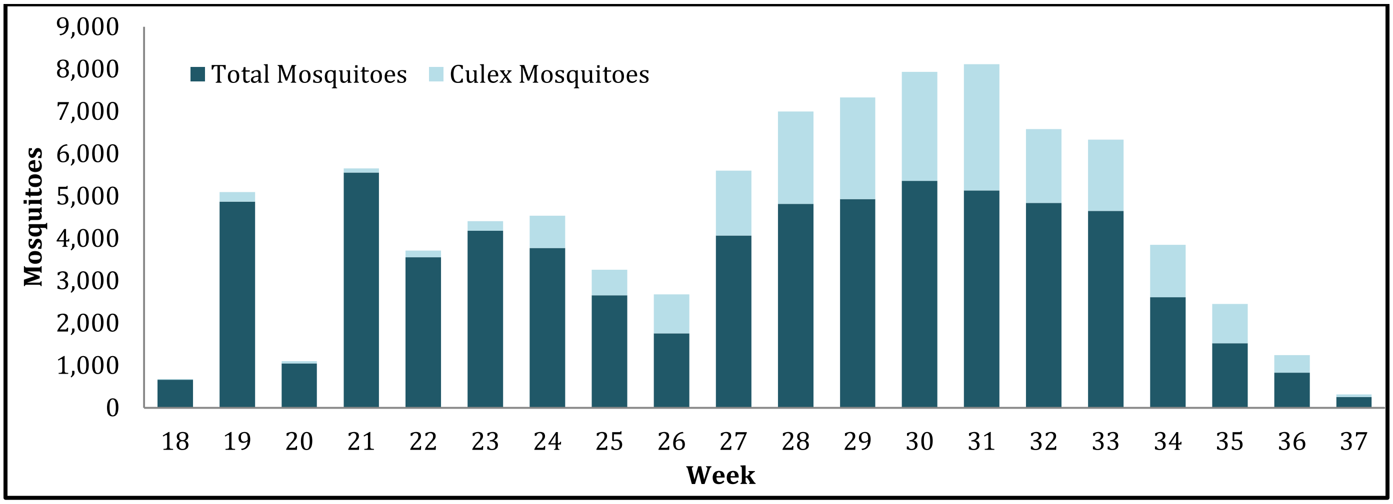

Figure 2. ACMAD's total mosquito sampling by week, with a distinction of important vector species (*Culex tarsalis & Culex pipiens*). Early season samples are primarily composed of nuisance (floodwater) mosquito species, with vector species abundance peaking in July-August.

During the 2019 season, ACMAD collected 67,068 mosquitoes. As seen in *Fig. 2,* WNV vector species, *Culex pipiens* (n=15,541) and *Culex tarsalis* (n=5,263) composed a yearly average of 30.9% mosquitoes trapped. In addition to monitoring the mosquito populations within Ada County, ACMAD tests all potential vector mosquitoes for WNV in-house through the use of Rapid Analytic Measurement Platform (RAMP) testing. This allows for a same-day response to positive WNV pools, and increases efficacy in controlling the potential spread of the disease.

Arbovirus Surveillance Operations in Ada County

ACMAD uses adult mosquito surveillance as a tool to monitor and reduce the spread of WNV. Upon collection of these traps, mosquitoes were separated by species, and the important vector species, *Culex pipiens* and *Culex tarsalis,* were then tested for WNV in a pool (1-50 individual *Culex* species of mosquitoes pooled together from a single site). In 2019, there were **25 WNV positive pools** detected in 23 trap locations found in Ada County.[3] When compared with data from 2018, ACMAD saw an increase of 36.00% in WNV positive pools, as well as a 57.12% increase in overall mosquito population from 2018.

[2] A map with all surveillance sites can be found in Appendix 1.2.
[3] A map depicting 2019 WNV+ locations can be found in Appendix 1.3.

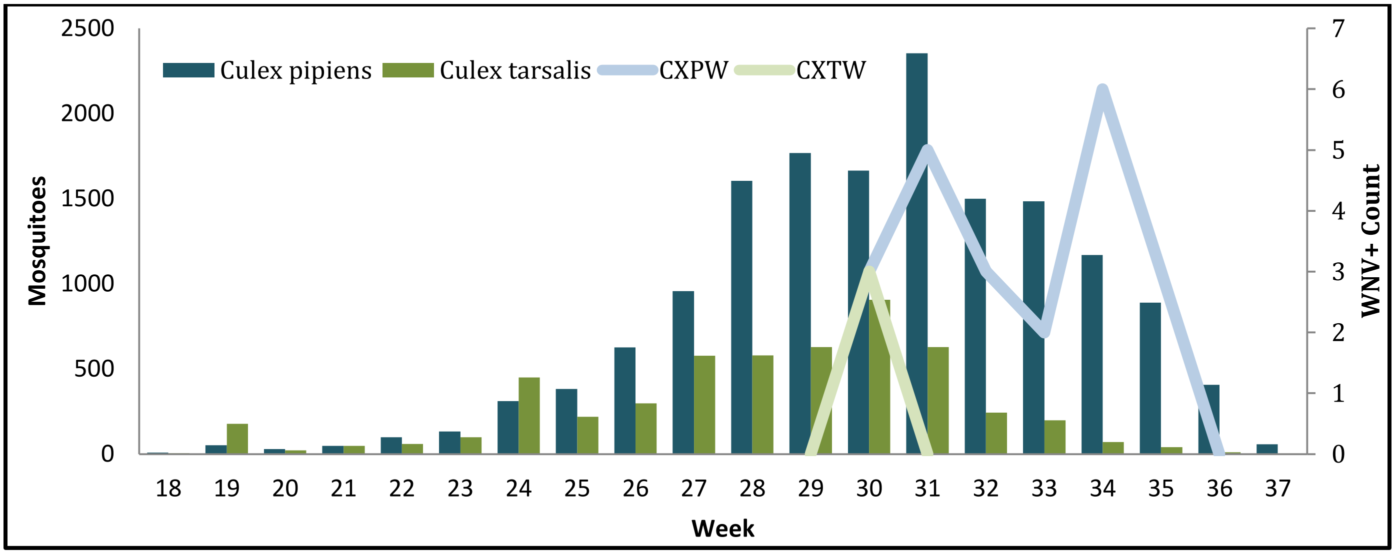

Figure 3. The above chart shows weekly *Culex pipiens* (CXPI) and *Culex tarsalis* (CXTA) collected samples and number of positive pools by each species (CXPW-*Culex pipiens* WNV+ and CXTW-*Culex tarsalis* WNV+) for the 2019 season.

A total of 1,847 RAMP tests were conducted during the 2019 season, which is an average of 11.15 mosquitoes per pool. When necessary, Reverse Transcription Polymerase Chain Reaction (RT-PCR) testing for WNV or St. Louis encephalitis (SLE) was conducted at the Idaho Bureau of Laboratories (IBL) on samples collected by ACMAD per a standard procedure set forth by the IDHW. Thirty-eight mosquito samples were sent to the IBL; WNV RNA was confirmed in 10 samples, and SLE was not found in Ada County during the 2019 season. The first mosquito pool to test positive for WNV was on August 6th, 2019 during week 31 (*Fig. 3*), which was one week later than in 2018.

Arboviral Risk Assessment

Ada County uses both a Minimum Infection Rate (MIR) calculation to assess risk of arbovirus transmission to the public as a variable in the WNV response matrix in additional to other factors and CDC's Vector Index Coefficient (VIC). Ada County uses both of these assessments along with other qualitative and quantitative factors within the surveillance area and further IMM tools to assess potential risk of transmission and to make management decisions and respond quickly and accordingly.

Note: MIR is expressed as the number of positive pools/1000 mosquitoes. In 2018, Ada County began quantifying transmission risk using the CDC's Vector Index Coefficient (VIC). This calculation is more in depth than previously used risk coefficients and accounts for pool size, geospatial factors, as well as multiple vector species in an area (CDC, 2013). VIC is expressed as the percent chance that a mosquito in any given mosquito trapped within a predetermined spatial zone will test positive for WNV. While VIC does not have a designated threshold for epidemic levels, it is an important indicator of arbovirus disease risk in Ada County, as there are two WNV vector species with differing habitat and population behaviors.[4]

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[4] CDC's *West Nile Virus in the United States: Guidelines for Surveillance, Prevention, and Control* describes the process of determining Vector Index Coefficient.

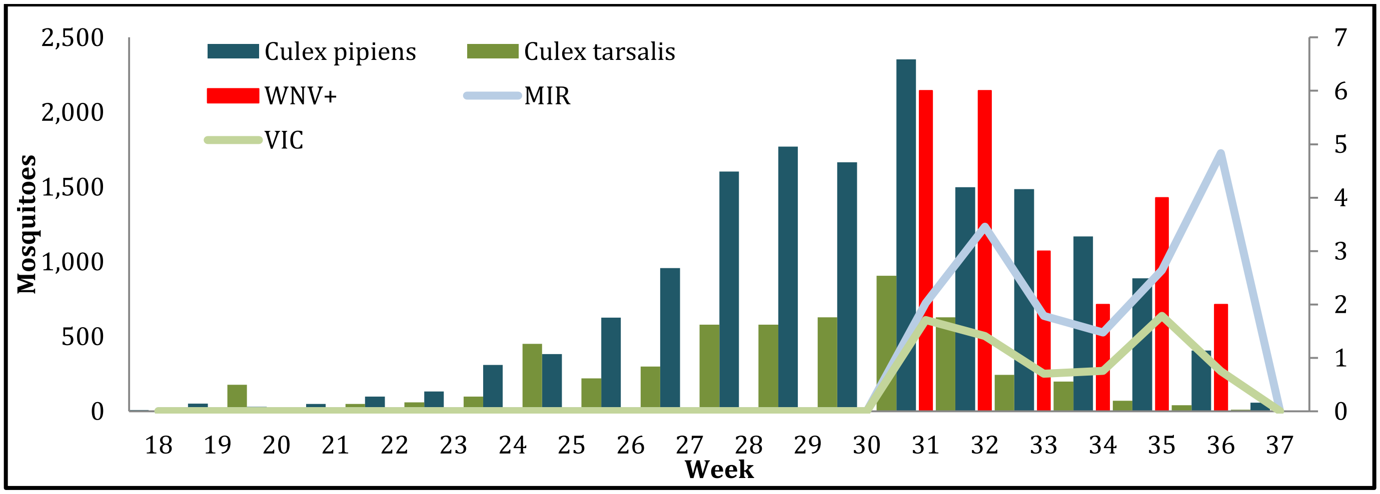

Figure 4. The minimum infection rate (MIR) and vector index coefficient (VIC) over time in 2019. These risk assessment coefficients help set thresholds for ground and/or aerial fogging and make best management decisions to reduce the spread of WNV.

In the comparison shown in *Fig. 4*, the distinction between these two risk assessment strategies can be observed. In 2019, the max MIR (4.8) was observed during week 36, when two positive pools were detected from a total of 416 *Culex* mosquitoes. The maximum VIC (1.78%) was observed during week 35 when four positive pools were detected from a total of 940 *Culex* mosquitoes. VIC accounts for many factors missed by MIR assessments, including the average number of infected vector species mosquitoes in each trap night in an area (CDC, 2013). The distinction between risk assessment tools comes from the notion that the arbovirus patterns differ in *Culex pipiens* and *Culex tarsalis.* It is important for ACMAD and other vector control institutions to compare multiple risk assessment variables and monitor aberrations closely. ACMAD will continue to use MIR and VIC combined with action thresholds to determine appropriate response to best protect the citizens of Ada County from vector-borne diseases.

Species Composition Data

In 2019, ACMAD collected 67,068 mosquitoes during WNV surveillance: *Aedes vexans* (n=43,504), *Culex pipiens* (n=15,541), *Culex tarsalis* (n=5,263), *Anopheles freeborni* (n=1163), *Culiseta inornata* (n=690), *Ochlerotatus nigromaculis* (n=498), *Ochlerotatus dorsalis* (n=130), *Aedes cinereus (n=109), Culiseta incidens* (n=105), *Coquillettidia perturbans* (n=39), *Ochlerotatus increpitus* (n=19) and *Ochlerotatus sticticus* (n=6). In 2018, *Aedes vexans* constituted 58.75% of sampled mosquitoes, which increased to 64.87% in 2019 (*Fig. 5*). *Culex pipiens* made up 20% of all trapped mosquitoes in 2019. *Culex tarsalis* population composition has dropped by nearly 40% since 2017, likely due to the more recent development of Ada County, as much of the habitat used by *Culex tarsalis* has been developed into urban and suburban areas which are primary habitat for *Culex pipiens*.

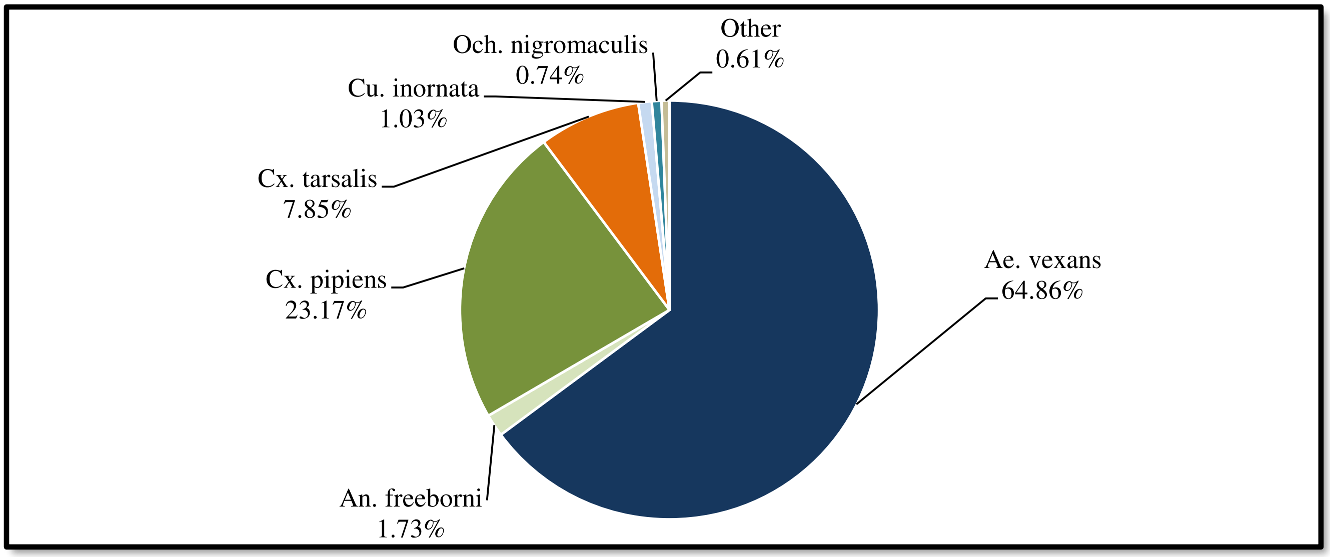

Figure 5. Species composition for mosquitoes sampled by EVS light traps, the remaining .61% (Other) is composed of *Ochlerotatus dorsalis* (n=130), *Culiseta incidens* (n=105), *Coquillettidia perturbans* (n=39), *Ochlerotatus increpitus (n=19) and Ochlerotatus sticticus* (n=6).

Mosquito Surveillance & Climate Data

Ada County had record-breaking rainfall this spring, with 10.71 inches as of May 28, 2019. This was the second wettest spring seen in Ada County since 1896 (Blanchard, 2019). Typical precipitation for Ada County occurs mainly outside of the mosquito development season, meaning most development sources are caused by irrigation and landscaping. *Fig.6* shows the total mosquito count and the *Culex* mosquitoes trapped by week. *Culex* species activity peaks when nightly temperatures are averaging 60-70+°F, and then slows down when nightly average temperatures reach 52-54°F or less, which is consistent with known *Culex* species behavior. The average temperatures were mostly typical of an Ada County summer, with a relatively wet spring, however; from week 23 to 25, the average temperatures fell close to 10°F from the previous week which is not typical. Additionally, there was a significant decrease in mosquito population during the two weeks following this anomaly.

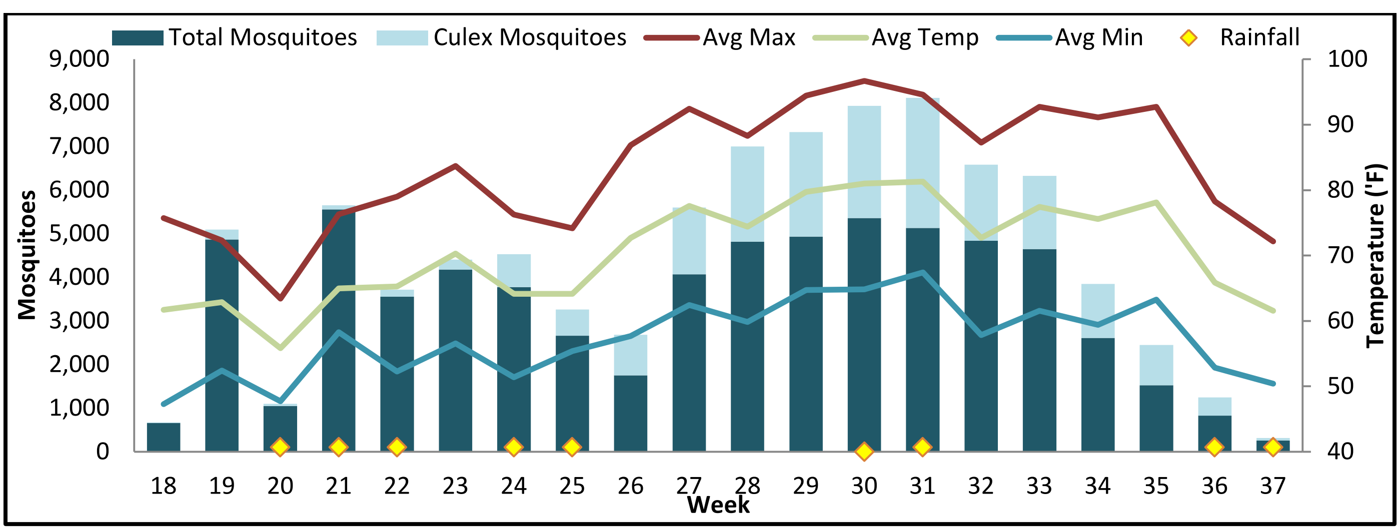

Figure 6. The correlation between mosquito population (left vertical axis) and climate (right vertical axis). The yellow diamonds represent the precipitation events to take place during the 2019 mosquito season.

Mosquito Larviciding Operations

The larvicide department spent the first week of the 2019 season studying and testing for the ISDA Pesticide Professional Applicator license exams. These exams ensure each field technician is educated on federal and state pesticide laws and regulations. There was an 83% pass rate after two weeks, for both the "Laws & Safety" and the "Public Health" exams, and a 100% pass rate one week following training. During the second week of training, in-house product knowledge testing occurred along with standard operating procedures and safety training of all seasonal employees. After education and training on safety and regulations, the seasonal employees were trained by full-time staff in the field on best management practices and mosquito control operations.

ACMAD continued pairing field technicians in 2019, as it allowed for the driver to focus on safe-driving practices and the second person to be the navigator, answer customer calls and to help to watch for new mosquito development sites. The two-person crew also allowed one person to complete inspections and/or treatments on smaller sites while the other person logged data. Having two technicians familiar with an area benefitted the department during transition periods throughout the season. During 2019, there were also two "floating" technicians that were not assigned to a specific larvicide zone. These technicians helped crews keep up with assigned areas by responding to WNV+ pools, and they also helped with larger treatments without disrupting daily operations in other zones.

Larval Site Inspections and Treatment Summary

Since 2018, ACMAD has mapped 1,995 new larvicide sites[5], for a total of 41,415 sites monitored during the 2019 mosquito season. After the mosquito season ended in October, full-time staff also mapped additional Drain Inlets (DIs) and storm drains in new construction areas and on new roads, bringing the total active sites to 41,782, which is an increase of 14.6% over the past three years. Of the total sites mapped in 2019, 78.9% are DIs, which are a favored oviposition habitat for *Culex pipiens,* an important vector for WNV. The larvicide crews made 99,262 site inspections this year, which was a 14.4% increase over the past three years. This led to 64,780 treatments, 3.99% more than 2018. That is an average of 3,970 inspections and 2,591 treatments per week (*Fig. 7*). The larvicide crew completed 726 public service requests in 2019, which is a 50.8% increase from 2018 operations. The larvicide crews treated a total of 881 acres by ground applications, which is an increase of 5.7% from 2018 season.

[5] All larvicide sites mapped during 2019 are shown in Appendix 1.4.

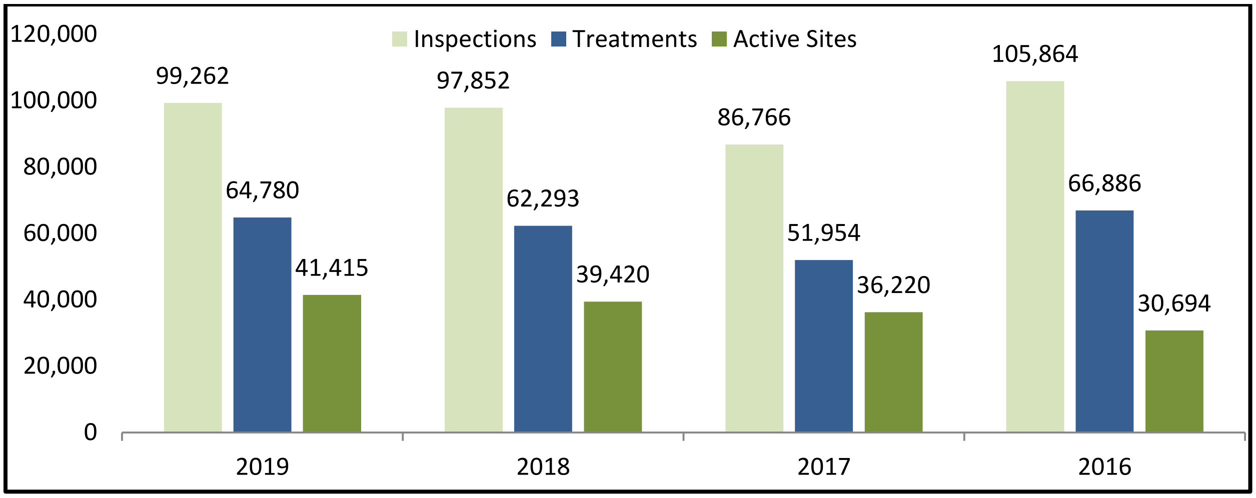

Figure 7. Larvicide Operation from 2015-2018; since 2017, ACMAD has seen an increase in treatments, sites, and inspections.

Larval Development Habitat Summary

Of the many different larval habitats in Ada County, the most-commonly monitored and treated are pastures and DIs. These locations are favored oviposition habitats for *Aedes vexans, Culex tarsalis* and *Culex pipiens* respectively. As seen in *Fig. 8*, 50.06% of acres treated in 2019 were pastures, and only 17.5% of acres treated were DIs. A total of 32,703 DIs are mapped in Ada County, making up 78.9% of ACMAD's known larval development sites. The acreage difference is relative to the size of the site, so while more pasture acreage is treated for mosquito larvae, DIs are monitored more, and the prime habitat of the main WNV vector, *Culex pipiens* in Ada County.

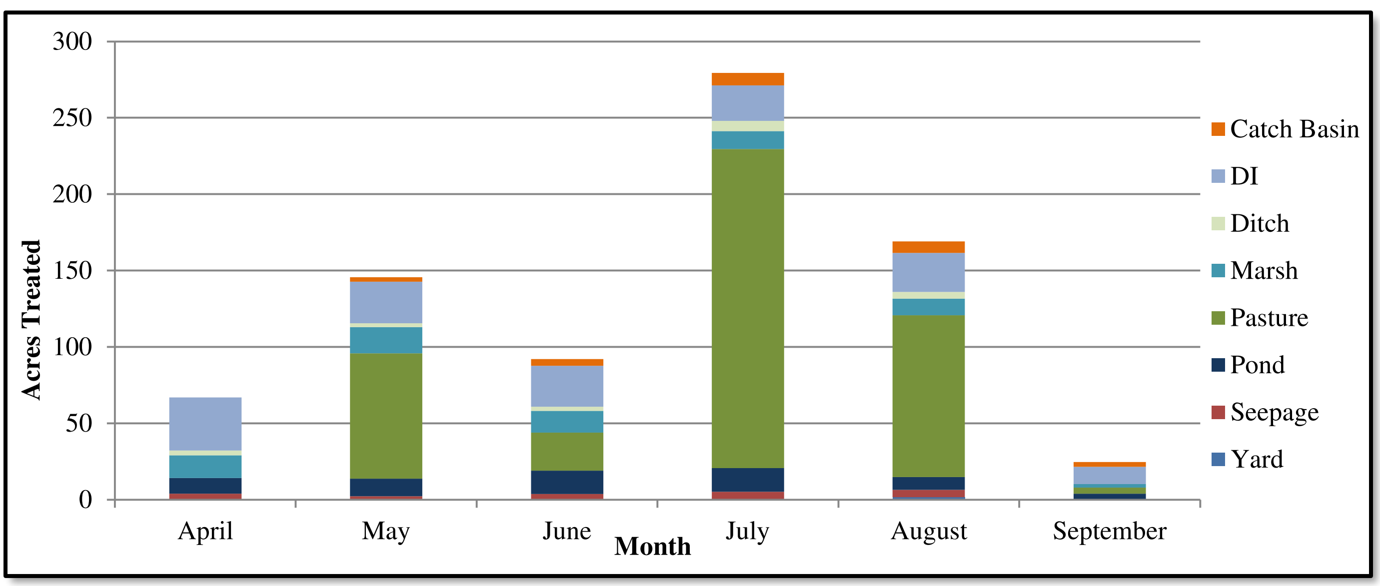

Figure 8. Acres treated by the ACMAD larvicide team, sorted by site category. *Note: only categories with a monthly total >1 acre is displayed.*

Larvicide Product Summary

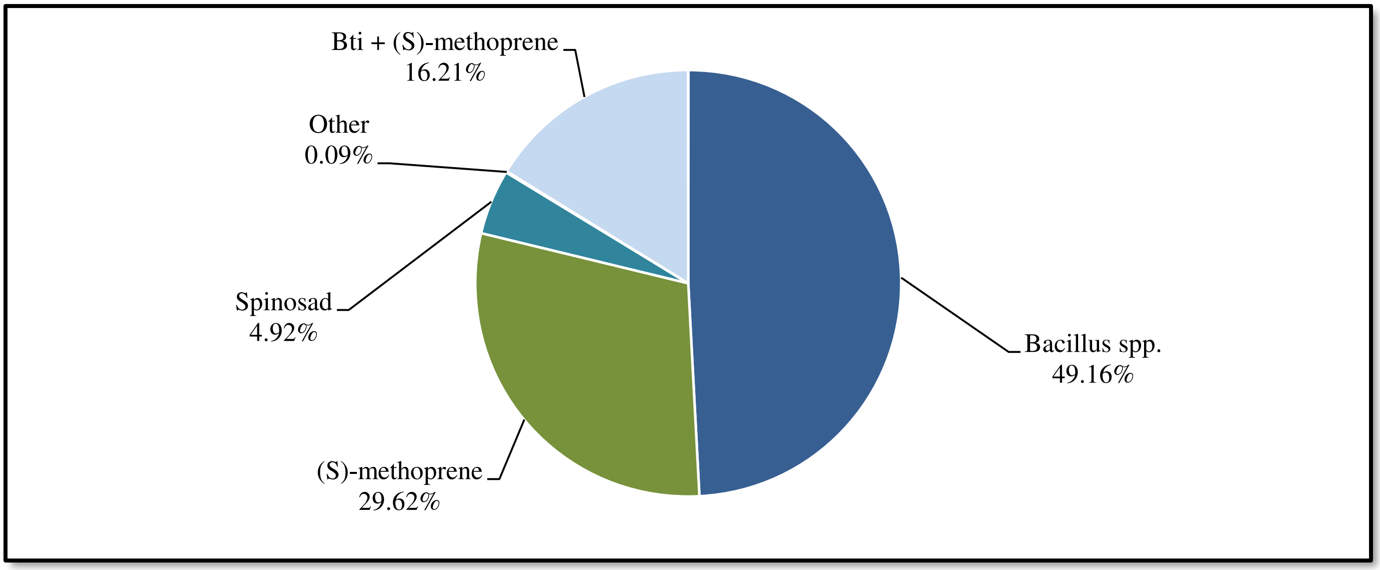

Figure 9. The active ingredients present in larvicide products used by ACMAD 2019.

As seen in *Fig. 9* of the 881 acres treated by the larvicide team, the vast majority are treated with biological control agents that are natural bacterium such as *Bacillus* species (*Bti*. and *Bs*.) or Spinosad. *Bacillus* species are soil-dwelling or aerobic spore-bearing bacteria which develop proteins toxic to insect larvae. Certain strains of *Bacillus* are toxic to specific insect larvae, such as *Bacillus thuringiensis israelensis (Bti)* which targets only mosquito and black fly larvae. *Bacillus* species do not leach into soil and are effectively non-toxic to humans, birds, fish, domestic pets, livestock, and other wildlife. Biological controls are an essential concept of Ada County's IMM program.

ACMAD also uses (S)-Methoprene to control mosquito larvae. (S)-Methoprene is an insect growth regulator, which is considered a biochemical pesticide. Instead of a chemical poison, (S)-Methoprene controls pests through interference of the life cycle and prevents the larvae & pupae from reaching maturity. (S)-Methoprene has no adverse effect on fish, waterfowl, mammals or beneficial insects according to the EPA-registered label. Typically, (S)-Methoprene has long-term residual activity which helps reduce labor costs and increase in larval source reduction and mosquito inspection efficiency.

Mosquito Adulticiding Control and Operations

The final line of defense against arboviral diseases and nuisance adult mosquitoes is Ultra Low Volume (ULV) application of adulticide insecticides. ULV foggers release micron-sized droplets of insecticides, which are lethal to flying mosquitoes but are not lethal to larger beneficial insects such as dragonflies, butterflies, or moths (Johnson 2010, Schleier and Peterson 2013, and Schleier and Peterson 2010). ACMAD also takes a proactive approach to avoid treating water bodies with fish, and known beehive locations when applying ULV pesticides by tracking and recording known locations and setting alerts that notify applicators when they are near sensitive locations. ACMAD only applies ULV pesticides after dusk, when bees have returned to their hive and are not actively flying or foraging on plants. *Fig. 10* shows the weekly spray miles by ACMAD's adulticide department during 2019. An estimated total of 64,603.64 acres were treated during 2019, with a total of

403.57 gallons of diluted insecticide were used within the mosquito abatement district throughout the summer. In 2019, there were no aerial insecticide applications in Ada County.

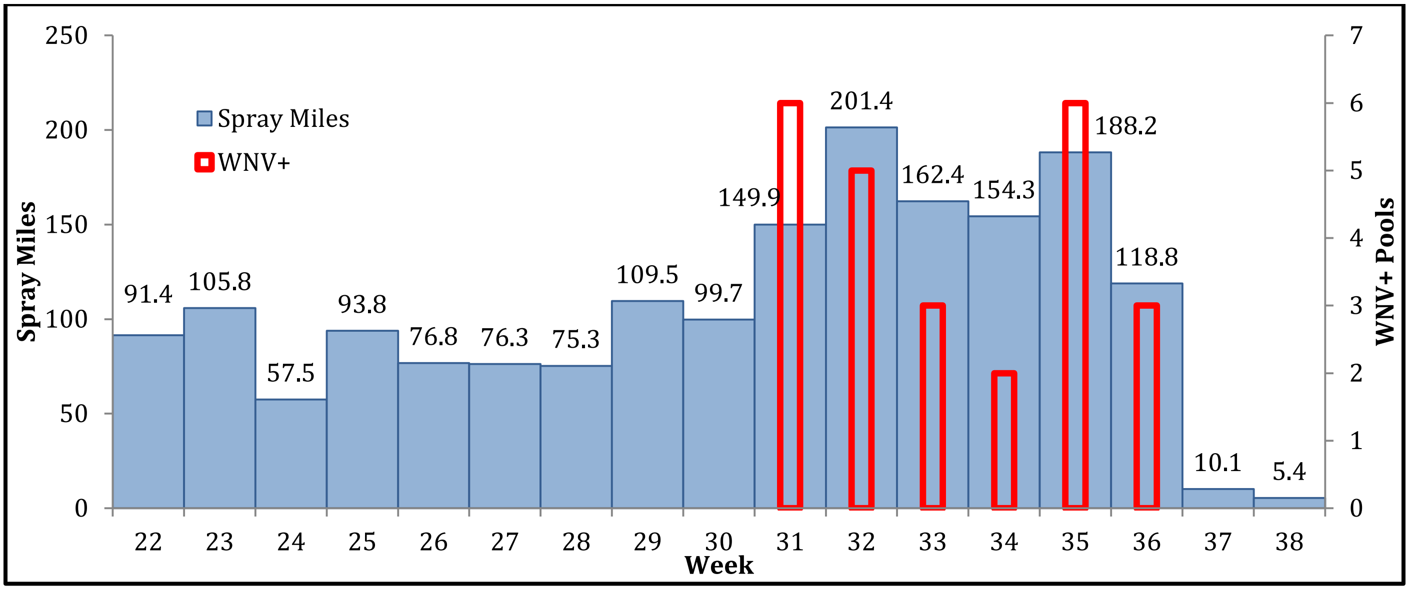

Figure 10. Weekly spray miles for 2019 with WNV+ pools. There is a correlation between the number of WNV+ pools, which result in a one mi^2 application, and the total weekly spray miles.

Adulticide Treatment Summary

ULV applications are based on public requests, WNV response, and mosquito population thresholds, as determined by surveillance. If a surveillance site traps more than five vector mosquitoes, or 25+ nuisance mosquitoes, and the action threshold has been met, an adulticide applicator is dispatched to the location within 48 hours. If WNV is found by the surveillance team, the adulticide team is dispatched within 12 hours and a ULV application is made to all accessible roads within one square mile of the positive location.[6] This is because *Culex* mosquitoes are not normally known to travel over a mile from their hatch location, but mosquito behavior can be dependent on species and blood source availability.

[6] Location of one square mile ULV applications can be found in Appendix 1.5.

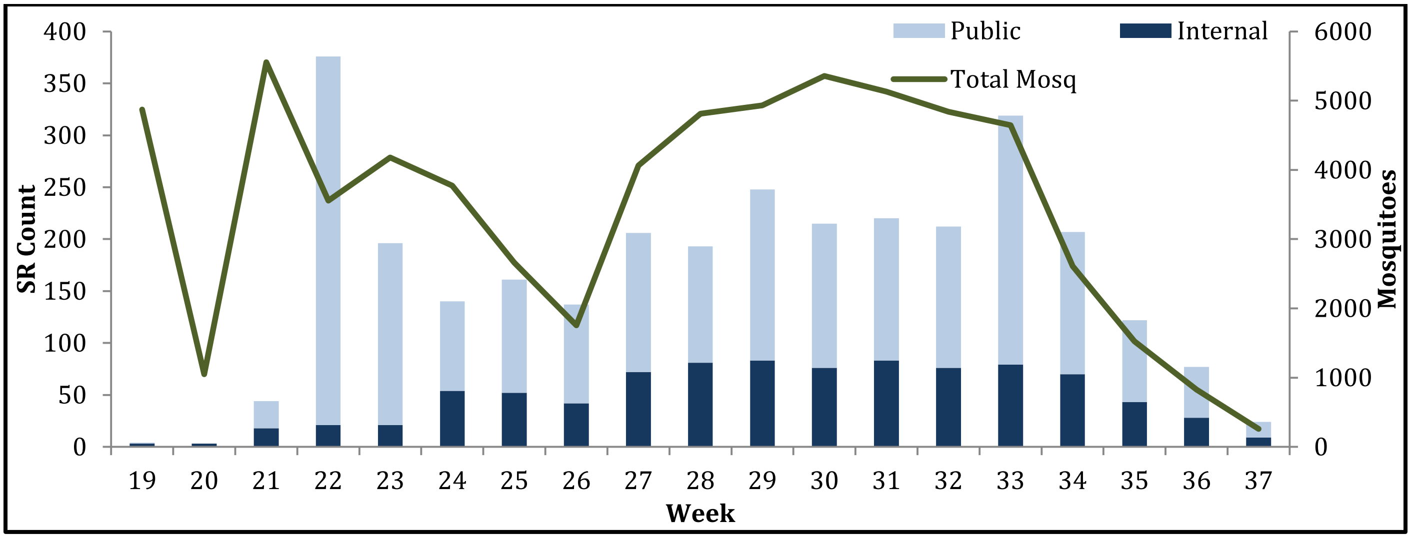

Figure 11. Comparison of public and internal adulticide service requests with total mosquito population by week.

As seen in *Fig. 11*, the adulticide team responded to 3,104 service requests; of those, 914 were prompted by internal action thresholds, and 2,190 requests were made from Ada County residents throughout the 2019 season. All public mosquito complaints were responded to by ACMAD adulticide crews, and many were verified with surveillance traps. In 2019, the ACMAD surveillance team conducted follow-up trapping in high priority areas to sample and determine adulticide operational efficacy. Through a sample analysis (n=13) of the 2019 surveillance data with parameters of a 12-hour application window, 48-hour re-trap window, and a minimum of 30 mosquitoes collected, a 67.10% decrease in mosquito abundance was observed at the surveillance site following a sample-size threshold ULV application. *Fig. 12* graphically shows the response to WNV+ threshold ULV application that also fit into the parameters mentioned above. When a WNV positive mosquito pool was found, and fit into the sampling threshold, the adulticide team's 1-mile application resulted in a 75.36% decrease in mosquito abundance. For both the WNV+ response results and sample size threshold results, confounding factors cannot be eliminated. ACMAD intends to conduct field research throughout 2020 to determine a more accurate representation of percent reduction and continue to improve adulticide operations and practices.

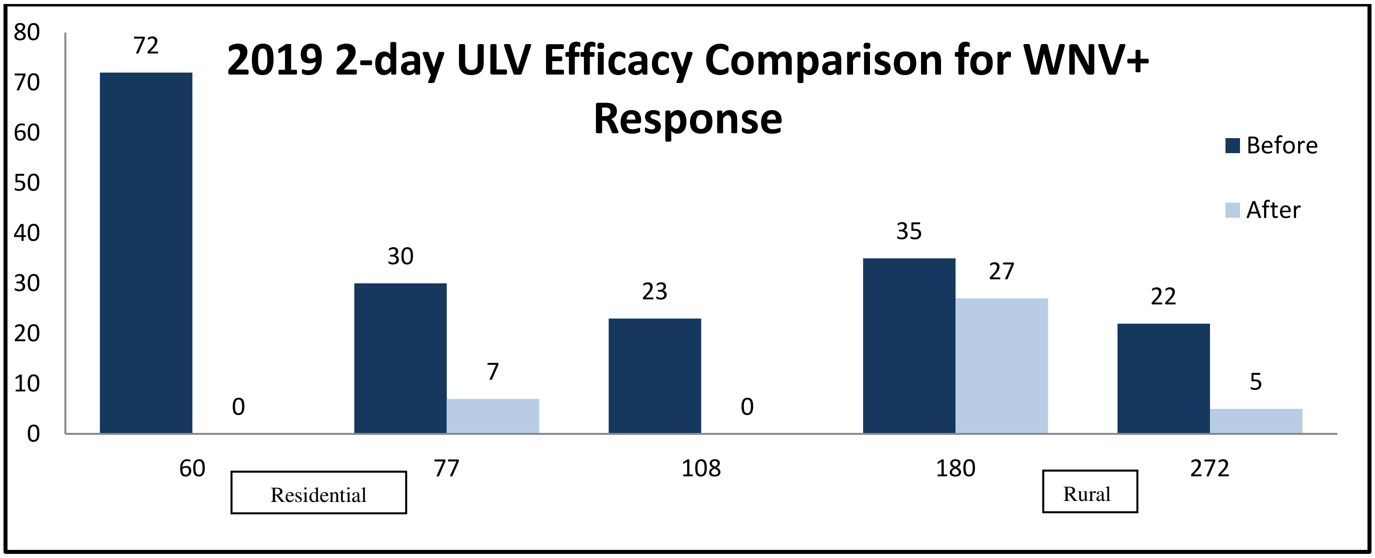

Figure 12. A sample of the mosquito population response to WNV+ action threshold ULV applications from ACMAD. Each surveillance site that collected >30 mosquitoes was treated within 12 hours, and no more than 48 hours between trap set times were included in the analysis.

Projects and Field Trials

Mosquito Trap Variations

During the 2019 season, ACMAD used many variations of mosquito traps to determine mosquito abundance and disease presence. BG Sentinel 2, gravid traps, rotational traps, elevated traps, and CO_2 cylinder baited EVS traps were used to sample mosquitoes. These traps were also placed in combination with dry ice-baited EVS traps for a comparison study.

Gravid Trap-

Gravid traps (n=52) were incorporated into ACMAD's nightly surveillance routine in early July in efforts to determine if there was WNV presence in previous mosquito populations via this trapping method. *Culex pipiens* and *Culex tarsalis* prefer to feed on avian species in early summer, which completes the transmission cycle and magnifies WNV infection. Gravid traps attract gravid (pregnant) mosquitoes and blood-fed mosquitoes (*Fig. 13*), because mosquitoes which are blood-fed have a higher chance of contracting WNV, gravid traps are more effective at finding WNV positive mosquitoes (Williams 2007). During the 2019 season, the vast majority of mosquitoes trapped using gravid traps were *Culex pipiens* (95.68%), which is the primary vector species in ACMAD. This year, one of the first WNV+ pool was collected using a gravid trap.

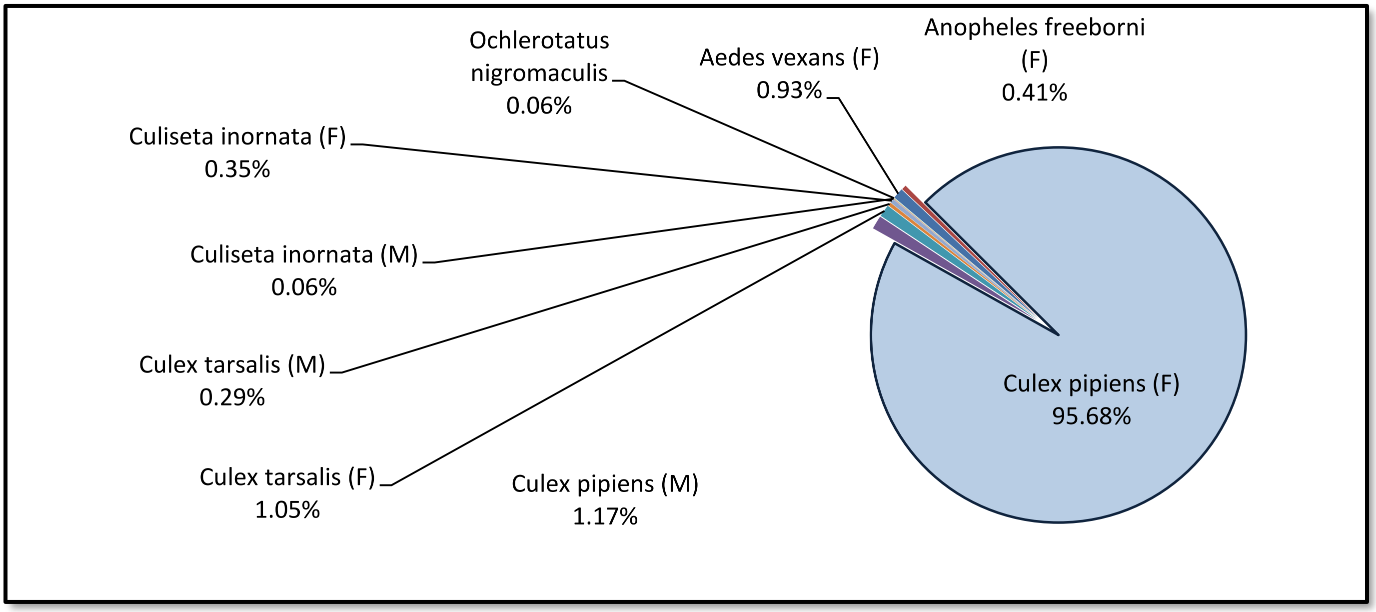

Figure 13. Species composition from gravid trap sampling, M stands for male mosquitoes, F stands for female mosquitoes.

Rotational Trap-

ACMAD uses the Collection Bottle Rotator trap (rotational trap) to study a high-priority areas or WNV+ locations over an extended period of time. The rotational trap can be programmed to sample multiple nights in a row, or consecutive hours, with each sample stored individually. During this season, the rotational trap was used at two different locations. Mosquitoes were trapped in two-hour increments on four different nights at site #325. During 2019, this location was the highest trap count (n= 1,609) and remained a location with high abundance for the majority of the season, regardless of larvicide and adulticide treatments. The rotational trap was used to sample mosquitoes on an hourly basis from dusk to dawn. This information was used to determine the most advantageous time to make adulticide applications to reduce mosquito population.

Additionally, using the rotational trap, ACMAD was able to sample mosquitoes for the hours leading up to, and following treatments made at 11:15 p.m. as shown in an example in *Fig. 14*. This information helps to show timing of species before, during and after applications, and to make application timing decisions, particularly in areas of concern, with consideration to WNV and human activity during those times, and in specific locations.

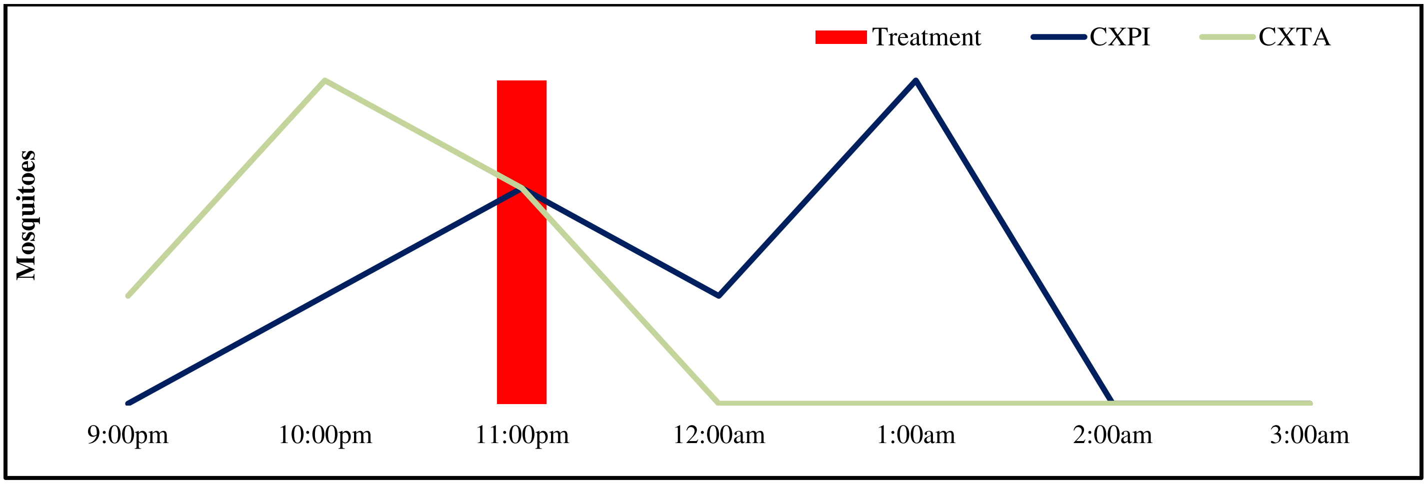

Figure 14. Rotational trap used to determine efficacy of WNV+ application made on 8/22/2019 at site #361. Mosquito samples were separated by two-hour collection increments, and the mosquitoes sampled after ACMAD's ULV application were tested for WNV. The post-treatment results of this assay were negative, confirming that infected mosquitoes were abated.

Elevated Traps-

Elevated traps (n=28) were also used in the nightly surveillance routine throughout the season in conjunction with ground-mounted EVS traps. The elevated EVS trap sampled *Culex pipens* (n=518), *Aedes vexans* (n=95), *Culex tarsalis* (n=72), *Anopheles freeborni* (n=11), and *Culiseta inornata* (n=5). A comparison between elevated EVS traps and ground-mounted EVS traps at the same locations helped ACMAD to prepare for possible WNV+ presence and mosquito abundance changes tied to seasonality. *Culex pipiens* and *Culex tarsalis* prefer to feed on avian species in early summer, which completes the transmission cycle and magnifies WNV infection. By placing an EVS trap in the tree canopy, ACMAD was able to mimic an avian host for vector species. ACMAD will continue using elevated traps during the 2020 season, and intends to improve methodology of placing this trap type in hopes to improve the ability to monitor the potential spread of disease.

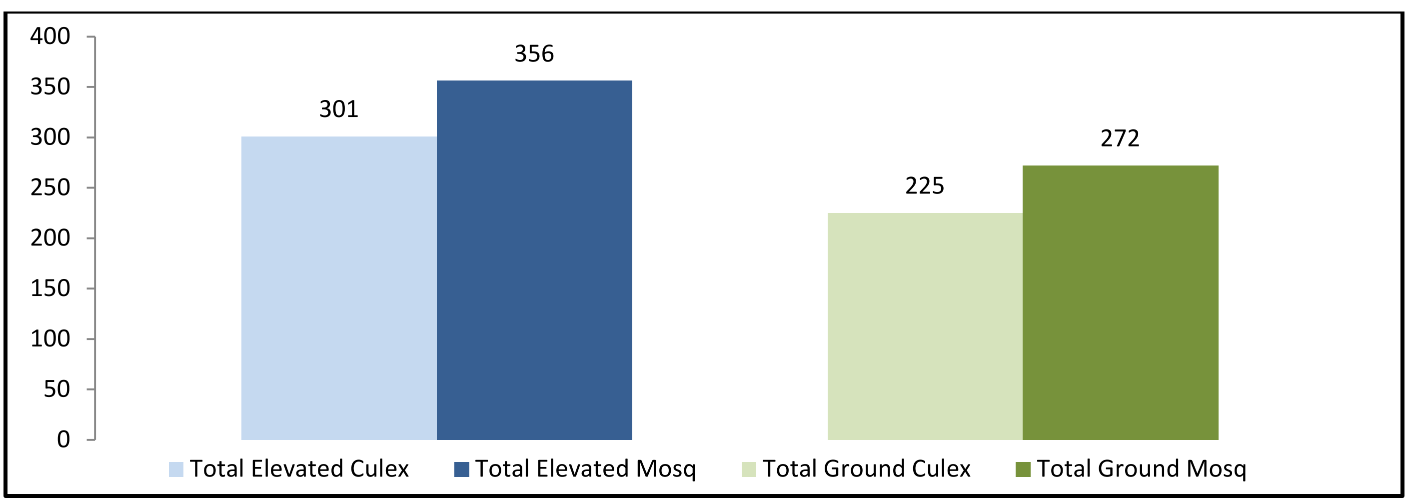

Figure 15. Elevated traps were regularly paired with ground mounted EVS traps in the same location. The combined abundance of *Culex* and total mosquitoes from these locations can be seen above.

CO_2 Cylinder Baited EVS Traps-

Beginning in 2019, the staff at ACMAD began a season-long comparison study detailing the efficacy of using CO_2 cylinders as bait for EVS traps. Historically, ACMAD along with most other mosquito abatement districts, used dry ice in a lined canister to attract mosquitoes to EVS traps. In recent years, there has been a transition away from dry ice as an attractant due to the increasing cost, and towards more efficient means of surveillance. Two surveillance locations were chosen for each night of trapping, based on available space, habitat diversity, and historic mosquito abundance.[7] Each CO_2 cylinder baited trap was placed 10-15 feet from a dry ice baited trap, and dry ice sublimation rates ranged from 130mL/min to 220 mL/min depending on ambient temperature over the 10 hour window, and CO_2 cylinders were calibrated to release CO_2 at a rate of 160 mL/min. *Fig. 15* shows a comparison in histograms between abundance data from dry ice baited EVS traps and CO_2 cylinder baited EVS traps. Using a one-way analysis of variance (ANOVA), it was determined that CO_2 cylinder baited EVS trapping has a statistically significant ($P<0.05$) higher mean abundance ($\bar{x}=26.5969 \pm 2.7302$, n=129) and is a more effective method of mosquito surveillance as compared to dry ice-baited EVS traps ($\bar{x}=17.1705 \pm 2.3404$, n=129).

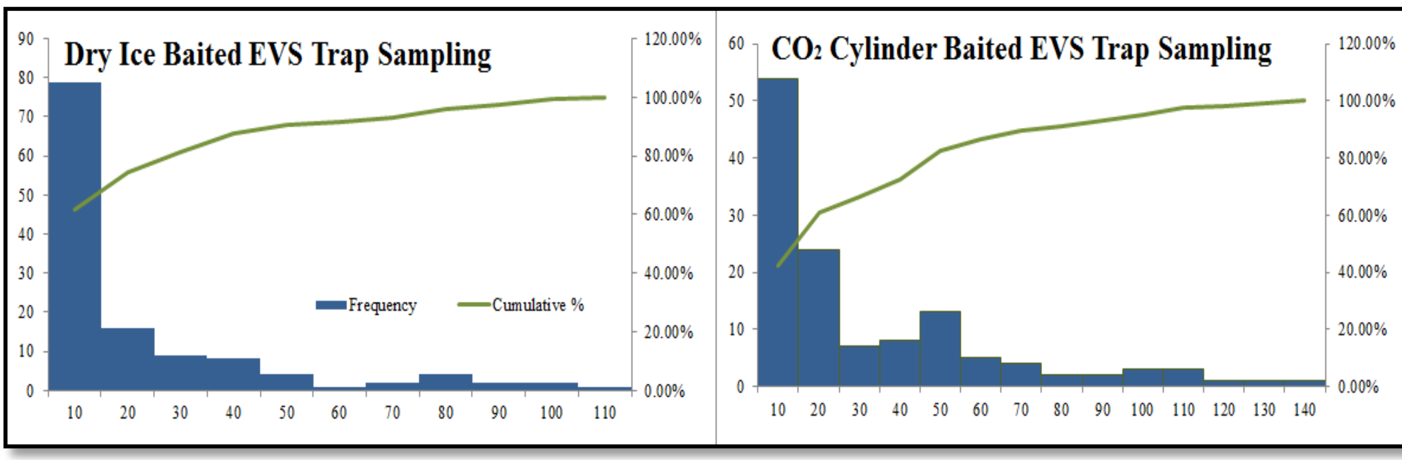

Figure 15 Shows a comparison of histograms depicting the frequency (y-axis) of total mosquitoes trapped per night (x-axis). The comparison of these two graphs shows that traps baited with dry ice more frequently collected fewer than 10 mosquitoes, and traps baited with compressed CO2 more frequently collected over 20 mosquitoes.

Other factors including cost and safety must be included. CO_2 cylinders are a more cost effective method for trapping mosquitoes, whether a fill station is added to the ACMAD campus, or if the cylinders are filled off-site. However, this difference does not include the resources associated with training staff on safety measures, and ensuring the safety of the public while EVS traps are in the field and will be assessed in the upcoming season.

Exotic Aedes Surveillance Using BG Sentinel 2 Traps-

ACMAD continued research on two important vector species, *Aedes aegypti* and *Aedes albopictus*, neither of which have a known population in Idaho. These exotic *Aedes* species are known to spread Zika, Dengue, Chikungunya, and other diseases. To sample for the presence of these mosquitoes, BG sentinel traps were

[7] A map of sampling locations and results can be found in Appendix 1.6

placed near nurseries which import plants from states with a known *Aedes aegypti* or *Aedes albopictus* population, and in neighborhoods with extensive landscaping sourced from these nurseries. BG Sentinel traps were placed 16 times at eight different locations in Ada County. A total of 1,656 mosquitoes were captured and identified from species including *Aedes vexans* (n=1,506; 90.9%), *Culex tarsalis* (n=70; 4.2%), *Culex pipiens* (n=37; 2.2%), *Anopheles freeborni* (n=26; 1.5%), *Culiseta inornata* (n=13; 0.7%), *Ochlerotatus nigromaculis* (n=3; 0.1%) and *Aedes cinereus* (n=1; 0.06%). As of 2019, there is no evidence of *Aedes aegypti* or *Aedes albopictus* in Ada County. Additionally, when the public calls in to make a service request, ACMAD conducts "soft surveillance" to identify specific areas that show signs of invasive *Aedes* presence. One of the questions asked is "are you being bitten during the day and/or inside your home"? If a resident confirms this, then ACMAD deploys a crew to immediately follow-up on the issue as these species of mosquitoes have a very specific feeding behavior. Research will continue during the 2020 season using BG Sentinel 2 traps with a variety of lures with the support of the IDHW grant.

Pesticide Resistance Testing

Pesticide resistance testing is a necessary step to evaluate that the most effective insecticides are being used to combat adult flying mosquitoes. Using the CDC Bottle Bioassay protocols, insecticide resistance was monitored at nine different locations in Ada County. These locations were tested for resistance to the technical-grade active ingredients Malathion, Deltamethrin, and Permethrin. In 2019 ACMAD used only insecticides with Permethrin as an active ingredient in nightly ULV applications. Malathion is historically a very common insecticide used in the private and public sector; however Malathion has not been used by ACMAD in recent years. The nine testing locations were chosen by the frequency and density of historical applications of insecticide containing these active ingredients, by public and private sector applicators throughout the years.[8]

Permethrin-

Samples were collected from surveillance trap locations in Eagle, Star, and Meridian. The first round of testing was conducted on May 23rd, sampling from the Star and Eagle locations and testing a resistance to Permethrin. During the May 23rd Permethrin testing, *Aedes vexans* (n_{Eagle}=115 and n_{Star}=69) mosquitoes were exposed to 15.0 µg Permethrin, and had a 100.00% mortality rate at the diagnostic time. This mortality rate indicates the mosquitoes are highly susceptible to Permethrin at the time of testing. Mosquitoes were also tested on September 9th, near the end of the season for Permethrin resistance. Using mosquitoes sampled from Star, *Aedes* vexans (n=50) displayed a 97.43% mortality rate at the diagnostic time which indicates a high susceptibility.

Deltamethrin-

On June 19th, mosquitoes collected in Eagle (n=62) were tested for resistance to Deltamethrin. Mosquitoes were exposed to 10.0 µg of Deltamethrin, and displayed a 70.73% mortality rate at the diagnostic time and a 100% mortality rate at 120 minutes. Adulticide products containing Deltamethrin were not used during the 2019 season, although they have been in previous years.

Malathion-

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[8] Density Analysis Maps can be found in Appendix 1.7 & 1.8

During the June 19th Malathion experiment *Aedes vexans* (n=83) mosquitoes collected from Star were exposed to 50.0 µg of Malathion and had a 100.00% mortality rate at the diagnostic time. Adulticide products containing Malathion have not been used by ACMAD in recent years. Malathion is still commonly used as an agricultural insecticide.

DI Treatment Comparison Study

ACMAD larvicide staff conducted a comparison study throughout the 2019 season to determine the most effective method of treatment for DIs. DIs make up 78.9% of mapped larval development habitats in Ada County, making an effective treatment plan essential. DIs can vary in form depending on location. Some can drain to retention ponds, or natural waterways, some connecting throughout a neighborhood but ultimately contained, and others can be individual with no outlet. Many larvicide products intended for use in DIs are slow-release formulations in briquette form, intended to control mosquito larvae for anywhere from 30 to 180 days. A major issue ACMAD has noticed in the use of these briquettes in this drain system is that they can be washed away with water flow. DIs are also regularly cleaned by highway management, and larvicide product can also be lost this way.

To help combat this issue, ACMAD tested each of the nine DI specific products available with the typical treatment method, and also with each briquette formulation contained in a mesh bag attached to the DI grate. Twenty treatment plans were assigned, and five diverse habitats were chosen throughout Ada County: DIs draining into retention ponds, DIs draining into a natural waterway, individual DIs, and two locations containing DIs which connect within the neighborhood storm drain system. This field trial was conducted from week 18 through week 37 with 100 DIs being sampled weekly. Of the 100 treatment locations, 30% were dry for the season. Of the remaining 70%, there was an observed 14% failure rate of product efficacy (the term failure could include a product washed away, product efficacy failure, product covered with heavy debris, or being cleaned out of a drain unknown to ACMAD), defined by the presence of mosquito larvae prior to the lapse over the expected control window. Ninety percent of failure occurrences were from one specific product formulation. When considering only failure occurrences, 60% used the traditional treatment method with DI's being treated without attachments. Of the DIs treated using a mesh bag containing product, 44.8% of the tethering string snapped and product was washed away. While the percentage of untethered briquettes which were "lost" cannot be calculated, the results of this study will help ACMAD determine the best treatment option for DIs.

Through this field trial, it was determined that 90% of treatment failures occurred within 100 feet of the Boise River. This distinction is important, because it shows how increasing flow in a DI can impact ACMAD's standard procedures and these DI's could possibly be attributed to failure of "wash out". In order to optimize DI treatment and control, ACMAD plans to categorize different types of DI and DI drainage pathways to improve aspects of future larvicide operations.

Larvicide Efficacy Comparison Study in Flood-Irrigated Pasture

While DI's contribute the majority of mapped larval development locations, flood-irrigated pasture makes up over 50% of the total acreage treated within the last three years. During the 2019 season, ACMAD conducted a field trial to compare efficacy and cost efficiency of two treatment plans - a long term (six week) treatment of Metalarv S-PT (4.25% (S)-Methoprene) and a short term (two week) treatment with VectoPrime FG (6.25% *Bacillus thuringiensis* subsp. *israelensis*). Metalarv S-PT has a higher unit price than VectoPrime FG, but saves on labor cost associated with less frequent treatments. This study was conducted in Eagle Island State Park, and consisted of six flood-irrigated pastures ranging from 10 to 40 acres in size. Each field was assigned a treatment plan: two control fields, VectoPrime FG at 2.50 lbs. /acre, Metalarv S-PT at 2.50 lbs. /acre, VectoPrime FG at 5.0 lbs. /acre, and Metalarv S-PT at 3.75 lbs. /acre. It was found that the low rate of Metalarv S-PT was effective through two flood cycles for the six-week range, and the higher rate saw control even after an 18 day pre-flood treatment. The low rate of VectoPrime FG at 2.5 lbs. /acre resulted in 100% mortality seven days post-treatment and the mid-label rate of VectoPrime showed an immediate mortality rate of 98% just 48 hours after treatment, although irrigation was turned off shortly after treatment. Metalarv S-PT at a rate of 2.50 lbs. /acre was determined to be the most advantageous treatment plan for flood-irrigated pasture, not only because this is the most economically efficient plan, but also due to the operational flexibility allowed by six-weeks of control. This flexibility reduced the cost of lost opportunity to inspect other locations and find new mosquito development sources.

Conclusion

With heavy rainfall in the spring of 2019, ACMAD saw a 47.93% increase in service requests across all divisions, from 2018 to 2019. There were 1,995 new larval development locations mapped in efforts to monitor WNV vector habitat. There were more floodwater species captured in surveillance efforts, as corroborated by public complaints. Because these complaints were recorded a week after surveillance data displayed population abundance, the increase in mosquito populations was likely due to irrigation practices of individual landowners and an increase in rainfall during the mosquito development season.

ACMAD sampled 25 WNV+ pools during the 2019 season, which was a 36% increase in disease presence in mosquito pool sampling from 2018. Larvicide crews focused their efforts on long-term treatments in storm drains and DIs at the beginning of the season, which helped reduce historically-known high *Culex* trap locations, and prevent the spread of vector borne diseases until week 31, over a month after neighboring mosquito control districts had detected disease presence. However, as development continues within ACMAD, and rural areas become more urban, there will be a need to continue to develop the program funding, landowner education (for source reduction), and increase in staff to cover the increased volume of mosquito development sources (storm drains and backyard habitats), and the increased number of residents within ACMAD.

ACMAD Goals

Goals for 2019…

I. <u>Strengthen our Integrated Mosquito Management practices by implementing more biological and mechanical mosquito controls.</u>
   - ✓ By encouraging field technicians to record remediation and education locations, we were able to quantify IMM controls and develop public education.

II. <u>Continue to improve upon training programs for start of year and mid-year training of seasonal staff.</u>
   - ✓ A fully developed training program helped us to achieve an 84% retention rate for our seasonal technicians.

III. <u>DI Bicycle Crew: continue to develop project & build software program.</u>

- ✓ On hold: This project will be reevaluated once the new software program has been implemented.

IV. <u>Preparing the next generation of vector control professionals and epidemiologists by offering internships through local colleges and universities.</u>

- ✓ Three students from Boise State University joined us for the duration of the 2019 season to gain valuable experience in a government operated laboratory, and to develop skills in entomology and vector ecology.

Goals for 2020:

I. Improve upon mid-season training for all seasonal staff to ensure ACMAD's Best Management Practices are followed.

II. Conduct Adulticide efficacy field trial and operations analysis.

III. Strengthen public education on land management practices with the help of our Public Information Specialist.

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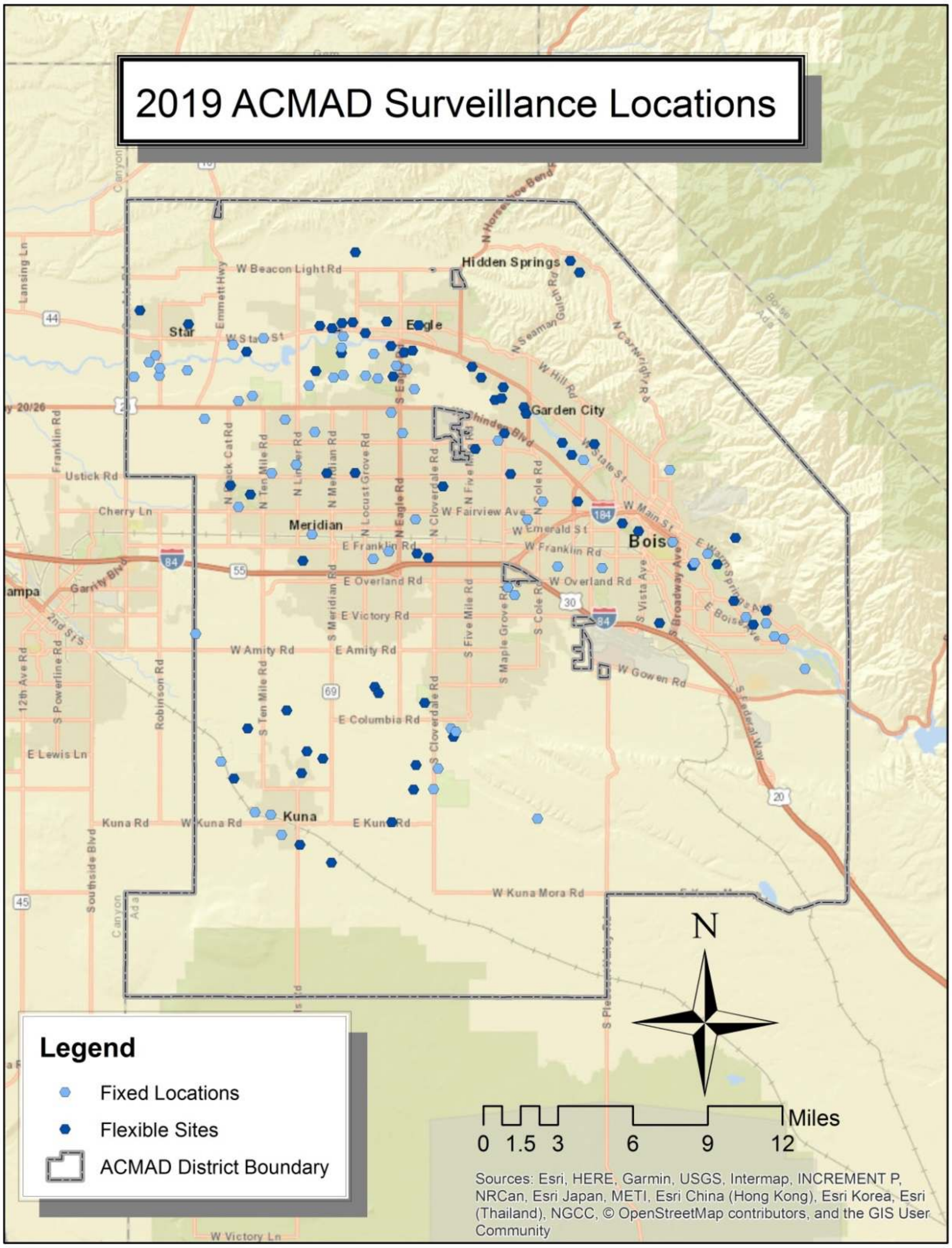
Appendices

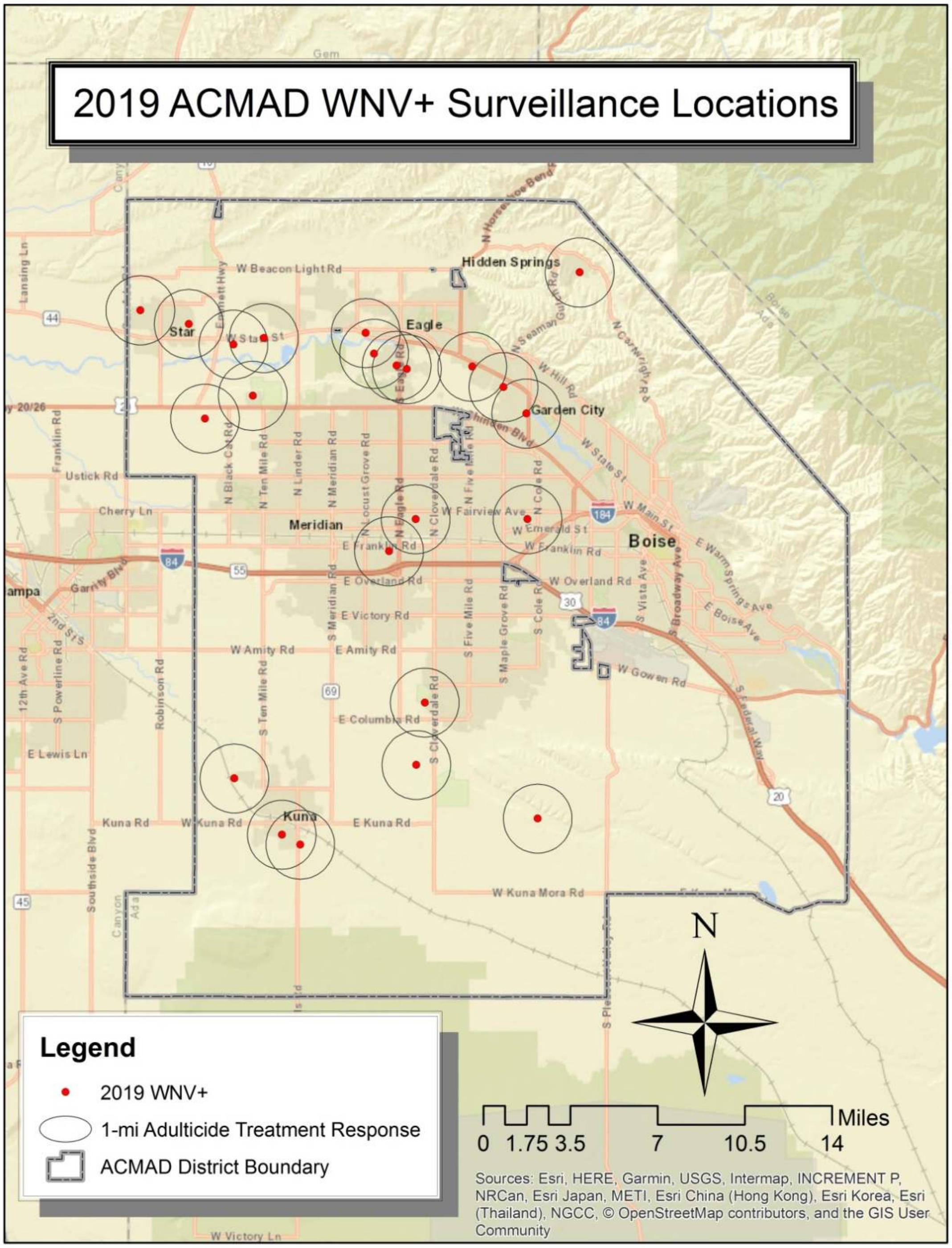
Appendix 1.1

Week	Start Date	End Date
14	April 7, 2019	April 13, 2019
15	April 14, 2019	April 20, 2019
16	April 21, 2019	April 27, 2019
17	April 28, 2019	May 4, 2019
18	May 5, 2019	May 11, 2019
19	May 12, 2019	May 18, 2019
20	May 19, 2019	May 25, 2019
21	May 26, 2019	June 1, 2019
22	June 2, 2019	June 8, 2019
23	June 9, 2019	June 15, 2019
24	June 16, 2019	June 22, 2019
25	June 23, 2019	June 29, 2019
26	June 30, 2019	July 6, 2019
27	July 7, 2019	July 13, 2019
28	July 14, 2019	July 20, 2019
29	July 21, 2019	July 27, 2019
30	July 28, 2019	August 3, 2019
31	August 4, 2019	August 10, 2019
32	August 11, 2019	August 17, 2019
33	August 18, 2019	August 24, 2019
34	August 25, 2019	August 31, 2019
35	September 1, 2019	September 7, 2019
36	September 8, 2019	September 14, 2019
37	September 15, 2019	September 21, 2019
38	September 22, 2019	September 28, 2019
39	September 29, 2019	October 4, 2019

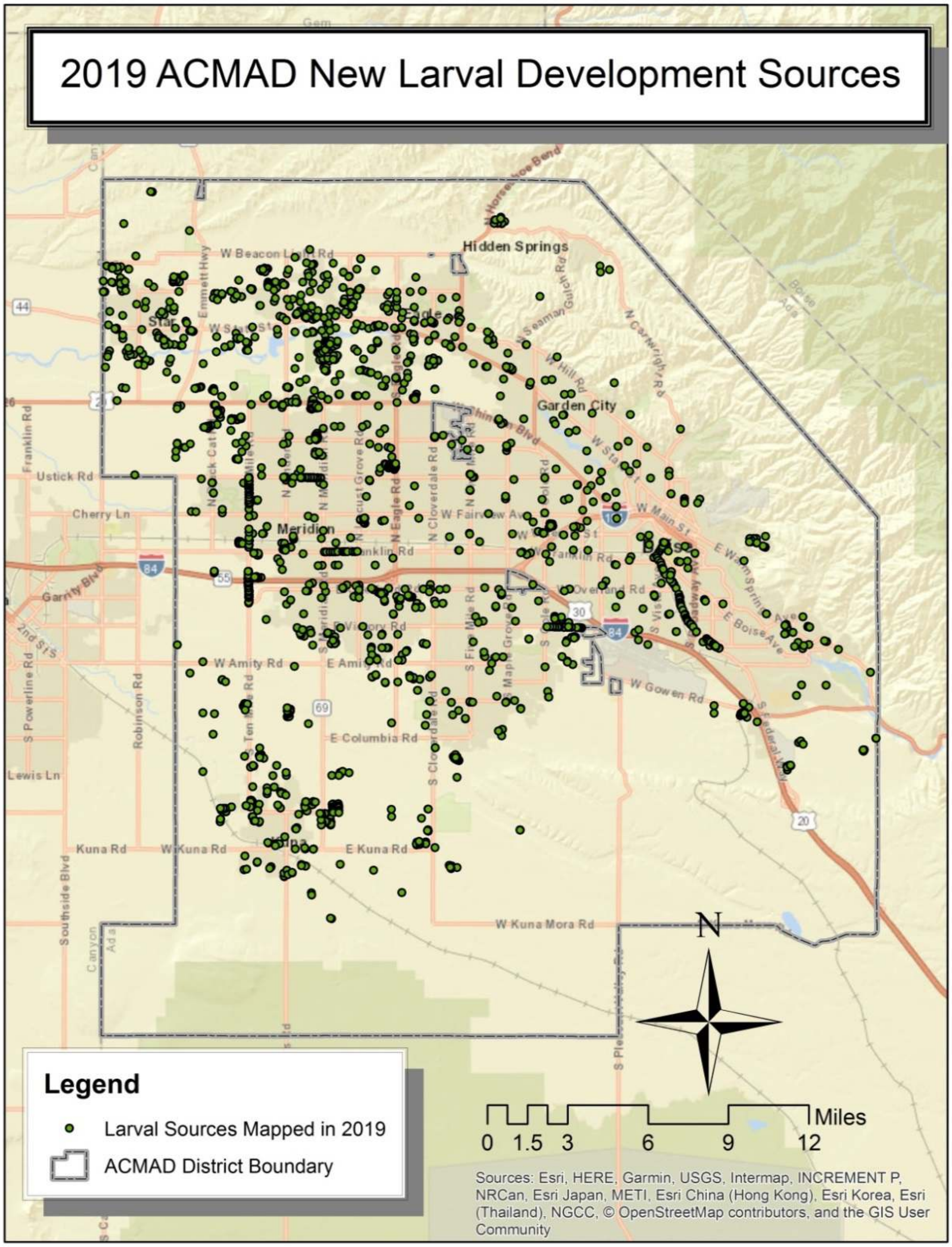
Appendix 1.2


2019 ACMAD Surveillance Locations
Legend
Fixed Locations
Flexible Sites
ACMAD District Boundary
N
0 1.5 3 6 9 12
Miles
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

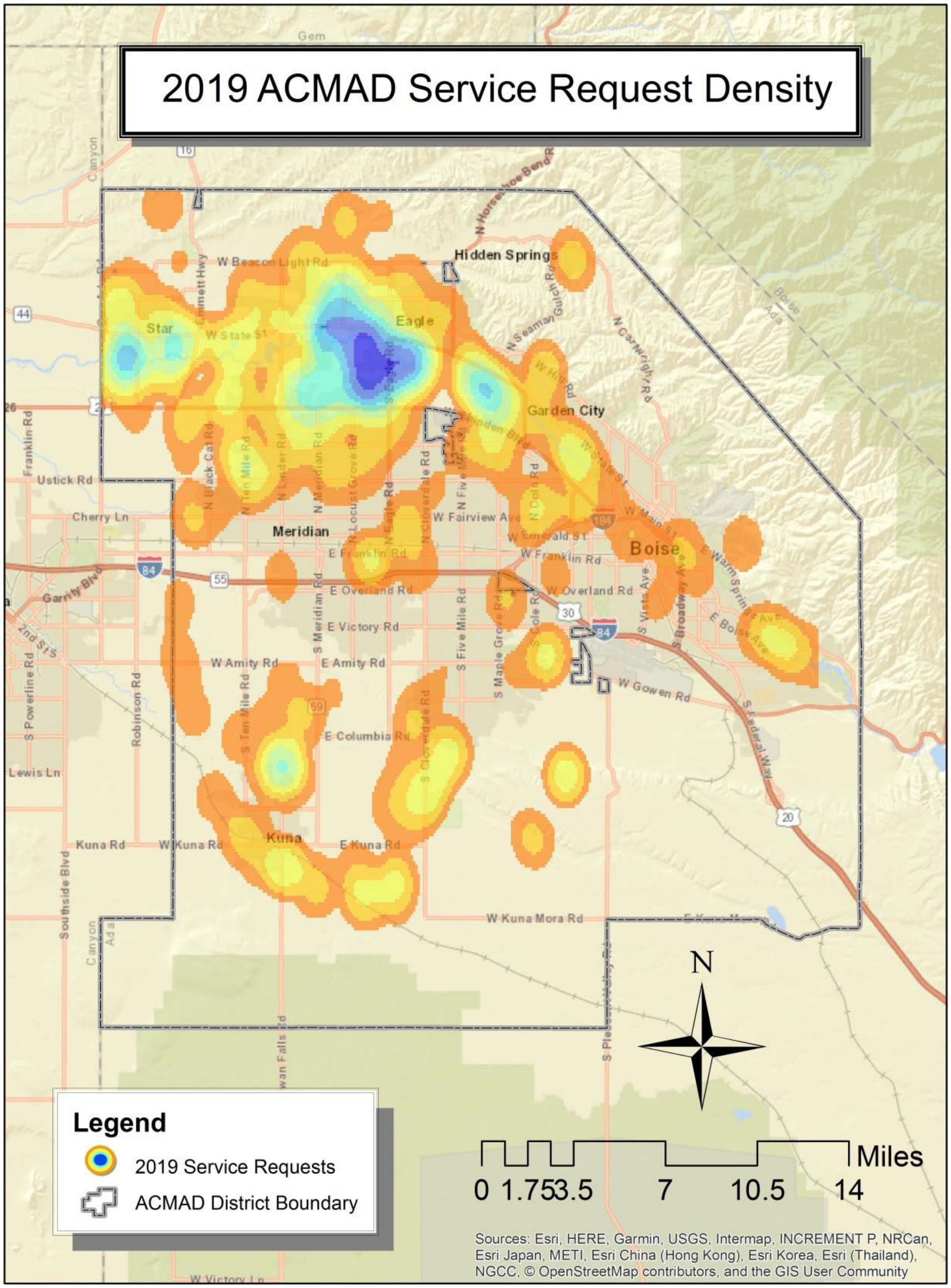
Appendix 1.3


2019 ACMAD WNV+ Surveillance Locations
Hidden Springs
Star
Eagle
Garden City
Meridian
Boise
Kuna
Nampa
N
Legend
2019 WNV+
1-mi Adulticide Treatment Response
ACMAD District Boundary
0 1.75 3.5 7 10.5 14 Miles
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

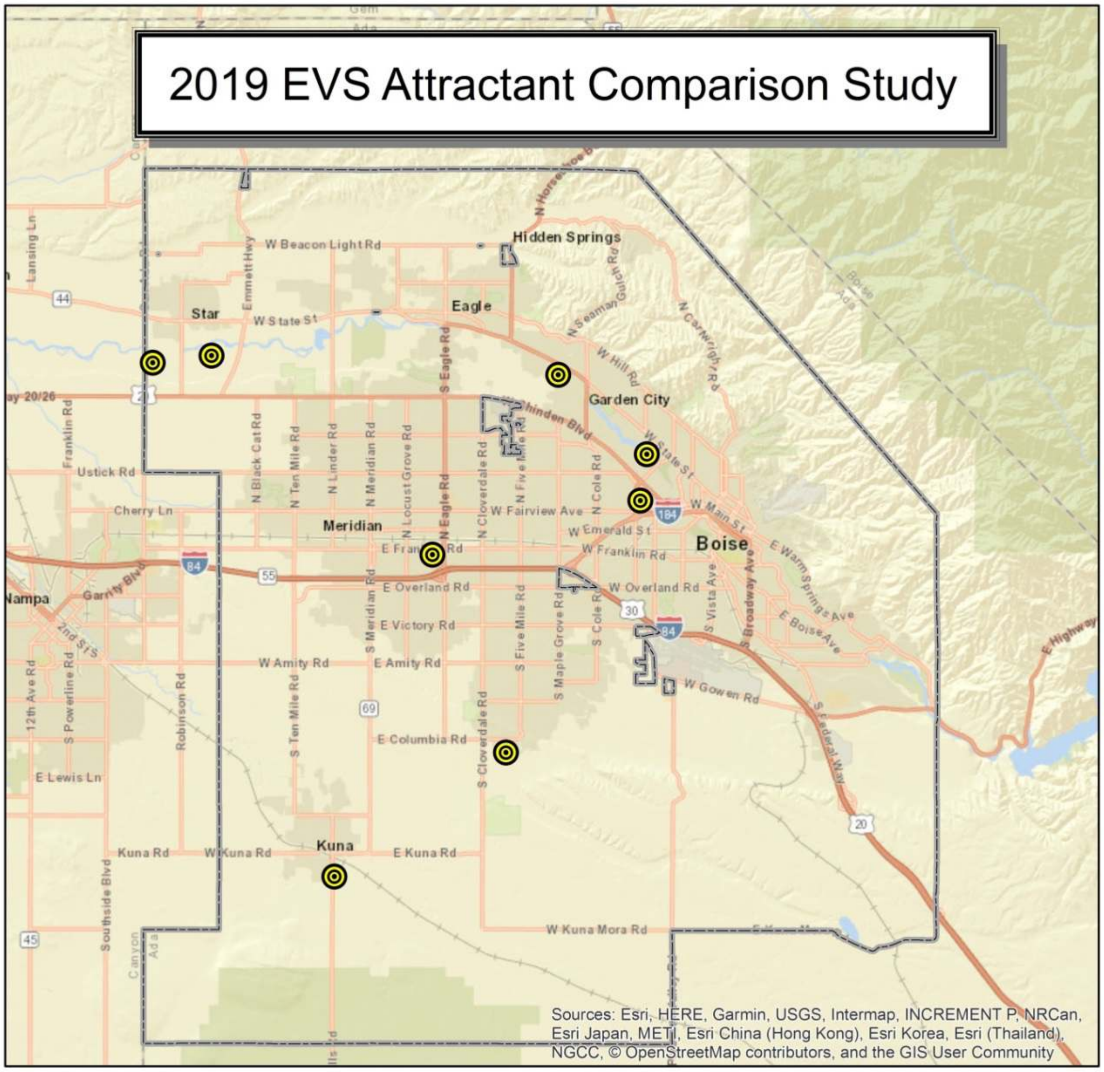
Appendix 1.4


2019 ACMAD New Larval Development Sources
Legend
Larval Sources Mapped in 2019
ACMAD District Boundary
N
0 1.5 3 6 9 12 Miles
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Hidden Springs
Garden City
Meridian
Star
Ustick Rd
Cherry Ln
Franklin Rd
W Beacon Light Rd
W Amity Rd
E Amity Rd
E Columbia Rd
Kuna Rd
W Kuna Rd
E Kuna Rd
W Kuna Mora Rd
W Gowen Rd
Lewis Ln
Robinson Rd
Southside Blvd
S Powerline Rd
Garrity Blvd
W Fairview Ave
W Main St
E Boise Ave
N Cartwright Rd
N Seaman Gulch Rd
W Hill Rd

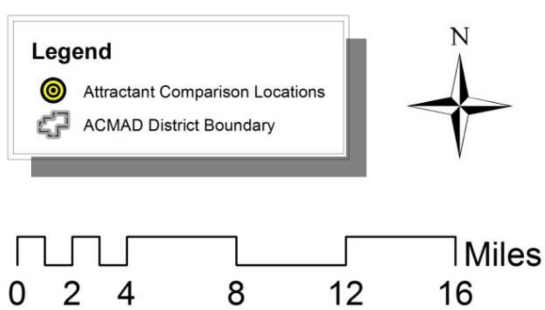
Appendix 1.5


2019 ACMAD Service Request Density
Legend
2019 Service Requests
ACMAD District Boundary
N
0 1.753.5 7 10.5 14
Miles
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Star
Eagle
Hidden Springs
Garden City
Meridian
Boise
Kuna

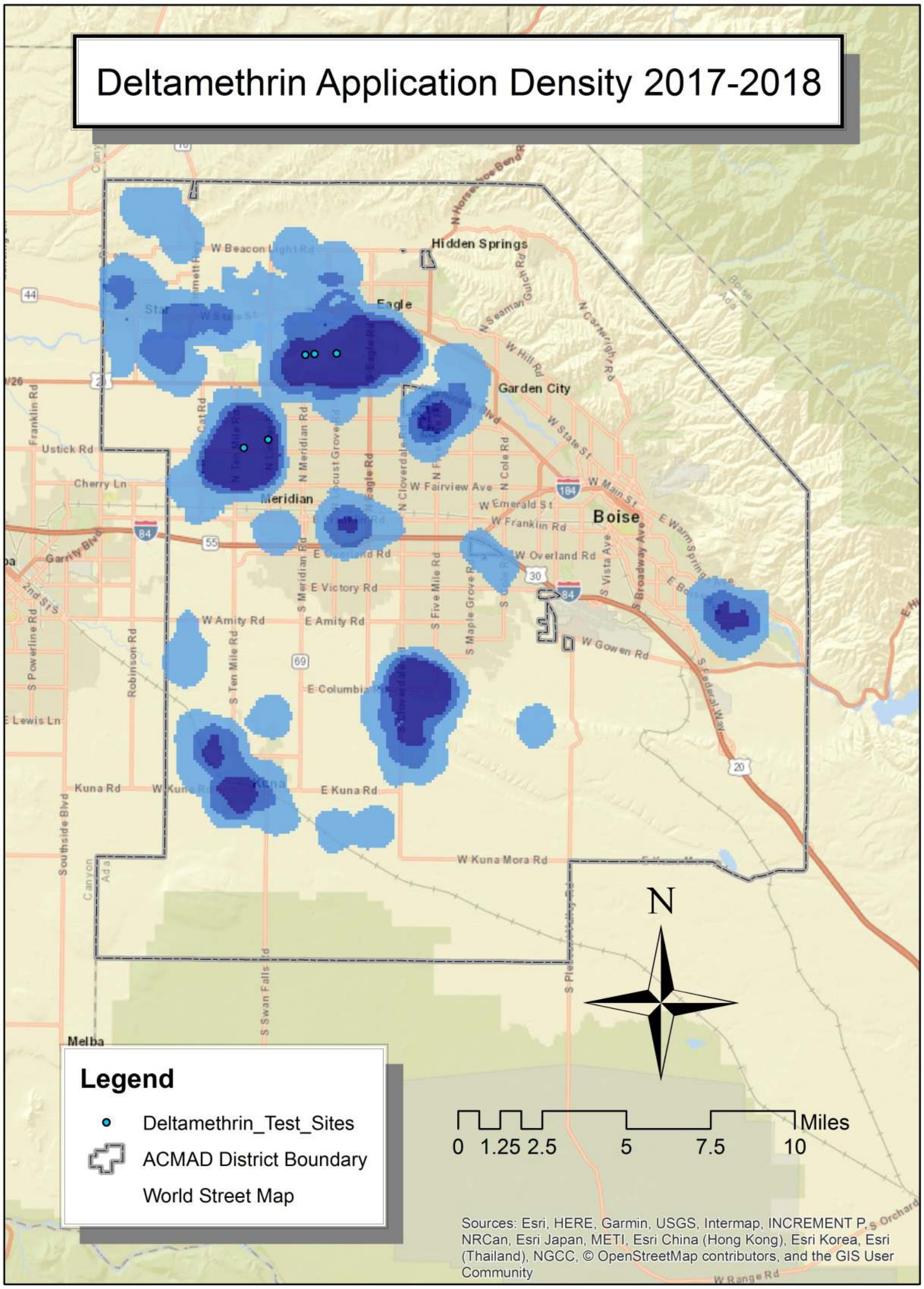
Appendix 1.6



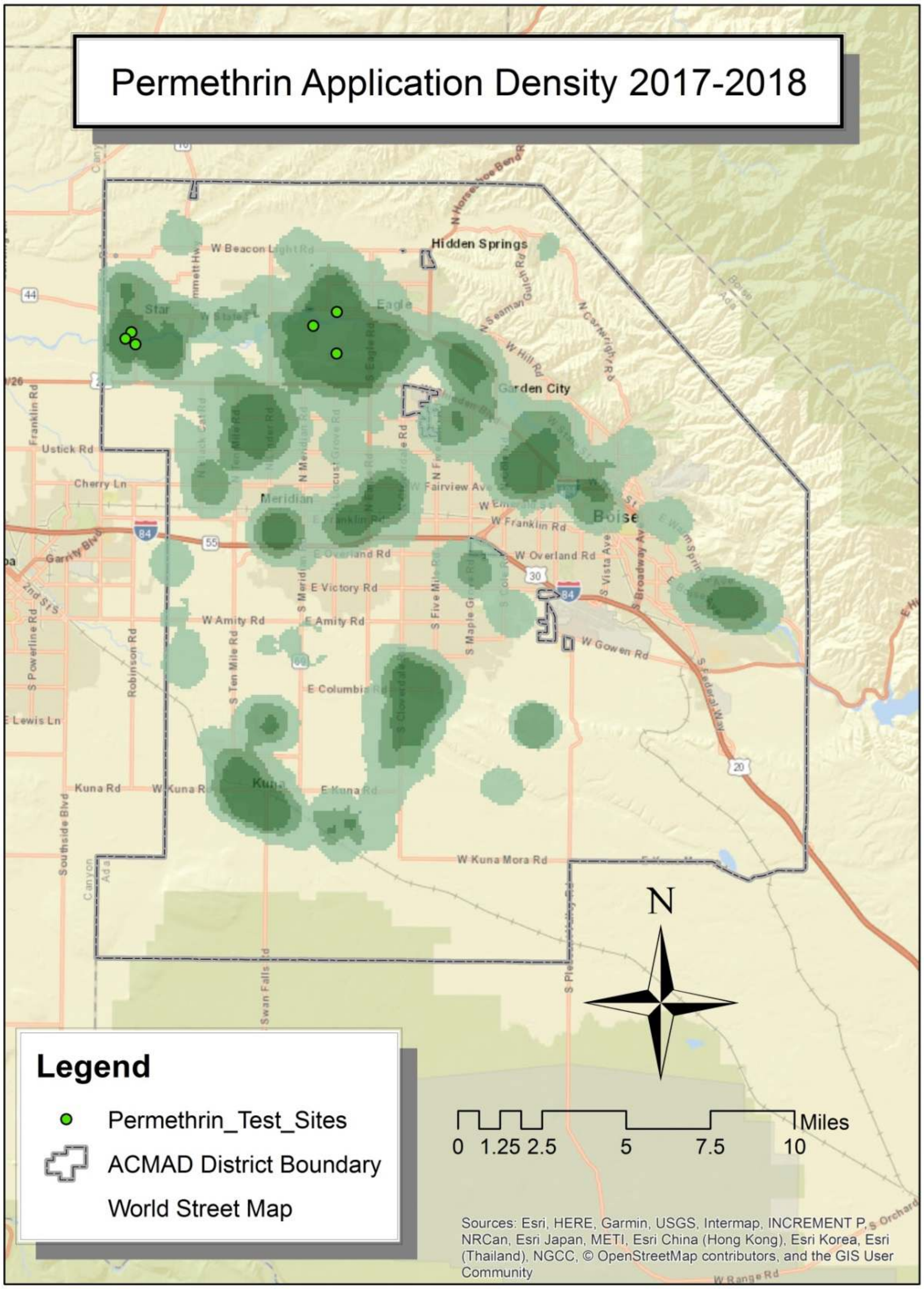
	Cylinder	*Dry Ice*
Mean	26.5969	17.1705
Variance	961.6175	720.9394
Observations	129	129
df	251	
t Stat	2.6101	
P(T<=t) two-tail	0.009	
t Critical two-tail	1.9695	



Appendix 1.7


Deltamethrin Application Density 2017-2018
Legend
Deltamethrin_Test_Sites
ACMAD District Boundary
World Street Map
N
0 1.25 2.5 5 7.5 10 Miles
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Hidden Springs
Eagle
Garden City
Meridian
Boise
Melba

Appendix 1.8


Permethrin Application Density 2017-2018
Legend
Permethrin_Test_Sites
ACMAD District Boundary
World Street Map
N
0 1.25 2.5 5 7.5 10 Miles
Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community
Hidden Springs
Garden City
Boise
Meridian
Eagle
Star
Kuna