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Edited by
Sammie Lee Dickson

UTAH MOSQUITO ABATEMENT ASSOCIATION
PO Box 788
Grantsville, Utah 84029

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Blaine Oakeson
PO Box 2369
Salt Lake City, UT 84110
(801) 328-1112

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55 South Hwy 89
North Salt Lake, UT 84054-2504
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Stephanie Whitman
1415 North 35th Street
Laramie, WY 82072
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ZOECON PROFESSIONAL SERVICE
Ted Sleek
Dana West Marina
24500 Dana Point, Harbor Dr.
Dana Point, CA 92629
(800) 877-6374 Ext. 6425

MERITORIOUS SERVICE AWARD

This award is presented to individuals who have distinguished themselves in administrative or technical service to mosquito control in Utah. The UMAA first presented this award in 1970. **Blaine Oakeson** becomes the 39th recipient of this award.

The UMAA consists of mosquito abatement district personnel, individual members from universities, health departments and related fields, as well as, individuals that help educate and supply control personnel with the tools they need to control mosquitoes. **Blaine Oakeson** has worked with the members of the UMAA for more than 14 years as a representative of Van Waters & Rogers through its various name changes to its current name of Univar. Through those years **Blaine** has strived to make available new products and formulations of existing products to UMAA members to make our job more successful. He has constantly gone the 'extra mile', doing such things as researching and obtaining special local needs labeling for adulticides and making available alternative products that both aid in price competition and availability. **Blaine** has been a member and supporter of the UMAA throughout his career. It is for these reasons and many more that the UMAA is proud to honor **Blaine Oakeson** with the Meritorious Service Award for 2003.

WNV SURVEILLANCE IN UTAH EPIDEMIOLOGIC PERSPECTIVE

MICHELLE KORTH
Utah Department of Health, Office of Epidemiology
PO Box 142104
Salt Lake City, UT 84114-2104

West Nile virus (WNV) has spread considerably since its first detection in New York City in 1999. To date in 2003, forty-four of the 48 contiguous United States have reported some form of activity, including 5,005 human cases, 2,177 equine cases, 8,406 dead birds, and 4,941 positive mosquito pools. States that have not reported local WNV activity in 2003 include Washington, Oregon, Idaho, Nevada, Hawaii, and Alaska.

WNV is transmitted primarily through the bite of a mosquito. In 2002, several other minor routes of transmission were identified. Transmission of the virus was identified in incidents such as blood transfusions, organ transplants, mother-to-child (breast feeding and transplacental), and laboratory needle sticks. These minor routes of transmission are being closely monitored in 2003 to determine actual risk for the general population.

West Nile disease manifests in humans in two major forms: West Nile fever and West Nile central nervous system disease. People over the age of fifty or with weakened immune systems are at higher risk for the more severe form of the disease. However, most people that become infected (about 80%) will never experience symptoms. Those that do experience symptoms usually do so within 3-15 days after exposure to the virus through the bite of a mosquito. WNV is seasonal in its incidence, with the peak season matching that of the mosquito season.

West Nile fever causes a mild flu-like illness in about 20% of those infected. This illness typically lasts 3-6 days and causes headache, fever, nausea, vomiting, weakness, and sometimes a skin rash. West Nile central nervous system disease (meningitis or encephalitis) occurs in less than 1% of those that develop symptoms and is much more serious, usually requiring hospitalization. Fever, headache, neck stiffness, and nausea are symptoms of West Nile meningitis (where the linings of the brain and spinal chord are involved). Those that also involve the brain tissue (encephalitis) include the above symptoms plus altered mental status.

Diagnosis of WNV is made by observation of clinical symptoms that are consistent with infection (determined by a health care provider) and a laboratory test showing antibodies to the virus. Currently, there is no human vaccine available and no recommended drug treatment (only symptom-specific treatment). About 10% of the central nervous system cases are fatal and many other patients never fully recover from their illness. Therefore, the goal of our WNV public health surveillance system is to prevent human infection.

WNV surveillance in 2003 consisted of testing mosquitoes, sentinel chickens, horses, dead birds, and humans. Utah reported its first WNV activity in August 2003. WNV was first detected in Utah in sentinel chickens, horses, mosquitoes, and dead birds before any human activity was detected (see figure 1 for results). The detection of West Nile virus led to mosquito control measures and more intense public education. These measures reduced human exposure to West Nile virus. To date, WNV has been detected in 9 of Utah's 29 counties (fig. 2).

Utah expects West Nile virus will return in 2004 and may have a greater impact on humans, birds, and animals. All of the agencies involved in WNV surveillance may expect many dead bird phone calls as well as general calls from concerned citizens. Public health officials are planning and preparing for such a situation by distributing information to each partner agency, health care providers, and veterinarians. Next spring, West Nile virus surveillance will resume with the testing of sentinel chickens, mosquitoes, horses, and dead birds reported by the public.

WNV media attention has the potential to be good or bad, so public education is critical. Utah launched the "Fight the Bite" public education campaign in 2003 with an emphasis on preventive measures; the campaign included public service announcements, brochures, web sites, posters, list servers, and billboards. This campaign will resume in the spring and run through the time period of highest risk.

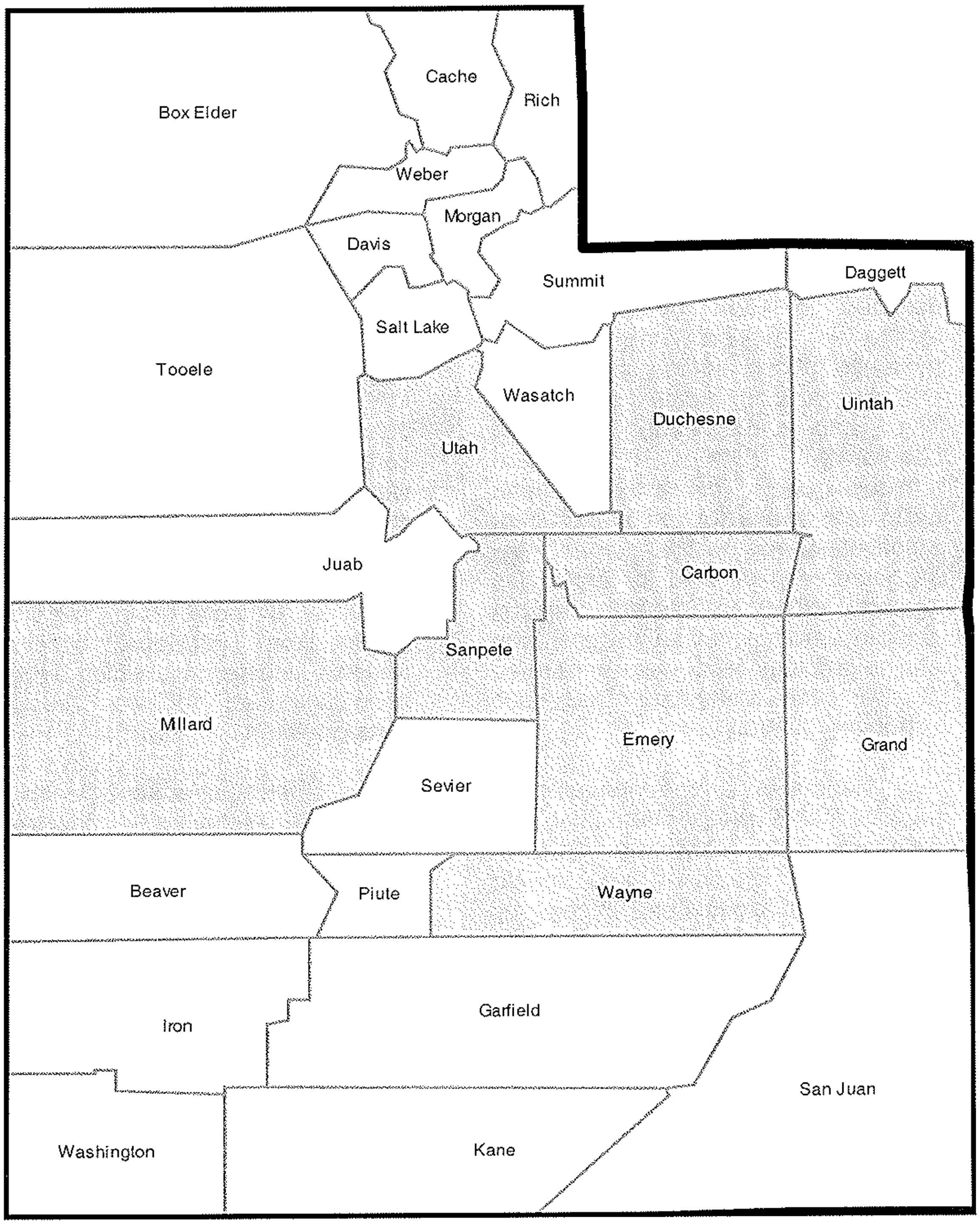
Education of health care providers and veterinarians is also important as part of WNV surveillance. We want these professionals to recognize signs and symptoms, to collect appropriate diagnostic samples, and to consider other causes of illness. Other diseases of public and animal health concern present similarly to WNV and, if clinicians are only testing for WNV, they could miss these other diseases.

The UDOH would like to thank and acknowledge our partners, the Utah Mosquito Abatement Association and the local mosquito abatement districts, the Utah Department of Agriculture and Food, 12 Utah local health departments, the Utah Division of Wildlife Resources and other wildlife agencies, health care professionals, laboratories, veterinarians, Utah's zoos and aviaries, and the Centers for Disease Control and Prevention, for helping with the tracking and monitoring of West Nile virus in Utah.

Fig. 1. WNV surveillance results in Utah, 2003.

County	Sentinel Chickens				Horses				Mosquito Batches				Dead Birds			
	Pos	Neg	Total	% Pos	Pos	Neg	Total	% Pos	Pos	Neg	Total	% Pos	Pos	Neg	Total	% Pos
Beaver																
Box Elder	0	20	20	0	0	1	1	0	0	244	244	0	0	2	2	0
Cache	0	20	20	0	0	7	7	0	0	74	74	0	0	12	12	0
Carbon	**4**	6	10	**40**	0	1	1	0	0	2	2	0	0	3	3	0
Daggett													0	1	1	0
Davis	0	60	60	0					0	548	548	0	0	16	16	0
Duchesne	**1**	19	20	**5**	**3**	12	15	**20**					0	2	2	0
Emery	**4**	16	20	**20**	**8**	0	8	**100**	0	34	34	0	0	3	3	0
Garfield					0	1	1	0								
Grand	0	18	18	0	0	1	1	0	0	91	91	0	**2**	9	11	**18**
Iron					0	1	1	0								
Juab					0	1	1	0								
Kane																
Millard					**4**	1	5	**80**	0	22	22	0	0	2	2	0
Morgan																
Piute																
Rich																
Salt Lake	0	40	40	0	0	4	4	0	0	411	411	0	0	60	60	0
San Juan													0	3	3	0
Sanpete					**2**	2	4	**50**								
Sevier	0	10	10	0					0	3	3	0	0	2	2	0
Summit	0	10	10	0	0	2	2	0	0	5	5	0	0	1	1	0
Tooele	0	10	10	0					0	1	1	0	0	2	2	0
Uintah	0	20	20	0	**16**	11	27	**59**	**1**	52	53	**2**	0	3	3	0
Utah	0	20	20	0	0	5	5	0	**1**	311	312	**0.3**	0	14	14	0
Wasatch																
Washington	0	10	10	0					0	73	73	0	0	2	2	0
Wayne					**2**	2	4	**50**					0	1	1	0
Weber	0	10	10	0	0	3	3	0	0	40	40	0	0	20	20	0
Out-of-state					0	2	2	0					**2**	0	2	**100**

Fig. 2. Utah counties where West Nile Virus was detected in 2003.



Arbovirus Surveillance in Utah 2003: Laboratory Perspective

JUNE INEZ POUNDER
Utah Department of Health Laboratory
46 N. Medical Drive
Salt Lake City, UT 84113

INTRODUCTION

West Nile Virus (WNV) was detected in Utah by surveillance testing in sentinel chicken sera, mosquito pools, equine sera, avian oral swabs, and human specimens. The Utah Department of Health Laboratory (UDOH) examined mosquito pools, avian brains, and avian oral swabs for the presence of arboviruses and tested human sera and cerebrospinal fluid for antibodies against WNV in 2003. Sentinel chicken serology, avian tissues, and equine serology tests were performed at the Utah Veterinary Diagnostic Laboratory (UVDL).

Mosquito surveillance entailed trapping insects weekly from June 2 to September 22, 2003 with CO_2 or gravid traps, identifying and sorting mosquitoes to species and shipping by 17 Mosquito Abatement Districts (MAD's). Pre- and post-season testing was performed for Moab MAD. All pools were tested for West Nile Virus (WNV), St. Louis Encephalitis Virus (SLE), and Western Equine Encephalitis Virus (WEE) by reverse transcriptase polymerase chain reaction (PCR). Target species, *Culex tarsalis* and *Cx. pipiens*, were considered the most important vectors for WNV in Utah and 100% of submitted pools of these species were tested. Additional testing of *Culex erythrothorax* from Grand County was performed due to the evidence of viral infection in birds and lack of target species.

Two hundred eighty White Leghorn chickens were deployed to 17 MAD's. Flocks were bled weekly from June 9 to September 22, 2003. The sera from the ten birds of each flock were pooled to screen for antibodies to WNV, WEE, SLE by an IgM Enzyme-Linked ImmunoSorbent Assay (ELISA). If the pool was equivocal or positive in the screen, serum from individual birds was retested to determine which birds had been exposed to the virus and seroconverted.

Veterinarians sent serum from horses displaying neurological symptoms to the UVDL for a WNV IgM ELISA test. Citizens were encouraged to report dead and ill crows, jays, magpies, ravens, and raptors to the Utah Division of Wildlife Resources (UDWR) and UDOH Epidemiology. UDWR, Local Health Departments, and MAD's were dispatched to obtain swabs of the oral cavity of dead birds. The swabs were mailed to the UDOH lab and tested for the presence of WNV by PCR. Bird carcasses were sent to the UVDL for PCR testing.

Humans with the most severe symptoms of WNV disease, meningoencephalitis, were tested at UDOH lab by IgM ELISA. Commercial labs referred positive specimens from Utah residents to the UDOH lab for additional and confirmatory testing. Human, mosquito, or avian samples requiring confirmation at the Center for Disease Control and Prevention were forwarded to the Division of Vector Borne Infectious Diseases branch in Fort Collins, CO.

RESULTS

A total of 1,945 mosquito pools were tested during the 2003 transmission season. Two pools of mosquitoes were positive for the presence of WNV. Both pools of *Cx. tarsalis* were trapped on August 11, 2003, one pool in Uintah County, one in Utah County. Table 1 represents all mosquito pools tested at the UDOH lab by MAD and species.

The total number of tests performed on sentinel chicken sera was 12,063 for the presence of antibodies to 3 arboviruses. Seroconversions of two birds in the Carbon County flock was detected in the 9th bleed assays, August 4, 2003. The 11th Bleed on August 18, 2003 showed seroconversion in four birds in an Emery County flock. Two more birds from the Carbon County flock seroconverted as detected during bleed 13 assays, September 2, 2003. One chicken seroconverted in the Duchesne County flock as detected during bleed 14 tests, September 8, 2003.

Ninety-nine horse sera or tissue samples were tested for WNV at the UVDL during the transmission season. Thirty five horses tested positive for the presence of WNV antibodies.

A total of 162 avian samples were tested for WNV by PCR from Utah in 2003. UDOH lab tested 126 oral cavity swabs, UDVL tested 11 avian tissue samples, Tracy Aviary had 24 live bird samples tested at Cornell University. On September 10, 2003 WNV was detected in a swab from a crow in Grand County. On October 9, 2003 a swab from a magpie from Grand County showed the presence of WNV. Two additional birds were shown to have been infected by WNV during travel to Colorado and Montana. Table 3 details the avian bird submission for testing in Utah.

Thirty-five Utah residents were tested for the presence of WNV antibodies at the UDOH lab. One resident of Uintah County was determined to have acquired WNV not associated with travel outside of Utah in September 2003.

Surveillance for arboviruses is expected to expand during the 2004 transmission season. Additional testing of mosquitoes, birds, and horses should allow for the most effective preventative measures to be invoked in a timely manner.

Thanks to Utah's Mosquito Abatement Districts, Kris Fehlberg, Tom Baldwin, Nancie Hergert, Mike Paskett, Britny Field, Bernie Ortiz, Kristopher Dunn, Barbara Jepson, Kim Christensen, Tom Ellevold, Rob Lanciotti, Denise Martin, Amy Lambert, Amanda Noga, and Michelle Korth for their invaluable assistance in surveillance for arboviruses in Utah in transmission season 2003.

Table 1. Total Mosquitoes tested at UDOH lab for WNV, SLE, WEE

MAD	*Culex tarsalis* # pools	*Culex tarsalis* # mos.	*Culex pipiens* # pools	*Culex pipiens* # mos.	*Culex erythrothorax* # pools	*Culex erythrothorax* # mos.
Box Elder	243	12,525	1	23	0	0
Logan	57	2,393	17	462	0	0
Carbon	1	13	1	10	0	0
Davis	518	24,568	30	1,086	0	0
Emery	34	384	0	0	0	0
Moab	50	1,354	0	0	41	2,008
Millard	22	327	0	0	0	0
Magna	176	8,475	78	3,663	0	0
SLC	101	3,938	29	644	0	0
SoSLV	3	53	24	864	0	0
Sevier	2	61	1	27	0	0
Summit	5	174	0	0	0	0
Tooele	1	25	0	0	0	0
Uintah	53	2,199	0	0	0	0
Utah	148	5,256	164	5,105	0	0
Washington	73	2,548	0	0	0	0
Weber	40	1,196	0	0	0	0

Table 2. Counties with WNV positive horses.

County	# Positive Horses
Duchesne	3
Emery	8
Millard	4
Sanpete	2
Uintah	16
Wayne	2

Table 3. Avian testing of Utah birds in 2003.

County	# birds
Box Elder	2
Cache	12
Carbon	3
Daggett	1
Davis	17
Duchesne	2
Emery	3
Grand	12
Millard	2
Salt Lake	60
San Juan	3
Sevier	2
Summit	1
Tooele	2
Uintah	3
Utah	14
Washington	2
Wayne	1
Weber	20

2003 MOSQUITO CONTROL IN EMERY COUNTY, AND ARRIVAL OF WEST NILE VIRUS

E. JAMES NIELSEN
Emery County Mosquito and Weed Control Department
PO Box 629
Castle Dale, UT 84513

2003 marked the 23rd anniversary of mosquito control efforts in Emery County. The program was organized in 1980 as a combined Mosquito and Weed control department, funded by the county general fund and has remained a County Department the entire time.

Emery County is a large county with a relatively small population. It is the 7th largest county in Utah with an area of around 4,480 square miles and a population of 10,598. It is an arid region of the Canyonland part of the Colorado Plateau with an annual precipitation of seven to eight inches. Elevation runs from around 4,000 feet in the S.E. corner ascending in step like terraces to over 10,700 ft in the N.W. part of the county.

Initially towns were located adjacent to the natural flowing streams out of the Manti-La Sal Mountains and the Green River. Later as irrigation canals were constructed to farm lands additional towns were established away from the natural riparian areas. Since mosquitoes are a product of an aquatic environment it seems a little out of place to think of mosquitoes as an Emery County problem. There are however some reasons, why this is the case.

In this arid county, riparian areas, farm irrigation land with its runoff and sub-up water, canals and ditches and their seepage all combine to create vital habitat which, it is estimated, 75% of all our animals require at some stage of their life cycle. Thus, mosquitoes and other animal life are closely sharing limited space. These wet areas are small in relation to the over all size of the county but are tremendously important because they make habitation of this area possible and because they concentrate human and other animal life.

The Mancos shale soils of the county are slow to take water, but once wet hold water in depressions, even as small as cow tracks, long enough to produce mosquitoes. Our canals and ditches running through the layers of Mancos shale leak a good percentage of their precious content which then resurfaces elsewhere carrying a heavy salt load. This alkali is a major source of the excess salt in the Colorado River and is the reason that governmentally subsidized sprinkling systems are now being constructed in the county.

2003 was a fourth extremely dry year in a row for precipitation in our valleys. Because of the West Nile threat, we made extra effort on drain cleaning and fixing or pretreating all known mosquito habitat. We responded as quickly as possible to the inevitable need for adulticiding in specific areas as necessary. In all, the general comment and feeling of the citizens was that this was one of our best years for mosquito control. Our feeling as a department was that West Nile Virus was on its way but probably would show up in some of the less arid areas of the state before it came to Emery County. We felt that with our extra efforts, the dry years, and fewer mosquitoes, it would be awhile before we saw the virus. It seems ironic, and is a great surprise to be among the first to be infected and affected by the virus. The extent to which we were affected was county wide, with the effects showing up North to South and East to West. The virus was first confirmed August 15th in a horse in the town of Emery on the South side of the county. The next week, August 22nd, four chickens tested positive on the North side of the county in our sentinel chicken flock in Elmo. On August 29th a horse on the West side of the county, West of Huntington, tested positive, then shortly thereafter two horses, on the East side of the county, died in the Green River. Only one of the horses was tested and it was positive.

Again the surprise was that the first two cases of the virus in Elmo and Emery, were both in towns that are not located on a naturally flowing stream. Because of the drought they are much drier than usual. Emery is located on the end of a canal which comes directly out of the mountain with no storage capacity so water was very short early in the season. The Elmo area was especially dry as many of the farmers sold their water to Utah Power for the Huntington Power Plant, and it was not applied to the land. Also the Ferron Creek area was under sprinkling systems for the first time rather than flood irrigation. As a result, I saw many areas that were dry for the first time in our departments 23 years of operation. This of course, meant we had fewer mosquitoes in those areas.

In spite of the reduced mosquito habitat, there was more confirmed and unconfirmed evidence that the virus was county wide. More horses became sick and reports of dead and sick birds started to come in. The list of birds included Ravens, Crows, Turkey Vulture, Western Tanager, Hawk and small Black birds. To date we have seven confirmed horse cases and four of our sentinel chickens. There was also one untested horse that died in Green River.

In a small department like ours, devoting part of two days to viral surveillance efforts takes a big chunk of our capabilities, since on those days we can't travel to the far side of the county which is two or more hours travel time away. Because surveillance efforts are essential, it would be helpful to us if chicken bleeding and trapping could occur on the same day.

Although *Culex pipiens* is found in Emery County, there was only one trapping in June that produced a pool large enough to be tested. *Culex tarsalis* samples were easier to come by and were sent in every week until September 23rd, when traps were no longer producing enough mosquitoes to be tested. The one time we trapped at the location of the sentinel chicken flock in Elmo, where the four positive chickens were identified, there was not enough *Cx. tarsalis* mosquitoes collected to be tested. Neither the Molen flock nor the mosquitoes from the trap located at the Molen flock tested positive and they are located on a naturally flowing creek.

We have observed in other states, that the impact of West Nile Virus increases in succeeding years. Now that West Nile Virus has arrived in Emery County, it is a concern to us as to the potential magnitude of problems in succeeding years and especially on years of normal or above normal precipitation. We feel fortunate that we have not yet had a human case in Emery County considering our neighboring state, Colorado, has had 1,542 human cases and 27 deaths as of September 25th,

2003. We can see that dealing with West Nile Virus is going to be a very complex problem and will tax our capabilities.

There is a disadvantage of not being a single purpose department in that many conflicting decisions have to be made. Should we send the crew to prevent seed production of a state declared noxious weed which, after four or five years, is in its final mop-up stage, or should we use those days to enhance mosquito control where West Nile Virus might be present? Should we spend herbicide budget money for additional adulticides and larvicides? If we could just have the hind sight first, it always gives the right answer.

GIS IN DAVIS COUNTY: 2003 ADVANCES

RYAN ARKOUDAS
Mosquito Abatement District – Davis
85 North 600 West
Kaysville, Utah 84037
rarkoudas@davismosquito.org

INTRODUCTION

Since late 2001, the Mosquito Abatement District – Davis (MAD-D) has worked at building a solid base of GIS (Geographical Information System) and GPS (Global Positioning System) data. This paper addresses the advancements and the efficiency that we at the MAD-D have seen using GPS equipment in the field and GIS in the office to coordinate information, analyze important data, and make critical decisions.

This paper will focus on GPS/GIS information gathered from tree hole work over the past three summers and its relationship to Canine Heartworm Disease (CHD) cases in a study area; second, the importance of urban mosquito control specifically aimed at *Culex pipiens* breeding in gutters, storm drains, and catch basins, and some of the challenges in this particular area of mosquito control; and third, the use of GPS equipment in aerial larvicide and adulticide applications.

EFFORTS TO CONTROL CANINE HEARTWORM DISEASE

In many older areas of Davis County, well established trees like sycamores, elms, maples, cottonwoods, and others present a serious problem. In Davis County, *Ochlerotatus sierrensis* is the vector for CHD and it is inside of trees, in rotted out tree holes filled with water where this species matures. Each tree hole that is found inspected for water and mosquito larvae, attributes of the tree and the hole are recorded as well as its position using a GPS receiver, it is also marked with blue paint for easy identification the following year, and it is treated with Altosid XR for 150 day control.

Since the summer of 2001 1,046 tree holes have been inspected and recorded. In 2001 and 2002, 26% of competent tree holes contained water at the time of inspection and treatment. In 2001, only 4% (36 out of 816) of inspected tree holes contained larvae. 10% of new tree holes were found positive during the spring and summer of 2002. Even with the extremely dry winter of '02-'03 and years of drought conditions, 23% of new tree holes found this past spring and summer contained water with nearly 12%, 23 out of 198, containing mosquito larvae. Since the district treats existing tree holes in February and March it is impossible to accurately give a number or percentage of tree holes containing larvae after the initial summer each hole is discovered.

Table 1 shows the number of reported CHD cases by year with the number in parenthesis being those physically within the Davis County limits. Also included are a few cases from Weber County whose proximity (usually less than a mile from the county line) is close enough to affect Davis County. Davis and Weber counties comprise 70% of all CHD cases in the state of Utah. Also listed is the number of cases within a study area. 22 cases were reported in 1997 but the district does not have specific information regarding these cases. Reporting and activity increased dramatically starting around 1997 and 1998 with an average of 30 new CHD cases reported annually.

The study area includes all of Sunset City and portions of Clinton and Clearfield. This particular area was chosen for two reasons: 1) A high number of CHD cases have been reported within a close proximity of one another and 2) the district has done extensive tree hole work in this area.

Although useful and informative, Table 1 does not accurately represent the progress made in this area. By recording CHD and tree hole positions with GPS equipment and importing those into a GIS, a relationship has been created. This relationship, when observed on a map with other features such as street lines and major roads, shows congested or problem areas. Once these areas were determined, action was taken in the form of a concentrated effort to inspect and treat all tree holes within these areas. The figures 1, 2, and 3 show how this process evolved.

The information in figure 3 shows a large portion of the study area free of any new CHD cases in 2002. Of 4 reported cases, 1 is in Weber County, the 2 cases within a block of one another had not been inspected for tree holes, with the fourth case in an area that has witnessed a decrease from 7 cases down to this one case (figures 1 and 2). The positive information achieved through this process acknowledges the efficiency of the GPS/GIS system incorporated into the MAD-D tree hole efforts. As a side note, during the summer of 2003 the remaining region of the study area was inspected for tree holes and data will be processed and studied with the arrival of CHD cases for the year 2003.

Culex pipiens IN AN URBAN SETTING

With West Nile Virus knocking on the door much attention was focused on two species figured to spread the disease. Within Davis County many *Culex tarsalis* breeding areas are known and inspected weekly but it is the evasive *Culex pipiens* and its sources which are of concern. For years a few drains and gutters were casually targeted, usually on a Friday afternoon after everything else was completed. This year a new approach was taken. Equipped with a mountain bike, an iPaq handheld computer with GPS attachments, and a fanny pack filled with WSP pouches and Altosid briquets, one employee inspected suspect areas of 5 cities. The plan was to check all storm drains, gutters, and catch basins within the assigned area and to record GPS position and attribute data for each source. In just a few short months and many miles pedaled, 765 possible *Culex pipiens* sources were found.

Table 2 presents these findings and poses some key questions. On the first line, only 80 of the 765 sources, about 11%, were larvae found. Only 4% of inspected sources were confirmed negative, with 85% of inspected drains as unknown. In other words, the drain was either too deep to inspect or the grate was too hard to remove. Even though each of these 765 sources were treated, the large number of unknown drains is unacceptable. An accurate account of positive sources is necessary in determining areas of focus and problem areas. And it is problem areas that can be addressed in meetings with city and county officials for possible replacement. From this summer's work, some of the problems and questions which have been found associated with these urban sources are: 1) How to accurately inspect drains (especially deep drains) without compromising the quickness and mobility necessary. The mountain bike is an efficient way to conduct storm drain inspection, but what piece of equipment can be used and carried on a bike which will allow accurate inspection?; 2) using Altosid XR, with approximately 150 days of control, works very well but there are concerns about silt layers in drains and Altosid's effectiveness if dropped into this layer; 3) using VectoLex WSP, with about 4 weeks of control, what happens after a flood event (rain, heavy watering, etc.) These are all vital questions and problems to accurately inspect and treat sources for *Culex pipiens*.

AERIAL LARVICIDE AND ADULTICIDE ACCURACY USING GPS

During the summer of 2003 MAD-D flew 8,240 acres for larvae and 37,560 acres for adult control. The entire western edge of Davis County is the Great Salt Lake and its marshes. This is a wonderful area to see shore and migratory birds but also habitat for numerous species of mosquitoes. The average number of acres sprayed by the airplane, from 1998-2002 is: 11,005 acres of larvicide and 23,163 of adulticide. The summer of 2003 was a dry year, as expected, and it is evident in the amount of spraying done for larvae, down considerably from the average. Adulticiding was above average with the threat of West Nile Virus and preventative measures being taken.

With such high numbers in acres sprayed, there is a great need for precision spraying. The purchase of a new airplane during the winter by MadFly came equipped with an older GPS system installed. The equipment used on this airplane was the WAG Flagger system. In the office WAG's TracMap software was used and data from the airplane was converted to a shapefile and then imported into ESRI's ArcMap. A simple compact flash card recorded and transferred data between the airplane and the computer.

Once an area was designated to be sprayed, certain events would transpire. First, the field inspectors thoroughly checked the suspect area, placing flags near visible corners of the spray area. Each flag position was recorded using a Trimble GPS unit. If accessible, the area would be driven by ATV and an area feature created using the GPS unit. The second phase of this process took place back at the office. The flag features and/or area features were downloaded from the GPS to a desktop computer. Files were processed and converted and the different layers of the spray area (flags and area features) were uploaded into ESRI's ArcView software. Adjustments were made, area size measured, details, or attributes, entered into a database, and the final map printed. A compact flash card was taken with the printed map to the airport. The flight was recorded onto the compact flash card and returned to the district shortly thereafter where it would again be processed and uploaded onto a readable map.

What was noticed from these flights was that swath widths began to widen as the plane flew down the spray area. Some parts of an area were missed altogether. One particular area was very concerning. A 70 acre section of the Farmington Bay Bird Refuge, surrounded on 3 sides by drivable dikes, displayed a pattern of overlapping and crisis-crossing spray lines and nearly a third of the area untouched. By meeting with the pilot some issues relating to the WAG Flagger system installed in the airplane were realized.

A couple of problems were immediately recognized. The WAG Flagger is not a navigational system, only a data recorder. The information received was all the system could do. It is unable to receive files; it only records where the airplane flies. The AB line, or first spray run, is set by the pilot and then the system attempts to line the airplane up for the remaining passes. This led to another problem, without a differential signal receiving real-time data the position of the airplane "bounces". If you have ever used a GPS unit you will notice that as you attempt to navigate back to a location and as you walk, it may show you 3 feet away and then suddenly jump to 10 feet. This is what is believed to have taken place with the airplane. As to the swaths overlapping or wide swathing, the pilot explained that the light bar in the cockpit sometimes lined the airplane up for its next run 100 to 300 feet away from the previous line. At other times the pilot was lined up on top of the previous line. Many times the pilot ignored the light bar to ensure proper coverage. Since this is a trusted pilot with years of experience in Davis County alone, an error in the equipment being used was concluded.

Some solutions to the problems were discussed with the following conclusions: 1) New equipment is needed, preferably with "moving map" equipment inside the cockpit; 2) A system capable of receiving real-time data to ensure accuracy; 3) New equipment that will accept files (preferably shape files) which can be uploaded into the system on the airplane. The overall conclusion is that the WAG Flagger is outdated and that a new system which meets the above specifications is needed. These specifications will increase the accuracy of the airplane and provide valuable data pertaining to the effectiveness of chemicals (granules vs. liquid) used with varying types of vegetation and the species being targeted, and hold accountable those flying the airplane.

CONCLUSION

The Mosquito Abatement District - Davis uses GPS and GIS technology for a number of different applications within the scope of mosquito control. Ornamental fish pond data is kept within the GIS and is managed from year to year with this system. To date, 1,060 ornamental fish ponds have been recorded using GPS equipment with detailed information attached to each pond. The location of each pond can easily be searched in a database and, once selected, is highlighted on a map. This is very useful in generating an end of year report submitted to the Utah Division of Wildlife Resources on all known and stocked fish ponds in Davis County. All treated larvicide sources have also been recorded with a GPS unit during the past two summers. Each source entry contains detailed information pertaining to the size of the area, the size and number of larvae per dip, species, chemical used to treat the source, and method of application. Requests for spray are also included in the system. The address from a request is mapped on the computer with important information included. This allows for monitoring of movements and problem areas.

GPS and GIS technology is an exciting new asset to mosquito control. Every year more advancement is made specifically related to the daily operations of mosquito control. ULV trucks can now be equipped with GPS units recording truck movement, truck speed, temperature and wind direction, and when the spray is on and off; airplanes equipped with certain GPS systems are unable to spray unless flying within a designated spray area. Utilizing this and other technologies as they become available will increase mosquito control effectiveness while producing better, more accurate records.

Table 1. Canine Heartworm Disease Cases in Davis County 1992-2002.

Year	Cases (within county boundaries)	# in Study Area
1992	11 (10)	2
1993	7 (6)	1
1994	4 (3)	1
1995	6 (6)	1
1996	4 (3)	2
1997	22 (No specific data)	No data
1998	29 (20)	2
1999	55 (39)	7
2000	20 (20)	7
2001	20 (20)	3
2002	29 (24)	4

Table 2. 2003 Storm Sewer Surveillance.

Number of Sources Inspected and Treated for *Culex pipiens*		
Larvae present	80	11%
No larvae present	38	4%
Unknown	647	85%
Total	765	

Fig. 1. Canine Heartworm Disease cases in study area from 1992-2001.

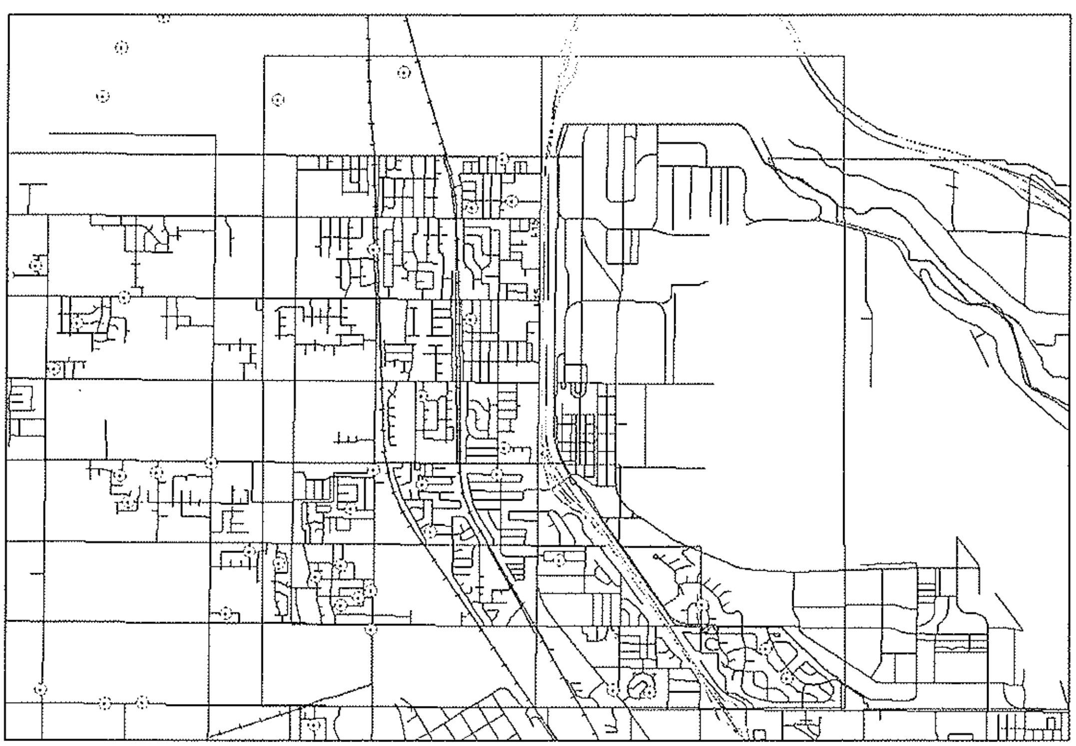


Fig 2. Tree holes (solid dots) found during 2002 in relationship to CHD cases (circled dots) from 1992-2001.

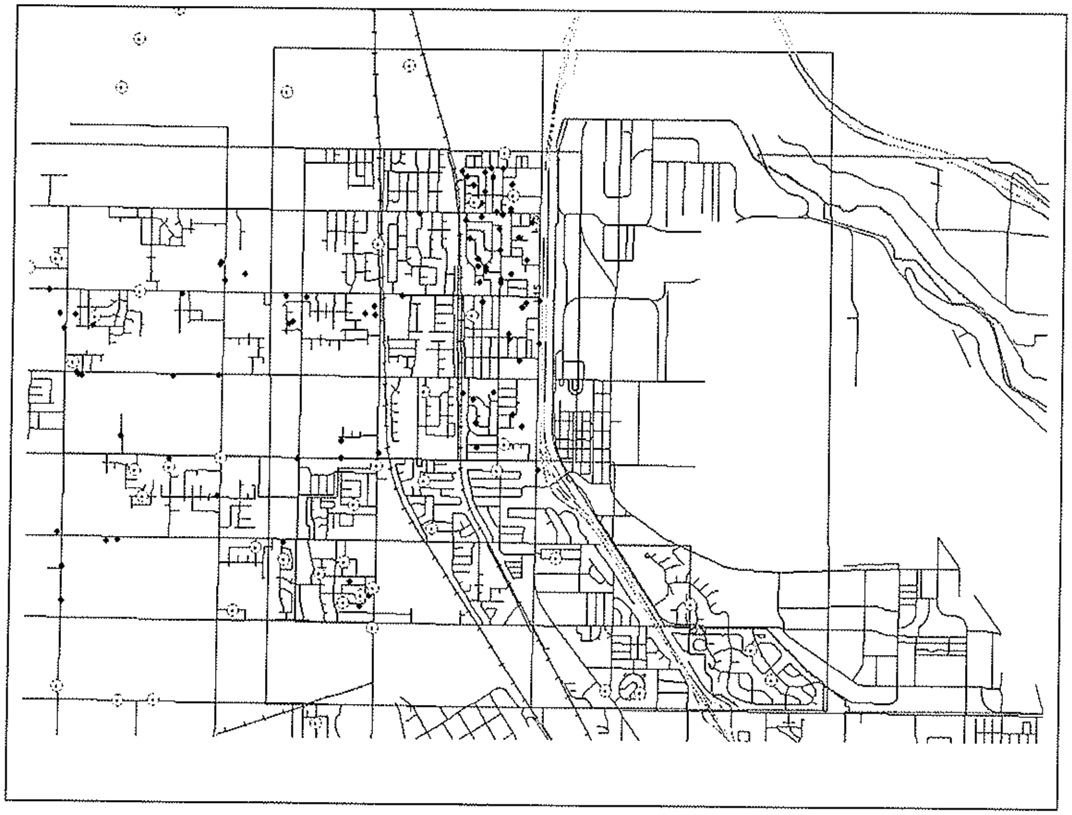
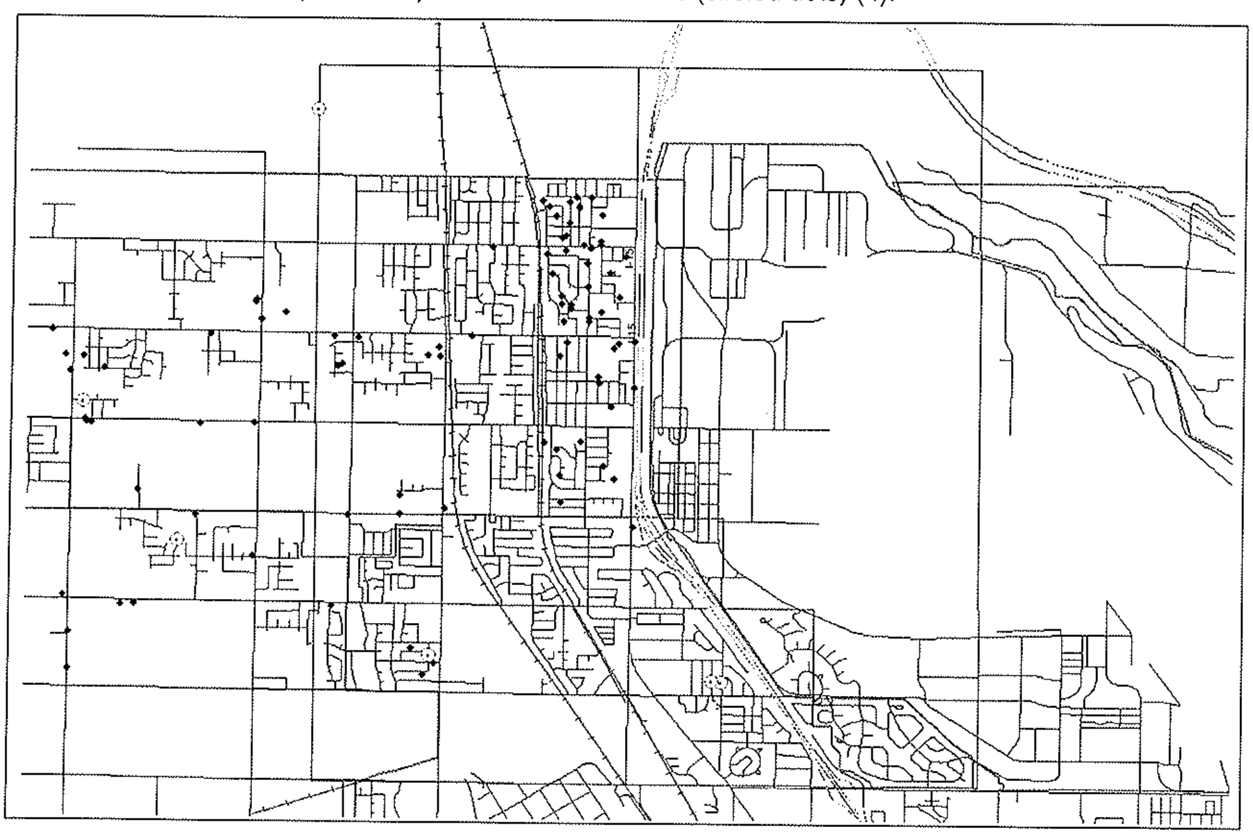


Fig. 3. 2002 tree holes (solid dots) and 2002 CHD cases (circled dots) (4).



INTEGRATED MOSQUITO SURVEILLANCE PROGRAM GUIDELINES FOR CALIFORNIA

RICHARD P. MEYER
Orange County Vector Control District
P.O. Box 87
Santa Ana, CA 92702

WILLIAM K. REISEN
Davis Arbovirus Research Unit,
Arbovirus Field Station, University of California,
Davis, CA 95616

OVERVIEW AND RATIONAL FOR A MODERN MOSQUITO SURVEILLANCE PROGRAM FOR CALIFORNIA:

The California Mosquito and Vector Control Association in collaboration with the University of California and California Department of Health Services – Vector Borne Disease Section has produced guidelines that will provide uniformity and standardization to mosquito surveillance activities throughout the State of California. Historically, adult mosquito surveillance has relied heavily upon the deployment of standard New Jersey Light Traps (NJLT) as the method to measure seasonal and geographical changes in mosquito abundances. This method proved successful until recently when data analysis of trap collections have indicated that New Jersey Light Trap effectiveness in urban, and to some extent periurban settings, has declined in comparison with concurrent trapping using carbon dioxide (dry-ice) baited traps (referred to in California as EVS or encephalitis Virus Surveillance traps or modified CDC-style battery operated traps) (Figure 1.) It was also discovered via trap comparison studies that gravid-traps (samples gravid females) (Figure 1.) placed at urban locations sampled more mosquitoes (e.g., dominant *Culex pipiens* Linnaeus and *Cx. quinquefasiciatus* Say) than either NJLT or EVS traps.

Combined with changing from NJLT to EVS and gravid trapping strategies, adjustments in sampling strategies also included a geographical component based upon distinctive environmental differences that typify California's varied and diverse landscapes and associated mosquito fauna. Therefore, four (4) regional programs were developed based upon local conditions presented by physiography/topography, climate, and mosquito species/vector dominance. The 4 "regional" models include to following: I. Coastal Region, II. Central Valley/Foothill Region, III. Southern California Region and IV. Desert Region.

COMPONENTS OF REGIONAL SURVEILLANCE PROGRAMS:

Regional surveillance programs include the application of a uniform stratified system (Strata 1-3) of land usage (Figure 2.) that combines mosquito and virus endemicity/focality, mosquito dispersal and settlement behavior, and disease/vector "bridging" from predominately rural to urban environments. Note: Trapping strategies involve extensive use of EVS traps (some special application of NJLT's) and gravid traps. Operationally, Stratum 1 (S1) includes wetlands, wildlife areas, and riparian corridors that have a documented history of vector production (*Cx. tarsalis* Coquillett as the principal target species) (Figure 3) associated with enzootic disease (e.g., arbovirus – WEE, SLE, and presumably WNV) transmission, Stratum 2 (S2) includes peripheral sites (e.g., agricultural settings, farms, and woodlands) that secondarily support mosquito production, mosquito resting sites, and epizootic transmission to susceptible reservoirs; and Stratum 3 (S3) includes largely urbanized landscapes impacted by a combination of the immigration of rural mosquitoes (e.g., *Cx. tarsalis*) and locally produced domestic mosquitoes (e.g., *Cx. pipiens* and *Cx. quinquefasciatus*). Stratum 3 represents an important component of each surveillance program where tangential transmission from urban to rural environs/vectors occurs with epidemic outbreak consequences involving considerable human risk to disease exposure.

SYNOPSIS OF REGIONAL SURVEILLANCE PROGRAMS:

The following regional surveillance program highlights have been included to illustrate both the conceptual and applied operational practicalities of the sampling strategies using EVS (S1 and S2) and gravid (S3) traps statewide.

I. COASTAL SURVEILLANCE PROGRAM:

The coastal surveillance strategy is based upon historical documentation of mosquito-borne encephalitis amplification beginning in primarily rural as compared to urban settings. Coastal environs have characteristically yielded few virus isolates from either mosquito pools or sentinel chicken seroconversons. However, systematic sampling should not be abandoned related to past history and heightened likelihood of intercepting invasive species (e.g., *Aedes albopictus* Skuse) associated with western Pacific rim import commerce. Stratum 1 (S1): Upland fresh water elements of coastal salt and fresh water marshes plus inland rural wetlands supporting *Culex* production. Stratum 2 (S2): Rural dispersal corridors and mixed agricultural sites adjoining suburban areas and urban population centers. Stratum 3 (S3): Outer perimeter of residential neighborhoods adjacent to S1 and S2 sites where bridging is most likely to occur.

II. CENTRAL VALLEY/FOOTHILL SURVEILLANCE PROGRAM:

The Central Valley and foothill surveillance strategy is focused on rural wetlands and riparian conveyances (floodwaters) that support *Culex* breeding and associated historical occurrence of encephalitis enzootic transmission. Stratum 1 (S1): Rural wetlands, wildlife areas/refuges, riparian flood planes (spring/winter overflows), and nearby woodland settlement sites that support *Culex, Aedes*, and *Ochlerotatus* (irrigated pasture species). Stratum 2 (S2): Mixed agricultural sites with embedded sloughs, river/creek tributaries, woodlands, wastewater wetlands, and wooded farm residences that support *Culex* and interconnect to form effective dispersal corridors. Stratum 3 (S3).: Suburban and residential sites that border mixed agricultural sites or embedded urban wetlands where infiltration by *Culex* (e.g., *Cx. tarsalis*) can effectively bring "rural" virus transmission into contact with housing residents.

III. SOUTHERN CALIFORNIA SURVEILLANCE PROGRAM:

The southern California surveillance strategy is designed to provide emphasis on the fact that spatial transition between "rural" and "urban" mosquitoes/strata occurs abruptly (often < 0.1km). Therefore, spatial attributes that are applicable elsewhere within the State do not apply in the close proximity conditions of the Greater Los Angeles Basin land maze and outlying "Inland Empire" and Moreno Valley bedroom communities. Stratum 1 (S1): Embedded "rural" wetlands, including extensive detention basin developments, and wildlife areas supporting *Culex* (e.g., *Cx. tarsalis* and *Cx. erythrothorax*). Stratum 2 (S2): Mixed agricultural sites that include farm oasis and waste water wetlands that collectively form linkage conditions and corridors for bridging rural to urban mosquitoes and associated encephalitis transmission (e.g., enzootic abruptly to epidemic). Stratum 3 (S3): Suburban and residential sites that spatially represent likely points of either rural or periurban mosquito infiltration into residential/commercial areas where encephalitis virus is "bridged" from rural (e.g., *Cx. tarsalis*) to urban (e.g., *Cx. quinquefasciatus*).

IV. DESERT SURVEILLANCE PROGRAM:

The desert surveillance strategy is unique to mosquito sampling because most habitats that support mosquito production are the direct consequence of human facilitated environmental change (e.g., "artificial" irrigation and vegetation). Both S1 and S2 conditions have been created by human mitigated conversion of the desert landscape into wetlands and seasonally irrigated mixed agricultural habitats that are exploited opportunistically by *Culex* vectors. Landscape alterations have also provided the right mix to foster the hyperendemicity of both WEE and SLE viruses and very likely the newly arrived WNV. Stratum 1 (S1): Man-made wetlands and wildlife areas, including wastewater disposal sites supporting the production of *Cx. tarsalis* and *Cx. erythrothorax*. Stratum 2 (S2): Mixed agricultural sites and overflow areas along irrigation channels and other storm water sites located aside residential developments. Stratum 3 (S3): Suburban and residential sites prone to infiltration by rural *Culex* in developed neighborhoods or communal farm facilities.

SUMMARY:

The Mosquito Surveillance Program Guidelines for California represent the first attempt at developing a statewide effort to systematically and uniformly apply common standards to monitoring mosquito populations over a wide and diverse area. The authors, on behalf of the Mosquito and Vector Control Association of California (MVCAC), encourage other states and mosquito control associations to obtain copies of the "Program Guidelines" for review and potential application in their state/regional surveillance efforts. Copies of the "*Integrated Mosquito Surveillance Program Guidelines for California*" by R.P. Meyer and W.K. Reisen, 2003, are available from the office of the Mosquito and Vector Control Association of California.

Figure 1. Photographs of a "standard" CO_2 Trap (or EVS – encephalitis virus surveillance) baited with dry ice trap and standard gravid trap recommended for sampling mosquitoes in California.

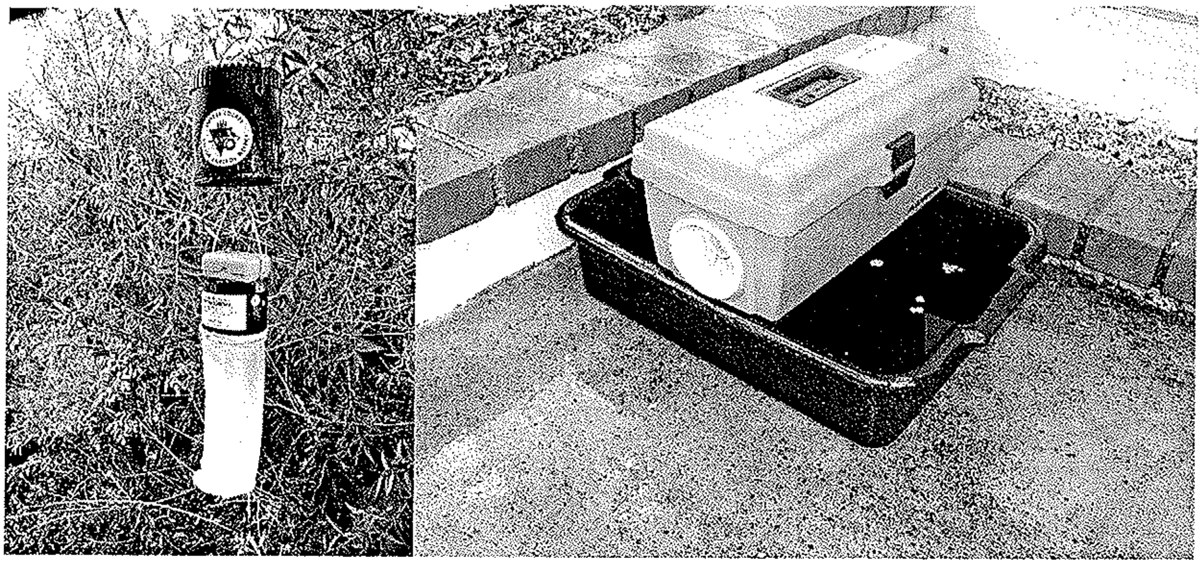


Fig. 2. Diagram illustrating the major elements/components of the integrated mosquito surveillance program guidelines for California.

Adult Mosquito Surveillance Strategy And Trap Placement Guidelines.

Regional Models For California

1-Coastal 2-Central Valley 3-LA Basin 4-Deserts

Mosquito-Borne EV Endemicity And Spread

Enzootic → **Epizootic** → **Epidemic**

↓ ↓ ↓

Landscape Features

Stratum 1 **Stratum 2** **Stratum 3**

Rural → Settlements/Corridors → Urban

Fig. 3. Diagram illustrating the integrated use/placement of mosquito traps according to land use (Strata 1-3) and targeted mosquito species.

Land Use, Trap Placement Strata, and Vector Mosquito Species		
Stratum – Trap	**Habitat /Ecology**	**Vector Mosquitoes**
Rural		
Stratum 1 – EVS	EV Wetlands Foci	CT, CE, CS, CP/Q
Stratum 2 – EVS	Corridors, Settlements	CT, CP/Q, CE, CS
Stratum 3 – Gravid/EVS	Embedded Urban	CP/Q, CS, CT
Urban		
Stratum 1 - EVS	Embedded "Rural" EV Foci	CT, CE, CS, CP/Q
Stratum 2 – EVS	Corridors, Parks, Basins	CT, CP/Q, CE, CS
Stratum 3 – Gravid/EVS	Urban Housing	CP/Q, CT, CS

CT = *Culex tarsalis*, CE = *Culex erythrothorax*, CS = *Culex stigmatosoma*, and CP/Q = *Culex pipiens / quinquefasciatus*

WHEN IS THE BEST TIME TO ADULTICIDE?

BRIAN HOUGAARD
SAMMIE LEE DICKSON
DENNIS KIYOGUCHI
Salt Lake City Mosquito Abatement District
2020 North Redwood Rd.
Salt Lake City, UT 84116

During the past few years the Salt Lake City Mosquito Abatement District (SLCMAD) has done its ground and aerial adulticiding at dawn and the hour immediately preceding. SLCMAD does not do routine ground or aerial adulticiding applications. Spraying events are triggered by a combination of factors including but not limited to: trap collections of adults and field observations of both biting adults and residual larval populations either missed or not killed in larval spraying. The rationale for morning spraying is different for ground and aerial applications.

When making ground applications, it has been convenient for technicians to come to work a couple of hours earlier than normal, spray the necessary areas and then work a normal day. Most employees would rather follow that routine than work eight hours go home have supper and then return and work for two or three hours in the evening. This results in having to make two complete trips to and from work.

The reasons for dawn applications from the air are much different. Salt Lake City is a hub for Delta Airlines and has two peak times when banks of airplanes are arriving. One of these times is just before dusk and the other just after dawn. Air traffic controllers became concerned that aerial spraying during these heavy air traffic times would not be safe. Since a lot of the aerial adulticiding applications were being made near the Salt Lake City International Airport, it was decided that spraying would be done at dawn before the morning bank of arriving passenger planes began for the day.

With the arrival of West Nile Virus (WNV) to Colorado in 2002 and the expectation of an outbreak along the Wasatch Front it prompted the SLCMAD to examine its adulticiding practices, especially for the most probable vector species, *Culex tarsalis*. The SLCMAD currently uses natural pyrethrum for ground and naled for aerial adulticiding applications. These products work as a contact toxin and therefore must impact the mosquito to deliver a fatal dosage. Thus, the most successful applications should be when mosquitoes are most active. Bellamy and Reeves (1952) using a lard can trap found that in California *Culex tarsalis* collections peak at sundown with a lesser peak at dawn. Beadle (1955) reported that *Cx. tarsalis* reached a peak biting activity one hour after sunset in northern Utah, but made no mention as to the host seeking activity at other times. He measured activity as the number of host-seeking females collected during 15 minute increments using a chloroform tube. Nelson and Spadoni (1972) stated that although much is known about the feeding behavior of various species, detailed information on patterns of biting activity is unavailable for many species. In their study they found that *Cx. tarsalis* had a peak biting activity 45 to 60 minutes after sunset and in at least one night's collections a smaller peak at dawn.

This paper describes efforts made to determine the highest periods of activity of *Cx. tarsalis* in order to maximize the effectiveness of both ground and aerial spray applications.

METHODS AND MATERIALS

Adult mosquitoes were trapped using an ABC® trap (Clarke Mosquito Control Products, Inc.), attached to a Collection Bottle Rotator® Model 1512 (John W. Hock Company) (Fig. 1). The ABC® trap has an insulated container that can hold approximately 3 pounds of dry ice, a fan, a photocell and is powered by a 6 volt battery that will run the fan for more than 24 hours (Fig. 2). The ABC® trap was programmed so that the fan would turn on at dusk and stay running until manually turned off the next day. The Collection Bottle Rotator® Model 1512 is a device that has eight plastic collection jars that rotate on a perpendicular plane to the ABC® trap and is powered by a 12 volt battery. A programmable timing device allows the jars to be rotated at various times so that during a trapping session eight individual samples can be made during a 24 hour period.

The trap was placed northwest of the Salt Lake City International Airport in an area located between wetlands adjacent to the Great Salt Lake and the city of Salt Lake City. The wetlands can produce large populations of *Cx. tarsalis* and *Ochlerotatus dorsalis*. The trap was operated on 20 nights between June 3 and August 21, 2003. On three nights the timing device was not programmed properly and on five nights there was too much wind to collect many mosquitoes. Twelve of the trap nights produced useable data.

The bottles were set up to rotate under two different regimes. On nine evenings the bottles were set to rotate hourly, the first bottle collecting from dusk until 10:00 PM, bottles 2 through 7 collecting for a single hour and bottle eight collecting from 4:01 AM until the trap was picked up later that morning. On three evenings the bottles were set to rotate every 20 minutes, the first bottle collecting from dusk until 9:20 PM, bottles 2 through 7 collecting for 20 minutes each and bottle eight collecting from 11:21 PM until the trap was picked up later the next morning.

During all trapping nights the trap was set to turn on with the photocell. This occurs at dusk. Dusk is a relative term, but in this paper it is used to express the decreased light intensity that would activate the photocell on the ABC trap. In mid-summer in Salt Lake City dusk is approximately one hour after sunset. The time of sunset varied by as much as 15 minutes in the hourly collection regime and 22 minutes in the 20 minute collection regime between collection evenings. This would mean that in the hourly collection regime the collecting time of the first bottle varied between one hour and one hour and 15 minutes, similarly with the 20 minute rotation regimes the first bottle collected between 20 minutes and 42 minutes depending on the actual time of sunset (Table 1).

RESULTS

The nine evenings of trapping with the collection bottles rotating on an hourly basis collected a total of 10,707 mosquitoes. *Culex tarsalis* made up 61% of the total catch with 6,606, and *Oc. dorsalis* 37% with 3,933 (fig. 3). Other species collected in too few numbers to draw information about time of activity were *Culiseta inornata* (70), *Culex pipiens* (23), *Culex erythrothorax* (58) and *Anopheles freeborni* (1). From dusk until midnight 65% of the *Culex tarsalis* were collected (fig. 4). Only 27% of the *Culex tarsalis* were collected from midnight to 4:00 AM and just 8% were taken from 4:01 AM until the traps were picked up later that morning. Seventy-seven percent of *Ochlerotatus dorsalis* were captured between dusk and 11:00 PM, with another 18% taken from 11:01 PM to 4:00 AM and 5% from 4:01 AM until the traps were picked up later that morning (fig. 5).

The three evenings of trapping with the collection bottles rotating on a 20 minute basis collected a total of 7,316 mosquitoes (fig. 6). *Culex tarsalis* made up 75% of the total catch with 5,476, *Oc. dorsalis* comprising 15% of the trapping with 1,094 and *Culex erythrothorax* making up 4% with 526 adults. Other species collected in too few numbers to draw information about time of activity were *Culiseta inornata* (44), *Culex pipiens* (149), *Aedes vexans* (23) and *Anopheles freeborni* (4). Seventy-seven percent of *Culex tarsalis* were collected in the approximate two hour period between dusk and 11:00 PM, with 34% of the catch in the 40 minute period from 9:21 to 10:00 PM (fig. 7). Only 10% of the *Culex tarsalis* were collected from dusk until 9:20. This is in contrast to the *Oc. dorsalis* which had 18% of the total catch from dusk until 9:20 PM (fig. 8). The collection pattern of *Culex erythrothorax* was very similar to that of *Culex tarsalis*, with 51% of the adults of this species being taken between 9:21 and 10:00 PM (fig. 9).

DISCUSSION AND CONCLUSIONS

If the activity of adult mosquitoes can be determined by their host seeking activity as indicated by carbon dioxide baited traps, then several interesting observations can be made from the results of this study. *Ochlerotatus dorsalis,* a major pest species in the district, has a peak activity at dusk until about 11:00 PM and then its activity rapidly diminishes. Only 5% of its activity occurred after 4:00 AM. This is in some contrast to *Culex tarsalis* which is active at dusk but doesn't reach its peak activity until about 9:20 PM lasting until about 11:00 PM. However, 34% of the activity of *Culex tarsalis* occurs over the 40 minute period from 9:20 to 10:00 PM. While figure 4 appears to show a small peak of activity at dawn, this is not really the case since the last bottle collected mosquitoes for more than two hours, 4:01 AM until dawn, rather than one hour. This is in contrast to both Bellamy and Reeves (1952) and Nelson and Spadoni (1972) who reported smaller spikes of activity at dawn for *Cx. tarsalis*. Cope et al (1986) found that *Cx. tarsalis* exhibits a strong human biting peak around 9:00 PM, in southern California followed by a relatively constant biting rate throughout the night until about 6:00 AM. This study found that the biting activity of *Cx. tarsalis* declines steadily throughout the night reaching its lowest level near dawn. On individual nights of trapping it was observed that there would be intermittent spikes of activity through the night. This was believed to be the result of winds increasing in intensity lowering the number of adults coming to the traps and then having the wind decrease in intensity and the trap numbers going back up making what appears to be a spike in activity.

For both *Ochlerotatus dorsalis* and *Culex tarsalis* it appears that adulticiding at dawn is the least productive time. The best time to adulticide should be between dusk and 11:00 PM. However, some circumstances may prevent applications being made during those times. Environmental conditions such as wind speed and direction are important. In the morning the wind is generally out of the southeast in the wetlands northwest of Salt Lake City, but shift 180 degrees in the evening. Thus, some access roads used in evening spraying may not permit applications to certain areas that could be treated using the morning breezes. Air and ground temperature become important in the hottest part of the summer. In the early evening the ground may be radiating enough heat that was stored through the day to make the droplet cloud rise or evaporate.

Human activity can disrupt spray routes. Activities such as picnics, barbeques, and children playing or camping out on lawns may hamper evening sprayings. Morning sprayings may be disturbed by milk or paper deliveries along with joggers and walkers.

It is the intent of the SLCMAD to maximize the effectiveness of its adulticiding application, i.e. killing the most mosquitoes, with the least amount of pesticide and disturbing the environment as little as possible. The results of this study indicate that ground adulticiding should be done from dusk until about 11:00 PM whenever possible. Aerial adulticiding should be done slightly earlier based on environmental conditions that will allow the spray cloud to reach the target area between dusk and 11:00 PM, since aerial spray clouds may take more than ½ hour to reach the ground. Similar conclusions were cited by Schmidt (2003) in Florida.

REFERENCES CITED

Beadle, LD. 1955. Man-biting habits of *Culex tarsalis* and associated mosquitoes in Northern Utah. Proc. UT Mosq. Abate. Assoc. 8:3.

Bellamy, RE, Reeves, WC. 1952. A portable mosquito bait-trap. Mosq. News 12(4):256-258.

Cope, SE, Barr, AR, Bangs, MJ. 1986. Human bait collections of mosquitoes in a Southern California freshwater marsh. Proc. Calif. Mosq. Cont. Assoc. 54:110-112.

Nelson, RL, Spadoni, RD. 1972. Nightly biting activity and parous rates of some California species. Proc. Calif. Mosq. Cont. Assoc. 40:72-76.

Schmidt, RF. 2003. Relationship of landing count observations to the time of sunset. Wing Beats 14(3):12-15.

Fig. 1. ABC® trap attached to a Collection Bottle Rotator® Model 1512 mounted on a custom pole.

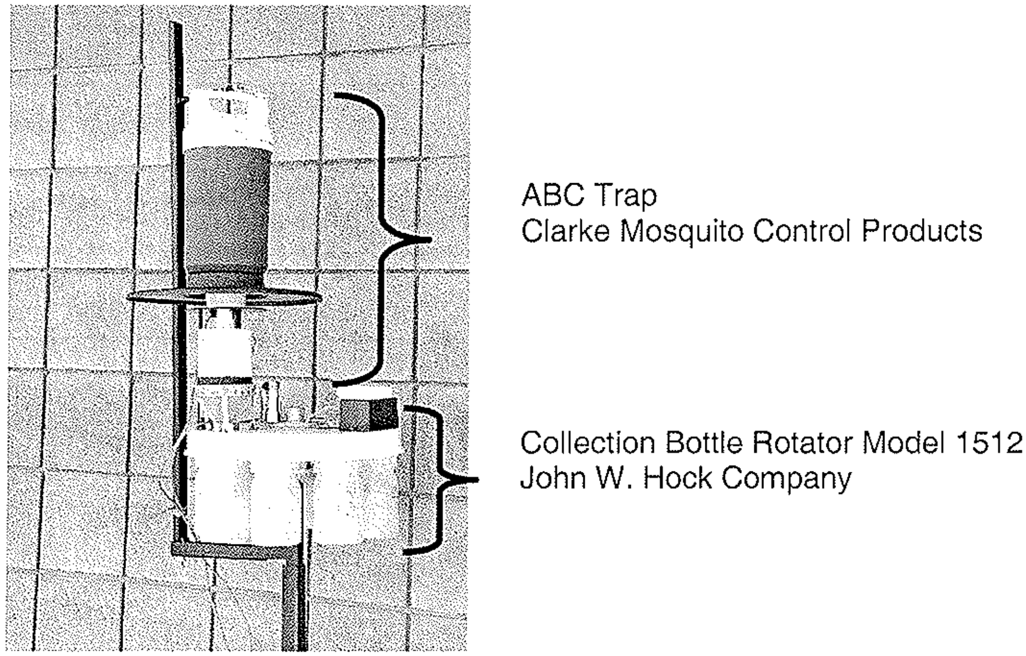


Fig. 2. Adult mosquito trap setup.

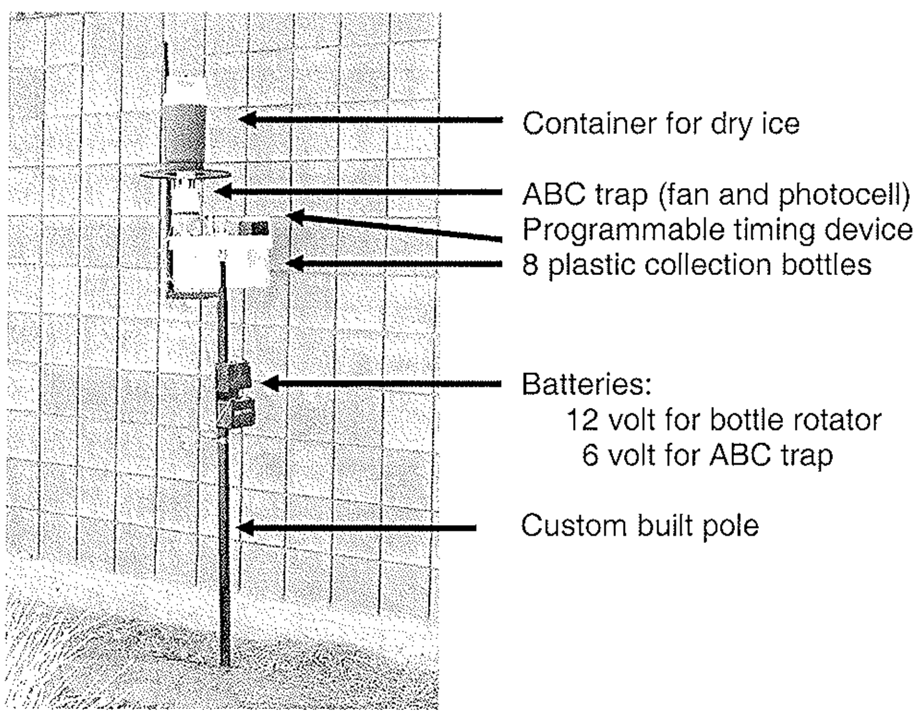


Fig. 3. Comparison of total adults collected from nine collections made between June 3 and July 29 of *Cx. tarsalis* and *Oc. dorsalis* with collection bottles changing every hour.

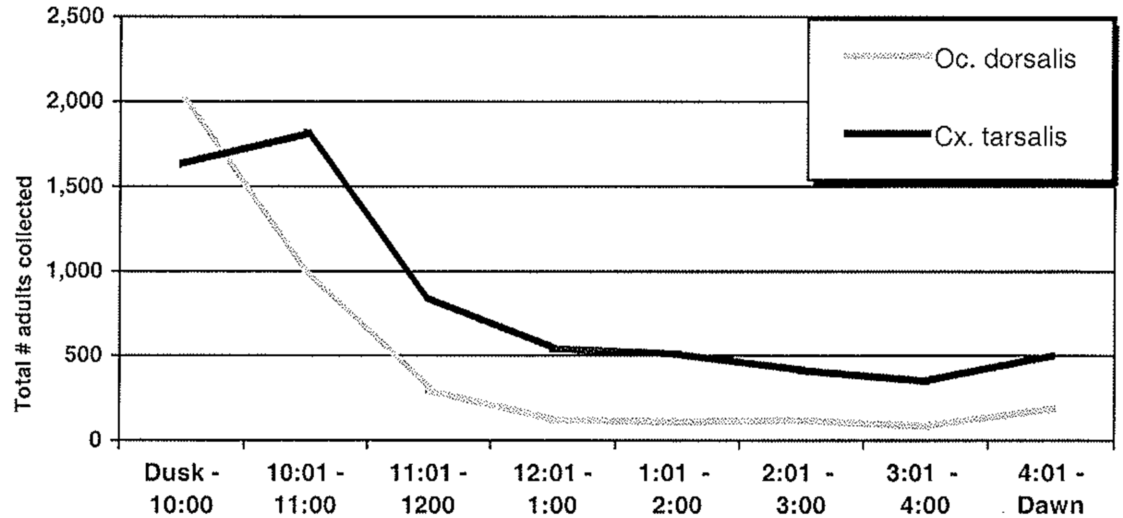


Fig. 4. Percent activity as indicated by the total number of *Cx. tarsalis* collected from nine collections made between June 3 and July 29 with collection bottles changing every hour.

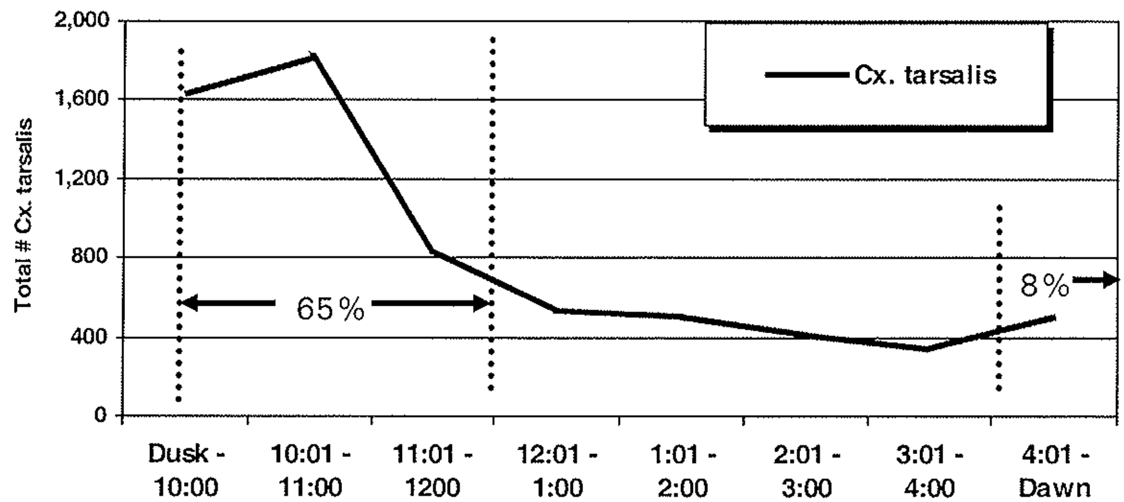


Fig. 5. Percent activity as indicated by the total number of *Oc. dorsalis* collected from nine collections made between June 3 and July 29 with collection bottles changing every hour.

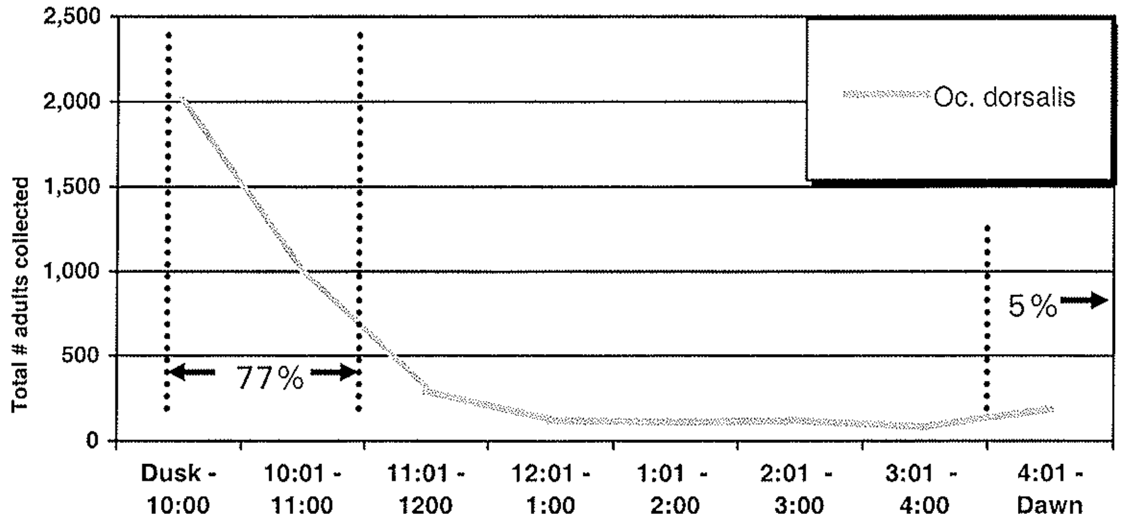


Fig. 6. Total number of adults collected during three nights of trapping (August 4, 18, 20) with a collecting bottle rotator changing collection bottles every 20 minutes.

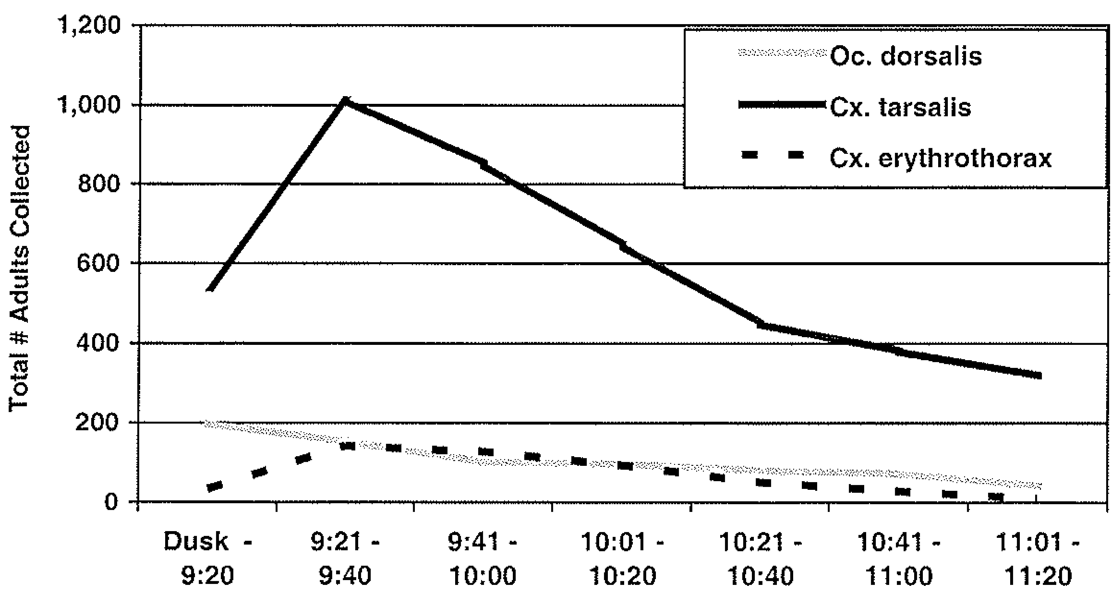


Fig. 7. Percent activity as indicated by the total number of *Cx. tarsalis* collected during three nights of trapping (August 4, 18, 20) with a collecting bottle rotator changing collection bottles every 20 minutes. The last collection period, 11:21 PM to dawn is not included in graph.

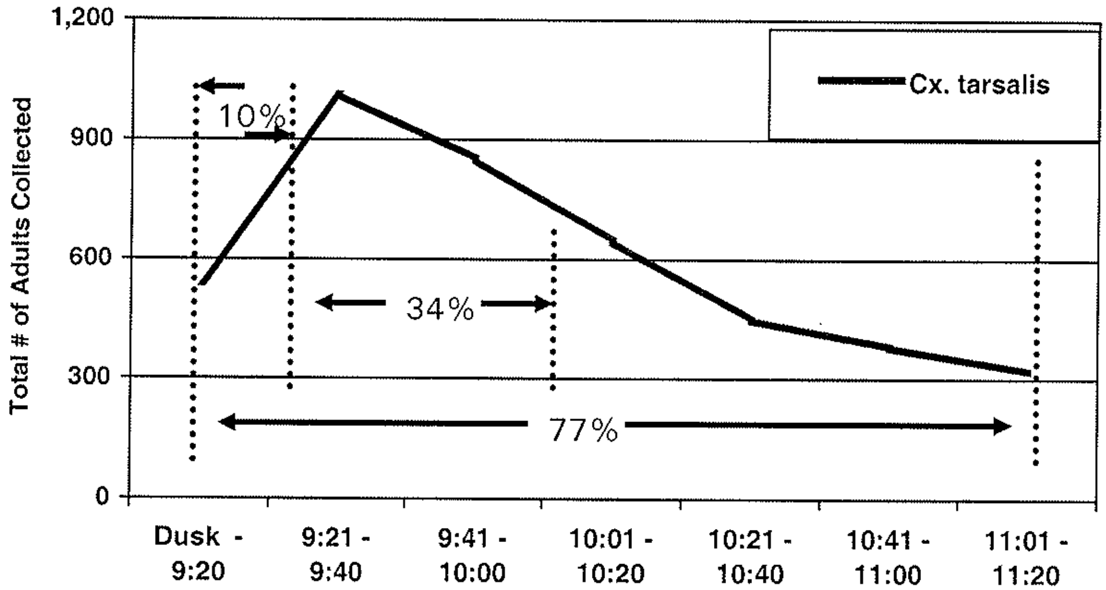


Fig. 8. Percent activity as indicated by the total number of *Oc. dorsalis* collected during three nights of trapping (August 4, 18, 20) with a collecting bottle rotator changing collection bottles every 20 minutes. The last collection period, 11:21 PM to dawn is not included in graph.

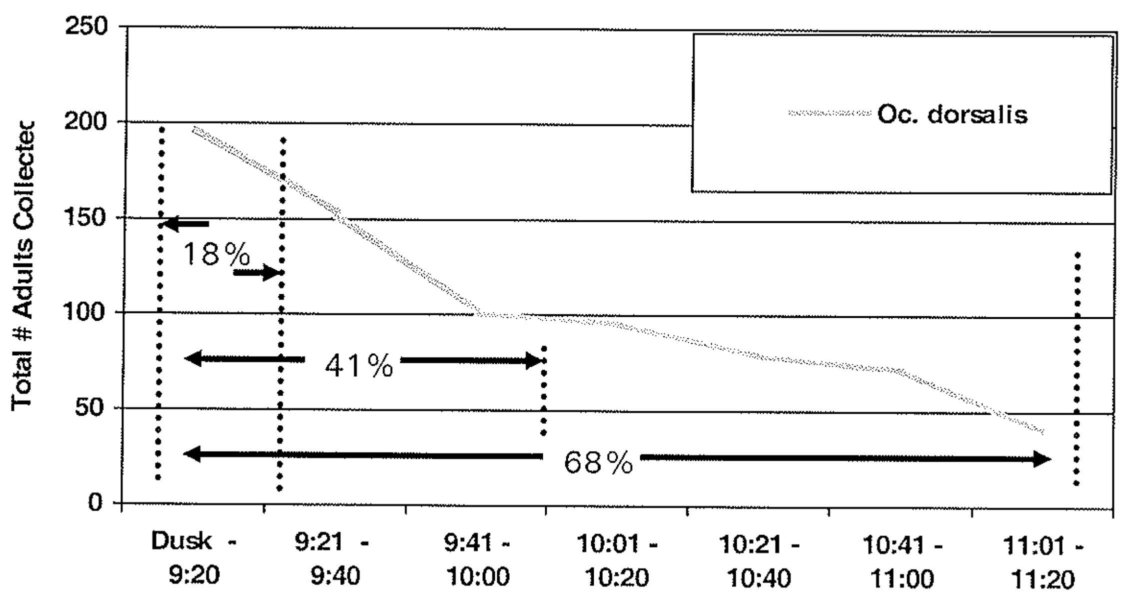


Fig 9. Percent activity as indicated by the total number of *Cx. erythrothorax* collected during three nights of trapping (August 4, 18, 20) with a collecting bottle rotator changing collection bottles every 20 minutes. The last collection period, 11:21 PM to dawn is not included in graph.

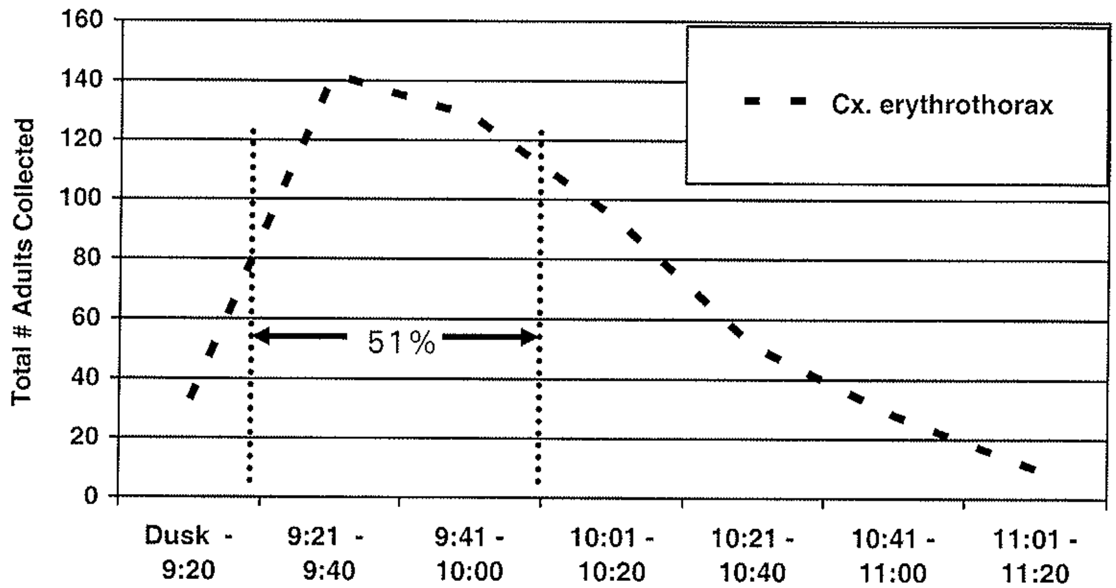


Table 1. Time of sunset for the days trapping occurred in both the 1 hour (June 3 – July 29) and 20 minute (August 4 – 20) bottle rotation regimes.

	Date	Time of Sunset
1 Hour Rotation	June 3	7:53
	" 12	7:59
	July 1	8:03
	" 8	8:01
	" 10	8:01
	" 21	7:54
	" 22	7:54
	" 28	7:48
	" 29	7:42
20 Minute Rotation	August 4	7:42
	" 18	7:23
	" 20	7:20

CO_2 TRAP PLACEMENT AND ADULT TRAPPING POTENTIAL

KEN MINSON AND JOSHUA GRAHAM
South Salt Lake Valley MAD
8682 S. Sandy Parkway
Sandy, UT 84070-6424

With the advent of West Nile Virus in the Western United States, effective trapping of mosquitoes became a serious concern to the South Salt Lake Valley Mosquito Abatement District in 2003. In 2002 a new placement of the sentinel chicken flock was made to better position the flock in a higher mosquito producing area. However, subsequent trapping of adults did not seem to produce the desired catches hoped for at this location. A New Jersey light trap had been used at this location for several years and had trapped enough *Culex* species to warrant the change to this location of the chicken flock. The addition of a CO_2 trap still didn't provide the numbers of mosquitoes required for testing at the State Health Lab. Realizing that these mosquito vectors, i.e., *Culex tarsalis* and *Cx. pipiens*, were feeders on roosting birds prompted a consideration of changing the altitude of the trap from approximately five feet to twelve feet above the ground. We felt this would place the trap closer to potential roosting birds in a nearby tree and would possibly give us a better sample of the number of adult mosquitoes (Fig. 1).

No attempt at this point was made to establish an ideal site for the CO_2 trap other than having it placed near the flock and high enough to satisfy the experiment. Wind dispersal of CO_2 was not a consideration though there is a prevailing south wind in the Salt Lake Valley. It might also be noted that observations of all other pictures published showing CO_2 trap placement showed the traps to be hanging close to the 5 foot mark that we determined to be a "normal" height. There is much recognition that our initial testing does not include many of the outside variables that could affect the collections on any given trapping session, but time and equipment constraints hampered more detailed testing at this point.

To test the height variable, a site was selected where several complaints had been called in to the office. Trapping with a Mosquito Magnet from July 1st to July 22nd, 2002 had only trapped 3 *Cx. tarsalis* females and 1 *Cx. pipiens* female. These numbers did not reflect the level of frustration coming from the occupants of the home. This home is set in a beautiful large yard with over an acre of forested area just south of the house. A pathway back through this wooded area provided a site that was thought to be ideal for a test (Fig. 2).

An "ABC" CO_2 trap was placed at a level of 12 feet in the trees bordering the aforementioned pathway. Weather conditions at this site at 4:00 PM were reported at 99 degrees F. and 35% humidity. We suspect that the humidity was much higher than locally stated because of the wooded nature of the site plus a large pond some 20 yards from the trap. The trap ran from 3:00 PM to 8:00 AM the next morning. The catch numbered 255 *Cx. pipiens* adult females. The next afternoon two CO_2 traps were placed; one at the 12 foot level and one at the 5 foot level. The trap catch at the 12 foot elevation was 118 *Cx. pipiens* females yet the 5 foot elevation trap catch had only 45 *Cx. pipiens* females and 3 *C. tarsalis* female adults (Fig. 3).

This data prompted a change in our locations of the CO_2 traps at the chicken flock site as well as two other sites selected for lab testing of West Nile Virus. Comparative results of these traps placed at the two levels are shown in figures 4 – 6 and table 1.

CONCLUSION

Conclusions of our work would be limited to the obvious. Traps placed at the higher level consistently had higher numbers than the lower placed traps. No attempts were made to measure temperature, humidity or wind speed in the trap vicinity (The weather data used was the local weather reports of the area). This was due to the inability to find the proper measuring devices. Every effort will be made as the study continues next year to acquire the needed instruments to enhance the results. Included in the continued work will be efforts to place two traps at the two different levels and run them the same night instead of alternate nights as was done this past year. Sheer time constraints may hinder these efforts depending on the pressure brought to bear from the West Nile Virus concerns.

Fig. 1. Placement of Co_2 trap by sentinel chicken flock.

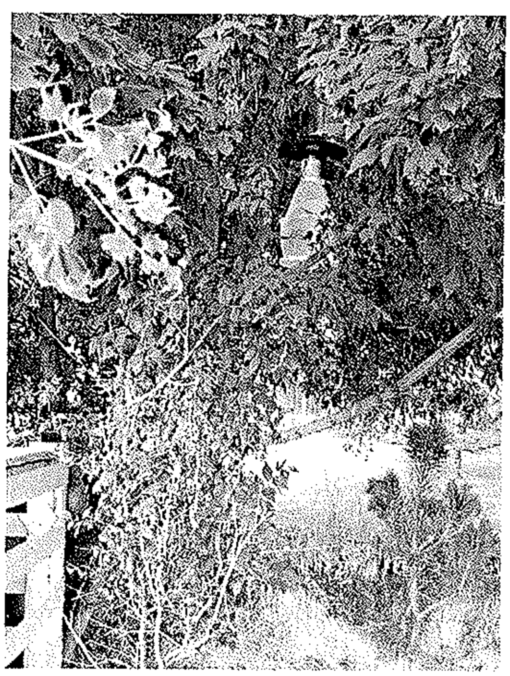


Fig. 2. Placement of CO_2 trap to test height as a variable in *Culex* collection.

Fig. 3. Placement of a trap at 5 feet and 12 feet above the ground to test for most effective trapping.

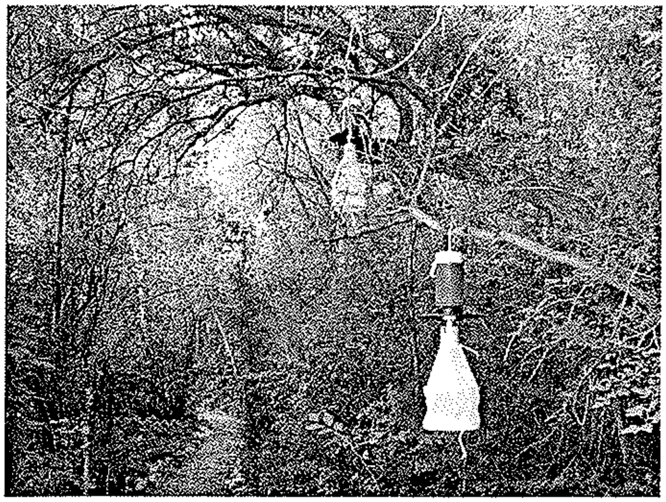


Fig. 4. BIRD's CO_2 trap data 2003 (5 feet and 12 feet).

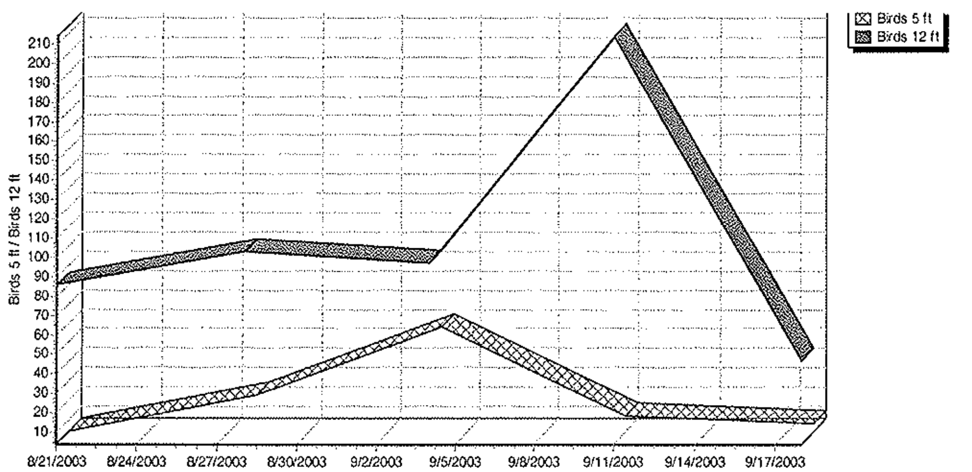


Fig. 5. THOM's CO_2 trap data (5 feet and 12 feet).

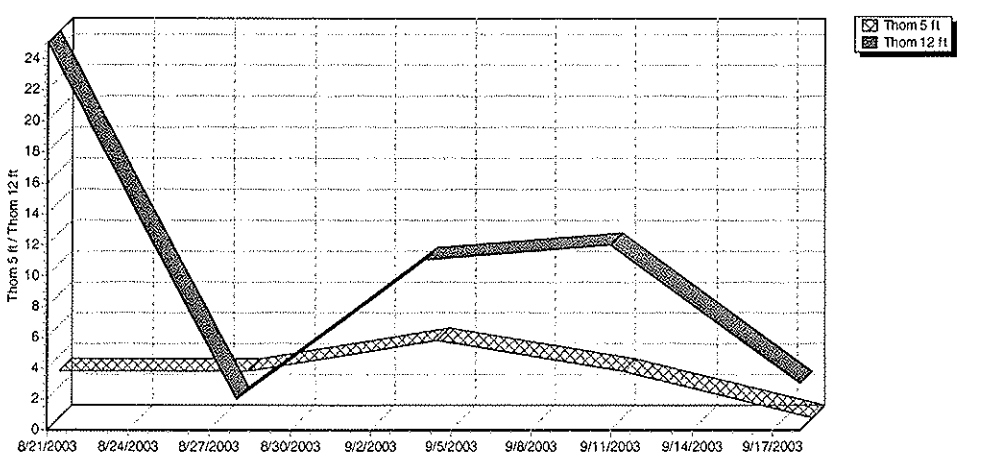


Fig. 6. FRIEND's CO_2 trap data (5 feet and 12 feet).

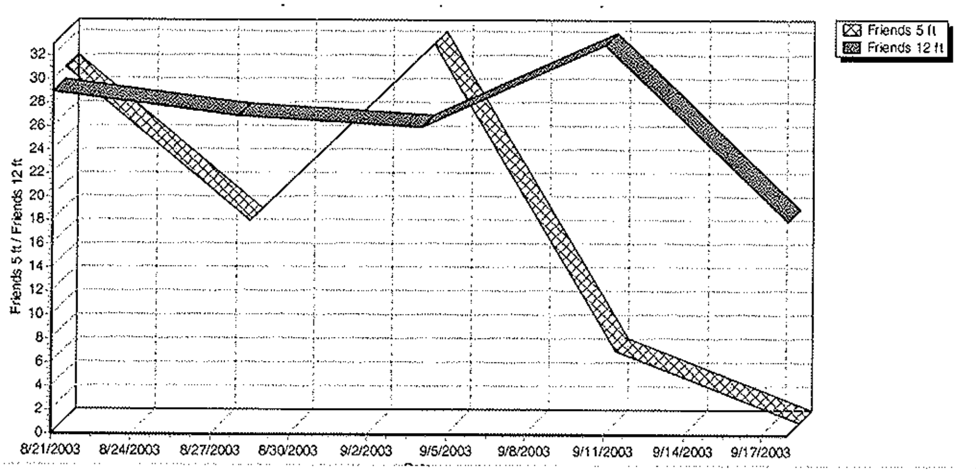


Table 1. Comparison of *Culex* adults collected in three traps in 2003.

Date	Time	Birds 12 ft	Birds 5 ft	Friends 12 ft	Friends 5 ft	Thom 12 ft	Thom 5 ft
8/21	9:54:21	86	4	29	30	25	3
8/28	9:54:20	103	23	27	17	2	3
9/4	9:54:19	97	58	26	32	11	5
9/11	9:54:18	214	12	33	6	12	3
9/18	9:54:17	47	8	18	0	3	0

GROUND ULV ASSESSMENT OF AQUA-KONTROL®

MAX V. MEISCH[1], JAMES R. BROWN, JR.[2] AND DAVID DAME[3]
[1]University of Arkansas, Fayetteville
[2]Navy Disease Vector Ecology and Control, Jacksonville, Florida
[3]Entomological Services, Gainesville, Florida

SUMMARY

Against caged field-collected *Anopheles quadrimaculatus* adults, ULV applications of 0.0007 lb a.i./ac of synergized permethrin (4% Aqua-Kontrol®) gave a high level of control (mean: 90%). Droplet collections on magnesium oxide-coated glass slides from the three applications revealed a mean deposition rate of 216 droplets/cm^2 and 11 volume median diameter (vmd) (based on Aqua Kontrol label spread factor of 0.61, which had not been confirmed at the time of this report).

MATERIALS AND METHODS

Field studies were conducted August 6, 2003 to assess the efficacy of Aqua-Kontrol® against adult *Anopheles quadrimaculatus* by ground ultra low volume (ULV) applications at a single delivery rate. The experiments were conducted near Stuttgart, Arkansas (Arkansas County). Participants and their primary responsibilities included James Brown (droplet observation), Dave Dame (strategy; calibration and droplet collection), Max Meisch (strategy; mosquito collection and bioassay), and Leon Edens, Stuttgart Mosquito Control (ULV applications).

Adult *Anopheles quadrimaculatus* mosquitoes were collected in mid-afternoon with battery-powered aspirators from livestock sheds in DeWitt, (Arkansas Co.) 25 miles south of Stuttgart. They were transported in insulated chests to the laboratory at University of Arkansas Rice Experiment and Extension Center in Stuttgart. Following immobilization with CO_2 they were transferred into 10 x 25 cm wire-mesh sleeves and held in insulated containers until evening. When required for field bioassay the wire-mesh containers were placed in plastic bags for transport to the field.

Individual cages were placed approximately 5 feet above ground level on stakes in the test plots at the Stuttgart Municipal Airport. Unexposed cages were placed on the stakes for 10 minutes to serve as untreated controls. The treatment cages were exposed to the test applications and retrieved not less than 10 minutes following application. After retrieval from the stakes, the cages were immediately taken to the laboratory, where the mosquitoes were immobilized with CO_2 transferred to clean holding cages, and supplied with sugar water (10%) pads. Mortality observations were made at approximately 1, 12 and 24 hours post treatment.

For each ground ULV application, cages were placed in three rows, separated by 100 feet, at 100, 200 and 300 feet downwind from the application route and aligned roughly perpendicular to the expected wind direction. Rotary impingers equipped with magnesium oxide-coated glass slides were placed on top of each stake in the center row to collect information on droplet size and density. These slides were analyzed at the Navy Disease Vector Ecology Control Center. A sample of the product was taken for spread factor determination.

Ground ULV applications were conducted with a truck-mounted LECO HD-1600 cold aerosol generator calibrated at 2 psi to deliver 15.5 fl. Oz/min of 4% permethrin with PBO. One-half gallon (64 fl oz) of Aqua-Kontrol® was diluted with 2 gallons (256 fl oz) of water to obtain the 4% formulation. The resulting mix was well suspended and easy to use; however, a layered suspension was observed 6 hr after mixing. At 10 mph the application rate was calculated to be 0.007 lbs a.i./ac of permethrin plus PBO. Applications were conducted between 2025 and 2204 hours in a light wind under temperature inversion conditions.

Three separate applications of 0.007 lb of synergized permethrin per acre were made during low velocity westerly winds (1.0-2.0 mph) at about 28^0 C. The bioassay data and droplet results are provided in Appendix A.

RESULTS

The applications were highly effective, producing a mean mortality of 93%, 90%, and 85%, respectively, 24 hours post treatment. The aerosols were observed to advance uniformly to and beyond the caged mosquitoes, remaining as a cloud from ground level to about 12 feet above ground level during this movement and providing optimum exposure.

The aerosol generator was not calibrated for droplet size prior to applications, but during each application droplets were collected with magnesium oxide-coated slides mounted on rotary impingers on the center bioassay stakes 100 ft, 200 ft, and 300 ft from the application line. The droplet collection data is presented in Appendix A. The observed vmd averaged 12, 11 and 11 at 100, 200 and 300 ft, respectively, based on a spread factor of 0.61. Large numbers of droplets were collected, ranging from 85 to 480 per cm^2. Greater than 80% of the droplets collected were in the optimum size range (6 – 18) for ULV efficacy, which represented an average of 83% of the spray volume captured on the slides.

Spread factor determinations for undiluted and diluted Aqua Kontrol have not been completed at the time of this report. When they become available, they could substantially modify droplet size estimates. A report addendum will be forwarded concerning spread factor and droplet size estimates.

Although there were some minor reversals in mortality observations between 1 and 24 hours, the overall mortality observations were similar at both intervals. Table 1 reveals; that although there were some differences in efficacy between the 200 and 300 ft distances at 1 hr after exposure to the aerosols, they were not significantly different at 24 hr. Mortality at 100 and 200 ft intervals was uniformly over 90%.

Table 1. Assessment of Mosquito mortality using GLM analysis*

Hours after Exposure	Distance (ft) 100	200	300
1	91.0 ab	92.7 a	83.3 b
12	93.2 a	90.8 ab	82.3 b
24	93.3 a	90.4 ab	85.3 ab

*P = GLM procedure t test (LSD). Means with the same letter are not significantly different.

Appendix A. Bioassay and Droplet Data for AquaKontrol vs. *Anopheles quadrimaculatus* (Stuttgart, AR, 2003). (Droplet estimates based on use of Univar Label Spread Factor = 0.61)

Distance from ULV Generator (ft)	Mortality (%) at Indicated Hour After Exposure			VMD (μ)	Droplets/ sq cm	Droplet Distribution									
						6 - 18μ		12 - 18μ		<21μ		<25μ		>32μ	
	1	12	24			% Size	%Mass	% Size	%Mass	% Size	%Mass	% Size	%Mass	% Size	%Mass
100	93	93	92	14	480	78	67	53	53	89	83	98	95	0	0
	91	94	90	11	197	89	82	35	44	99	99	100	100	0	0
	89	92	97	12	197	87	84	56	62	98	96	98	96	0	0
Mean	**91**	**93**	**93**	**12**	**291**	**84**	**78**	**48**	**53**	**95**	**93**	**99**	**97**	**0**	**0**
200	97	99	98	11	247	92	87	39	49	99	98	99	98	0	0
	88	86	83	12	104	85	75	32	39	91	80	94	86	0	0
	93	87	90	9	153	91	86	30	38	99	98	100	100	0	0
Mean	**93**	**91**	**90**	**11**	**168**	**89**	**83**	**34**	**42**	**96**	**92**	**98**	**95**	**0**	**0**
300	87	88	88	11	310	89	83	44	52	98	96	99	98	0	0
	89	82	89	10	173	95	93	35	48	98	96	99	98	0	0
	73	76	80	11	85	96	94	52	63	100	100	100	100	0	0
Mean	**83**	**82**	**85**	**11**	**189**	**93**	**90**	**44**	**54**	**99**	**97**	**99**	**98**	**0**	**0**
Overall Mean	**89**	**89**	**90**	**11**	**216**	**89**	**83**	**42**	**50**	**97**	**94**	**99**	**97**	**0**	**0**
Control Mean	**0**	**3**	**4**												

BARRIER TREATMENT FOR ADULT MOSQUITO CONTROL

JING ZHAI
Bayer Environmental Science
95 Chestnut Ridge Road
Montvale, NJ 07645

Barrier treatment has become increasingly popular in mosquito control programs in recent years. It allows an insecticide to be delivered to where mosquitoes are resting and harboring.

Six pyrethroid-based residual products were evaluated against *Culex quinquefasciatus.*

1. DeltaGard WDG, deltamethrin 0.03, 0.06% @ 1 gal/1000 ft^2
2. Demand CS, lambda-cyhalothrin 0.03% @ 1 gal/1000 ft^2
3. Suspend SC, deltamethrin 0.01, 0.03 and 0.06% @ 1 gal/1000 ft^2
4. Talstar FL, bifenthrin 0.06% @ 1 gal/1000 ft^2
5. Tempo Ultra SC, beta-cyfluthrin 0.05% @ 1 gal/1000 ft^2
6. Tempo Ultra WP, beta-cyfluthrin 0.1% @ 1 gal/1000 ft^2

Each insecticide was applied onto a concrete block and plant foliage using a compressed-air sprayer. The treated surface was dried and aged outdoors before efficacy was assessed at the laboratory. Mosquitoes were allowed to rest on the treated surface for 1 hour before they were transferred to a clean container. Mortality was determined at 24 hours.

Results are presented in Figures 1 and 2. Data indicated that deltamethrin is the most active pyrethroid available for use in mosquito control. It provides long residual activity on foliage for up to 60 days. It is dependent on substrates, environmental conditions, and mosquito species. Re-treatment may be needed to achieve season-long mosquito control.

Fig. 1. Residual activity of pyrethroid products on concrete against *Culex quinquefasciatus.*

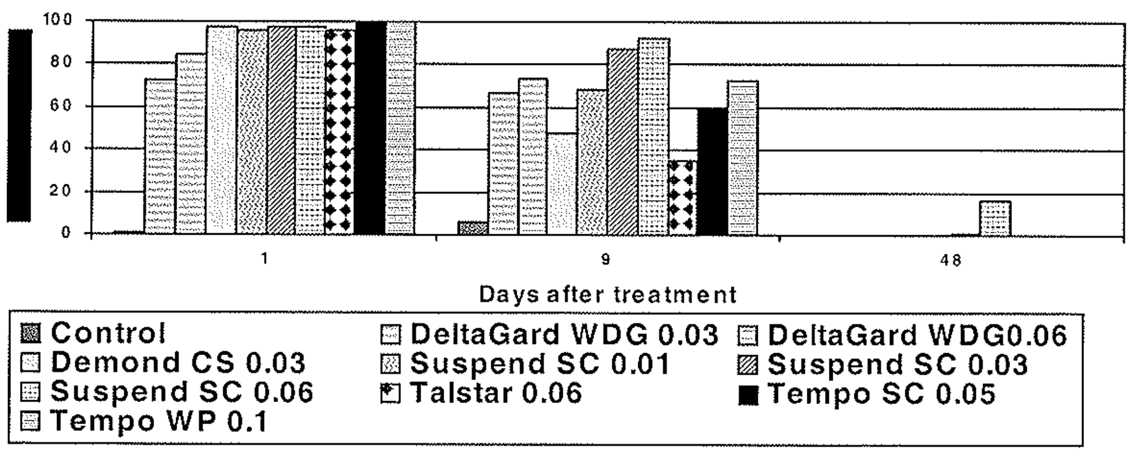
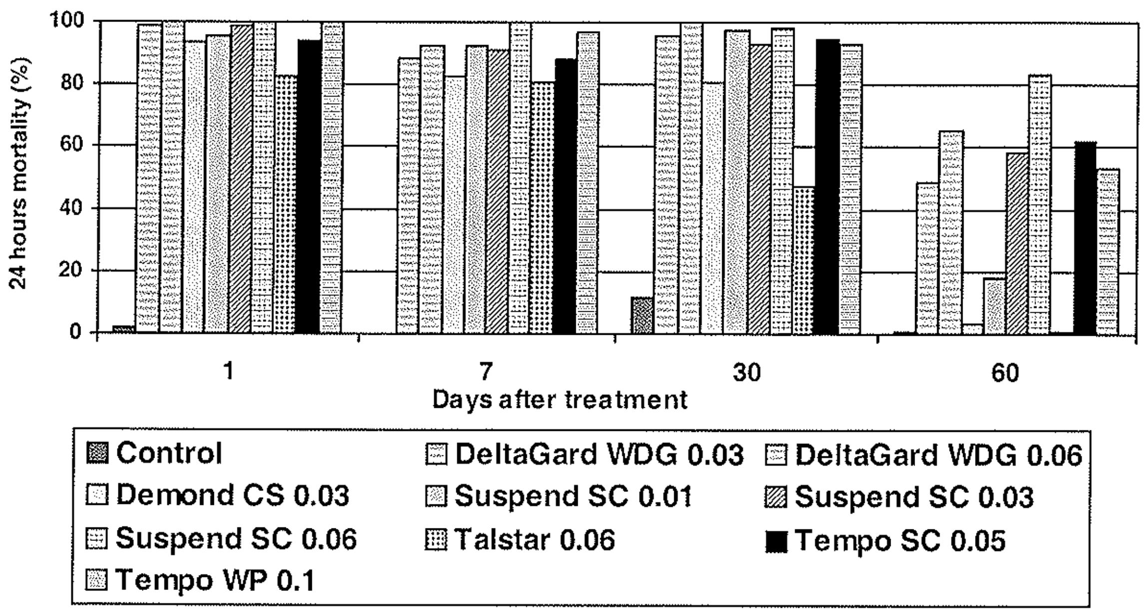


Fig. 2. Residual activity of pyrethroid products on foliage against *Culex quinquefasciatus.*



WE FOUGHT THE BITE AND WON

HARVEY A. TEYLER AND JUDY JOLLY
Alamosa Mosquito Control District
Alamosa, Colorado
(719) 589-5409
moscasa@fone.net

In the fall of 2002, eastern Colorado experienced its first season of West Nile Virus (WNV). Its spread was documented along the Platte and Arkansas River systems primarily by horse and bird cases, however 14 human cases were also reported (http://www.cdphe.state.co.us/dc/Zoonosis/wnv/wnvmap.html). A horse testing positive in Conejos County was the only indication that WNV had spread into South Central Colorado. This horse was just 12 miles south of Alamosa Mosquito Control District (AMCD).

Early in 2003, the AMCD decided to take a pro-active approach in our fight against WNV. The emphasis not necessarily trying to control it, but to minimize it's effects in the district. Our strategy included: 1.) A fully integrated mosquito control program that was operational April 1st, as the mosquito population started to emerge. 2.) The use of the WNV VecTest™, an antigen assay, specific for WNV detection in mosquito samples. 3.) A response plan was drawn up to provide the staff with an organized outline of control efforts to be taken in the event of our first WNV positive.

I. A FULLY INTEGRATED MOSQUITO CONTROL PROGRAM

Our integrated mosquito control program was operational the first week of April, before the emergence of mosquitoes, and was maintained through late September. Our program was composed of many facets of control:

Larval surveillance consisted of daily identification of larval habitats, dip sampling, and control measures being taken when deemed necessary.

Our adult surveillance program was centered on a permanent trapline of 16 CDC light traps that were set up across the district. The traps were ran five nights a week for 23 weeks. Species identification and density counts allowed us to make educated and economical decisions regarding the areas to be ground fogged each night. Six additional CDC light traps, in which we have termed "Scouts", were moved around the District to sample new sites. These traps were particularly important in sampling WNV positive "hot spots".

We also had a state funded sentinel chicken flock consisting of 10 Leghorn chickens. Their blood was drawn eight times at biweekly intervals, starting June 2nd. The Colorado State Health Department tested the blood and we had the results approximately a month later.

Additionally as part of our preparedness, we had contracted a local aerial applicator in April. His plane was equipped with ULV nozzles and a GPS system. Our board of directors also purchased a set of ULV nozzles to ensure against possible loss of time in the case of nozzle malfunction and shipping time of a new set. Lastly, we had chemicals purchased in advance and in house. Our stockpile was usually enough to be prepared for a month's worth of mosquito control.

II. THE VECTEST™

A new addition to our control program was the VecTest™. It was our most important device in the detection of WNV. The procedure was simple and the results were visible within 15 minutes. Each light trap was tested twice a week. Tests were conducted on mixed species pools ranging from 1-50 mosquitoes. We chose to have a mixed pool sample to ensure that all potential vectors were tested.

The VecTest™ in house was better than the alternative of sending mosquitoes away and receiving the results months later, as we had the year before.

** As a side note: the San Luis Valley Veterinarian Association agreed to provide supplemental funding to additionally test for St. Louis Encephalitis and Western Equine Encephalitis.

III. AMCD'S WEST NILE VIRUS RESPONSE PLAN

It was important to have a reactionary plan of attack in the occurrence of our first WNV positive. One that would allow the staff to have an efficient response time and greatly reduce the risk of WNV in 15 hours or less.

We feel that our plan reduces excessive chains of notification, initiates an immediate response to the risk, mobilizes the staff and equipment, and attacks the source.

ALAMOSA MOSQUITO CONTROL DISTRICTS WEST NILE RESPONSE PLAN

1. A WNV positive VecTest™ result in the morning
2. Plot out a three mile radius circle (4,524 acres) around the positive trap on our district map
3. Contact the Board of Directors and County Nurse (they contact other authorities and the press)
4. Notify the aerial applicator to prepare for first aerial
5. 12:00 p.m. - Staff meeting and assignments
6. Afternoon aerial within the circle
7. Ground foggers commence afternoon spraying within the circle
8. Set up Scouts and GPS sites within the circle
9. Inspect larval habitats within the circle
10. 5:00 p.m. - Staff debriefing and evening assignments
11. Commence evening aerial and ground fogging within the circle
12. 11:00 p.m. - Pick up traps in circle, VecTest™ and reset traps
13. Next morning - Pick up traps and VecTest™ traps in circle

RESULTS AND DISCUSSION

Collectively, our program and staff got the job done. Our goal was to limit the potential threat of WNV via mosquito vectors. The planned actions reduced the mosquito counts by 96%. Figure 1 demonstrates our success in two of the seven traps from within the WNV positive circle.

In our $7^{1}/_{2}$-week battle with WNV, we learned about the value of classic sentinels. Most have proven to be ineffective indicators of WNV in terms of timely mosquito control and risk reduction. July 14^{th}, we had our first mosquito pool test positive. The first bird reported with WNV in our district was picked up July 29^{th}, sixteen days after our first mosquito pool tested positive. The first positive horse was reported August 15^{th}, a month later and four of our chickens sero-converted August 25^{th}, six weeks later. The mosquito pool proved to be the earliest sentinel of detection.

CONCLUSION

In conclusion: 1. Our fully integrated mosquito program, which was enacted early in the season, aided in reducing vector mosquito density. 2. AMCD's WNV Response Plan allowed our staff to be knowledgeable and ready to respond. 3. The VecTest^{TM} proved to be an integral addition to our response plan as it provided quick detection of WNV and allowed for timely implementation of control measures.

Although we had 44 light trap samples test positive for WNV, we feel that we were successful in limiting the risk of WNV by reducing the mosquito density across the district.

Figure 1. The AMCD's Response Plan at work. Our first WNV positive mosquito pool occurred at trap #7. Trap #14 was located within the circle of treatment.