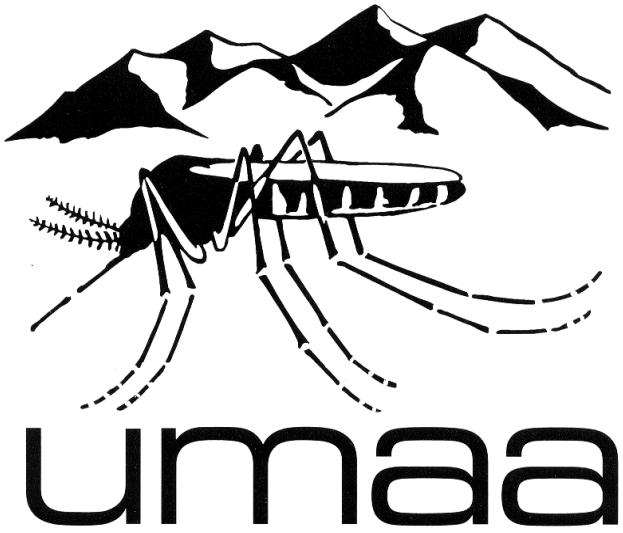
Proceedings and Papers

of the

Fifty-Ninth Annual Meeting

of the

Utah Mosquito Abatement Association



Holiday Inn Resort
Hotel and Conference Center
St. George, Utah

October 1-3, 2006

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Held at
Holiday Inn Resort
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St. George, Utah

October 1-3, 2006

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IN MEMORY OF DR. ROBERT E. ELBEL

The Fifty-Ninth Annual Meeting of the Utah Mosquito Abatement Association is dedicated to the memory of Dr. Robert E. Elbel, who died in a tragic accident in December 2005. Dr. Elbel was a recognized authority on bird lice and fleas, but also made notable contributions as a malarialogist and a researcher in studies on mosquito-borne encephalitis. Dr. Elbel was a strong supporter of the UMAA who regularly attended the annual meetings during which he presented numerous papers. For his many contributions he received the UMAA Meritorious Service Award in 1988.

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Dr. Don Merrill Rees Memorial Award

In 1987, the UMAA Board of Directors established the **Dr. Don Merrill Rees Memorial Award**. The award honors Dr. Rees, 1901 – 1976, who is often referred to as the "Father of Mosquito Abatement in Utah". The highest award of the Utah Mosquito Abatement Association is given to individuals who have made distinguished contributions to mosquito science and control.

This year's recipient is **Dr. Steven V. Romney**. Dr. Romney is a native of Utah and received his graduate education at the University of Utah. He received his Masters Degree in 1968 studying the biology of *Aedes niphadophsis* in Tooele County. In 1971 he received his PhD on a study of mosquitoes and other organisms that exist in desert potholes in south eastern Utah. The amazing diversity of organisms that Steve found in this environment received the attention of the National Geographic Society which published a report of this work in the October 1975 issue of their magazine entitled "Miracle of the Potholes".

Following the receipt of his PhD, Steve spent two years on a Post Doctoral Study at the University of North Carolina researching the biological control of mosquitoes using fungal parasites of the genus *Coelomomyces*. In 1975, Steve became the manager of the Uintah Mosquito Abatement District, a position he has held with distinction for 32 years. He has served notably as a member of the UMAA, serving twice as its president, contributing on numerous committees and presenting many papers at the annual meetings and workshops. Steve is retiring in the spring of 2008. We hope he will remain active and a valued contributor to this Association.

MERITORIOUS SERVICE AWARD

The **UMAA Meritorious Service Award** is presented to individuals who have distinguished themselves in administrative or technical service to mosquito control in Utah. The Utah Mosquito Abatement Association consists of mosquito abatement 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. The UMAA first presented this award in 1970. This year's recipients are: **Gary Hatch, Craig Bott,** the **Utah Public Health Laboratory Personnel,** and the **Utah Veterinary Diagnostic Laboratory Personnel**.

Gary Hatch is presented with the UMAA Meritorious Service Award for his dedicated service as chairman of the UMAA Encephalitis Surveillance Committee. Gary has spent countless hours coordinating the efforts of the Utah Department of Health, the Utah Public Health Laboratory, and the Utah Veterinary Diagnostic Laboratory in behalf of the Utah Mosquito Abatement Association. Because of his hard work with the state agencies and laboratories, individual mosquito abatement districts receive timely results of positive disease detection.

Craig Bott, as an attorney with the Utah Local Governments Trust (ULGT) was an important part in the training of full time employees, seasonal employees, and district trustees. Craig has trained on a variety of subjects at the annual spring workshop held each April and the UMAA Annual Meeting held in October. Craig stopped working for the ULGT in the spring of 2006.

The **Utah Public Health Laboratory Personnel** and the **Utah Veterinary Diagnostic Laboratory Personnel** are each awarded the UMAA Meritorious Service Award. The Public Health Lab, besides conducting the testing of West Nile Virus in humans and wild birds, has the responsibility of processing all mosquito pools submitted by mosquito abatement districts and county health departments. The Veterinary Diagnostic Lab processes all blood samples taken by mosquito abatement personnel from sentinel chicken flocks. Each lab has aided mosquito abatement districts with rapid and accurate returns on positive samples. Most testing is completed the same week it is submitted. The UMAA honors the dedicated service of these two laboratory staffs.

UTAH'S UNIQUE ROLE IN THE AMERICAN ANTI-MOSQUITO CRUSADE

Gordon M. Patterson, Ph.D.

Florida Institute of Technology, Melbourne, FL 32901

"Act well your part, there all the honour lies."
Alexander Pope
Essay on Man

"To forget one's purpose is the commonest form of stupidity."

Friedrich Nietzsche
Der Wanderer und sein Schatten Menschliches Allzumenschliches: Zweite Abteilung

It is an honor and a pleasure to meet with you today. The Utah Mosquito Abatement Association has a unique place in the history of the mosquito control movement. It is a storied tradition of epic proportions replete with heroes and villains (I hasten to add that the great majority of the villains had six-legs). I would be remiss, if I did not at the beginning of these remarks express my gratitude to several individuals present this morning. I want to thank publicly Glen Collett and Professor Lewis Nielsen for their kindness and sage counsel. Wherever I have gone in my research, the names Collett and Nielsen universally evoke respect and admiration. Respect for their commitment to the highest professional standards; and, admiration for their collegial, ever-willing to help, natures. I would also like to thank Sammie Dickson for his hospitality. I spent a week at Sammie's shop in 2005 and I returned last June. Finally, I owe thanks to Gary Hatch, Ryan Arkoudas, Ken Minson, and Mike Oldham for their encouragement. Mike has done a marvelous job in arranging the conference's program. I look forward to learning more about the contemporary challenges facing mosquito control in Utah as well as hearing the talks by AMCA President Joe Sanzone and MVCAC President Elizabeth Cline.

It may seem strange to begin a talk on the history of the anti-mosquito movement with a quotation from an eighteenth century poet and a nineteenth century philosopher. I will argue that these quotations point to two of the central themes in the history of the anti-mosquito movement in twentieth century America. They are particularly appropriate quotations to place at the beginning of a talk about the achievements of the mosquito control movement in Utah. The first comes from Alexander Pope's Fourth Epistle in his *Essay on Man.* After ruminating on human pride and vanity, Pope expressed his judgment on what constituted true nobility. He declared: "Act well your part, there all the honour lies." The second quotation is from the German philosopher Nietzsche. Nietzsche declared: "To forget one's purpose is the commonest form of stupidity." I hope to demonstrate this morning that the individuals who forged the anti-mosquito movement, Leland Osian Howard at the USDA, John Smith in New Jersey, William Brodbeck Herms in California, and Don Rees "acted well their parts" and succeeded in never forgetting the purpose of their work. To do this I need to say something about the origins of the mosquito movement at the beginning of the twentieth century before discussing the organization of Utah's part of the campaign. Organizationally, what follows may be thought of as a play in three acts:

Act: 1 The Beginning of the Mosquito Crusade

Act 2: Launching Anti-Mosquito Work in Utah

Act 3: Forging a National Movement.

ACT 1: THE BEGINNING OF THE MOSQUITO CRUSADE

It is difficult to say precisely when the mosquito crusades began. Some might choose Patrick Manson's discovery of the role of mosquitoes in the transmission of filariasis, or Ross's discovery of the man-mosquito malaria cycle, or the Reed Commission's work in Havana. I think, however, that a strong argument can be made that the real beginning of organized mosquito control in the United States came on May 16, 1901, in South Orange, New Jersey. Late in the afternoon that day Spencer Miller, a successful civil engineer, drove his carriage to the train station and picked up Leland Osian Howard, chief entomologist at the United States Department of Agriculture. Howard had just published a book *Mosquitoes: How They Live; How they Carry Disease: How they are Classified; How they May be Destroyed*. Miller had recently moved to South Orange and begun construction on a magnificent house. The mosquitoes proved so numerous that the men working on the house threatened to stop work. Miller vowed to do something about the mosquitoes. He constructed a number of extravagant, if ineffectual devices, that failed to solve the problem. During an earlier business trip to Ithaca, New York, he learned of Howard's work. He returned to South Orange and organized a small group

called the South Orange Improvement Association. They rented a hall and advertised Howard's talk as the beginning of a mosquito crusade.

There is no extant copy of Howard's remarks. There were a number of newspaper reporters present. They commented the next day that Howard's talk was punctuated with enthusiastic applause. They added that it was impossible to discern whether the thunderous clapping was generated by the audience's approval of what Howard was saying or a reflection of the participant's desperate effort to ward off the prodigious numbers of mosquitoes that were interested, if thirsty, observers of the proceedings.

One thing that probably did amaze the audience was the depth of Howard's knowledge about New Jersey's mosquitoes. In his book Howard drew extensively on the work of John B. Smith, professor of entomology and state entomologist at the Agricultural Experiment Station at Rutgers. Smith, who was a self-trained scientist, had begun studying New Jersey's mosquito problem two years earlier. What is important for our discussion today is that Smith believed that mosquito control must be based in a scientific understanding of the life history of mosquitoes. In 1902, Smith secured from a somewhat incredulous New Jersey legislature $10,000 to study the state's mosquitoes and make experiments on their control. In 1904, with Spencer Miller's help, Smith secured the addition of five words, "waters that breed mosquito larvae" to the description of what constituted a "public nuisance" to the state's health code. Two years later Smith won the state's commitment to undertaking salt marsh work.

Smith's career offers an important lesson on "acting well your part." His genius was his recognition that mosquito control must be based on science. He cautioned against those who offered panaceas. He resisted the enthusiasts and the profiteers and called for careful scientific work. His legacy was his belief that effective mosquito control must rest on a thorough understanding of the life history of mosquitoes and their habitats.

Smith's influence stretched across the continent. In the spring of 2006, I discovered a treasure trove of documents in the basement of Blake Hall, home of the Entomology Department at Rutgers. In a closet attached to the boiler room, I found copies of every letter that Smith wrote between 1902 and 1912 and, even more remarkably, bound volumes of every letter he received. These letters provide a wealth of information of the formative period of anti-mosquito movement. When I came to Utah this summer I was still inebriated with what I had found. Glen Collett and Professor Nielsen will attest to my reading a handful of these letters to them. One letter written on April 18, 1905 was of particular importance. It was a letter from H.J. Quayle, a young entomologist at the University of California, Berkeley, describing the beginning of anti-mosquito work on the south San Francisco Bay. He wrote: "I am in receipt of your report on Mosquitoes and wish to thank you very much for the favor. I am constantly referring to it in my work on mosquitoes here and find it a great help. Indeed, it is the only guide I have for practical control work on a large scale (Quayle 1905).

Smith's *Report on the Mosquitoes of New Jersey* provided a scientific and practical guidebook for the growing mosquito crusade. A few weeks later C.W. Woodworth, head of entomology at Berkeley, wrote to Smith asking if he had any young men that he could send out. Smith did not and Woodworth began a three year search for Quayle's replacement.

In 1908, Woodworth offered the position to William Brodbeck Herms. Herms had grown up in rural Ohio. Seven bouts with malaria left him with a desire to become a medical missionary to China. In 1898, he learned of Ross's discovery of the man-mosquito-malaria cycle and began to study entomology. (I found in Smith's papers at Blake Hall at Rutgers an exchange between the student Herms and John Smith. Smith promised to send Herms everything he had published on mosquitoes.) Herms earned his Masters from Ohio State and won a fellowship to Harvard in 1907. When he returned to Ohio, he received Woodworth's offer. His professors at Harvard advised him against taking the job. California was "uncultured" and nothing "good would come out of Berkeley." Herms reasoned California was nearer to China than either Massachusetts or Ohio and took the post. He arrived on a foggy August day. Everything seemed to go wrong. He later revealed that he feared he had made a colossal mistake. Woodworth tried to interest him in salt marsh mosquito work along the San Francisco bay. Herms demurred. His interest lay in malaria. In 1909, Woodworth assigned Herms to accompany the state's agricultural and horticultural train. The train consisted of 7 cars. Herms contribution was "four small glass-covered boxes containing specimens of fleas, lice, flies, ticks and particularly specimens of anopheline mosquitoes, and a few charts (Herms 1929).

As the train made its way from southern California northwards, Herms found that there was tremendous interest in his short talks on malaria. He discovered that despite the obvious differences between the Ohio River Valley and California's Great Central Valley, that there was one disturbing similarity: the presence of malaria. In 1910 Herms launched an anti-malaria campaign in Penryn, a small town located in the foothills of the Sierra. By August, Herms had expanded his work against malaria to Oroville and Bakersfield. The lesson of Herms' work for the history of mosquito control was his commitment to service.

ACT 2: LAUNCHING ANTI-MOSQUITO WORK IN UTAH

An organized, anti-mosquito movement in Utah began in the early 1920s. Concern about mosquitoes

goes back, however, to 1847, when the first settlers arrived in what is now Salt Lake City. Great hordes of mosquitoes, as Glen Collett and Lewis Nielsen have previously noted, were considered acts of nature like droughts, floods, crickets, and grasshoppers. In 1922, T.B. Beatty, Utah State Health Commissioner and a handful of progressive citizens decided that the time had come to do something about mosquitoes. Reports of the successful work in New Jersey and in California inspired Beatty and a local attorney named E.W. Senior to invite Major Joseph Le Prince to come to Salt Lake and discuss what could be done about the mosquito situation.

Le Prince was, of course, one of William Gorgas' team of medical doctors, entomologists, and engineers. Le Prince had spent ten years working in Panama. In 1914, he returned to the continental United States and took a commission as a sanitary engineer with the newly formed USPHS (1912). When America entered World War I, Le Prince was placed in charge of developing mosquito control (anti-malaria work) around military facilities. After the war, he became an advocate of expanding mosquito control across the nation.

Le Prince made a preliminary survey of the Salt Lake City area in 1922. He suggested the outlines for legislation authorizing the formation of abatement districts. He also carried back to the east coast news of the stirring events that were taking place on the west side of the Wasatch Front. In his report on the "General Plan for Mosquito Work in the Southern States and its Apparent Results", Le Prince called attention to Utah.

> To arouse public interest in mosquito elimination the state health officer of Utah writes his messages to people about mosquitoes with mosquitoes. The words are made with the mucilage and mosquitoes are poured on. All his messages are read. And the cartoons referring to mosquitoes are rich and enjoyed.

The Utah legislature and the state's governor got Beatty's message and passed the bill authorizing the formation of mosquito abatement districts in 1923. The Salt Lake Mosquito Abatement District was organized in 1924. It held its first meeting on May 19 and considered "what temporary measures" as might be taken so late in the season. A week later, the commissioners authorized hiring a "competent man" (the most notable condition of competency was that he be able to supply his own car) and paying him $100 a month until the beginning of October. Temporary work continued in 1925. Real work began in 1926.

In 1928, Le Prince wrote a letter to the Salt Lake City Trustees advising them to allocate funds for an entomological survey of the district. He told the trustees that "All of the successful work done in the coastal counties of New Jersey was based on a similar survey and, as you know, more progress has consequently been made in that state in mosquito control than in all the other states combined" (Anonymous 1928). Le Prince told the Board that he had met with the dean of the Biology Department at the University of Utah. The dean suggested that professor R.V. Chamberlin be assigned the task. Le Prince warned the trustees that "if this study is ignored, then sooner or later your committee may be severely and justly criticized for working blindly and wasting funds because of lack of knowledge of local entomological data" (Anonymous 1928).

The trustees accepted Le Prince's counsel and hired Professor R.V. Chamberlin ($60 per month) to undertake the survey. Le Prince dispatched one of his assistants, W.E. Komp, a Rutgers graduate and one of Thomas Headlee's first graduate students, to help Chamberlin plan the survey. Chamberlin, on his part, had found a young man to help him. That man was, of course, Don Rees.

The Minutes of the Salt Lake City Abatement District make for interesting reading. When Chamberlin and Rees completed their survey the board printed twelve copies. The thrifty Salt Lake City Trustees assumed that there would be no further need for a survey and thanked Chamberlin for his effort. It is to Chamberlin and Don Rees's credit that they convinced the board that the survey must be continued in the future. Chamberlin and Rees appreciated the critical role that science played in building a mosquito control program.

ACT 3: FORGING A NATIONAL MOVEMENT

The 1930s presented tremendous challenges to the mosquito control movement. The Great Depression left millions unemployed and forced draconian cutbacks in municipal and state appropriations for sanitation. Mosquito control programs were particularly hard hit. Roosevelt sought for innovative relief programs. In November 1933, FDR authorized USDA to supervise a dramatic initiative in which the federal government would directly employ hundreds of thousands of workers to do anti-mosquito work through the newly formed Civilian Works Administration (CWA). The problem was that in many areas there was no supervision for the work. Drainage projects were undertaken with no practical utility. Worse, some projects damaged sensitive habitats for wildlife. Opposition within the federal government from the United States Biological Survey and citizen groups such as the Audubon Societies led to a national conference in 1935 on the topic of "What's Wrong with Mosquito Control." Fred Bishopp from the USDA defended mosquito control from its critics.

Utah escaped much of the fury. In November 1933, 1000 men were assigned to do work under CWA. Nearly half of them were under Don Rees's supervision

in Salt Lake. Rees, a life-long hunter and fisherman, possessed a deep sensitivity to wildlife issues. In their 1929 entomological survey, Rees and Chamberlin demonstrated that the roughly 14 duck clubs along the east side of the Great Salt Lake were a major source of pest and nuisance mosquitoes. Ever practical, Rees sought to overcome the antipathy of the gun clubs through careful study and persuasion. In 1939, Rees told the delegates attending the New Jersey Mosquito Extermination Association's (NJMEA) annual meeting that "a proposed cooperative plan for mosquito control on the gun club properties west of Salt Lake City has tentatively been accepted by all parties concerned" (Rees 1939).

One of the outcomes of the national outcry against mosquito control was the formation of the Eastern Association of Mosquito Control Workers (EAMCW) in June 1935. The stated objective of the EAMCW was to fend off attacks on the mosquito control movement while forging an alliance between mosquito workers. In 1941, the EAMCW began to publish a national journal, *Mosquito News.* Late in 1942, an editorial meeting was held in New York about the journal's future. Ostensibly, the topic was what should be the journal's format. On December 12, 1942, Robert Glasgow, New York's state entomologist wrote a letter to Tommy Mulhern who was a member of the committee seeking to revise *Mosquito News.* Glasgow's seven-page, single-space type written letter provides a remarkable insight into the final instar of what would become the American Mosquito Control Association (AMCA). Apparently, during the meeting the discussion had turned to the question of forming a national organization in which there would be equal representation between all of the different members of the anti-mosquito movement. Glasgow wrote, "I think you and I have known each other long enough to speak with absolute frankness; and I think I can trust you….I shall not be mealy-mouthed about calling a spade a spade." During the course of the meeting, some members of the committee raised the objection that forming a national organization would mean "we might lose control of the association." As Glasgow rode the train back to Albany, he mulled over this protest…this subconscious fear that 'New Jersey and New York might lose control'. He told Mulhern that he "personally believe[d] that any such idea would prove to be a disastrous fallacy" (Glasgow 1942).

The challenge was to find a way to bridge the gap between the eastern, midwestern, southern and western members of the anti-mosquito movement. Here is where I think that Utah played a unique role. In the 1930s, R.V. Chamberlin and Don Rees were regular participants in the NJMEA annual meetings. In fact, Thomas Headlee expressly asked Don Rees to come to the Association's meetings to inform the eastern workers as to what was happening in the west. Simultaneously, Rees was actively engaged in building a close connection with California. In the early 1930s, he sent a request to the Dr. Morris District (Kern County) for *Gambusia affinis.* (They died and Le Prince sent 11 fish from Tennessee that Rees succeeded in raising in Utah.) Rees, as many of you know, earned his Ph.D. at Stanford. He was a regular participant in the California mosquito abatement associations meetings.

My argument is that Utah (Don Rees) provided the collegial element that was indispensable in the emergence of the AMCA. Utah established a tradition of scientifically based mosquito control work, sensitivity to wildlife issues, and cooperation. Don Rees embodied these qualities. In the early 1940s, Rees played a central role in the creation of the AMCA. He was a member of the AMCA's Executive Committee in 1947-48, chairman of the association's Interim National Board in 1949, and AMCA's president in 1952. Four of Rees' students Lewis Nielsen, Glen Collett, Jay Graham, and David Bruce Fancey) have served as President of the AMCA. In the 1950's, the AMCA held two national meetings in Salt Lake City. The tradition of Utah's leadership role in AMCA continues. Sammie Dickson is but the latest member of the Utah Mosquito Abatement Association to lead the AMCA.

I began this talk with two quotations. In the first, Pope offers the sage counsel: "Act well your part, there all the honour lies." This is, I think, one of the great achievements of the Utah Association. Since the 1920s you have led by example and set a high standard of cooperation. Perhaps more fundamentally, you have not forgotten the twin messages of Smith and Herms. Mosquito control must be based on science; and, mosquito control must serve the community. Nietzsche is right: "To forget one's purpose is the commonest form of stupidity." Long may the Utah Mosquito Association remain wise.

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2006 MOSQUITO SEASON IN UTAH COUNTY

Robert C. Mower, District Manager

Utah County Health Dept., Mosquito Abatement Division, Provo, UT 84606

INTRODUCTION

Utah County is located immediately south of Salt Lake County with an area of over 2,000 square miles. The metropolitan area is Provo/Orem but particularly rapid population growth is occurring in the north and south ends of the county and census numbers are approaching half a million residents. Utah Lake is the largest natural freshwater lake in Utah, fed by several mountain streams, springs, and wetlands that provide abundant mosquito habitat. The first human case of West Nile Virus (WNV) in the county was in 2005.

SUMMARY OF 2005 SEASON

Climatic conditions began to suggest a reason for concern. The wet spring provided large areas of mosquito habitat particularly in the Provo Bay, Benjamin Slough, and White Lake areas as the water level of Utah Lake rose. The 2005 season indicated a probable increase in WNV activity for 2006. Utah County led the state in 2005 in WNV positives for mosquitoes pools (45 of 80), horses (39 of 68) and human cases (16 of 52). The first positive WNV mosquitoes were trapped the last week of July 2005 in Utah County and significant population increases began the second week of July in 2005. Plans were made for increased night spraying and funding was provided to contract aerial spraying for the first time in many years. Early spring field work identified potential aerial targets inaccessible with ground ULV sprayers. Mosquito surveillance plans were increased for CO_2 trapping from our normal 15 sites, to gather baseline data to determine aerial work. Chicken flocks were placed in the same four locations as previous years.

2006 SEASON

The wet spring was followed by early hot temperatures ideal for WNV. The first positive mosquito pool was detected from a trap set in Goshen on 12 June 2006, six weeks earlier than the previous year. The next positive mosquitoes were found on 3 July. WNV positives continued each week throughout 11 September. Significant increases in *Culex tarsalis* numbers were found in traps on 10 July and plans were made to begin aerial spraying. Aerial spraying with Trumpet® EC began 15 July in non residential areas bordering Utah Lake, particularly concentrating on trapped, shallow water habitat, to create a barrier between mosquito source and concentrated human populations. Evening spraying continued through 21 August targeting the vector mosquito *Cx. tarsalis* with a total of nearly 60,000 acres being treated. Significant reduction in WNV vector mosquitoes was noticed, compared with the previous year (Figure 1). Regular evening fogging crews targeted residential areas of high mosquito activity in West Provo on Tuesdays; Lehi on Wednesdays; and, Palmyra, Lakeshore, and Benjamin on Thursdays, throughout the summer. WNV activity continued to accelerate throughout the season. The season totals for Utah County in 2006 were: 93 positive mosquito pools, 26 positive chickens, 17 positive horses, and 66 human cases. The horse cases this year were less than half of the 2005 totals. These horses were all unvaccinated or lacking updated vaccinations. The importance of vaccinating horses is beginning to be realized. The human cases were more concentrated on the northern half of the county whereas last year it was concentrated in the southern half. Over 3/4 of the cases fell within 18-59 age ranges and two deaths occurred in the ≥65 age range in Utah County.

COMPARISON OF PAST YEARS

There were some interesting differences in the two most recent seasons. The county WNV positive infection rate from the mosquito pools tested (positive pools ÷ total pools tested) peaked at 20% this year with mosquitoes trapped on 31 July, compared with 12% on 8 August 2005. We had only 2 positive *Culex pipiens* pools of 998 total pools tested in 2005. This year 43 *Cx. pipiens* pools were positive of 891 total pools tested. This accounts for 46% or our 93 positives being *Cx. pipiens* and 54% being *Cx. tarsalis*. That is a significant increase in this bird biting vector. Birds seemed to be loaded with virus. Comparing the major species we encountered the past four seasons there has been a significant increase in WNV vector mosquitoes (Table 1). The drier years of 2003 and 2004 produced more irrigation/flood water species. The wetter springs and hotter summers have been more conducive to WNV vector mosquitoes in Utah County.

CONCLUSIONS

WNV surveillance through CO_2 mosquito traps and chicken flocks provide excellent early detection of virus activity. Aerial spraying provides an effective way of reducing populations of *Cx. tarsalis* in large

inaccessible areas. Positive wild birds seem to have increased with the increase of *Cx. pipiens*. Horse vaccination continues to be an effective means of protecting these animals. Considering the increased percentage of *Cx. tarsalis* in our traps, the decrease in the total numbers directly related to aerial spraying as well as the nearly two times increase in the Minimum Infection Rate (MIR), Utah County could have had a much larger human infection than was manifested.

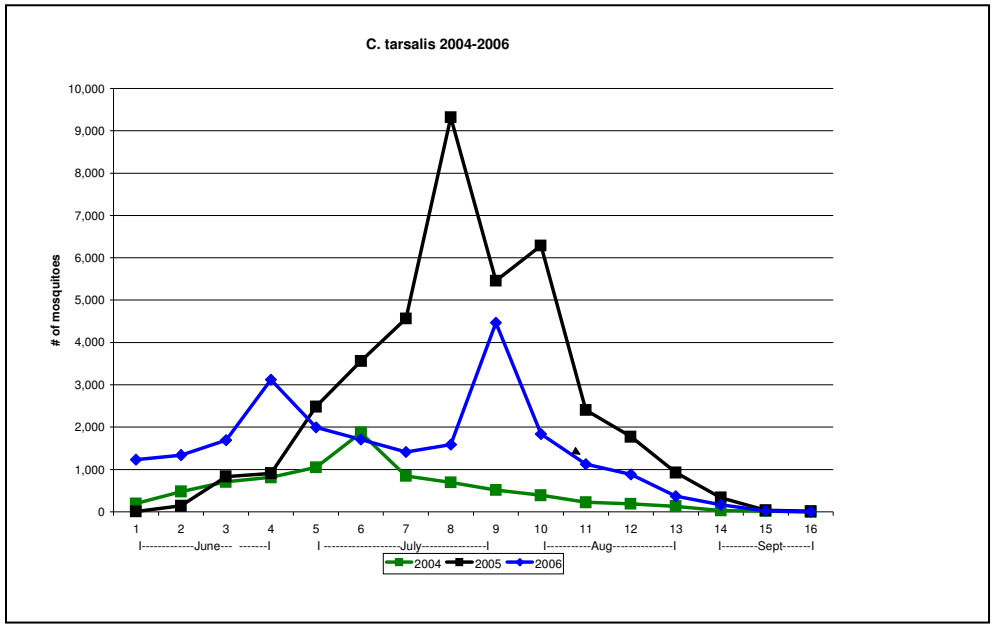

Figure 1. Comparison of *Cx. tarsalis* from 2004 to 2006.

	2003	2004	2005	2006
Cx. pipiens	5%	11%	19%	26%
Cx. tarsalis	8%	18%	47%	56%
Ae. vexans	57%	45%	10%	2%
Oc. dorsalis	9%	12%	4%	2%
Cs. inornata	<1%	<1%	16%	7%
TOTAL	**9,000**	**45,000**	**83,000**	**49,000**

Table 1. Summary of collected mosquitoes from 2003 to 2006.

2006 MOSQUITO SEASON SUMMARY - SOUTH SALT LAKE VALLEY MOSQUITO ABATEMENT DISTRICT

Val Bowlden, District Manager

South Salt Lake Valley Mosquito Abatement District, Sandy, UT 84070

2006 has been a very interesting mosquito season for us in the south part of Salt Lake County. Our regular work load, coupled with West Nile Virus (WNV) activity has made it an extra busy summer.

I'd like to begin with some information about our district, then share what our goals were for 2006, and finally discuss WNV activity.

SOUTH SALT LAKE VALLEY MOSQUITO ABATEMENT DISTRICT

Our district covers 447 square miles, which is about 60% of Salt Lake County. We have a population of about 711,000 or 70-75% of the people in Salt Lake County. We serve 15 cities and a large unincorporated area. Each city, except Alta, provides a board member to represent their people. Also, Dr. Dagmar Vitek from the Salt Lake Valley Health Department, represents the county at large.

The district consists of a variety of ecological habitats which produce mosquitoes. Some examples are irrigated pasture lands, wetlands along the Jordan River, marsh areas with subdivisions nearby, retention ponds built to control storm runoff, 14 golf courses, water features, parks and recreation areas with broken sprinklers and over watering problems, unkempt swimming pools, ornamental ponds, and catch basins.

As we began 2006, we had 3 goals:

1. Control larval and adult mosquito population numbers.
2. Improve control of *Culex pipiens.*
3. Control WNV vector numbers.

To accomplish these goals we hired 21 seasonal employees and our full time people. The seasonal employees are involved in the following district programs.

MOSQUITO CREWS

Consisting of 7 people, divided into 3 crews, they are responsible for inspecting, recording data, and treating all known mosquito producing spots in the district, which number about 1,280.

CATCH BASIN CREWS

These 4 people, riding bicycles, have treated over 53,000 catch basins with Altosid WSP. This is an increase of 4,000 from last year.

FISH CREW

These 3 individuals deliver mosquito fish or Altosid 150 day XR briquets to individuals with ornamental ponds who call and request this service. This year about 1,080 ponds were mapped and treated; an increase of 150 ponds.

TREE HOLES

During April, May, and June this team of two people contact home owners on the east side of the district concerning holes in their trees that may be producing the dog heartworm vector, *Ochlerotatus sierrensis*. If larvae are found, holes are mapped and treatments are made using Altosid briquets or pellets.

HORSE TROUGHS

Brian Hougaard's paper will cover this program.

BLACK FLY CONTROL

This program was started in 1978 by Ken Minson. Two workers inspect and treat 210 miles of streams, canals, ditches, and the Jordan River each week.

2006 AND WEST NILE VIRUS

Looking at some of the data collected through the summer gives us an idea about how well we did in accomplishing our 3 goals. Larval counts and adult trapping numbers indicate good control. The increase in the number of ponds and catch basins treated along with the new horse trough program leads us to believe we are improving our control of *Cx. pipiens*.

WNV activity is still a major concern and is the motivation for much of the work we do in the district. Good surveillance programs are a critical key to virus

detection. We use the following methods of West Nile surveillance. CO_2 traps are placed at 29 different sites each week. The trapped adults are speciated, counted, pooled, and sent to the health lab at the University of Utah. We have two chicken flocks, each consisting of 5 birds. Each week chickens are bled and their blood sent to the diagnostic lab in Nephi.

From our local and state health departments, division of wildlife resources, and the State Department of Agriculture and Food, we receive surveillance information concerning humans, birds, and horses. The following data are the results of these different surveillance reports.

West Nile activity was first detected in a magpie on June 2, about two and a half months earlier than in 2005. Three weeks passed and we began thinking there may have been a mistake. However, on June 20 a second magpie tested positive and we became very concerned. A total of 21 birds tested positive in 2006, 16 magpies, 3 scrub jays, 1 raven, and 1 sharp-shinned hawk. On July 6 we received reports from the lab of our first positive mosquito pool. Positive pools continued through the rest of the summer. A total of 981 pools were sent in, 156 were positive (about 16%). Of these, 45 were *Culex tarsalis* (about 30%), and 111 were *Cx. pipiens* (about 70%). In sentinel chicken surveillance, 11 of 15 chickens sero-converted. Six horses reported positive. There have been 32 reported human cases, 17 female and 15 male. Of the female cases 9 are neuro-invasive, 8 fever, and in males there are 6 neuro-invasive and 9 fever cases.

We responded to each of the human cases and many of the bird reports in the following ways: (1) Night fogging is done using fogging units mounted in pick-ups. Some individual yard fogging is done using hand-held “Colt” London Fog units. (2) The day following a report of human WNV, crew members are asked to focus their efforts within a half mile radius of the person’s address; rechecking known spots, ponds, catch basins, or horse troughs and also looking for new spots.

Toward the end of July a decision was made to do an emergency aerial spray. This decision was made jointly by state and local health personnel and the three district managers in Salt Lake County. Reports showed very good success in reducing mosquito numbers and eventually the Minimum Infection Rate (MIR).

After the aerial spray, and for the remainder of August and September it was hold on, do the best you can, and pray for an early frost. With the cooler weather, virus activity seemed to slow down.

HORSE TROUGH PROGRAM 2006

Brian Hougaard, Assistant Manager

South Salt Lake Valley Mosquito Abatement District, Sandy, UT 84070

INTRODUCTION

With the threat of West Nile Virus (WNV) looming and with *Culex pipiens* being a main vector of WNV in 2006, the South Salt Lake Valley Mosquito Abatement District (SSLVMAD) decided to try and treat every *Cx. pipiens* spot that was practical. The SSLVMAD has for years been treating ornamental ponds; it also has a program treating gutters and catch basins, with a change this year in using bikes for this program. Both of these programs target *Cx. pipiens*. There is another source, however, of *Cx. pipiens* that has never really been addressed – horse troughs!

In the 2005 mosquito season, the SSLVMAD had four human cases of WNV. As employees of the district checked around the areas where these WNV cases lived, it was noticed that in three out of the four cases, there were numerous horses in the area. With horses come horse troughs. As the employees inspected these horse troughs, they noted that over half of the troughs contained mosquito larvae.

The SSLVMAD is mainly an urban district. But, in this urban setting there are many residences that enjoy having horses. Especially in the south end of the district, there are many neighborhoods that are zoned for horses. The horse troughs in these areas, which can be big mosquito producers, are all in very close proximity to humans.

Because of WNV and the number of potential horse troughs in the SSLVMAD, it was decided to implement a program to treat horse troughs. The goals of this program are first, to find the area where troughs are located. Second, notify horse owners of potential risk of WNV due to unmaintained horse troughs. And third, either treat horse troughs with larvicides or make sure they are being maintained on a weekly basis.

METHODS AND MATERIALS

The horse trough program consists of one full time and one part time employee going through the SSLVMAD and finding residences with horses. Once horse owners are located, the abatement technicians asked to check their horse troughs, and if necessary treat them with larvicides. If the troughs are maintained, the technicians recorded that information.

The horse trough location was then mapped with a GPS unit. If the horse owner was not home, the technician would leave a flyer on their door. The horse owner would hopefully read the flyer and call the SSLVMAD, indicating if they either maintained their troughs or that they wanted their troughs treated. If the treatment option was taken, the technicians would return to the location and treat the troughs with larvicide.

The first thing that was done, was to locate where horses were in the SSLVMAD. To do this, each of the municipalities in the district were contacted and asked to provide a zoning map of their city. These maps were originally asked for in an electronic format that was compatible with the SSLVMAD GIS mapping system. Many cities were not willing to give the electronic format of the zoning maps, but, were willing to give a paper copy. From these maps, the zones where horses could be located were identified.

The horse trough flyers were designed to be placed on doors. They gave information about the horse trough program. They talked about WNV, the mosquito that carries WNV, *Cx. pipiens*, and that these could come from horse troughs. It also gave information about Altosid XR briquets, the pesticide used to treat the troughs. The flyer then asked the horse owner to contact the SSLVMAD to have the district treat their troughs or to let them know if the troughs were maintained on a weekly basis.

The pesticide used to treat the horse troughs was Altosid XR Extended Residual Briquets. The formulation of this product is a small charcoal briquet impregnated with *methoprene.* This product has a residual larval control of up to 150 days. The briquet was placed into the trough and covers 100 sq. ft. The hope was with the use of this pesticide horse troughs would only need to be treated once during the season.

Mapping the locations of the horse troughs was a big part of the program. It was done using a Trimble Geo XM GPS unit. This unit was not only used to map the location of the horses, it was also used to record data about a particular location. It recorded the address, number of troughs at a location, if troughs were maintained or treated with Altosid, and if the troughs had larvae present. This information is useful for future treatments.

RESULTS

There were 1,595 horse trough locations mapped. This is not the number of horse troughs, but number of locations. Each location may have more than one horse trough. 152 locations were treated with Altosid. This is only 9.5% of the total locations mapped. In 481 of the locations, the troughs were maintained at least weekly. This is 26% of all mapped locations. There

were also 30 locations with automatic watering devices, 17 with running water, and 8 with fish in the trough to control mosquito larvae. Trough information, whether treated or maintained, was obtained on only 633 of the 1,595 of all the locations mapped, only 40%. Sixty percent of horse owners in the SSLVMAD did not contact the district with information about their troughs.

Of the 633 trough locations that were treated or maintained, 444 were serviced in response to the flyers. There were 189 locations serviced in response to phone calls. The phone numbers of horse owners were found by using the horse owner's addresses and then a reverse phone directory on the internet.

The total cost of the horse trough program was approximately $16,657.59. Employee wages were $10,970.48, GPS equipment cost $3,430.00, treatment product cost $1,950.00 and door hangers cost $307.11.

DISCUSSION AND CONCLUSIONS

The first goal of the horse trough program, to find areas in the SSLVMAD where horse troughs were located, was accomplished very well. Most of the horse trough locations in the valley were mapped. This gives the SSLVMAD valuable information and makes it easier next year when the horse trough program is continued.

The second goal of the program was to inform horse owners of the potential risk of WNV due to untreated horse troughs. This goal was also accomplished. Most horse owners in the SSLVMAD were contacted and informed about WNV, either by personal contact with abatement technicians or by a door hanger / flyer.

The third goal was to lower the number of *Cx. pipiens* in the SSLVMAD by treating all of the horse troughs, or making sure they were maintained weekly. This goal was not fully accomplished and needs improvement for 2007.

There are a number of reasons why the third goal was not fully met. As mentioned above, the SSLVMAD used door hanging flyers to let horse owners know that their troughs would be treated. The first flyer used stated that the SSLVMAD technicians would automatically treat troughs within the next few days if horse owners did not call. Most horse owners are very sensitive about their horses and a number of calls came in from angry horse owners, stating they disliked this approach. Also, many horse owners had locked gates or dogs. The horse trough technicians were not comfortable going in yards without permission. Because of this, the SSLVMAD made a second flyer. In this flyer, the horse owners were specifically asked to call the district to indicate whether they maintained their troughs, or, they wanted the mosquito abatement to come and treat them. If the horse owner did not call, troughs were not treated.

Because of the lack of call backs from horse owners about their troughs from the flyers, and after mapping the entire district for troughs, the horse trough crew used a reverse phone directory to obtain phone numbers of horse owners from their addresses. The crew called all the numbers that were listed. Horse owners were asked if the SSLVMAD could come and treat their horse troughs or if the horse owner maintained their troughs. If people were not home, they left messages asking them to call back about their troughs. Again, phone calls were not very successful.

As the management and technicians of the SSLVMAD discussed how the horse trough program could be improved for next year, a number of good suggestions were made.

The first suggestion was to send horse owners a letter in the spring, letting them know that their troughs would be treated during the summer. With the trough locations mapped, the addresses were available to do this.

The second suggestion was to hire a technician to work in the evening. By doing this, hopefully more horse owners would be at home.

Another suggestion was to redo the flyer. It would have a questionnaire on the back, which horse owners would fill out. It would ask if they maintained their troughs or if the troughs could be treated. They would then hang it back on the door and our technicians would pick it up the next day knowing what to do at that location.

The horse trough program for 2006 was not perfect, but a lot was accomplished and learned. Next year improvements will need to be made so that more of the horse troughs will be treated or maintained.

VECTOMAX® TRIAL

Ben Sperry and Mike Maynor

Mosquito Abatement District – Davis, Kaysville, UT 84037

In 2006, Utah had 158 cases of West Nile Virus (WNV). Fifty-five of those were neuroinvasive, with five deaths (CDC website). In Davis County there were ten human cases of WNV and three horses. In the interest of public safety it is important that our mosquito control be as efficient and effective as possible. In Davis County, the Mosquito Abatement District Davis (MADD) has an area of *Culex tarsalis* habitat difficult to control for many reasons. Because of the lack of success, we were glad to have the opportunity to do a trial with VectoMax®, a new vector control from Valent Biosciences Corporation. Our results were positive.

The area that gives us problems has several obstacles that limit our effectiveness. The area is about 50 acres of marshland in the Farmington Bay Bird Refuge. Only a limited portion is accessible by foot. There is a lot of organic matter, tall reeds, and grassy areas. To complicate things further the MADD has restrictions on the types of pesticide used in the area. The area has been treated exclusively with *Bacillus thuringiensis israelensis* (BTI) for many years and is now becoming more and more difficult to achieve acceptable results. The restriction on organophosphates and other larvicides prevents us from using a diversity of control measures. We decided to try VectoMax® to overcome these problems. VectoMax® is a special combination of BTI and *Bacillus sphaericus* (BS), both approved for use in the bird refuge.

Our traps and larval observations throughout the season informed us of the need to test additional pesticides. We conducted our first larval count 24 hours before treatment with VectoMax®. Our numbers were high and across the spectrum – first instars through pupae (Figure 1). In order to best track our numbers, we set up eight flags in permanent locations. For consistency, we took ten dip counts equidistant in a straight line about the flag. We recorded the number of each instar at each dip location, calculating the average for each flag. From the initial dip counts, our total numbers for all 8 flags were as follows: first instars 886, second instars 260, third instars 174, fourth instars 168, and pupae 112. The total shown in our numbers only represents a very small part of the total area. Larvae were found consistently throughout the entire 50 acre area. With WNV creeping into Davis County we were anxious to control these numbers. There is a high population of birds in this area and therefore a greater chance that WNV will be spread.

Twenty-four hours after the initial larval count we treated the area by airplane with VectoMax® granules. The rate used in the study was 7.5 lbs. per acre. In order to monitor the application rate, buckets were set up along a line centered by the flag. When the plane applied the pesticide, the granules would fall into the buckets which could then be counted. After counting the granules in each bucket, we were able to formulate the application rate for the area around each flag and the average application rate for the entire area. We had very different application rates among the different flags. The desired, or recommended, application rate was seven and a half pounds per acre but the actual application rate ranged from 33 lbs per acre to 0.6 lbs per acre (Figure 2).

Another larval count at each flag location was conducted 24 hours after the aerial application with stunning results. We had a 98% kill overnight. Even areas of low application saw a major reduction in numbers. We also did larval counts at 48 hours, 96 hours, 1 week, 2 weeks, and at 3 weeks. Within 96 hours we had a 98% kill (Figure 3). The numbers stayed very low through the whole 3 week trial. By the end of the three weeks the season was winding down. The weather became colder and our CO_2 traps were collecting fewer adult mosquitoes.

With 4,219 cases of WNV in the United States and 161 fatalities, we need to be looking for effective vector controls. VectoMax®, in this trial, proved to be a very effective vector control. We look forward to it coming on the market.

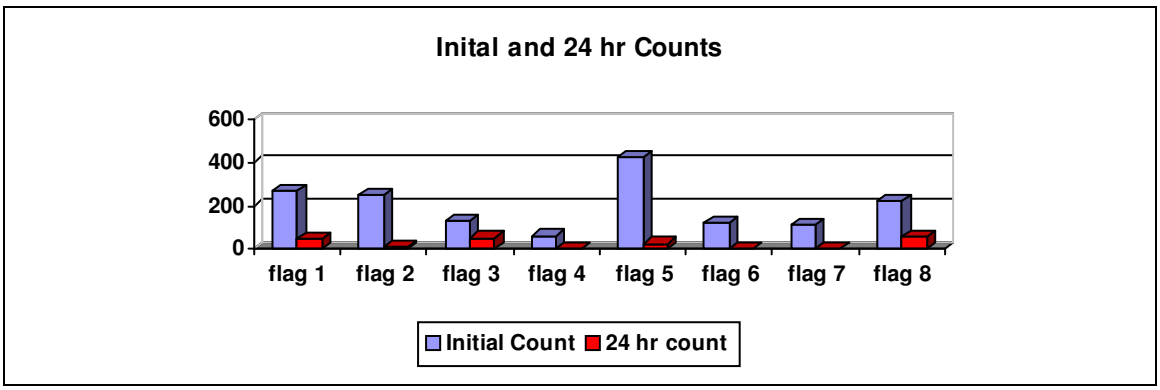

Figure 1. Initial larval count (1600) for the eight flags and the larval count 24 hours (207) post treatment.

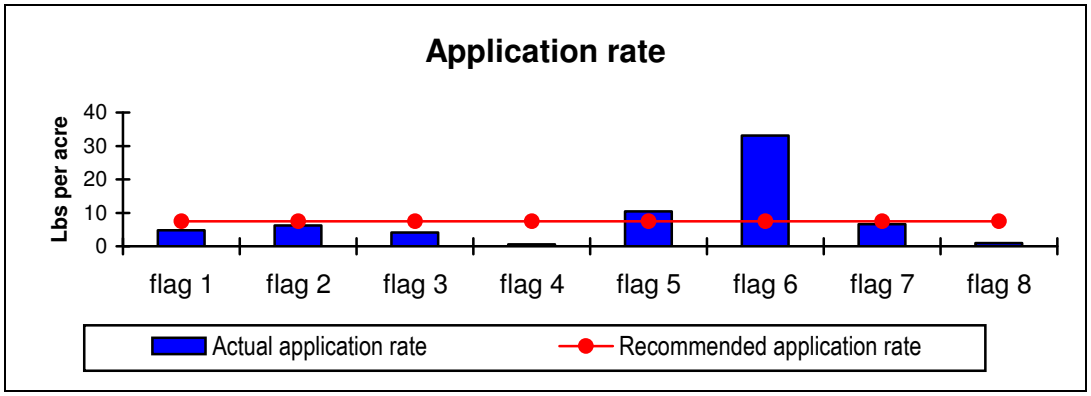

Figure 2. Application rate of 7.5 lbs. per acre and the actual application rate recorded at each flag.

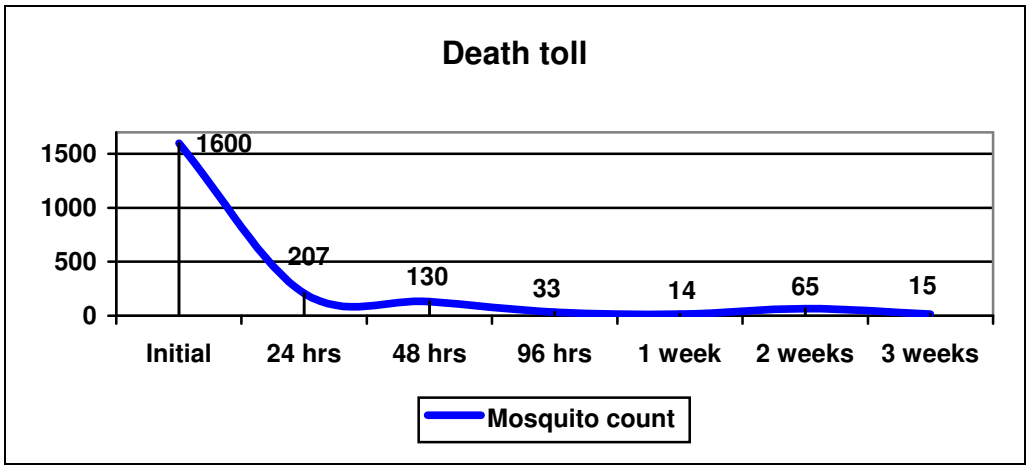

Figure 3. Total number of larvae collected pre- and post treatment at eight dipping locations in the study area.

MESA COUNTY ZOONOSES 2006 – WEST NILE VIRUS, PLAGUE, AND TULAREMIA

Steve DeFeyter, Director of Environmental Health

Mesa County Health Department, Grand Junction, CO 81502-5033

INTRODUCTION

The Mesa County Health Department (MCHD) prepared to deal with a resumption of West Nile virus (WNV) activity that had resurfaced in 2005 after severely impacting the county in 2004. WNV surveillance was fine tuned with reliance placed principally on mosquito pool based WNV viral detection and human case monitoring. Avian surveillance for WNV was greatly reduced. The MCHD budgeted $165,000 for WNV education, surveillance, and control during 2006. By season's end, the county had experienced a resurgence in WNV activity in comparison to 2005, but not as severe as the 2004 outbreak. During 2006 the MCHD also dealt with sylvatic plague and tularemia activity migrating into populated areas.

WNV CONTROL EFFORTS

Mesa County, located on Colorado's central western border with Utah, has an estimated population of 130,000, and encompasses 3,309 square miles, of which approximately 72% is public owned. Most human and WNV activity occurs within the urban area surrounding the city of Grand Junction, which is nestled in the heavily irrigated Grand Valley. The Grand River Mosquito Control District (GRMCD), with a 2006 budget of nearly $900,000, is responsible for mosquito control along a 20 mile stretch of the valley floor. Ironically, the GRMCD boundary jogs around the main part of the city of Grand Junction, and thereby excludes the most densely populated section of the county. The health department based Mesa County Mosquito Control Team (MCMCT), with a budget of $165,000, attempts to provide disease vector control coverage in areas outside of the district. Both the GRMCD and MCMCT rely primarily upon larvicides (Bti, B. sph., surfactant, or IGR's), for mosquito control. All identified storm sewer catch basins within urban areas were treated with methoprene briquets by the two control organizations. Mosquito breeding sites identified within MCMCT jurisdiction were entered into the team's ArcView® based geographic information mapping system. Vehicle ground based or aerial adulticiding was not conducted by MCHD or the GRMCD during 2006. The "Fight the Bite" WNV prevention educational campaign returned at about the same level as 2005. However, no additional Mosquito Dunks® were purchased for distribution to the public as part of the "Backyard Mosquito Control" campaign.

WNV SURVEILLANCE

WNV surveillance during 2006 consisted of mosquito collections at 60 trap sites, a limited amount of dead corvid testing, and human case and blood donor reporting. Dead corvids accepted for testing were subjected to oral swab and VecTest®. The MCMCT operated 20 CO_2 baited CDC miniature light trap sites collocated with gravid traps. The GRMCD operated 40 CO_2 baited CDC miniature light traps within their jurisdiction. Mosquito collections were keyed at all sites with *Culex* mosquitoes sorted and pooled for testing based on individual trap sites or combined pools from geographic areas as deemed appropriate. All *Culex* mosquito pools collected at the county's single designated "Sentinel" site were submitted for PCR analysis through the Colorado Department of Public Health & Environment (CDPH&E) laboratory in Denver. All other *Culex* pools were submitted for testing with the less sensitive VecTest® method to the CDPH&E Western Slope Branch Laboratory housed in the Mesa County Health Department. MCHD clinical staff monitored human WNV case reports and performed follow-up interviews where possible. West Nile viremic blood donor reports supplemented the human data component and were obtained through the local blood bank. Some of the blood donor reports converted to human cases following donor interview and case definition comparison.

WNV SURVEILLANCE RESULTS

Mosquito trapping got off to an early start beginning the first week of April at the lower elevation trap sites. Adequate numbers of *Culex* mosquitoes for WNV testing started showing up four weeks later. After wading through piles of the ubiquitous early bird *Aedes vexans,* the mosquito ID crew was excited on May 2nd to find our first recorded specimens of the Great Basin dwelling *Oc. niphadopsis*. This excitement was short lived, however, as a backlog of incoming mosquito collection bags began to pile up when the full complement of traps sites came on line around June 1st. Total *Culex* mosquito numbers by collection week at the six "reference" trap sites generally paralleled

previous seasonal population growth trends, but at a somewhat lower level. The first indication of WNV activity in the area (and Colorado) came in the form of a Black-billed Magpie swabbed in early June. Dead corvid testing yielded a total of 5 positive specimens out of 12 tested during the 2006 season. The first WNV positive *Culex* mosquito pools (2) were collected on July 5th at GRMCD sites in Fruita and the Redlands. This WNV activity indicator was 3 weeks later than the corresponding finding during the 2004 peak outbreak year, yet 4 weeks earlier than that of 2005. Viral activity as determined by positive *Culex* pools was found to persist through to the middle of September. The percentage of WNV infected pools of the total submitted weekly did not approach 2004 levels which exceeded 50% in mid July. The highest percentage by week for 2006 was 12.5% which occurred a week later than observed in 2004. The highly effective public health emergency aerial adulticiding campaign conducted during July and August of 2004 prevents an accurate comparison of mosquito trap/test results for comparable late season periods in following years. For a comparison of *Culex* pool WNV testing results over the past 3 years refer to Table 1.

HUMAN CASE SURVEILLANCE

The finding of WNV bearing mosquitoes in early July alerted staff epidemiologists to watch for human cases and viremic blood donors in the Grand Valley. As is the case with arboviral outbreaks, there is a significant lag between initial infection, illness diagnosis, and case reporting. The first confirmed Mesa County human WNV cases were reported in early August with onset dates that followed initial indications of viral activity by several weeks. As a general trend, human case report onsets rose and fell in concert with WNV positive *Culex* pool results (Figure 1).

Year	Cx. Pools Tested	WNV +	%
2004	500	114	22.8
2005	747	16	2.4
2006	522	30	5.8

Table 1. Mesa County Culex Pool Testing Results 2004 – 2006.

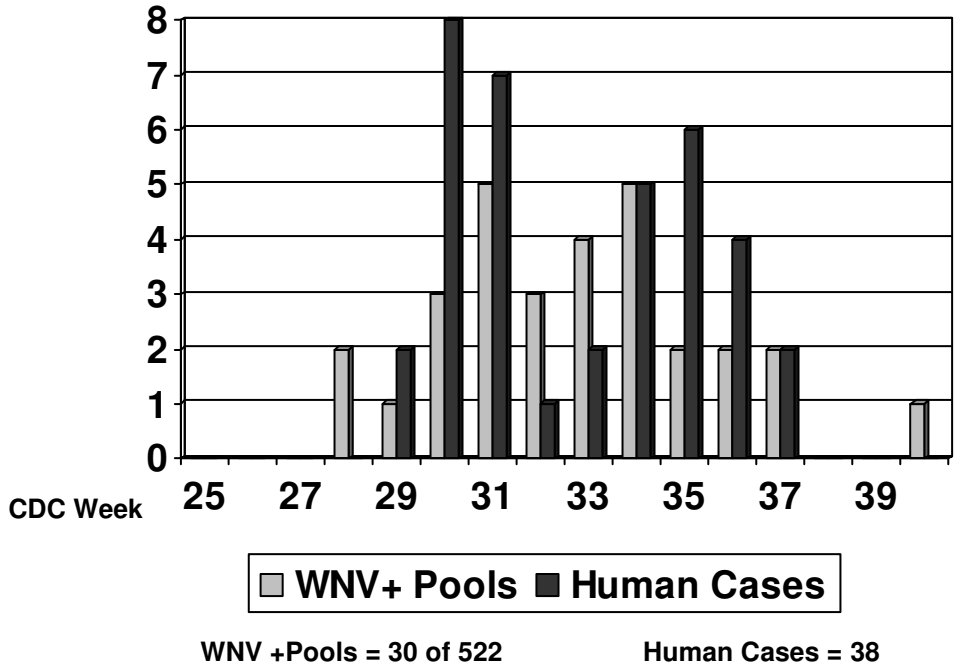

Figure 1. Mesa County, Colorado 2006 Human Case Onset & WNV Positive Culex Pools.

Showing similarity to the 2004 outbreak, human case onsets peaked at approximately the same early seasonal point (CDC Week 30/July 23rd) as the corresponding *Culex* weekly trap totals and *Culex* testing pool submissions. The similarity ends there however, as the amplitude of the 2006 human epicurve peak was much lower at 8 per week, compared to 23 for 2004. A curious bifurcated curve developed after a secondary human case onset peak emerged around the middle of August. There has been much speculation regarding the relationship of the WNV positive *Culex* pool increase and the corresponding but delayed jump in human cases around this time. Thirty-eight confirmed WNV human cases and two deaths were identified during the 2006 season (Table 2). Three human cases were confirmed from viremic blood bank donor reports through interviews and positive IgM antibody tests. An additional 9 blood bank donors were still being evaluated as possible cases at season's end.

Year	Cases	Deaths
2003	19	2
2004	127	4
2005	10	1
2006	38	2

Table 2. Mesa County Human WNV Cases 2003 - 2006

WNV DISCUSSION

There was a significant resurgence in WNV activity in Mesa County during 2006. WNV activity, as determined primarily through mosquito pool testing and human case confirmation, did not approach the degree of intensity experienced during the 2004 peak outbreak year. Although a measurable mid-season climb in WNV activity was apparent, the level of concern was not high enough to trigger the declaration of a public health emergency as was done in 2004. The debate will undoubtedly continue among vector control and public health agencies on the best method for determining an emergency adulticiding threshold point. Although MCHD based WNV surveillance and mosquito control funding was slated for reduction in 2007, the resurgence in WNV activity resulted in restoration of program funding to the previous level.

PLAGUE AND TULAREMIA

Plague re-emerged very early this year in Mesa County after carrying over in the wild from 2005. Plague infected chipmunks at the National Park Service managed Colorado National Monument (CNM) near Fruita were found dead on February 2, 2006 at a campground facility. In the spring of 2005 Mesa County experienced the first human case of bubonic plague in recorded MCHD history, which preceded a plague epizootic in wild and domestic animals. Although the *Yersinia pestis* bacterial transmission route involved in the human case was not clearly ascertained, it was assumed to involve the rodent/flea transmission cycle. A total of 6 cases of plague were identified in rodents, rabbits, and domestic cats that year. After the findings at CNM it became apparent that the outbreak of sylvatic plague was continuing to burn its way through rodent communities on the south side of the Colorado River. Plague sickened domestic cats became an important surveillance tool as veterinarians were advised to watch for and test symptomatic pets. Zoonoses program staff went door-to-door in the vicinity of Redlands neighborhood case sites, contacting adjacent property owners and warning them of the risk of contracting plague. Rodent burrows around case sites were dusted with deltamethrin to eliminate potentially infected fleas. By the end of the season 13 of 76 animal specimens submitted for testing were found to be infected with the plague bacillus. Animals infected included: domestic cats (6), chipmunks (4), white-tailed antelope squirrel (1), and rock squirrel (2). Tularemia activity, caused by infection with the bacteria *Franciscella tularensis,* was limited to a single dead cottontail rabbit found along U.S. Highway 50 in the south central section of Mesa County. It is quite fortunate that no human cases of plague or tularemia were identified in Mesa County during 2006.

2006 REVIEW OF WEST NILE VIRUS IN DAVIS COUNTY

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Mosquito Abatement District – Davis, Kaysville, UT 84037

The 2006 mosquito season was the most active series of months for West Nile Virus (WNV) in Davis County. As expected, the Mosquito Abatement District – Davis (MADD) witnessed a large increase in WNV positive *Culex tarsalis* and *Culex pipiens* pools compared to 2004 and 2005. Sentinel chickens, although not a great indicator of early WNV activity indicated the transmission of the virus to animals.

As a busy summer in 2006 was anticipated at the close of the 2005 season, effective plans were put into place, encephalitis surveillance measures were stepped up, and a public outreach to the county health department, individual city councils, and the citizens of Davis County was extended. All proved to benefit the efforts used in attempting to control WNV.

PREPARATIONS FOR 2006

During 2004 and 2005, changes were made to many of the operating procedures done in the field. Prior to the rapid movement of WNV across the United States, *Ochlerotatus dorsalis* was the primary mosquito species targeted by the MADD. Although only a nuisance mosquito and not a transmitter of disease in Utah, *Oc. dorsalis* was the cause of many spray requests. Depending on weather patterns and conditions, multiple migrations of *Oc. dorsalis* could occur during a summer, moving quickly from the freshly flooded wetlands of the Great Salt Lake a few miles into heavily populated cities along the Wasatch Front.

When it was determined that *Cx. tarsalis* and *Cx. pipiens* were to be the species of concern for WNV in the western United States, and specifically in Utah, more attention was placed on the biology of each species. Thresholds for larval ground and aerial spraying were lowered from 4-5 per dip to 1 per dip. Less tolerance for large adult numbers trapped in New Jersey Light Traps and ABC CO_2 Traps (Clarke Mosquito Control Products) was shown. Rather than selling older ULV foggers, these were kept in storage, brought out during the summer, started, and wired to be ready to be placed in a field truck with only a day's notice.

Better field training for seasonal employees on mosquito biology began with more emphasis on permanent and semi-permanent water sources for *Cx. tarsalis* and artificial, container, and catch basin sources for *Cx. pipiens.*

The MADD has contracted for several years with MadFly Aerial Spraying for all its air based larvicide and adulticide needs. However, due to MadFly's use of a single engine aircraft, adulticiding over residential or populated areas has not been allowed. In early 2006, MADD signed a contract with Vector Disease Control, Inc. (VDCI) to conduct aerial adulticiding, using a twin engine plane, over residential areas. Maps were drawn and portions of the county were designated as possible target areas. But when flight plans were submitted and approval requested by VDCI to the Federal Aviation Administration (FAA), they were repeatedly denied throughout the summer.

SURVEILLANCE METHODS

The MADD uses eleven sentinel chicken flocks as part of its encephalitis surveillance program (Fig. 1). These flocks are divided into five 10 bird flocks and six 5 bird flocks. From June through September, a blood sample is taken from each chicken on a weekly basis, usually on Monday morning. Results for encephalitis positive chickens are received on Thursday or Friday of the same week from the Utah Veterinary Diagnostic Lab in Nephi. During the testing months of 2006, 13 sentinel chickens tested positive for WNV in Davis County. The first WNV positive chicken was detected during the week of Aug 7-13, 3 full weeks after the first WNV positive *Cx. tarsalis* pool, and 1 week after the first WNV positive human case. Quite a bit of disappointment has been expressed over the inability of sentinel chickens to be an early indicator of WNV in our area.

The second method, and more efficient indicator, used in the encephalitis surveillance program for the MADD, is ABC CO_2 traps (Fig. 1). One to two nights per week, from June until late September, 12 permanent or stationary CO_2 traps are set. Six part-time, or "floating," CO_2 traps are set on an as needed basis. During 2006, CO_2 traps collected 79,258 total mosquitoes. 1,422 individual mosquito pools were submitted to the Utah Department of Health Public Laboratory; the majority being *Cx. tarsalis* (Fig. 2).

The MADD also assists, when called, in the oral swabbing and collecting of dead birds. Most dead bird calls taken by the MADD were birds not in the *corvid* family or raptors. Only a handful of oral swabs were taken and submitted by MADD personnel.

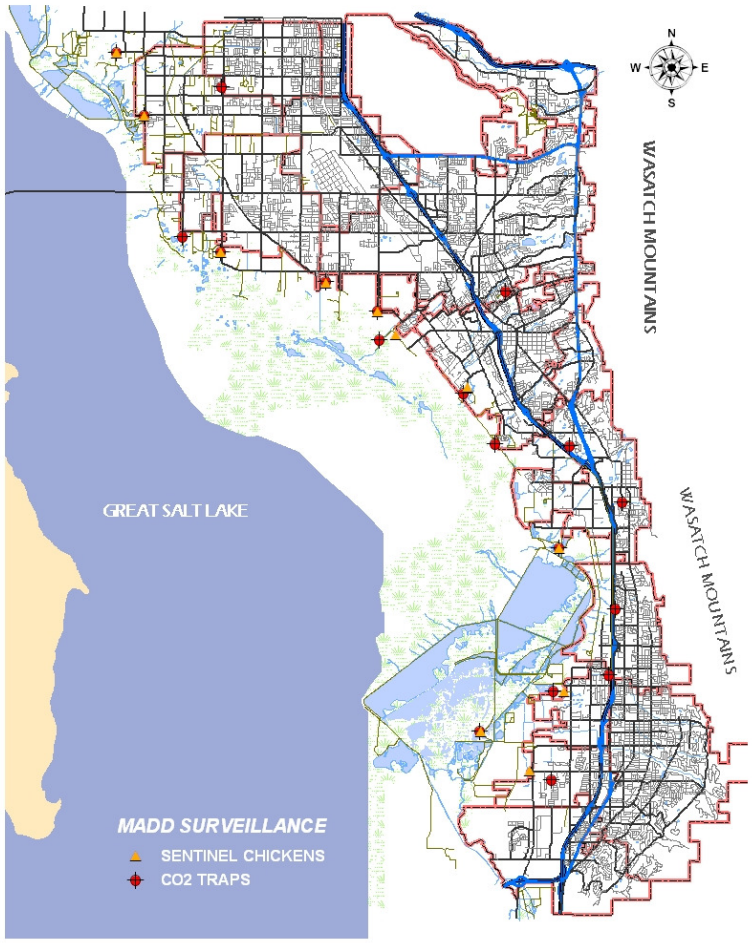

Figure 1. Mosquito Abatement District – Davis' encephalitis surveillance program.

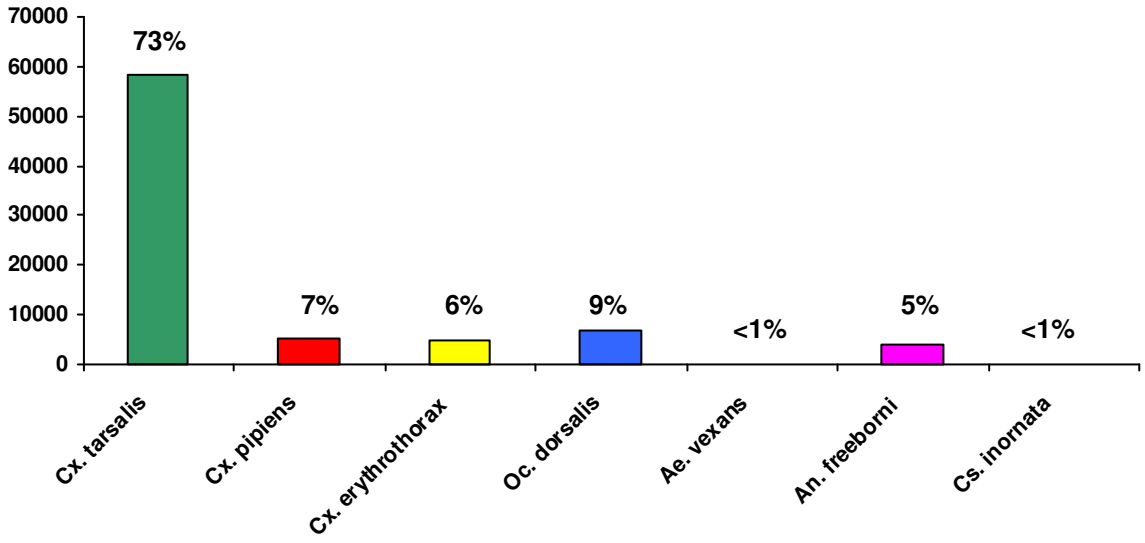

Figure 2. Mosquito species collected in ABC CO_2 traps in 2006.

WNV CASES IN DAVIS COUNTY

History of WNV in the United States and in Utah points to a significant increase in the number of WNV cases in humans and animals during the second year after the virus has established itself in an area. This is true for areas like Utah and Salt Lake Counties. In 2004 Davis County had one human case and no activity detected in mosquitoes, sentinel chickens, wild birds, or horses. There were 6 WNV positive sentinel chickens, 1 WNV positive mosquito pool, and 1 WNV positive horse in 2005. All of these cases happened late in the year. This makes the WNV activity during 2006 the liveliest season on record in Davis County. (Table 1) But it also makes the prospect of 2007 unclear. Was 2006 the "second year" marked increase of WNV in Davis County? Or is the second year phenomenon in 2007?

Year	Humans	Blood Donor	Mosquitoes	Sentinel Chickens	Wild Birds	Horses
2004	1	0	0	0	0	0
2005	0	0	1	6	0	1
2006	10	2	43	13	3	3

Table 1. History of West Nile Virus cases in Davis County.

The county's first WNV positives in 2006 were detected in two *Cx. tarsalis* pools from two CO_2 trap locations on 18 July – one at the Jones trap in Kaysville and the other in the Farmington Bay trap in Farmington. Lying only a few miles apart, these two trap locations are in the middle of the Great Salt Lake Marsh running north to south in the county. Although considered excellent trapping locations, these were not the traps expected to produce the first detections of WNV in Davis County in 2006. Already during the summer, Salt Lake County, and specifically the Salt Lake City Mosquito Abatement District had positive mosquito pools at its border with Davis County.

Part of the plan developed for the summer was to hit back hard whenever a WNV positive case was found – whether it was a human, mosquito pool, sentinel chicken, etc. With these first positive pools, the airplane was used to spray a long stretch of marsh, 7,680 acres, encompassing these two positive CO_2 trap locations. Ground ULV was also used in these areas, with three additional ULV machines being added to a fleet of five spray trucks. This pattern of aerial adulticiding, combined with ground ULV work continued throughout the season until the day and evening temperatures dropped significantly in September.

As the next week's samples were submitted, three additional *Cx. tarsalis* pools tested positive for WNV. Each of these pools was from three different CO_2 trap locations, and did not include the traps from the previous week. The district now had five positive locations stretching from the north end of the county to the south.

The week of July 31 – August 6 produced the first human detection of WNV, a neuroinvasive case, in Davis County in 2006. When located by a general address it came as no surprise. This person lived less than one mile from a "hot spot" of WNV activity in Salt Lake County. This third week of activity also produced the first positive *Cx. pipiens* pool. What was most unsettling about this find was its distance from the Great Salt Lake marsh. It was also the sixth CO_2 trap location to test positive, of which none had tested positive a second time to date.

The fourth week of activity in Davis County reported 2 additional human cases, one being diagnosed as a fever case and the other as an asymptomatic blood donor. This same week, August 7-13, was the first detection of WNV in a sentinel chicken; the location of the chicken coop being in close proximity to the first human case the previous week. This came as a disappointment to MADD personnel (Figure 4). This pattern continued throughout the remainder of the summer as sentinel chickens continued to test positive later than expected.

The next eight weeks, until 1 October, the MADD continued to submit numerous *Cx. tarsalis* and C*x. pipiens* pools, blood samples from sentinel chickens, a handful of oral swabs from dead birds, and continued to receive timely faxes from the Davis County Health Department on additional human cases (Table 2).

DISCUSSION

A few things MADD personnel wanted to gauge throughout the season was the effectiveness of ground and aerial ULV spraying as WNV cases began to show and to determine the quality of its encephalitis surveillance program. Although CO_2 trap numbers alone may have required an aerial spray, after 17 July

those sprays were largely determined by WNV pools of *Cx. tarsalis,* and, on a few occasions, *Cx. pipiens*.

In attempting to determine whether the methods were effective, each CO_2 trap with the total number of trapped mosquitoes and the number of WNV positive pools were all recorded and compared weekly. This information was used to evaluate the reduction of total mosquitoes trapped after an aerial ULV spray and if any positive pools were collected after the spray event compared with positives from the week before. The information provided some valuable help in the MADDs efforts to fight WNV. During those first 3 weeks of WNV activity in the county, six separate CO_2 trap locations yielded six positive pools. It wasn't until the fourth week that a CO_2 trap produced a positive a second time. This was the Jones trap in Kaysville which was one of two positive locations the first week of activity.

This area is noted to be a large producer of *Cx. tarsalis* and is sprayed often by air but because of high tension power lines, the geographic window of getting pesticide to the ground is very difficult. By ground it is even more complex because of the lack of access by truck. The difficulty in controlling the area was proven when the following week, August 14-20, another *Cx. tarsalis* pool tested positive, the first such time a CO_2 trap was positive for 2 weeks. However, this location did not yield another positive until the final CO_2 trap collection on 25 September when just one pool was submitted with only 17 *Cx. tarsalis* trapped. A sentinel chicken flock of 5 birds, located about 200 yards from the CO_2 trap site, did not produce a positive during the season.

As was mentioned earlier, sentinel chickens were very disappointing as early indicators of WNV. Although thirteen chickens sero-converted from six of the eleven coop sites, only one showed notable activity and followed a recognizable pattern. The Schillings chicken coop in west Layton produced six of the thirteen positive chickens, all happening after 28 August. This coop continued to produce at least one positive chicken the next four weeks. Meanwhile, four positive mosquito pools were taken from the same site, all before the first positive chicken.

As the MADD tried to evaluate itself during the season, and especially afterwards, a lot of time and thought went in to the effectiveness of the time field employees spend in a ULV truck. The job quality of the airplane can be determined by pre and post trapping, but a ground vehicle has many more obstacles, obstructions, and limitations. But with the opportunity to use VDCI to spray over residential areas denied by the FAA, ground spraying took on a great importance.

The previous summer MADD purchased four GeoFlow units to be used with London Fog machines from Adapco. These units have the GPS capability to track where the truck travels and sprays during a spray mission. GeoFlow notes when the spray is on and when it is off. The machines also come equipped with a variable flow system which allows the volume sprayed to be matched to the speed of the vehicle. All of this data comes complete in a file which can then be downloaded to a computer and viewed using any program which can view shapefiles (MADD uses ESRI's ArcGIS). With the GPS position recordings and the flow data, MADD personnel were able to daily view previous missions and schedule missions for that evening. With this information, an up to date summary of acres sprayed, hours and miles sprayed, and total number of ounces/gallons sprayed is at hand. (Four other ULV machines used in the field are not equipped with GeoFlow.)

The quality of data collected from the ground ULV machines and the quality of well documented aerial sprays give the MADD a confidence in fighting WNV. Positive mosquito pools from CO_2 traps, although high with a total 43, had only five of eighteen locations test positive 2 weeks in a row, and only one 3 weeks straight. The determination of the MADD is that consistent, methodical, and well planned and timed aerial and ground ULV spraying continually disrupted the transmission capabilities of *Cx. tarsalis* and *Cx. pipiens* throughout the summer. Although the county saw far too many cases, both in animal and, especially, in humans, the information collected and the recognition of "hot spots" provides insight as to what works, what is less effective, and of geographical areas to give more attention. Even though WNV has been documented in Davis County since 2004, the summer of 2007 is being looked at and projected as the second year phenomenon where the virus is established and is ready to strongly show itself. But the plans, methods and equipment, and learned lessons from the past provide the district with the tools it needs to continue its fight against WNV in Davis County.

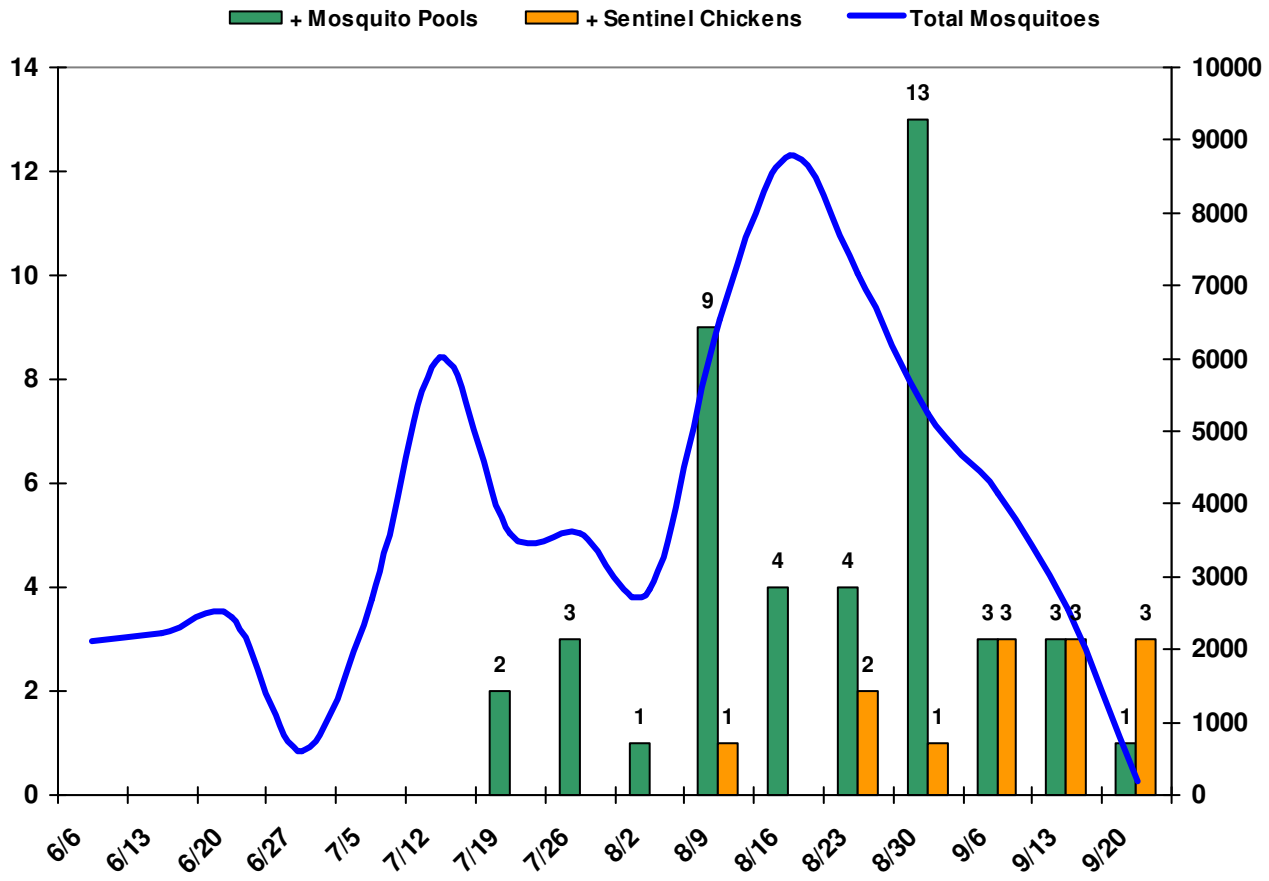

Figure 4. History of mosquito collections and WNV positive pools compared with sentinel chicken sero-conversion.

Date	Human	Blood Donor	Mosquito	Sentinel Chickens	Wild Birds	Horses
Jul 17-23	0	0	2	0	0	0
Jul 24-30	0	0	3	0	0	0
Jul 31-Aug 6	1	0	1	0	0	0
Aug 7-13	1	1	9	1	0	0
Aug 14-20	0	1	4	0	0	1
Aug 21-27	1	0	4	2	0	2
Aug 28-Sep 3	2	0	13	1	0	0
Sep 4-10	3	0	3	3	2	0
Sep 11-17	0	0	3	3	1	0
Sep 18-24	1	0	1	3	0	0
Sep 25-Oct 1	1	0	No samples	No samples	0	0
TOTAL	**10**	**2**	**43**	**13**	**3**	**3**

Table 2. History of WNV cases in 2006 by the week each was reported.

WEST NILE VIRUS SUMMARY REPORT 2006 SEASON

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The purpose of this document is to provide Utah West Nile virus (WNV) partners a concise summary of this season's major results. Information displayed in this report has been compiled by the Utah Department of Health (UDOH), but reflects information obtained from concerted joint efforts. All activities related to WNV during the 2006 season involved major contributions from many different agencies. These include as follows: blood banks of Utah, local health departments (LHDs), Utah Department of Agriculture and Food (UDAF), Utah Division of Wildlife Resources (UDWR), Utah Mosquito Abatement Association (UMAA), Utah Public Health Laboratory (UPHL), and the Utah Veterinary Diagnostic Laboratory (UVDL). In addition to the direct contribution of surveillance data, these agencies were also involved in the systematic planning and preparation for the 2006 season. The intent of this report is to document the results of the efforts put forth by these entities during the 2006 WNV season.

Please note that the purpose of this report is to describe general trends that occurred during the 2006 season. Specific non-human positive counts may be subject to change as surveillance data continues to be reconciled for the season.

INTRODUCTION TO WNV

During the summer of 2006, WNV reemerged in Utah. This was the fourth year WNV activity has been detected in Utah. WNV is a disease transmitted by mosquitoes. Birds are the natural hosts of the disease with humans and horses serving as accidental hosts. The majority of people infected with WNV never develop symptoms. A small percentage of infected individuals will display West Nile fever symptoms (i.e. fever, headache, and body aches). A more serious form of the disease, West Nile neuroinvasive illness, may also occur when the virus infects the central nervous system. People with this form of the disease will have high fevers, severe headaches, neck stiffness, and mental confusion. Hospitalization may be required and death is possible.

INTRODUCTION TO WNV SURVEILLANCE IN UTAH

Surveillance for WNV activity involves several different components. Since the disease is zoonotic in nature, both human and animal surveillance occurs. In Utah, WNV surveillance involves human, mosquito, wild bird, horse, and sentinel chicken populations. Due to the involvement of these different populations, surveillance efforts this season enlisted the expertise and abilities of many different agencies. Local mosquito abatement districts in conjunction with the UMAA performed the necessary trapping and identification for mosquito surveillance. Testing of these mosquitoes occurred at the UPHL. Sentinel chicken flocks were also maintained and bled by mosquito abatement personnel. Chicken blood samples were processed at the UVDL - Nephi. Oral swabs from wild birds, live and dead, collected by UDWR officials and other designated staff were sent to the UPHL for testing. Horse blood samples were collected and submitted by local veterinarians with the UDAF coordinating testing efforts at the UVDL - Logan. Major health care providers submitted human samples across the state with testing occurring at both the UPHL as well as private laboratories such as ARUP (Associated Regional and University Pathologists). The three major blood banks servicing Utah (American Red Cross, ARUP, and Mountain Star) coordinated screening of donated blood for identification of viremic donors. All LHDs in Utah were involved with disseminating, investigating, and responding to surveillance data indicative of local WNV activity.

2006 SEASON NATIONAL HIGHLIGHTS

As of November 28, 2006 avian, animal, or mosquito WNV infections have been reported to CDC ArboNET from the following states: Alabama, Arizona, Arkansas, California, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Idaho, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, and Wyoming.

As of November 7, 2006, a total of 2,093 (55%) cases for which such data were available occurred in males with a median age of patients being 51 years with a range: 3 months-99 years. Dates of illness onset ranged from January 6 to October 22, a total of 119 cases were fatal. (Fig. 1)

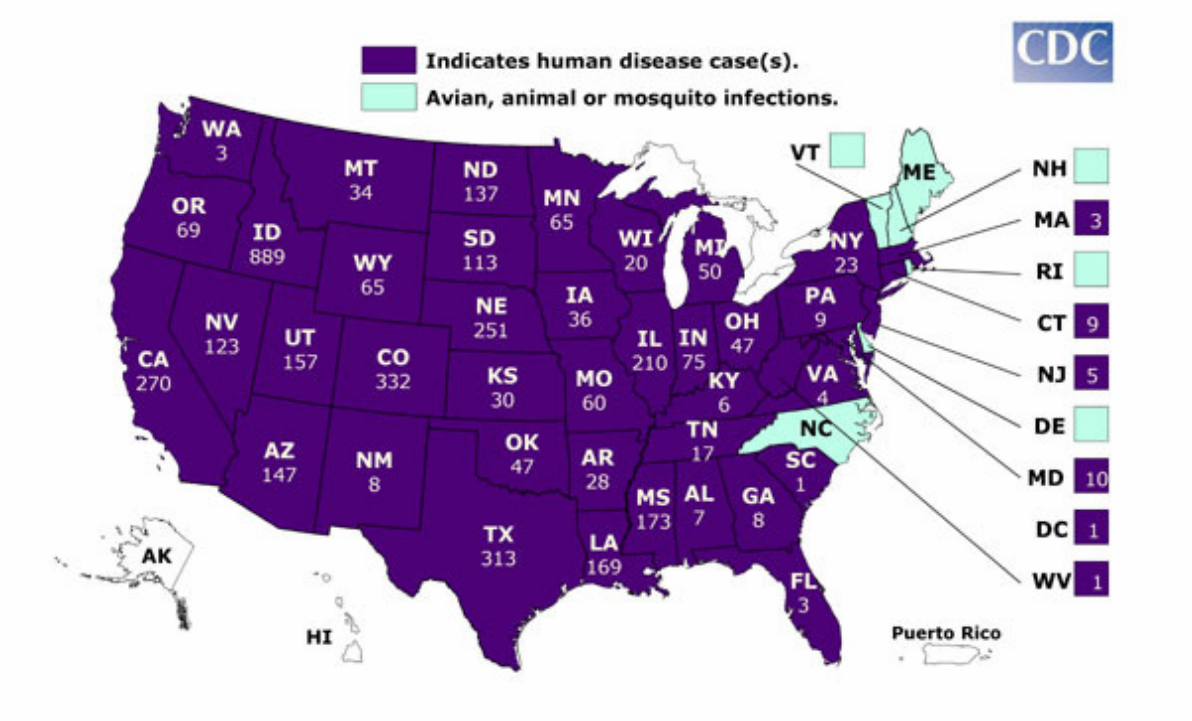

Figure 1. 2006 U.S. WNV Human Case Counts (reported to the CDC as of 11/28/2006).

2006 SEASON UTAH HIGHLIGHTS

2006 was the most active WNV season for Utah as of present. The magnitude of activity was a dramatic increase compared to activity detected during prior seasons. The geographic spread of activity was also increased over past seasons with human and animal activity detected in northern areas of the state where activity had not been previously detected. A total of 19 counties had activity detected during the 2006 season (Table 1). Major areas of activity included more populous regions of the state, fueling higher human case counts.

PAST SEASON COMPARISON

2003 was the first year WNV activity was established in Utah. Similar to many initial seasons in other states, activity was muted. One human case was reported for the 2003 season in Utah in addition to one viremic donor who did not develop symptoms. Horse activity was the main indication of WNV presence in 2003. 2004 was the first year WNV activity was established in northern Utah along the Wasatch Front. The majority of activity for 2004 occurred in extreme southern and eastern areas of Utah such as Washington and Grand counties. During 2005, activity expanded into more northern regions of the state and Utah and Uintah counties served as focal points for detected activity (Table 2).

2006 UTAH ACTIVITY TIMELINE

The majority of surveillance measures began in May 2006. West Nile activity was detected on June 2, 2006 in an oral swab taken from a bird in Salt Lake County (Fig. 2). This is the earliest West Nile has been detected in Utah with past season detection typically occurring in July. Activity was detected throughout August and September with WNV activity being detected in all surveillance measures (human, horse, wild bird, chicken, mosquito) by July. Human and equine cases continued to be reported into October. All active surveillance for the 2006 season had ceased by the end of October. However, testing of suspect human and horse cases continues year-round.

COUNTY	Human	Horse	Bird	Chicken	Mosquito
BEAVER	0	0	0	0	0
BOX ELDER	1	2	0	0	13
CACHE	2	10	0	9	1
CARBON	3	0	2	4	0
DAGGETT	0	0	0	0	0
DAVIS	11	4	3	4	42
DUCHESNE	3	1	1	19	0
EMERY	0	1	1	3	0
GARFIELD	0	0	0	0	0
GRAND	0	0	1	0	0
IRON	1	0	0	0	0
JUAB	1	1	0	0	3
KANE	0	0	0	0	0
MILLARD	0	1	0	0	5
MORGAN	0	0	0	0	0
PIUTE	0	0	0	0	0
RICH	0	0	0	0	0
SALT LAKE	56	11	48	23	290
SAN JUAN	0	0	0	0	0
SANPETE	0	0	0	0	0
SEVIER	0	0	0	0	0
SUMMIT	0	1	0	1	0
TOOELE	3	0	0	11	9
UINTAH	1	0	1	3	1
UTAH	66	18	12	24	95
WASATCH	0	3	0	0	0
WASHINGTON	0	0	0	3	4
WAYNE	0	0	0	0	0
WEBER	10	6	7	3	3
STATE TOTAL	**158**	**59**	**76**	**107**	**466**

Table 1. 2006 WNV Activity in Utah (Positive Counts Only).

	2006	2005	2004	2003
Human	158	52	11	1
Horse	59	68	5	35
Bird	76	22	8	2
Chicken	107	79	32	9
Mosquito Pools	466	80	181	3
Counties with Detection	19	17	11	9

Table 2. Utah WNV Season Comparison, 2003-2006.

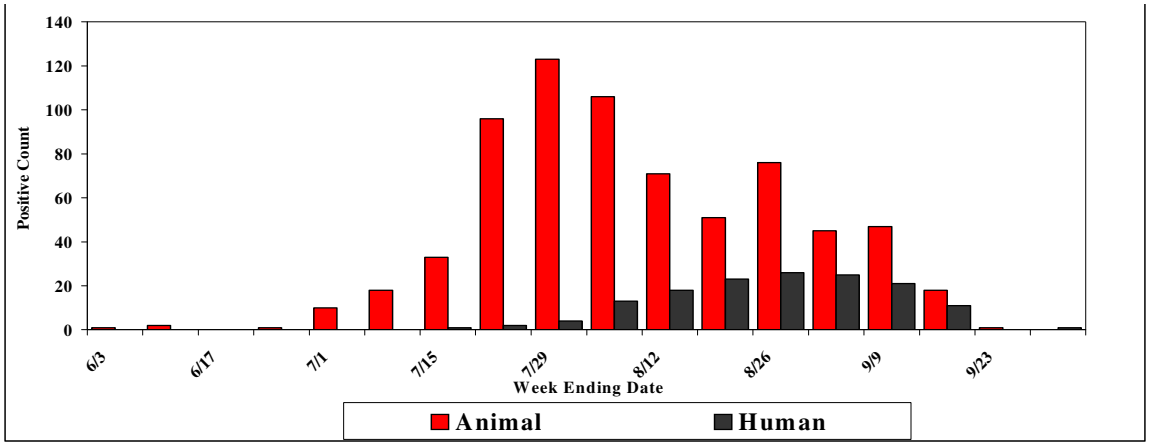

Figure 2. West Nile Virus by Type and Week, Utah 2006.

HUMAN SURVEILLANCE

Human surveillance occurs primarily through reporting of results indicative of acute infection from major laboratories. LHDs were immediately notified in these instances for the initiation of case investigations. The majority of private lab specimens for positive humans were forwarded to the UPHL for verification of results. The UPHL tested samples for both WNV and St. Louis Encephalitis (SLE) antibodies. Additionally, major blood banks servicing Utah screened donations for the presence of WNV. The total Utah human case count for the 2006 season currently stands at 158 cases (Tables 3 and 4).

Twenty-two individuals were identified as being infected with WNV through blood donation screening. Eight of these individuals were identified as having symptoms and were classified as WNV cases. The remaining 14 individuals (2 Davis, 6 Salt Lake, 1 Tooele, 4 Utah, and 1 Washington) remained under the asymptomatic viremic donor classification.

	Utah	United States
Case Number	158	4028
Fatalities	5	135
Fatalities (%)	3	3
Neuroinvasive (%)	35	34
Male (%)	51	55
Median Age	48 years	51 years
Age Range	1 year - 88 years	3 months - 99 years

Table 3. 2006 WNV Season, Clinical and Demographic Comparison of Human Cases. United States versus Utah.

	≤ 18 years	19-39 years	40-64 years	≥ 65 years
Case Number	12	47	82	17
Fatalities	0	0	0	5
Neuroinvasive (%)	67	28	27	71
Hospitalized (%)	50	28	32	76
Male (%)	67	37	57	65

Table 4. Clinical and Demographic Characteristics by Age Group, Utah 2006.

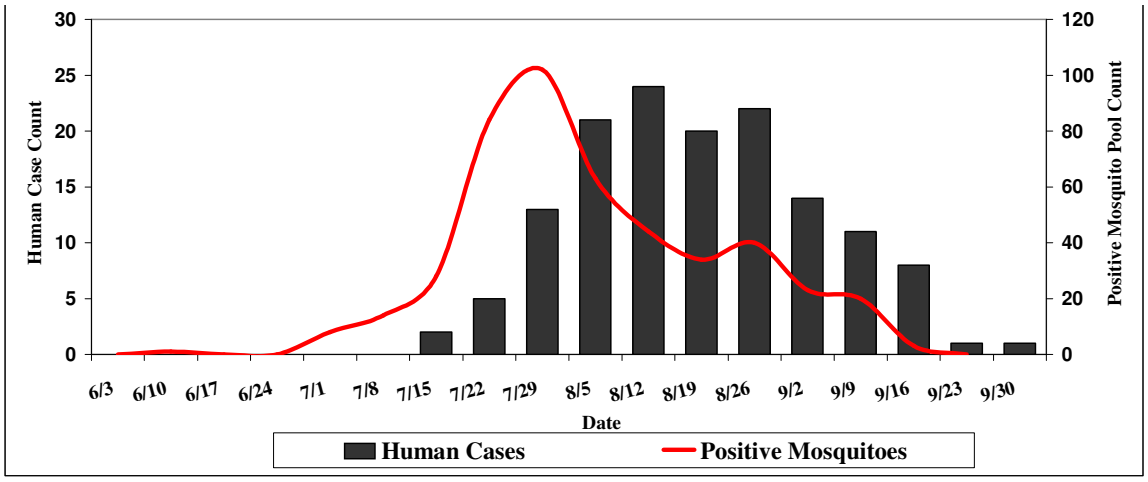

Figure 3. WNV Human Cases by Symptom Onset and Mosquito Activity, Utah 2006.

MOSQUITO SURVEILLANCE

Personnel from mosquito abatement districts across the state performed the primary functions of trapping mosquitoes at various locations in their district. Trapped mosquitoes were identified and sorted into "pools" based on species. Each mosquito pool contained 10-50 individual mosquitoes. These pools were shipped to the UPHL for testing. The pools were individually tested for WNV, SLE, and WEE using PCR techniques. Figure 3 identifies human case onset in comparison to positive mosquito pools.

SENTINEL CHICKEN SURVEILLANCE

This season, approximately 38 flocks (10 chickens per flock) were distributed across the state. Mosquito abatement personnel maintained flocks and flocks of 10 were sometimes split into two flocks of five for greater geographical coverage. Chicken blood samples were tested at the UVDL-Nephi. Samples from sentinel flocks from Grand County were sent to a diagnostic laboratory in California.

HORSE SURVEILLANCE

Surveillance of equine disease related to WNV infection was again coordinated by the UDAF. Veterinarians across the state were encouraged to submit samples from suspect equine cases to the UVDL-Logan for testing. Results of these serum tests were reported by the UDAF to the UDOH with appropriate notification occurring for positive cases. The majority of samples submitted for testing were from domestic, privately owned horses with symptoms indicative of infection and histories of not being vaccinated. Disease awareness among veterinarians and horse owners was accomplished through distribution of pamphlets and periodic updates using the Utah Veterinary Alert Listserver.

WILD BIRD SURVEILLANCE

Surveillance of WNV infection in wild bird populations was again coordinated by the UDWR. The UDWR officers and other certified personnel collected oral swabs from reported dead birds meeting testing

criteria. Testing criteria focused on collecting samples from Corvid family members, birds of prey, and other avian species considered at greater risk of WNV-related fatalities. Collected swabs were sent to the UPHL for PCR testing (WNV, SLE, and WEE). Samples were also collected from live birds at banding stations located throughout Utah from a variety of species. These samples were tested by the UVDL-Logan and none of these samples were positive for WNV. Results of these tests were reported by the UPHL and UVDL to the UDWR and the UDOH with appropriate notification occurring for positive results.