City of Fort Morgan
Mosquito Control Program
2015 Season Report

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SUMMARY

For the 2015 mosquito season, the City of Fort Morgan contracted OtterTail Environmental, Inc. (OtterTail) to operate an Integrated Mosquito Management (IMM) program to help protect public health from the effects of West Nile Virus (WNV) and other vector-borne diseases, and to suppress local populations of nuisance mosquitoes. This report provides a summary of the 2015 program.

West Nile is a mosquito-transmitted virus that can cause a wide range of effects, from an asymptomatic infection to a neuroinvasive disease termed West Nile meningitis or encephalitis. West Nile Virus was first detected in the United States during the summer of 1999 in New York City while conducting routine St. Louis Encephalitis (SLE) and Eastern Equine Encephalitis (EEE) surveillance. The virus has since spread across the U.S. and has been confirmed in all continental states. Bird populations act as a reservoir for the virus until a mosquito bites an infected bird. Only then can an infected mosquito pass the virus on to humans, horses and other animals through their bite. While many people who contract WNV experience mild or no symptoms, the more severe cases of West Nile meningitis or encephalitis can result in severe illness and even death.

There are over 50 mosquito species in Colorado, yet only species from the genus Culex are known to be effective transmitters of WNV. Mosquitoes and other insects that transmit disease are called vectors; mosquitoes that are not known to transmit a disease are often called nuisance mosquitoes. The most abundant mosquito in Colorado, *Aedes vexans,* is an aggressive nuisance mosquito. The two primary vector mosquitoes that are most likely to spread WNV in Colorado are *Culex tarsalis* and *Culex pipiens*.

Following Integrated Pest Management principles, the City of Fort Morgan and OtterTail Environmental focused on controlling and reducing mosquito populations and thereby protecting public health by decreasing the likelihood of WNV transmission. Through surveillance of potential mosquito breeding sites (larval sites), areas producing mosquito larvae were identified and treated with control materials known as larvicides. Larvicides prevent the mosquitoes from developing into adults, and next to eliminating the source, is the most efficient way to reduce mosquito populations. In addition, control of larvae reduces the need for non-biological control of adult mosquitoes such as ultra-low volume pesticide spraying.

In addition to larval mosquito surveillance and control treatments, OtterTail and the City of Fort Morgan monitored adult mosquito activity within the area by utilizing data from five permanent location adult mosquito traps. These trap collections enabled OtterTail to monitor mosquito populations and possible WNV activity. The adult monitoring also allowed the City and OtterTail to make informed decisions on the potential for any adult mosquito control throughout the season. Adult control decisions were based upon a combination of the weekly trap counts, residential complaints and potential WNV activity.

The State of Colorado experienced a second consecutive year of relatively low WNV activity in 2015. The climate patterns and temperatures that occurred during the 2015 season caused mosquito populations to remain at below average levels throughout the majority of the season; consequently, there was relatively low WNV activity within the region. Fort Morgan's IMM program coupled with education and personal protection measures, also likely continued to help reduce mosquito populations and WNV activity within the city and surrounding areas during 2015.

1.0 INTRODUCTION

The City of Fort Morgan contracted OtterTail Environmental, Inc. to operate an integrated mosquito management program in 2015. The City's goal was to protect local residents from the effects of West Nile Virus (WNV) and to suppress the local populations of nuisance mosquitoes. To accomplish this goal, specific objectives were established for the program. First, the City wanted to monitor possible mosquito habitats and treat those sites when mosquito larvae were present. Treatment of these areas with control methods during this stationary larval stage, before mosquitoes become airborne, is the most cost-effective and efficient means to reduce mosquito populations. Secondly, they wanted to monitor adult mosquito populations and use the population numbers as a possible trigger for adult mosquito control. They also wanted to limit the effect on the environment from control materials and be as cost-effective as possible.

This report explains the methods used in the integrated mosquito management program and provides a detailed summary of the results of this year's effort.

2.0 WEST NILE VIRUS (AND OTHER MOSQUITO-BORNE DISEASE) UPDATE

As of October 13, 2015 there were 1,332 WNV human cases and 66 WNV related deaths in 44 states and the District of Columbia (**Table 1**). Colorado ranked third in the national case count with 88 human WNV cases and 2 WNV related deaths reported as of October 2, 2015. Most WNV cases occurred in Colorado within the populous regions of the Front Range **(Table 2)**. The Colorado Department of Public Health did not report any mosquito pools, horses, birds or humans as positive for St. Louis Encephalitis or Western Equine Encephalitis during the 2015 season**.** The relatively low WNV activity and number of human infections in Colorado may be attributed to the temperature and precipitation patterns observed during the 2015 mosquito season and the affect they had on mosquito populations, as discussed further in **Section 3.0**.

Table 1 West Nile Virus Incidence, 2002 - 2015

Total WNV Human Cases	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cases in the United States[1]	4,156	9,862	2,539	3,000	4,269	3,630	1,356	720	1,021	712	5,674	2,469	2,205	1,332
Deaths in the United States[1]	284	264	100	119	177	124	44	32	57	43	286	119	97	66
Highest State Count in United States[1]	884	2,947	779	880	996	578	445	115	167	158	1,868	379	801	311
Cases in Colorado[2]	13	2,947	291	106	345	582	71	103	81	7	131	322	118	88
Deaths in Colorado[2]	0	66	4	2	7	7	1	3	4	0	5	7	5	2
Cases in Morgan County[2]	0	61	1	4	2	11	2	3	0	0	2	16	3	2
Deaths in Morgan County[2]	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total WNV Positive Results	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
Mosquito Pools in Morgan County[2]	0	11	1	9	5	3	2	3	0	0	0	10	0	0
Birds in Morgan County[2]	0	5	0	0	2	0	0	0	0	0	0	0	0	0
Horses in Morgan County[2]	4	0	1	0	2	0	0	0	0	0	0	1	0	0

1. Reported by the Center for Disease and Control (CDC); 2015 data reported as of October 13, 2015.
2. Reported by the Colorado Department of Public Health and Environment (CDPHE); 2015 data reported as of October 2, 2015.

As of October 2, 2015 there were 2 WNV related illnesses and no related deaths reported in Morgan County **(Table 2)**. With widespread and frequent testing of mosquito pools throughout the state, none of the tested mosquito pools from Morgan County were reported as WNV positive, and the Morgan County human WNV case count comprised approximately 2.3 percent of state totals (**Table 2**).

The lower number of human WNV cases and lack of WNV positive mosquito pools suggests that the viral activity in Morgan County was significantly less in 2015 than during previous years with epidemic outbreaks. It is likely that the continued widespread mosquito control efforts to reduce mosquito populations, coupled with public education and personal protection measures, helped reduce the exposure and disease transmission within the City of Fort Morgan and its surrounding areas.

Table 2 Colorado WNV Cases and WNV Positive Mosquito Pools, 2015

County	Human Cases[1]		Human Deaths[1]		Positive Mosquito Pools[1]	
	Number	% of State	Number	% of State	Number	% of State
Adams	5	5.7%	0	0.0%	4	2.4%
Alamosa	1	1.1%	0	0.0%	0	0.0%
Arapahoe	9	10.2%	0	0.0%	2	1.2%
Boulder	11	12.5%	0	0.0%	10	6.0%
Broomfield	1	1.1%	0	0.0%	0	0.0%
Costilla	1	1.1%	0	0.0%	0	0.0%
Crowley	1	1.1%	1	50.0%	0	0.0%
Delta	0	0.0%	0	0.0%	1	0.6%
Denver	9	10.2%	0	0.0%	9	5.4%
Douglas	2	2.3%	0	0.0%	0	0.0%
El Paso	1	1.1%	0	0.0%	0	0.0%
Freemont	2	2.3%	0	0.0%	0	0.0%
Huerfano	1	1.1%	0	0.0%	0	0.0%
Jefferson	5	5.7%	0	0.0%	2	1.2%
La Plata	1	1.1%	0	0.0%	0	0.0%
Larimer	19	21.6%	0	0.0%	102	61.1%
Logan	1	1.1%	0	0.0%	0	0.0%
Mesa	1	1.1%	0	0.0%	1	0.6%
Morgan	2	2.3%	0	0.0%	0	0.0%
Pueblo	4	4.5%	1	50.0%	7	4.2%
Rio Grande	1	1.1%	0	0.0%	0	0.0%
Washington	1	1.1%	0	0.0%	0	0.0%
Weld	9	10.2%	0	0.0%	29	17.4%
Colorado Totals	**88**		**2**		**167**	

1. Reported by CDPHE as of October 2, 2015

3.0 REGIONAL 2015 CLIMATOLOGICAL DATA AND MOSQUITO ACTIVITY OVERVIEW

The weather patterns leading into and during the mosquito breeding season are important factors that influence mosquito abundance and WNV activity. The following section describes the regional climate, the weather during the season, and how that may have affected the mosquito populations.

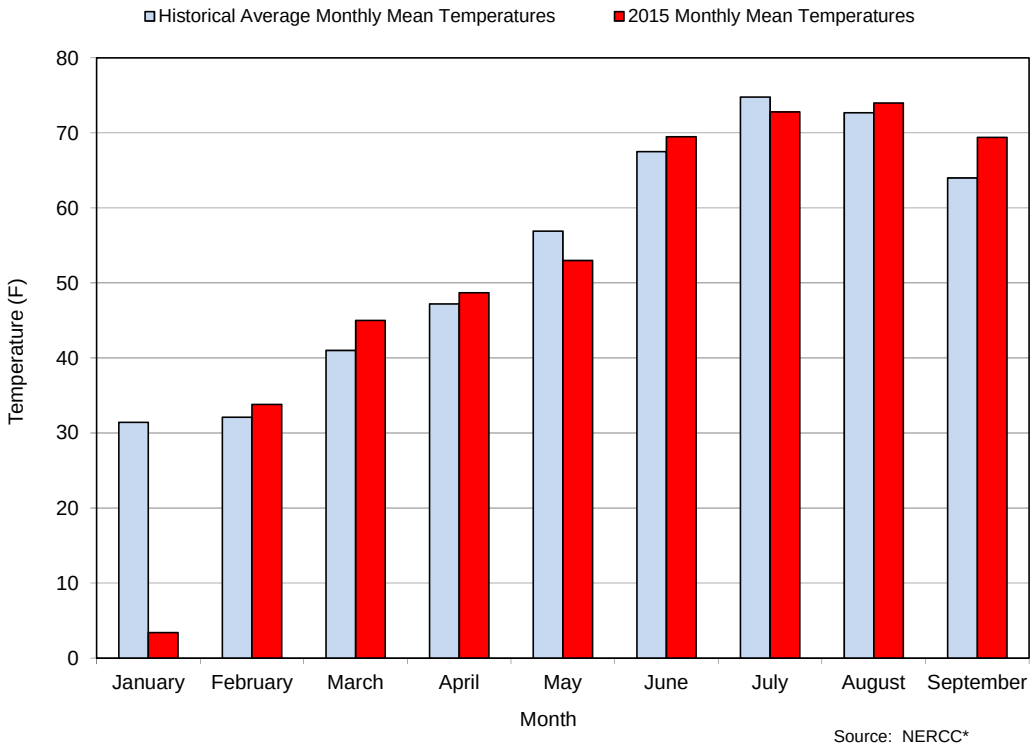
Fort Morgan is located in a semi-arid environment with an elevation of approximately 4,300 feet above sea level (CDATA 2013). The mosquito season for the Fort Morgan program area is from April to September. Current and historical climate data from the Northeast Regional Climate Center's (NERCC) Denver International Airport weather station was used for regional temperature and precipitation patterns.

Historical records for the mean monthly temperature at the station suggest that temperatures usually have a steady increase from April to July, making July, on average, the hottest month of the year. Typically there is then a steady temperature decrease into September. In 2015, every month of the mosquito season except May and July had temperatures above normal. The months of May and September experienced the highest variations from normal during the season. May had a monthly mean temperature that was approximately 4 degrees below normal, while September's monthly mean temperature was approximately 5 degrees above normal (**Figure 1**).

The historical averages for the monthly mean precipitation indicate that April, May and July are usually the wettest months of the year (**Figure 2**). During 2015, the accumulated precipitation from January through September was higher than the historical average for the same period. During this time period in 2015, there was an accumulation of 13.7 inches. This is approximately 6 percent more than the normal amount of accumulation when compared to the historical average, which is 12.9 inches. Five of the nine months received precipitation amounts higher than their normal averages. The most significant variations during the mosquito season were the months of May and September. May received approximately 73 percent more precipitation than average, making it wettest month of 2015, while September received approximately 8 percent of its normal precipitation, making it the driest month of 2015 (NOAA 2015).

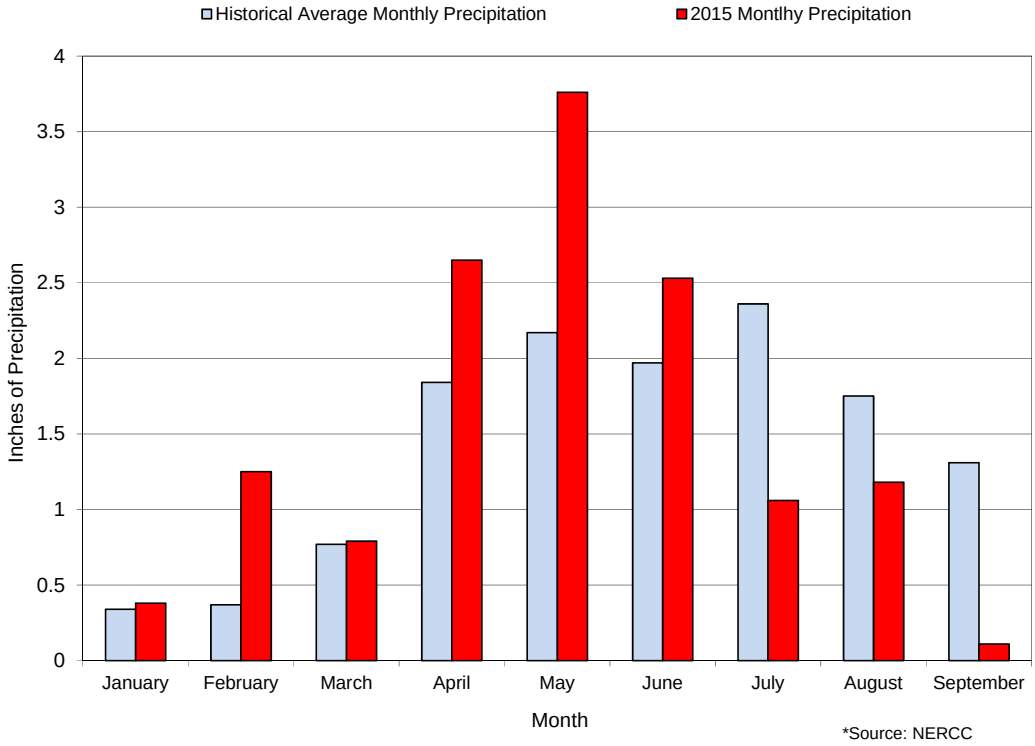
Temperatures and precipitation amounts varied throughout the 2015 mosquito season. High rainfall amounts in the spring led to many mosquito habitats being inundated with water early in the season. Temperatures then rose to above normal averages during the month of June, allowing nuisance mosquito populations to rapidly increase at the beginning of the summer. The month of July was then drier and cooler than average, followed by a much drier and hotter than average August and September, causing many of the mosquito larval sites to quickly dry up during the second half of the season. After peaking in late June, nuisance mosquito populations quickly decreased to below normal averages for the remainder of the season, while Culex populations remained at below average populations throughout the entire summer. These climate patterns, along with the City's larval control program, were the likely causes of the below average abundances of nuisance and Culex mosquitoes throughout the majority of the 2015 mosquito season.

Figure 1 2015 Monthly Mean Air Temperature Historical Averages*



Source: NERCC*

Figure 2 2015 Monthly Total Precipitation Data and Historical Averages*



*Source: NERCC

4.0 LARVAL MOSQUITO SURVEILLANCE AND CONTROL

LARVAL SURVEILLANCE METHODOLOGY

Ottertail began the 2015 season by identifying and inspecting larval habitat sites within the City of Fort Morgan project area (**Appendix C**). Many of the habitats were those with stagnant water high in nutrients and organic matter including: cattail marshes, non-flowing drainage ditches, small stagnant ponds, and temporary pools. Habitat sites were added and refined throughout the field season as needed. A detailed explanation of the larval surveillance methodology used during the 2015 season can be found in **Appendix A.**

To ensure a comprehensive larval control program, OtterTail maintained a toll-free telephone hotline for citizens to report areas of concern. OtterTail provided site inspections and any consequential treatments to potential larval habitats as necessary. If landowners gave permission, then suitable areas were added to the project and checked regularly. OtterTail field technicians only accessed private properties if permission was granted by the owner.

LARVAL CONTROL METHODOLOGY AND APPLICATION METHODS

The primary focus for OtterTail's IMM program is to control mosquitoes while in the larval stage. Larval mosquito control methods employed by OtterTail were aimed at preventing adult mosquito emergence, which reduces the potential of the mosquito-borne disease, WNV, and minimizes the annoyance level of mosquitoes to local residents. To achieve a high level of effectiveness and efficiency of larval control efforts, OtterTail identified and inspected mosquito larval habitats on a regular basis. The threshold for larval control was presence of any mosquito larvae. Finding and documenting consistent mosquito producing sites was an important component of the program because it created a pattern that is monitored and systematically controlled to help understand mosquito populations and WNV trends. Being environmentally sensitive, the City of Fort Morgan and OtterTail believe in concentrating on larval control to reduce the need for adult mosquito control spraying.

The application of *Bacillus thuringiensis israelensis* (*Bti*), *Bacillus sphaericus (Bs)*, *and BVA-2 mosquito larvicide oil (BVA-2) are OtterTail's primary methods used for larval mosquito control. Control materials were applied within the labeled rates, thereby minimizing any potential adverse impacts to areas being treated. Routine post-treatment checks were conducted to ensure the larval control was effective. If any larvae were found during the post-check, a second application was applied.

In balancing environmental resources, cost effectiveness, and public health needs, *Bti* was selected as the primary treatment product. *Bti* is a naturally occurring protein that is toxic to mosquito larvae upon its ingestion. It provides a residual treatment that lasts for approximately two days. Since new mosquito larvae may hatch after the product dissipates, the sites must be inspected for mosquito larvae every one to two weeks. The presence of mosquito larvae between monitoring periods has the added benefit of allowing these larvae to continue to be part of the aquatic food web, but be eliminated before they can emerge as adults. This helps protect the public from potential WNV transmission while still providing a food source for many aquatic animals.

Bacillus sphaericus is a larvicide very similar to *Bti* but has a longer residual time. The protein in *Bs* products is able to provide continuous treatment of mosquito larvae for up to four weeks and was typically used on sites that were found to be continuously producing mosquitoes. Although the longer residual time of this larvicide allows for fewer site checks and cost savings in labor and travel, it is only practical in certain situations because it costs substantially more than *Bti*.

It should be noted that *Bti* was the primary control material used, but this product is not effective if pupae are found at a site. Mosquitoes do not feed during their pupal stage; therefore, the use of *Bti* and *Bs* is ineffective against mosquito pupae since these proteins must be ingested. In these instances of pupae occurrence, BVA-2 is used. BVA-2 is a highly refined mineral oil that creates a thin film on the water surface. The film these products create interrupts the air and water interface during the mosquito's larval and pupal development stages, causing them to drown.

LARVAL SURVEILLANCE AND CONTROL RESULTS AND DISCUSSION

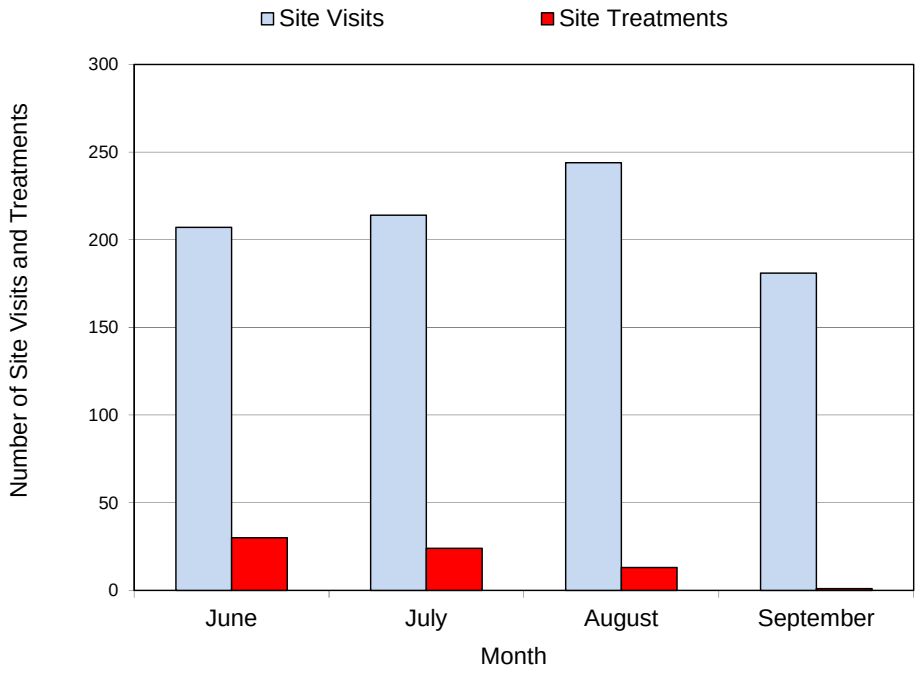
The 2015 larval surveillance season started in May and lasted through September. During the season, a total of 846 individual larval site visits were performed within the program area. Approximately 121 lbs of *Bti*, 25 lbs of *Bs*, and 32 gallons BVA-2 were used to treat approximately 27 acres of active habitat during 68 treatments (**Table 3**).

Table 3 Larval Surveillance Summary, 2015

Habitat Site Surveillance	Totals
# Site Visits	846
# Site Treatments	68
Amount of Treated Acreage	27

Many of the habitat sites produced mosquito larvae multiple times during the season causing the treated acres at certain sites to be counted multiple times for the season total. As the season progressed, the sites were categorized according to larval abundance and occurrence. Low priority mosquito sites were not producing mosquitoes, had poor habitat or had the presence of aquatic predators. High priority mosquito sites typically had larvae when sampled and consistently produced mosquitoes every seven to ten days during the peak season. **Figure 3** shows the number of site visits and treatments performed each month during 2015. It is likely that the City of Fort Morgan's larval control program helped reduce the adult mosquito population levels in the city and surrounding areas during 2015.

Figure 3 Numbers of Site Visits and Treatments per Month, 2015



5.0 ADULT MOSQUITO SURVEILLANCE AND CONTROL

ADULT SURVEILLANCE METHODOLOGY

Adult mosquito population surveillance is a crucial component of any successful IMM program. Adult surveillance provides information on what types of mosquito species are in an area as well as information on their abundance. Mosquitoes collected from the mosquito traps can be tested for a variety of mosquito-borne diseases and are critical for their monitoring and forecasting vector threats, particularly WNV.

Most mosquito species prefer to rest during the heat of the day in areas known as harborage areas. A mosquito harborage area is usually a shaded, wind protected and moist area because adult mosquitoes can dehydrate quickly during the daylight hours if they do not have a shady area to rest and escape the heat. Relevant examples are groves of tall trees with a layer of shrubby undergrowth, dense bushes, tall live grasses, or in residential areas under roof eaves and inside tires. Adult mosquito trapping efforts target these harborage areas to monitor adult mosquito populations.

OtterTail used the CDC style carbon dioxide (CO_2) light trap to monitor the adult mosquito populations within Fort Morgan. The CO_2 light traps are based on the principle that most adult female mosquitoes are attracted to light, CO_2 (via respiration), and heat. The CO_2 light trap collects adult female mosquitoes that are seeking a blood meal. This type of trap is set overnight and on the following morning the nets are collected and returned to OtterTail's lab to be identified and counted. A detailed explanation of the CO_2 light trap used during the 2015 season can be found in **Appendix B**.

Beginning in June, five permanent location light traps were set on weekly basis through mid-September to capture adult mosquitoes. The traps were set throughout the city in adult mosquito harborage locations in areas that were used in previous years of the program (**Appendix C**). OtterTail used the adult mosquito data collected to help City officials determine local areas of concern for public awareness and safety. The data also guided any potential adulticide effort within the City, which was an important health and environmental issue to local officials and residents.

ADULT SURVEILLANCE RESULTS AND DISCUSSION

Over the season, from all five permanent traps, there was an average of 53 total adult mosquitoes per trap per night and an average of 14 adult vector mosquitoes per trap per night. The total adults collected during the season resulted in *Aedes/Ochlerotatus species* (73 percent) being the most abundant, followed by *Culex species* (26.1 percent), *Culiseta species* (0.8 percent), and *Coquillettidia species* (0.02 percent) as shown in **Table 4**. This results in approximately 74 percent non-vector vs. 26 percent vector adults being collected over the entire season.

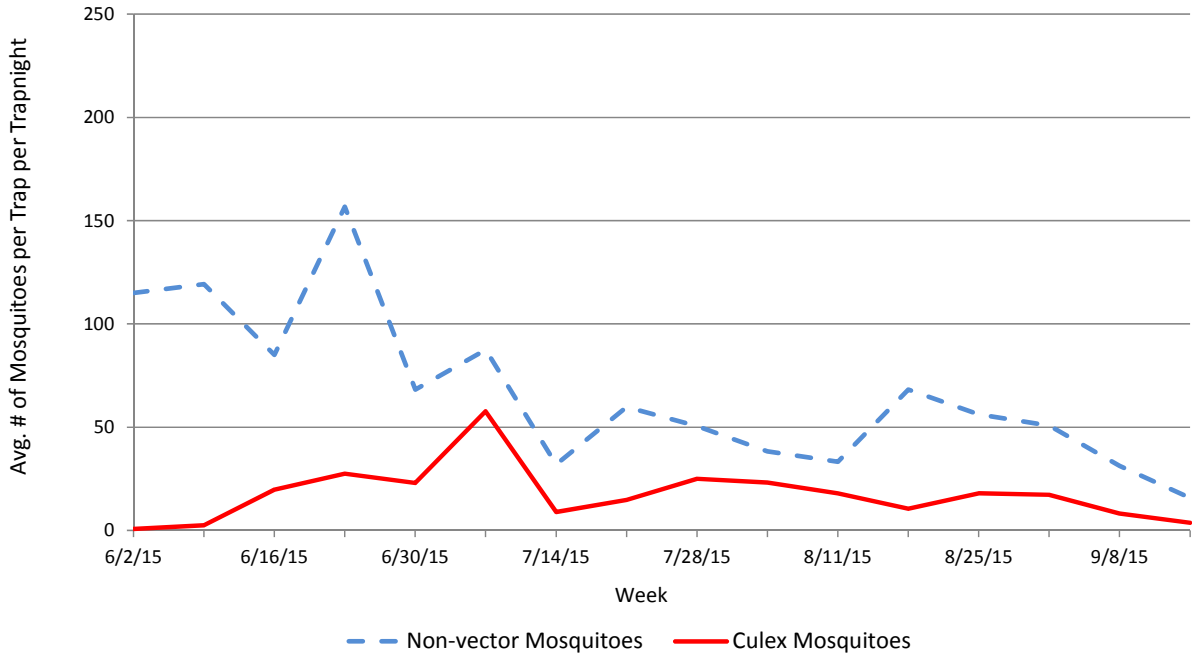
Table 4 Total Number of Adult Mosquitoes per Trap for the 2015 Season[1]

Trap Name	FM-01	FM-02	FM-03	FM-04	FM-05	Season Totals
Trap Location	Northwest Riverside Cemetery	Southwest Brenda Joy Park	Southeast Jaycee Park	Northeast Green Acres	Downtown City Park	
Trap Type	CDC Light	CDC Light	CDC Light	CDC Light	CDC Light	
Species						
Culex pipiens	14	21	7	13	13	68
Culex salinarius	6	1	0	0	6	13
Culex tarsalis	217	216	199	244	159	1035
Total Culex	**237**	**238**	**206**	**257**	**178**	**1116**
% RA Culex	**32.5%**	**19.4%**	**23.8%**	**34.1%**	**25.7%**	**26.1%**
Aedes vexans	321	754	352	298	366	2091
Oc. dorsalis	159	131	242	185	95	812
Oc. hendersoni	1	5	0	3	3	12
Oc. increpitus	1	1	1	0	24	27
Oc. melanimon	5	11	8	1	1	26
Oc. nigromaculis	2	19	12	6	14	53
Oc. trivittatus	1	56	36	3	1	97
Total Ae./Oc.	**490**	**977**	**651**	**496**	**504**	**3118**
% RA Ae./Oc.	**67.2%**	**79.5%**	**75.1%**	**65.8%**	**72.8%**	**73.0%**
Anopheles spp.	0	0	0	0	0	0
Total Anopheles	**0**	**0**	**0**	**0**	**0**	**0**
% RA Anopheles	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**	**0.0%**
Coquillettidia perturbans	0	1	0	0	0	1
Total Coquillettidia	**0**	**1**	**0**	**0**	**0**	**1**
% RA Coquillettidia	**0.0%**	**0.1%**	**0.0%**	**0.0%**	**0.0%**	**0.02%**
Culiseta inornata	2	13	10	1	10	36
Total Culiseta	**2**	**13**	**10**	**1**	**10**	**36**
% RA Culiseta	**0.3%**	**1.1%**	**1.2%**	**0.1%**	**1.4%**	**0.8%**
Trap Total	**729**	**1229**	**867**	**754**	**692**	**4271**
Trap % RA	**17.1%**	**28.8%**	**20.3%**	**17.7%**	**16.2%**	**100.0%**
Avg. per Trap Night	**49**	**82**	**58**	**50**	**46**	**- - -**

Notes: 1. Adult surveillance season was from June 2 to September 15, 2015 (80 trap nights).
2. %RA = Percent Relative Abundance

As described in **Section 3**, temperatures and precipitation amounts varied throughout the 2015 mosquito season. High rainfall amounts in the spring led to many mosquito habitats being inundated with water early in the season. Temperatures then rose to above normal averages during the month of June, allowing nuisance mosquito populations to rapidly increase at the beginning of the summer. The month of July was then drier and cooler than average, followed by a much drier and hotter than average August and September, causing many of the mosquito larval sites to quickly dry up during the second half of the season. After peaking in late June, nuisance mosquito populations quickly decreased to below normal averages for the remainder of the season, while Culex populations remained at below average populations throughout the entire summer (**Figure 4**).

Figure 4 Season-Wide Weekly Adult Trap Counts of All Trap Stations, 2015



ADULT CONTROL METHODOLOGY AND DISCUSSION

The overwhelming majority of the program's efforts are focused on larval control but many IMM programs still include ultra-low volume (ULV) adult control to enhance control options. Although every effort is made to identify and control all mosquito larval habitats within the city, it is possible that additional mosquito habitats occur in inaccessible lands and locations outside of the project area. Mosquitoes originating from these uncontrolled habitats can migrate into the project area, causing adult populations to exceed local annoyance levels, increase the populations in excess of the city's threshold level, increase the potential WNV risk, and trigger the need for adult control. OtterTail and the City of Fort Morgan made adult control decisions based on a combination of the weekly trap counts, residential complaints, and WNV activity levels. When trap populations were high and there was a correspondingly high number of residential complaints, OtterTail would then perform adult control in those areas of the city with the increased mosquito activity.

OtterTail's philosophy with adult control applications is to provide effective control of adult mosquito populations and minimize potential impacts to the public and the environment. OtterTail's trained staff follows the appropriate application practices and utilizes state-of-the-art equipment for adult control. OtterTail uses ULV equipment designed and calibrated to effectively control adult mosquitoes with a minimal amount of active ingredients. ULV delivery techniques, such as timing and weather monitoring, are also designed to minimize environmental and non-target impacts, while at the same time effectively managing populations of adult mosquitoes.

OtterTail recognized the need for increasingly accurate pesticide application and documentation. OtterTail's GPS/GIS based software and hardware for its ULV applications was added to its operations in 2009 and continued through the 2010 - 2015 seasons. OtterTail maintains a fleet of ULV-equipped vehicles enhanced with the Monitor 4 system, which is a GPS based variable flow pump and sprayer control system. This system gives OtterTail the ability to incorporate GPS and GIS into truck-mounted ULV applications, which can dramatically improve several components of an adulticiding program.

In general, this system has increased the accuracy of pesticide applications and documentation. Specific improvements include 1) complete documentation of specific locations and amounts of spray applied; 2) assurance of consistent application rate by its adjustment of spray volume with vehicle speed (including shutoff if vehicle speed exceeds pesticide label recommendations); 3) the ability to report linear miles of actual spraying rather than total vehicle trip miles; 4) the documentation of spray shutoff for residents on "no spray lists"; 5) enhanced GIS data management and reporting efficiency; and 6) the ability to graphically display data in GIS mapping formats. OtterTail's incorporation of these technologies into its entire fleet of ULV trucks has proven to be a valuable improvement to our adulticiding programs.

OtterTail's 2015 adult mosquito control applications were performed with the water-soluble adulticide Aqualuer® 20-20. This product is highly effective for the quick knockdown and control of adult mosquitoes and its water-soluble formulation is safer and easier to work with than more traditional pesticides. The active ingredient in Aqualuer® 20-20 is a synergized permethrin (a synthetic pyrethroid). Synthetic pyrethroids are synthesized derivatives of naturally occurring pyrethrins, which are taken from pyrethrum, an extract of chrysanthemum flowers. These products generally cause rapid knockdown of adult mosquitoes, exhibit low mammalian toxicity, and degrade rapidly in sunlight with little or no residual product.

During the 2015 season, approximately 19.6 linear route miles (at an application rate of 0.0035 lbs Permethrin a.i. per acre) of adult control were performed for the City of Fort Morgan. A detailed summary of the Fort Morgans's 2015 adult treatment applications can be found in **Appendix C**.

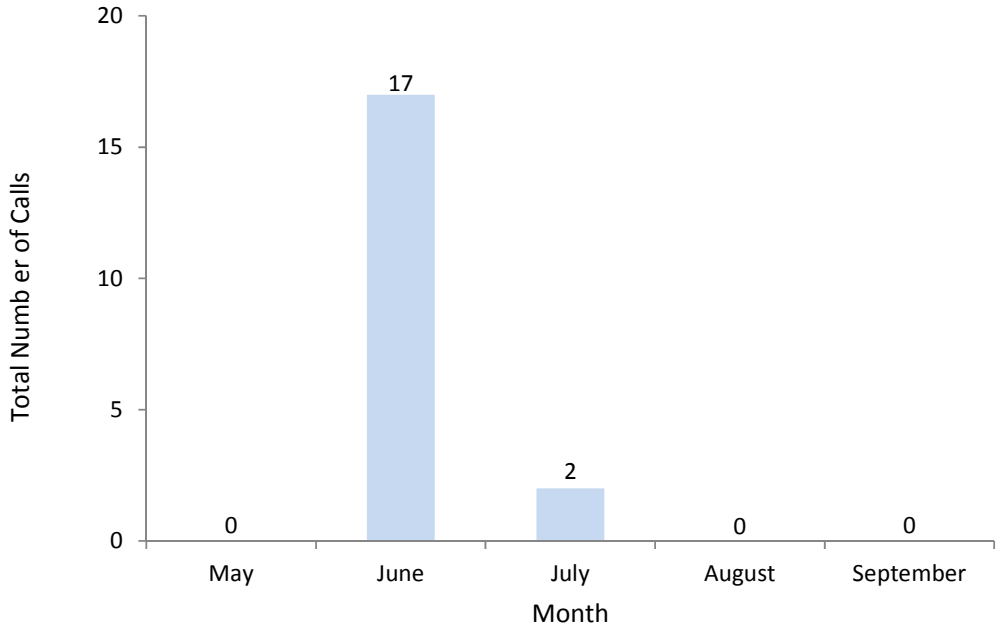
6.0 PUBLIC OUTREACH AND EDUCATION

Public education is an important component to any mosquito control program and is vital in combating West Nile Virus. OtterTail continued to provide valuable educational materials to residents and the general public through local media outlets, educational materials and their internet website. The educational materials stressed the importance of actions that residents could take to aid in the effort to combat WNV; topics included personal protection, property maintenance for source reduction, and general information related to the WNV disease cycle. OtterTail staff also conducted numerous interviews and provided an abundance of mosquito control related information to several media outlets throughout the 2015 season.

OtterTail offered an extensive amount of information on its website, including sections on mosquito biology and control and actions residents could take to help aid mosquito control efforts. The website also provided online spray notifications for the areas where OtterTail would be performing adult control applications each week, as well as allowing residents to fill out an online request form to be included in OtterTail's *Spray Notification and Shutoff Service.* OtterTail also continued to provide local and toll-free telephone hotlines so that residents of Fort Morgan could call and get answers on any specific mosquito related issues, report potential mosquito breeding areas and request to be added to its *Spray Notification and/or Shutoff Service* list. OtterTail received a total of 19 calls to its Mosquito Control Hotline from Fort Morgan Residents during the 2015 season (**Figure 5**).

Educating residents on the need for property maintenance, source reduction, and the use of personal protection measures continued to be crucial in the fight against WNV in 2015. The resulting actions taken by the public likely helped reduce the mosquito populations and the WNV activity levels and cases in the area during the 2015 season.

Figure 5 Number of Mosquito Control Hotline Calls by Month, 2015



7.0 REFERENCES

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APPENDIX A - DETAILED LARVAL SURVIELLANCE AND SITE SELECTION METHODOLOGY

Larval Surveillance Methodology

The following is a summary of the procedures used by OtterTail during larval surveillance. To inspect a mosquito source, a plastic dipper cup with a 3-foot wooden handle was used to collect water from the site. Each sample (dip) was closely examined for mosquito larvae presence. Many of the sites inspected had mosquito-sustaining habitat around the perimeter of the site, but the middle remained mosquito free due to water circulation and/or natural predators. At these sites, the dipping effort was completed using a *linear approach* (walking around the perimeter and sampling the margins).

In sites with widespread mosquito habitat, the entire site was methodically sampled using the *surface area approach*. With this approach, sites were dipped approximately every 10 to 20 square feet. Since each site's characteristics could vary as the season progressed (e.g., become drier, wetter, increased vegetation), there were changes made during the field season to adjust the appropriate number of dips.

Larval Surveillance Site Selection/Characterization Methods

OtterTail generated and used a series of maps for identifying and monitoring the larval habitat areas within the city that could support mosquito larvae. Mosquito larvae require stagnant water, and will thrive in areas where the water is high in nutrients, organic matter, or other organic pollutants. Common habitats include: wetlands, riparian groundwater sinks, non-flowing irrigation ditches, flood irrigated fields, floodwater retention ponds, lake and river shores, and a wide array of man-made habitats including pools, tires, pots, buckets, eves troughs, bird baths and other similar containers. Since habitat sites can change over time, the sites were re-evaluated and classified, based upon their breeding potential, at the beginning of the season.

To ensure a comprehensive larval control program, OtterTail maintained a toll-free telephone hotline so that residents could report areas of concern. OtterTail provided site inspections and any consequential treatments to property owners with lands containing potential larval habitat. If landowners granted permission, any new suitable mosquito sources were added to the surveillance maps and checked regularly.

APPENDIX B - ADULT MOSQUITO TRAP DESCRIPTION

For the season, carbon dioxide (CO_2) baited Centers for Disease Control (CDC) Light Traps were incorporated into Fort Morgan's adult mosquito surveillance system. The following is a detailed description of the CO_2 light trap.

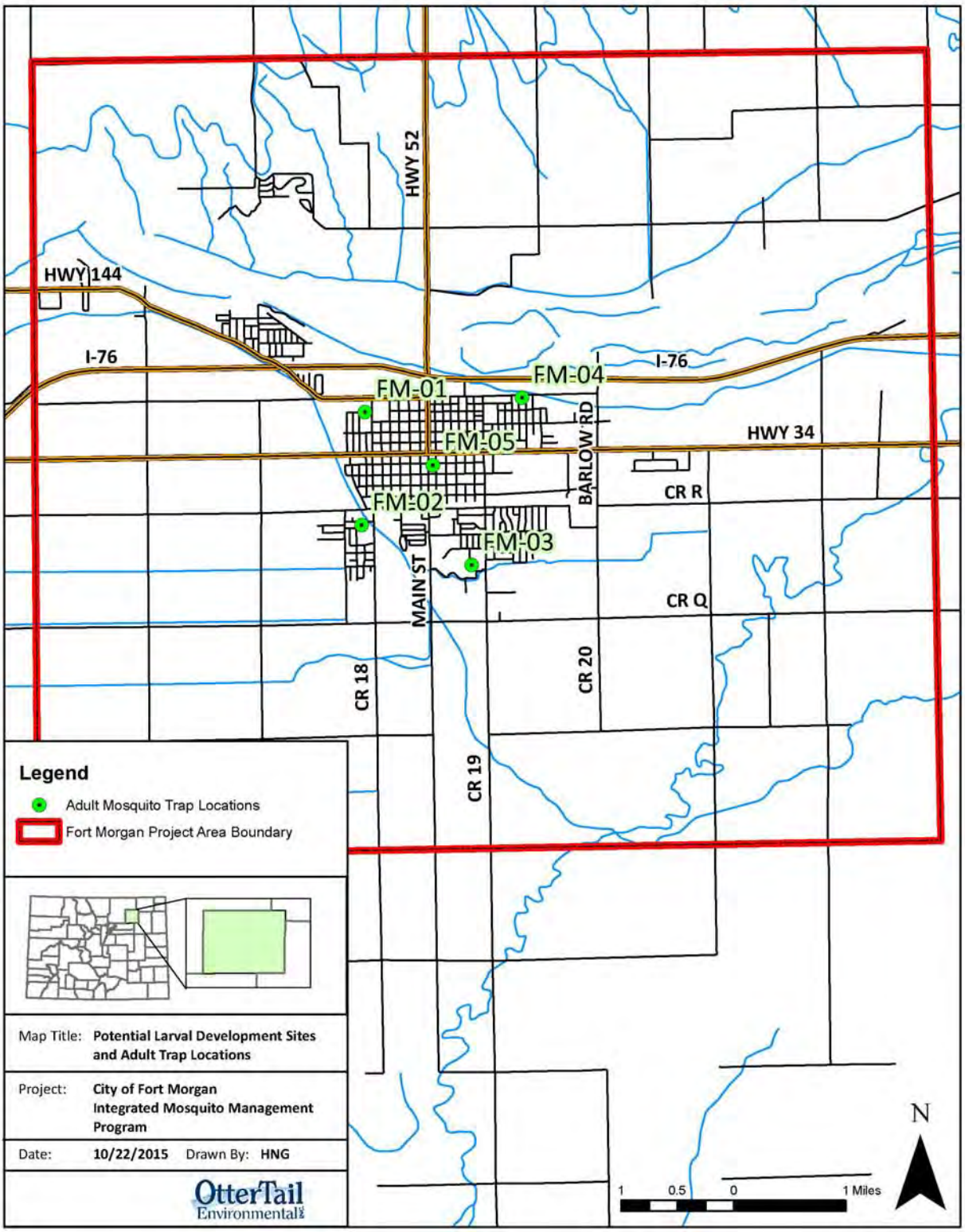
CO_2 Light Trap

To capture the most representative sample of adult mosquitoes in an area, CDC Light Traps are baited with CO_2 in the form of dry ice and set overnight in adult mosquito harborage areas throughout the mosquito season. The traps are designed with the knowledge that the female mosquito species are attracted to light, CO_2, and heat. The number and types of mosquitoes captured in these traps can provide local officials with a valuable early indication of the threat of WNV.

The traps consist of a plastic insulated thermos filled with enough dry ice (CO_2) to last throughout the trapping cycle. Units consist of a light, fan unit, and fine mesh net which hang below the thermos. The device is placed on a tree branch with the thermos approximately five to seven feet off the ground and is suspended by a small chain or rope to allow the thermos and net to hang free. Holes at the base of the thermos allow dissipating CO_2 to be emitted as an attractant around the trap. Batteries run the small fan and light positioned above the net. The light provides further attraction and once the mosquitoes are near the light, they are pulled down into the net by the downward force of the fan.

In the morning, the mosquitoes are removed and frozen to prepare for identification. During the identification process, the mosquitoes are sorted by species and sex. Female vector mosquitoes are routinely submitted to the Colorado Department of Public Health and Environment (CDPHE) lab for WNV testing as needed.

APPENDIX C – CITY OF FORT MORGAN PROJECT AREA



APPENDIX D – 2015 ADULT CONTROL APPLICATIONS

Adult Mosquito Control Summary

Truck Mounted ULV

Area	Material	Start Time	End Time	Route Miles[1]	Spray Miles[2]
FORT MORGAN - Southeast Quadrant	Aqualuer 20-20	6/15/2015 20:40	6/15/2015 21:34	7.1	6.2
FORT MORGAN - Northwest Quadrant	Aqualuer 20-20	6/29/2015 20:18	6/29/2015 20:55	6.2	5
FORT MORGAN - Southwest Quadrant	Aqualuer 20-20	6/29/2015 21:00	6/29/2015 21:39	6.3	6.1
			Total:	**19.6**	**17.3**
			Average:	**6.5**	**5.8**
			Minimum:	**6.2**	**5**
			Maximum:	**7.1**	**6.2**

1. Includes entire mileage of route, including both ULV spray-on and spray-off miles; should be used when comparing 2015 data to historical data
2. Only includes ULV spray-on mileage (excludes shutoffs,turnarounds,etc.)