Public Perceptions of the Backyard Ecological Impacts of West Nile Aerial Spraying in Dallas County, Summer 2012

Dallas County Master Gardener Project
Final Report

Marilyn Waisanen, Sue John[1] and Mike Merchant, Ph.D.[2]

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Abstract
In the summer of 2012, Texas, and Dallas County especially, experienced a record number of human cases of mosquito-borne West Nile virus. On 09 August, 2012 a state of emergency was declared by the Dallas County Health Department, and on 10 August plans were announced by the county to commence aerial spraying in an attempt to break the epidemic cycle. Numerous individuals in the community, however, expressed concerns about the safety of aerial spraying. In addition to concerns about human health, many were highly concerned about environmental impacts of insecticides on beneficial wildlife. Consequently, we initiated a survey to ask gardeners and beekeepers their perceptions concerning the impacts of aerial spraying on beneficial insects and fish kept in water features. Results of the survey revealed mixed perceptions about spray impact, though the largest number of respondents (44% to 49%) rated the impacts on butterflies, pollinators and spiders as slight to no impact (n=63). 76% of gardeners with fish in water ponds (n=17) reported no effect on their fish, though 2 respondents reported 10-50% mortality and 2 reported less than 10% mortality. Of five respondents who maintained bee colonies in the backyard, 4 reported no unusual bee deaths, and one reported less than 10% mortality. Verbal comments about the spray effects revealed highly diverse opinions about the effectiveness and impacts of aerial spraying.

Introduction
West Nile virus is a mosquito-borne illness normally circulated between bird and mosquito hosts. It can, however, be transmitted to humans and cause periodic epidemics when conditions are favorable. In the summer of 2012 Dallas County experienced such an epidemic. As of October 11, 2012, 386 human cases of West Nile virus had been reported to the Dallas County Health Department, including 170 West Nile neuroinvasive cases and 216 West Nile fever cases.[3] The high number of human infections prompted Dallas County to issue three Health Advisories and eventually declare a State of Emergency on 9 August, 2012. By 10th of August officials judged that ground based spray efforts were inadequate, and Dallas County announced plans to conduct aerial

[1] Master Volunteer Entomology Specialist interns, Dallas County A&M AgriLife Extension office. Contact: Marilyn Waisanen, mjwaisanen@sbcglobal.net and Sue John, sjo449@airmail.net
[2] Professor and Extension Urban Entomologist, Texas A&M AgriLife Extension Service, Dallas, TX. Contact: m-merchant@tamu.edu 972-952-9204.
[3] Personal communication, Dr. Wendy Chung, Dallas County Health Department (November 1, 2012).

spraying of the county and any interested communities. By 15 August eleven cities had opted to participate in the aerial spray program, and aerial spraying commenced on August 16.

Considerable public concern was expressed during the days and weeks leading up to spraying concerning the health and environmental impacts of aerial insecticide applications. Among the expressed areas of concern were impacts of the aerial spraying on wildlife, butterfly and honey bee populations. Gardeners with fish ponds were also concerned about the impact of spraying on koi and other domesticated fish in water gardens.

Because of these concerns, we conducted a survey of Master Gardeners, beekeepers, fish pond owners and other interested gardeners in the aerial spray zones to assess their perceptions of the ecological impacts in their own backyard gardens following the aerial applications.

Methods

On August 16th, an announcement concerning the online survey was sent to representatives of the following organizations who then notified their members and associates:

- Dallas County Master Gardeners Association
- North Texas Chapter of Master Naturalists
- Texas Discovery Gardens (which included it in their public blogs)
- Dallas Arboretum
- Dallas Zoo
- North Texas Water Garden Society
- Urban Honeybees
- Trinity Valley Beekeepers
- Trinity River Audubon Center and Dogwood Canyon
- Swiss Avenue Historic District Association
- Mariana Greene
- Dirt Doctor

We received over 125 responses, of which 75 were deemed valid. Surveys were considered invalid if:

- Respondents filed prematurely, prior to seven days after the last aerial spraying (To fairly judge the impact of the aerial spraying, we requested participants to continue observing their garden for one full week after the last spraying. Many realized their error, continued to survey their garden and then resubmitted a survey.);
- Respondents did not reside in an area that received aerial spraying or did not provide a traceable address (In cases where a zip code was provided we were able to validate the survey).

We also read comments from all non-valid surveys and do appreciate the respondent's opinions. We noted that most comments from discarded surveys were similarly expressed by other, valid respondents' surveys.

The online Qualtrix software program (https://tamuag.qualtrics.com), licensed through Texas A&M AgriLife Extension Service, was used to survey participants and analyze the data. The Qualtrix program is easy to learn and survey generation is quick. A list of questions used in the survey is included in Appendix 1.

Results

The Qualtrix survey was activated in mid-August and acceptable responses were received on 27 August and for several weeks after. After eliminating those that did not meet inclusion requirements, 75 completed surveys were selected for analysis.

Beneficial insect impacts

A total of 63 valid responses were received for all questions about beneficial insect impacts. Forty-four percent of respondents observed slight (10-20%) to no detectable change to butterfly visitation in their gardens; however 33% of respondents reported substantial to heavy reduction in visitation (60-100% reduction) (Figure 1). This bimodal response pattern was seen for all beneficial insect observations in this study. Eleven percent of respondents were unsure whether they saw any changes in butterfly visit frequency.

Similarly, 49% of respondents observed slight (10-20%) to no detectable change to pollinator visitation in their gardens; however 33% of respondents reported substantial to heavy reduction in visitation (60-100% reduction) (Figure 2).

More respondents (30%) indicated that they were unsure about the impact of aerial sprays on spider populations, perhaps because spiders are less frequently noticed by gardeners (Figure 3). Nevertheless, similar proportions of respondents thought sprays resulted in no or slight reduction of spiders (37%) or substantial to heavy (25%) reductions.

Figure 1. What change did you notice on butterfly visitation in your garden over the week following the last aerial mosquito spraying?

#	Answer		Response	%
1	No detectable change		19	30%
2	Slight (10-20%) reduction in visitation		9	14%
3	Moderate (30-50%) reduction in visitation		7	11%
4	Substantial (60-80%) reduction in visitation		7	11%
5	Heavy (90-100%) reduction in visitation		14	22%
6	Not sure		7	11%
	Total		63	100%

Figure 2. What change did you notice on pollinator (bee, fly, and wasp) visitation in your garden over the week following the last aerial mosquito spraying?

#	Answer		Response	%
1	No detectable change		24	38%
2	Slight (10-20%) reduction in visitation		7	11%
3	Moderate (30-50%) reduction in visitation		7	11%
4	Substantial (60-80%) reduction in visitation		9	14%
5	Heavy (90-100%) reduction in visitation		12	19%
6	Not sure		4	6%
	Total		63	100%

Figure 3. What change did you notice in spider activity in your garden over the week following the last aerial mosquito spraying?

#	Answer		Response	%
1	No detectable change		20	32%
2	Slight (10-20%) reduction in visitation		3	5%
3	Moderate (30-50%) reduction in visitation		5	8%
4	Substantial (60-80%) reduction in visitation		7	11%
5	Heavy (90-100%) reduction in visitation		9	14%
6	Not sure		19	30%
	Total		63	100%

Fish ponds

Perceived impacts on bees and fish were lower than those for beneficial insects. Of the 17 respondents who maintained fish ponds, 76% saw no observable impact of the aerial sprays on their

fish (Figure 4). Two respondents reported "slight" (less than 10% mortality) and two reported "significant" mortality (10-50%). Fourteen of 17 (82%) of respondents covered their ponds before aerial spraying. None of the respondents, including those reporting significant mortality, reported dead fish following the aerial spraying. One respondent reported seeing fish parts, presumed to be mortality due to birds or raccoons. One respondent said they thought they had fewer *Gambusia* and small goldfish, but noted that they were not able to easily see and count dead fish because of many water lilies covering the water feature surface. That same respondent was the only one to report a financial impact of the spray ($65). Presumably, for most water gardeners, estimates of fish mortality would be more accurate than observations about beneficial insects, because dead fish are relatively easy to count; although estimating numbers of small fish like minnows or *Gambusia* would still be subjective. All four gardeners who rated fish kill as "slight" or "significant" covered their water feature before the application. None of the gardeners who left their water feature uncovered reported any fish kills. It is possible that the act of covering a water feature may itself have caused some fish mortality. Based on these data there was no evidence to support significant fish mortality in water gardens following aerial sprays.

Future surveys might ask what kind and size of fish gardeners maintain in their water features. We could not assess whether the fish gardeners were saying declined were minnows or more expensive goldfish or koi.

Bee hives

Five respondents maintained honey bee hives and responded to the survey. Of these, four of the five (80%) reported seeing no observable impact or suspicious bee death (Figure 5). One reported low mortality (less than 10%). The average number of hives/colonies per yard was 1.6. One respondent had two wild bee colonies in a single tree in the backyard (one in a wood duck box and another on an exposed branch); that respondent noted no noticeable change in bee activity at either colony. Another reported a hive living in the roof of the house. Two of the three respondents with managed hives covered their hives prior to the sprays. The one beekeeper who rated their hive as having a low (<10%) mortality rate did not report seeing dead bees, leaving some doubt about the reported mortality.

Bee observations are likely to be more reliable than casual observers of beneficial insect activity because most beekeepers are well attuned to the health of their hives and would likely notice unusual bee die-offs. However, two of the five respondents to this survey did not maintain domestic honey bee hives, and based their observations on bee activity around wild colonies. Our small sample size limits what can be said about managed bee hive mortality community-wide, but among the survey respondents bee mortality appeared to have been very low, including two managed hives that were not covered during spraying. Future surveys should make an effort to enlist more hobby and commercial beekeepers, should include a question about whether hives were wild or managed, and should ask about tree canopy coverage around the hive. Tree canopy, which is more common in residential areas compared to agricultural land, may provide natural protection for urban hives.

Figure 4. [for respondents who maintained fish in water ponds] Which of the following best describes the overall impact of spraying on your fish within 24 hours after the FINAL aerial mosquito spraying?

#	Answer		Response	%
1	No observable impact (no dead fish)		13	76%
2	Slight impact (less than 10% mortality or illness)		2	12%
3	Significant impact (10-50% mortality or illness)		2	12%
4	Heavy impact (51-90% mortality or illness)		0	0%
5	Full impact (more than 90% mortality or illness)		0	0%
	Total		17	100%

Figure 5. [for respondents who maintained bee hives] Which of the following best describe the condition of your colony/colonies within 24 hours after the Final aerial mosquito spraying?

#	Answer		Response	%
1	No observable impact (no unusual bee death)		4	80%
2	Slight impact (less than 10% loss of bees)		1	20%
3	Significant impact (10-25% loss of bees)		0	0%
4	Heavy impact (51-75% loss of bees)		0	0%
5	Full impact (more than 75% loss of bees)		0	0%
	Total		5	100%

Participant comments

The survey asked participants to add any additional explanatory comments they wished to make about the impact of mosquito spraying on their landscape. This opened ended format provided respondents an open forum to discuss their general perceptions and opinions about the aerial spray campaign in 2012. Fifty-three of the 75 respondents posted comments. All comments are presented in Appendix 2.

Comments reveal a wide diversity of opinion about mosquito spraying and its impacts on beneficial insects. Some representative comments include:

- I have kept daily records on insect activity in my yard and at Hope Community Garden… from Aug. 16- Sept. 7. Overall, I observed no change in insect activity. Both my yard and

at the community garden had many honey bees, wasps, dragonflies, butterflies, houseflies, and native bees. I don't usually see spiders, so I can't tell whether they were affected at all. I found one dead honey bee on the frost cloth after the second aerial spraying. Other than that, I can't say I saw much change from the usual. Of course, the mosquito population was less, though it has somewhat increased again (flood water mosquitoes?)

- I did notice that on the evening of the 20th after spraying there were several dead cicadas on driveway and more the following days. I have also monitored my chickens (hen house in backyard-two chickens) and there ha[ve] been no adverse effects of the spraying on them to date.
- Dragonflies were very prevalent prior to spraying, observed an approximate 80% reduction.
- In addition to my garden, I also checked the neighborhood during daily walks (approximately 3 miles each) which included passing two local stocked ponds. Looked for presence of dead fish in the ponds (no dead fish), dead birds and/or insects on the ground. Listened for cicadas. No noticeable signs of damage post spraying.
- This was completely unnecessary, if you would have reduced the number of people overwatering their lawns, that would've helped the whole situation. Why else would we have such a bad mosquito problem during a DROUGHT??
- I go outside anytime and I come in my house with 5 to 15 bites every time. My neighbor said the other day. You have 5 [mosquitoes] on just your calf!!! Spraying has… only made the [mosquitoes] stronger for next year. Just like roach spray has done with roaches over the past years I see No Butterflies. No spiders. No bees no slugs Just roaches and roaches
- After the first spraying I didn't notice any real change in populations of insects, baby toads, or even mosquitoes, as I was bit by several and killed at least 2-3. After the second spraying, I still saw the same types of animals- butterflies, baby toads (and recently 9-4-2012 some larger ones), a large Argiope female, and still some mosquitoes although maybe not Tiger Mosquitoes… the numbers/frequency of butterfly visitors seem to be about the same and increased after any good rain or watering…
- Bird visitation [has] dropped dramatically since spraying.
- Here are my observations from my yard. I was happy to see 2 blue dragonflies and a ladybug in the yard on 8/25! Although there are generally more, (generally 2-3 ladybugs, and multiple dragonfly sightings) I was just happy to see some. The grass in my yard was very high during the spraying, but after the spraying I cut it, and I did notice lots of insect activity in the grass, which was good.
- I was pleased to see butterflies and bees the very next day. I found no dead butterflies at all and I have a garden primarily for butterflies and birds.
- A barn owl, visited our back patio [and]… 30 minutes later left off the fountain and was dead. We called the County Health Department thinking that this might be related to the west Nile virus and put the barn owl in the freezer to preserve it. We were told that if no one contacted us within 24 hours to dispose of the owl. No one called regarding the owl and we disposed of it, but still wonder if in some way this owl got infected with the virus.
- I only learned about the spraying the day before it was scheduled--bad public relations by the city. I was very upset by the aerial spraying because it is not targeted, it affects every living thing in the environment, and we cannot be sure of the long-term consequences.
- Definitely saw no mosquitoes for > 2 weeks after spraying, also, only dead flies, and no more grasshoppers, aphids, only dead cockroaches, no ants....
- We have had a organic yard for 16 years and after this spraying I have noticed less mosquitoes, less butterflies, dragonflies, flies. Have not been able to find any of the praying mantis but could be there. Bee hive has less activity on outside than normal.

- Seems like an issue that deeply affects small numbers of people and marginally affects great numbers of people.

Confounding factors
Ground spraying was conducted in several areas pre- and post-aerial spraying and this may have influenced insect populations in gardens as much as, or more than, aerial spraying. In addition, most respondents seemed to have some commitment to organic gardening and tended to avoid insecticide use, while some gardeners reported using sprays and mister systems. For example, two respondents reported use of mosquito mister systems, four respondents reported using professional pest control services, and nine reported using do-it-yourself treatments to help control mosquitoes at their home. Because of the relatively low numbers we did not conduct a cross-tabulation of responses to determine whether past pesticide use might have influenced responses about perceived pesticide impacts on non-target organisms. Future surveys should ask respondents about their use of insecticides (organic or not), and their opinion about aerial and ground spraying for mosquitoes. A larger sample size would enable more detailed and statistically reliable analysis of results.

Conclusions

This survey allowed us to hear from citizens, throughout Dallas County, who have an interest in the quality of the habitat we live in. Whether for or against aerial spraying, all participants demonstrated thoughtful participation and provided valuable information about their perceptions. We hope that these results will be useful to those in government making decisions about future aerial spraying and mosquito control.

Without actual insect counts, these data do not allow us to say definitively what impact aerial spraying had on beneficial insect and spider populations, or on mosquitoes. Because perceptions of changes in beneficial insects were highly subjective (we did not ask respondents to conduct actual insect counts), it is possible that respondents' answers were, at least to some extent, more reflective of their predisposition to be for- or against- aerial spraying. This idea is supported by the bi-modal (two peaked) responses to perceived impacts of the sprays on beneficial insects. Some respondents observed dramatic changes and others observed no, minimal, or very short-lived change. Should aerial spraying be conducted in the future, an expanded survey of this type should be considered, as well as some ground based-insect counts to verify insect, fish and bee activity. A modified survey of this type could also be administered to residents of areas treated with ground-based mosquito spraying.

Dallas county data (Appendix 4) show a dramatic reduction in WNV cases post-spray compared to pre-spray. A final report from the Centers for Disease Control is expected to provide further insight into the impact of aerial sprays in Dallas and surrounding counties in 2012. More graphs and statistics about the 2012 outbreak are available online at:

http://dallascityhall.com/council_briefings/briefings1212/WestNileVirus_120512.pdf

Certainly all of us are interested in controlling the mosquitoes in the least environmentally harmful method possible. This is where Dallas County Master Gardeners and North Texas Chapter of Master Naturalists can be impactful. We have developed excellent speaker programs that could disseminate information on mosquito behavior and mosquito control with every presentation. We can partner with city and county departments that are charged with mosquito control. Perhaps we could partner with Dallas County Health and Human Services on an educational program such as

we have partnered with city of Dallas on WaterWise gardening. Most importantly, we can lead by example.

The most encouraging outcome is that Dallas County Commissioners are already thinking about better ways to approach the control of mosquito populations for the 2013 season. We need to stay involved in the process and be sure that our concerns are heard.

In the long run, many hope that scientists and governments will find a more targeted approach to mosquito control.

Acknowledgements
Thanks to all the respondents who participated in the online survey, and to Dr. Wendy Chung and others at the Dallas County Health Department for supplying links, statistics and information about the aerial spraying operations.

APPENDICES

Appendix 1- Qualtrix Survey

Appendix 1 contains the original online Qualtrix survey.

Default Question Block

2012 Impact Assessment -- Dallas Aerial Mosquito Spraying.

Thank you for being willing to participate in this informal survey of perceived environmental impacts of mosquito spraying in your community. This is a voluntary survey. You do not have to provide your name and email, but we do need your address information should you choose to participate.

The **survey is designed to be completed approximately one week after completion of aerial spraying**. This delay is necessary because we would like you to have enough time to assess impact over several days, since insect populations are naturally variable from day to day.

It's important to start your observations now, however, prior to or just after spraying. Click here for a data sheet you can use to keep notes through the week following the aerial spraying. You may want to read the survey to know what to look for during the process, but please do not complete the survey until one week after the final spray. Depending on how many spray dates are determined necessary, this may be as soon as Friday, August 23. To return to this survey, simply reuse the link you used to access this site.

Please provide us the following information to better help us serve you:

The following information is optional and may be skipped.

Name (optional)

Email (optional)
example: name@domain.com

Phone (optional)
example: 979-555-1234

Click to write the question text

- ○ Click to write Choice 1
- ○ Click to write Choice 2
- ○ Click to write Choice 3

This information is required for the survey.

Street Address (Required)

City (Required)

Zip Code (Required)

Date (Required)

Do you have either of the following in your yard?

- ☐ Water feature with live fish
- ☐ Bee hive
- ☐ None of the above

Was your home treated for mosquitoes prior to the aerial spraying? Check all that apply.

- ☐ Ground spraying
- ☐ Personal mosquito mister system
- ☐ Professional

Professional

Do-it-yourself Treatment

If your property prior to aerial spraying was treated, please describe dates, type of treatment and chemicals used.

Was your home in the treatment zone for the aerial mosquito spraying?

Yes

No

If yes, what date(s) was your neighborhood treated? (Please enter all dates in the format mm/dd/yyyy, e.g., 08/01/2012)

If there were no subsequent treatments after the first treatment, leave those spaces blank.

Enter date of first treatment (MM/DD/YYY)

If there was a second treatment, enter date of second treatment. (MM/DD/YYY)

If there was a third treatment, enter date of third treatment. (MM/DD/YYY)

General Garden Insect Block

General Garden Insect Observation

What change did you notice on **butterfly visitation** in your garden **over the week following the last aerial mosquito spraying?**

- No detectable change
- Slight (10-20%) reduction in visitation
- Moderate (30-50%) reduction in visitation
- Substantial (60-80%) reduction in visitation
- Heavy (90-100%) reduction in visitation
- Not sure

What change did you notice on **pollinator (bee, fly, and wasp) visitation** in the your garden **over the week following the last aerial mosquito spraying**?

- No detectable change
- Slight (10-20%) reduction in visitation
- Moderate (30-50%) reduction in visitation
- Substantial (60-80%) reduction in visitation
- Heavy (90-100%) reduction in visitation
- Not sure

What change did you notice in **spider activity** in your garden **over the week following the last aerial mosquito spraying?**

- No detectable change
- Slight (10-20%) reduction in visitation
- Moderate (30-50%) reduction in visitation
- Substantial (60-80%) reduction in visitation
- Heavy (90-100%) reduction in visitation
- Not sure

My methodology for estimating reductions in insect and spider abundance in my garden was based on:

- Timed Pre- and Post-counts (e.g., numbers of butterflies counted and recorded over 15 minute interval at set time of day)
- Untimed Pre-and Post counts made at different times of day
- Post spray counts only
- General impression from observing the garden

Water Block

Water Features

What is the approximate square footage of the water feature with fish that you maintain on your property?
(multiply water feature length X width)

- 0 - 20 square feet
- 21 - 40 square feet
- 41 - 80 square feet
- 80 - 160 square feet
- Over 160 square feet

Approximately how many live fish were in your water feature prior to the aerial mosquito spraying?

- 0 - 5
- 6 - 10
- 11 - 20
- 21 - 40
- 41 - 80
- more than 80
- I don't know

Did you cover or protect the feature during the time of mosquito treatment?

Yes	No
○	○

If you covered or protected the feature during the time of mosquito treatment, please describe

Approximately how many dead fish did you observe in your water feature AFTER aerial mosquito spraying?

Which of the following best describes the overall impact of spraying on your fish within 24 hours after the **FINAL** aerial mosquito spraying?

- No observable impact (no dead fish)
- Slight impact (less than 10% mortality or illness)
- Significant impact (10-50% mortality or illness)
- Heavy impact (51-90% mortality or illness)
- Full impact (more than 90% mortality or illness)

If you have a water feature with live fish, and suffered loss after spraying, what do you estimate the cost will be replacing the fish?

Beekeeping Block

Beekeeping

How many bee hives (colonies) do you maintain on your home property?

Did you cover or protect the hive during the time of the mosquito treatment?

Yes | No

If you protected the hive during the dime of the mosquito treatment, please describe

If you have a loss, please estimate the number of dead bees around the hive after the **Final** aerial mosquito spraying.

Which of the following best describe the condition of your colony/colonies within 24 hours after the **Final** aerial mosquito spraying?

- No observable impact (no unusual bee death)
- Slight impact (less than 10% loss of bees)
- Significant impact (10-25% loss of bees)
- Heavy impact (51-75% loss of bees)
- Full impact (more than 75% loss of bees)

What do you estimate the cost of the losses you sustained (honey production, bee replacement)?

replacement)?

Block 4

Please add any additional explanatory comments you wish to make about the impact of mosquito spraying on your landscape.

Appendix 2- Open-Ended Comments

Appendix 2 contains comments generated from survey Question 29. These open-ended comments are organized by the response to Question 13. Please see the appendix for further explanation.

Appendix 2 – Open-Ended Comments

The below unedited responses to question 29 are arranged in the order received and categorized according to the participants response to question 13. The numbers 1 through 4 in parenthesis indicate the choice of that respondent to question 13 and the initials NMG (no methodology given) in parenthesis indicates that there was no response given to question 13. We felt that the methodology used in observing the gardens added important information to the respondents comments.

Question 13: My methodology for estimating reductions in insect and spider abundance in my garden was based on:

1. **Timed Pre- and Post-counts (e.g., numbers of butterflies counted and recorded over 15 minute interval at set time of day)**
2. **Untimed Pre- and Post counts made at different time of day**
3. **Post spray counts only**
4. **General impression from observing the garden**

Question 29:
Please add any additional explanatory comments you wish to make about the impact of mosquito spraying on your landscape.

(1) Timed Pre- and Post-counts (e.g., numbers of butterflies counted and recorded over 15 minute interval at set time of day)

(1) I still have a few mosquitoes. Backyard used to have bees, wasp, butterflies, dragon flies, bumble bees and little small flies. I might see one of each in a thirty minutes time frame. The bird activity in my garden is gone, no bluejays, cardinals, mockingbirds, sparrows, robins or hummingbirds. I also noticed less chameleons in my garden.

(1) We are in Addison, but have a Dallas zip code.

(1) decrease in adult and immature grasshoppers observed...though not counted pre spray, were easily viewed in beds and lawn. See none now.

(1) I noticed decreased bird activity after the frist spraying but it rained very hard after the first spray. I saw fewer large butterflies but many skippers and moths. No reduction in cicadas or grasshoppers. There were no spiderwebs after the first spraying but perhaps that was because of the hard rain since there were the usual number in the usual places just before and after the second spray. There seemed to be fewer pidgeons and still are. No noticeable reduction in bees, wasps or hornets.

(1) I have more mosquitos

(1) I have kept daily records on insect activity in my yard and at Hope Community Garden (1108 Cristler, Dallas) from Aug. 16- Sept. 7. Overall, I observed no change in insect activity. Both my yard and at the community garden had many honeybees, wasps, dragonflies, butterflies, houseflies, and native bees. I don't usually see spiders, so I can't tell whether they were affected at all. I found one dead honey bee on the frost cloth after the second aerial spraying. Other than

that, I can't say I saw much change from the usual. Of course, the mosquito population was less, though it has somewhat increased again (flood water mosquitoes?).

(1) Did bee survey on 8/11/2012. Counted 18 bees on 1 celosia plant in 15 min - 4 bumble bees, rest were honey bees. Also noted a few butterflies and beetles, & 3 wasps. The 1st aerial spray was on 08/19/2012. The next day, I counted 16 bees, 1 cricket, & 1 spider in 15 min. Second spray was on 08/20/2012. One week later, I saw >30 bees on my basil spikes. On 08/30/2012, saw no bees at all. On 09/02/2012 again saw many bees. Some people have said after the aerial spray, there are now bees. According to my observations at my garden, the bees can be a large #, a few, or none. I believe they come & go at different times.

(2) Untimed Pre- and Post counts made at different times of day

(2) I did notice that on the evening of the 20th after spraying there were several dead cicadas on driveway and more the following days. I have also monitored my chickens (hen house in backyard-two chickens) and there has been no adverse affects of the spraying on them to date.

(2) The amount of flying mosquitos were definitely reduced.

(2) The butterfly, dragonfly, bee, and all other pollinators were wiped out. I am a gardener and have many nectar producing attracting plants in my garden. I have always had a large population of the above until the sprays began. There are none of these creatures in my garden now since the aerial spray. I noticed a reduction in the frog population in the area as well. Many less birds also.

(2) Dragonflies were very prevalent prior to spraying, observedd ~80% reduction.

(2) I saw no bee activity until day 6 after the spraying which is unusual for my garden. I have not seen a single butterfly since the spraying. Have seen dragonflies, ants, pantry moths and heard cicadas.

(2) I do not raise fish, but tadpoles and toads. These are integral to my insect and mosquito control. Racoons disturbed the tarps the first spraying and there was a 30% loss of young tadpoles; ones with proto legs were fine. We saw no butterflies and bees for several days after the spraying. Still no dragonfliers. Before we had plenty of all. Mosquitos came back within a day after both sprayings. A neighbor reported seeing ill and dying bees. Another neighbor released her dog who has epilipsy into her yard the morning after spraying; he immediately went into seizure.

(2) In addition to my garden, I also checked the neighborhood during daily walks (approximately 3 miles each) which included passing two local stocked ponds. Looked for presence of dead fish in the ponds (no dead fish), dead birds and/or insects on the ground. Listened for csikadas (sorry about the spelling). No noticeable signs of damage post spraying.

(2) Yellow Jacket nests are failing. Huge aphid population that I've never had this time of year broke out about a week ago. Have only seen four honey bees and less than 12 sightings of those small bumble bee looking bees/flies. Can't say I've seen any red wasps either. I have lots of fresh water in my yard so have always attracted many wasps, bees and yellow jackets. Not holding out a lot of hope for my fall garden :(

(2) This was completely unessecary, if you would have reduced the number of people overwatering their lawns, that would've helped the whole situation. Why else would we have such a bad mosquito problem during a DROUGHT?? Maybe if the head of Agriculture and Mayor actually gave a damn about the people in this city, arial spraying would not have even been an option. I am sick to my stomach, along with countless others at how the government has handled this. I have completely lost faith in this system. Nothing but a bunch of fat, greedy politicians. FDA claiming it's "safe"?! Then why do I have friends in the hospital with burning skin and upper respiratory problems that may die! The people of Dallas, will not stand for this kind of governent/corporate greed.

(2) The mesquito count dropped for two days after the 08/20/2012 spraying, but since have returned.

(2) Experienced rain between sprayings, which boosts some plant blooms in my yard (as opposed to sprinkler water), specifically Desperado Sage and Confetti Lantana. Noticed same numbers of bees and wasps, geckos, hummingbirds, butterflies and cicadas. Post-spraying, noticed a few dead bees and wasps, yet dead bees have been the "norm" the last few summers (not caused by aerial mosquito spraying.) While I use no pest control, certain that most of my neighbors in my densely packed lawns/homes, do use pesticides.

(2) The morning after the first spray I saw a large red dragon fly, thinking maybe this was not as bad as expected I went out to investigate. The dragon fly and a small moth that I disturbed in the grass was all the activity that I saw. Day 2 - Sat. morn. saw 1 large bumble bee, 2 moths. Day 2 - Sat eve. 2 bumble bees. Day3 - Sun morn - 1 damsel fly, 1 butterfly passing through, a new spider "line" between perennials, two hover fly / wasp critters (too small and fast to properly identify). Day3 - Sun afternoon - 2 bumble bees, damsel flies, hover flies, 1 Humming bird, NO honey bees, little activity. Sun eve - green lacewing. Day 4 -Monday, there were a few more critters, more dragonflies, damsel flies, hover flies, NO honey bees, saw first bat in the evening, And mosquitos. Day 5 - Tues, dragonflies, damsel flies, hover flies, small spiders in grassy areas, more bird activity (have several wrens) passing moths maybe a butterfly, bats. Day 6 - Wed. same as above, but saw my first geckos in the evening. No anoles, No honeybees, bats in evening, Day 7 - Thurs same critters but now more spiders, bumble bees, a hummingbird moth, gulf frittilary, geckos, bat. Day 8 - Friday - Same Day 9 - Saturday - saw first honey bee in morning. By afternoon there were several. Lacewing back in larger numbers, more mosquitos, more geckos, bumble bees, bats. Friday August 31st - Every day there are a few more insects in the yard/garden. The butterflies and bees are still not as numerous as before the spraying. I think last night I may have seen one of my screetch owls, but am not sure. I know that they come and go, but before the spraying I had a family of 4 owls that came to my bird bath just as it was dark, every night ! Hope some of this helps.

(2) I go outside anytime and I come in my house with 5 to 15 bites everytime. My neighbor said the other day. You have 5 mesquites on just your calf!!! Spraying has killed the good for that thst nature provides and only made the mesquites stronger for next year. Just like roach spray has done with roaches over the past years I see No Butterflies. No spiders. No bees no slugs Just roaches and roaches

(2) After spending over 30 years to insure that NO chemicals are anywhere near my organic property, it only took 2 sprays and a few moments to change all that. All my house plants are outside. I grow herbs and vegetables. I have multiple bird houses and bird feeders, and 2 birdbaths. I have a dog and a cat. Luckily, it rained after both sprays on my property. I also did

extensive watering to wash any chemical residue from my plants and outdoor furniture. I make sure there is no standing water on my property. I grow plants specifically designed to attract butterflies and saw them regularly. Since the aerial sprays, I have only seen one butterfly on 09/02/12. I have yet to see bees or dragonflies return. The smell after the sprays was putrid, so I can only imagine the effects to my landscape- but they were NOT good.

(2) At first we didn't know if the zoo had actually been sprayed on Friday and are still just pretty sure. We also had a very heavy rain the next day which washed away a small pool of tadpoles and variuos aquatic invertebrates that I was trying to watch during spraying activities. After the first spraying I didn't notice any real change in populations of insects, baby toads, or even mosquitoes as I was bit by several and killed at least 2-3. After the second spraying, I still saw the same types of animals- butterflies, baby toads (and recently 9-4-2012 some larger ones), a large Argiope female, and still some mosquitoes although maybe not Tiger Mosquitoes so much but that was also the type I killed by hand so maybe I ruined our sample :) Our front garden has no irrigation and only gets watered by hand on occassion so it is not as rich in nectar as it could be, but the numbers/frequency of butterfly visitors seem to be about the same and increased after any good rain or watering. The same story with the baby toads, they seem to show up here behind the building mainly after rains but in the wooded creek area they are still pretty active. I had wished to have more time to do a better survey down there on the toads but work time did not allow. Our bees seem fine so far although as i said in the survey, I don't know if the honey is tainted or not. I haven't really seen that the spary has done all that much good or bad but I know that there may be many effects we can not see or won't see for a while maybe. My home in southern Arlington was not sprayed so far by anything as far as I know and insect/mosquito numbers seem comparable to me. I did find a couple dead Bumble bees along a creek in southern Euless on Friday 08/31/2012 but have no idea if it was spray related or if the area was even sprayed by plane. Just thought I'd throw that in anyway.

(3) Post spray counts only

(3) Our butterfly visitation seems to have been impacted the most. After the first spraying I observed several of the large bees visiting the Althea, but after the second spraying-none, just the small bees. The small flies and knats seem to not be impacted, and perhaps the two spiders that I initially observed may have moved, but I did not see any others either. There was not any noticeable odor the next morning. One concern was our two feral cats that we care for. One we were able to get into the garage, the other we could not. So far, neither seem to have any ill effects. We hope that they will be OK.

(3) We have observed a heavy reduction in anoles & geckos. We had lots of families before spraying occurred. There are only a few babies, probably born after the spraying. There's been no birds, squirrels, rabbits or rat activity whatsoever & we have families of all of those. We've observed dead bees on the ground. We have a fountain & butterfly bush & 1 Monarch & 1 dragonfly showed up about a week after spraying. Although the mosquito population has been reduced somewhat and my husband never gets bitten, I have been getting bitten by them beginning on the 4th day after spraying. And not that these creatures would ever be affected, the fire ant & crazy ants are still in full force!

(4) General impression from observing the garden

(4) still see a small trace amount of mosquitos in our yard.

(4) Bird visitation dropped dramatically since spraying.

(4) Here are my observations from my yard. I was happy to see 2 blue dragonflies and a ladybug in the yard on 8/25! Although there are generally more, (generally 2-3 ladybugs, and multiple dragonfly sightings) I was just happy to see some. The grass in my yard was very high during the spraying, but after the spraying I cut it, and I did notice lots of insect activity in the grass, which was good.

(4) I still have mosquitos and just got bit while in my hot tub.

(4) I found a dead hawk in the road that was perfectly intact that was stiff and bugs had started to eat it but it seemed to be uninjured. My wife and I also detected some minor throat irritatoins and a dry cough that was not illness related.

(4) I do not maintain a bee hive, but I know the spray's residue killed honeybees because I watched them die the next morning when they landed on frost cloth covering my huge, sprawling datura plant. Several bees usually are inside each blossom at one time, at dusk when they open and in the morning before they close about 10 a.m. The night of the first spray, about 100 flowers were open, tho the plant was covered with frostcloth. They landed on the cloth and became lethargic, would not fly when I tried to shoo them away. Within minutes they had curled up and died. I observe far, far fewer bees on the datura flowers now, a week after spraying. My bullfrogs have stopped calling. I have observed only one large, older bullfrog, but before the spraying I had four or more. I hear no leopard frogs now, whereas before they called every night. I have seen no butterflies in my garden, which is planted with host and nectar plants. I still have dragonflies. I have not seen the anoles.

(4) I don't think it is possible to know the full impact of the spraying. For example, I worry about the food sources in my yard that were sprayed--I have about 15 American Beautyberry bushes in the front and back. The berries are now ripe (deep purple) and the Mockingbirds and other birds gobble up the berries. If schools are washing down play equipment (just in case so was said) then what impact could this have on wildlife in spray areas that are getting a much larger dose from eating sprayed berries, seeds etc. I noticed on my Turks cap that was more exposed to the spray that the fruit/seed was black. I had never noticed anything like that, it is usually bright red. My guess is that it was impacted by the spray.

(4) Despite hearing concerns in the media, we noticed no notable change in insect, butterfly, moth and bee population in our yard. Even our hummingbirds were unaffected. We DID, however, see a reduction in the number of mosquitos. Critics of aerial spraying fail to recognize that many of us have neighbors who either do not eliminate standing water or are not currently living in the homes they own. Two of the houses adjacent to us are vacant. The house behind us is also vacant. And our neigbor on the west side travels and often is not here. Teaching personal responsibility is NOT the answer in our case. One additional fact: since the aerial spraying, we have regularly eaten herbs from my garden with no ill effects. Of course, I do wash them first. I'm all for aerial spraying and just wish the city of Dallas had agreed to do ground spraying in our neighborhood as well.

(4) I was out of town after areial spraying which included the 1 week later date. But 10 days after areial spraying I do not notice any change in the fish

(4) we still have lots of mosquitos and no-see-ums

(4) I was pleased to see butterflies and bees the very next day. I found no dead butterflies at all and I have a garden primarily for butterflies and birds.

(4) no impact noticed at all in bee population, or with fish in our lake. Still have the baby lizards on our brick wall, small frogs in our pond and fountain. One unusual thing did happen in our landscape on Friday August 10th. A barn owl, approximately 16. Inches tall visited our back patio, landed on the fountain there and surprised us, as we had never seen one in our back yard before. have seen screech owls regularly, but never a barn owl! The barn owl returned on Saturday about noon, again landed in the fountain and about 30 minutes later left off the fountain and was dead. We called the County Health Department thinking that this might be related to the west Nile virus and put the barn owl in the freezer to preserve it. We were told that if no one contacted us within 24 hours to dispose of the owl. No one called regarding the owl and we disposed of it, biut still wonder if in some way this owl got infected with the virus.

(4) We just moved into our house in April, so I don't know what's normal over a summer. I feel like activity in general is low, until we get more wildlife friendly plants in. I haven't really seen many butterflies since mid August, but I also didn't have any blooming plants. They've started blooming again after the rain, and I've seen a handful of pollinators (still no butterflies, though). We have a heavily treed landscape. There were just as many mosquitoes here after each spraying, and nothing we've done has been effective against them. (We just tried garlic oil and cedar yesterday, and they're back). The only odd insect behavior I noticed after the spraying was erratic flying of green beetles (and one dead one), as well as dying ants on the windshield of my car, which was parked under a tree. I did notice much less bird and squirrel activity the morning after the spraying, but again, I saw just as many mosquitoes as before. I tried to walk outside at around the same time each morning and evening to check on general activity.

(4) I haven't noticed any difference in the health of my plants, but production in my vegetables seems to have halted. There are no longer bees buzzing all over my mint. I have found mosquitoes in my car and house though, when that hasn't happened all summer.

(4) I did not learn about the survey or requests for observations before the spraying, so my observations are general. I only learned about the spraying the day before it was scheduled--bad public relations by the city. I was very upset by the aerial spraying because it is not targeted, it affects every living thing in the environment, and we can not be sure of the long-term consequences. We can look at history and know that this kind of mass-hysteria response to a perceived threat in the past has led to catastrophic long-term consequences (DDT, e.g.). The spraying also does not address the problem of the next generation of mosquitos that will occur as soon as we have another rain. More public education, more targeted responses, more personal involvement by city employees in neighborhoods would be far more effective.

(4) It is really hard to say, I didn't have all that many flowers blooming before the spraying. However, with the additional rain, my flowers took off again. I did expect to see more butterflies and I have seen only 1. I am also avoiding being outside because of the heat.....and esp. at dusk so I am not out much now. I have been trying to figure out online when we have had spraying. I can only confirm the one on Aug. 19, according to the county map but I thought I heard on the news we would have a couple. Sorry.....I can't find the info online!

(4) The swarms of mosquitos disappeared, until the rain storm and then were many tiny mosquitos that are apparently a different breed. Now there are not very many of any variety, but enough that I still get bites in the night.

(4) Defintely saw no mosquitoes for > 2 weeks after spraying, also, only dead flies, and no more grasshoppers, aphids, only dead cockroaches, no ants....

(4) I was pleased to see activity immediately following the spraying. I have observed no dead butterflies or bees, but I still have plenty of mosquitos!

(4) Although I was very concerned about butterfly, caterpillar, pollinating tiny insects, wasps, etc. being affected by the spraying, I saw normal populations of all the next day and days after. I was purposely observing this. Honeybees, tiny insects seen pollinating flowers, butterflies, lizards, dragonflies, etc. seem to be normal. Mosquitos were knocked back for a few days then came back in their normal large numbers. All standing water is monitored and sprinkled with the BTi. And I check every other day for larvae and have seen none but still have plenty adult mosquitos coming into my yard because of the amount of vegetation.

(4) We have had a organic yard for 16 years and after this spraying I have noticed less mosquitoes, less butterflies, dragonflies, flys. Have not been able to find any of the praying mantis but could be there. Bee hive has less activity on outside than normal.

(4) I did not see any reduction in the number of wasps and flies but a significant reduction in honeybees. Normally I have numerous honeybees necatring all day on my flowers but I have only seen one in the last month. The butterfly numbers were significantly reduced during the Month of August. I keep a fruit feeder in my backyard for Hackberries, question marks, etc. and I only see June Beetels and flies on it now.

(4) All of my plants seem to have done well through the spraying. My rose bushes are starting to rebloom as is normal this time of year when the weather has a couple of cool spells. I have not noticed less insects, bees or moths around.

(4) All plants look fine. Did notice less mosquitoes

(4) the mesquitos are back more than ever

(4) I was very disappointed that Carrolton chose to use aerial spraying and I believe it had a significant impact on the reduction of bees and butterflies in my garden.

(4) Very noticeable drop off in activity in our garden. Usually our lantana is loaded with insects, however, throughout the observation periods we noticed only a couple of monarchs, bees and wasps. We also saw very few birds in our garden or the area. It was very quiet and still like they had all disapeared. We did not notice any dead insects around the gardens.

(**NML) No Methodology Given**

(NMG) I'm still getting bitten by mosquitoes anytime outside; haven't seen any of my dragonflies or butterflies; fewer baby frogs in the yard (on the second batch this season from the pond); haven't noticed the sound of Cicadas in the afternoon.

(NMG) Seems like an issue that deeply affects small numbers of people and marginally affects great numbers of people

Total responses to Question 29 = 53

Appendix 3- Response to Common Questions

Appendix 3 was created to respond to the dominant questions we received from people we spoke with in the process of gathering information for this survey.

Appendix 3 – Response to Common Questions

Appendix 3 was created to respond to the dominant questions we received from people we spoke with in the process of gathering information for this survey. Dr, Mike Merchant prepared responses to the following five questions posed by respondents:

(1).What are the unknown long term effects of aerial spraying?

There should be no long term effects from the insecticides, since the active ingredients used in aerial application have a very short life in the environment. Long term effects with pesticides are only seen in those compounds with long environmental half lives (90% allethrin degraded in 8 hours of sun, approximately the same for sumithrin).

(2). If your garden is an organic garden, how does mass spraying of chemicals affect an organic garden?

According to rules from the TDA, any organic produce that was in the garden at the time of a public health spray event cannot be sold as organic. However, vegetables that grow after the sprays can be considered organic with no mandatory waiting period. This is just the legal definition for organic in Texas, and does not mean that vegetables that were present in the garden at the time of spraying should be considered unsafe.

There are no restrictions on the label of Duet that would prohibit consumption of honey from hives that have been exposed to aerial or ground spraying operations. If the EPA had determined health effects from honey of sprayed bees there would be a restriction or waiting interval to honey collection.

(3). Are there long term problems after the birds and other critters have eaten the seeds that were sprayed?

There should be no short or long-term impacts on larger organisms, like birds, reptiles, fish, larger insects, mammals, etc. The amounts used for mosquito control are too low to harm larger animals.

(4). We are told that dawn and dusk is the time of day with the most mosquitoes out. How does the spray impact the mosquito population if it is applied during the late evening and night if they are not out in as great a number?

Mosquitoes are active throughout the nighttime hours. Research has shown that Culex mosquitoes are most active laying their eggs at dawn and in early evening in some areas, but continue to actively seek hosts later in the evening. Later evening sprays likely still impact a significant portion of the mosquito population, including biting mosquitoes.

(5). What is the difference in the spray used for the truck spraying versus the aerial spraying?

Aerial spraying achieves much better coverage and penetration of upper tree canopies (where WNV-carrying Culex mosquitoes mostly live) than ground based spraying. Also aerial spraying has the advantage of treating areas that are outside the range of truck based sprayers (e.g., parks, greenbelts, fields, etc.) which can, at best, reach 300 feet downwind from an accessible road. Perhaps the most compelling reason for aerial spraying during a health emergency like we had this summer, however, is efficiency. A single plane can cover 64,000 acres in a night, about 1000X the coverage of a truck mounted sprayer. Since Dallas and Dallas County together had only 6 trucks to cover the entire county, the community had no choice but to go to aerial spraying if they were to quickly suppress the mosquito problem. The disadvantage of aerial spraying is that it cannot be as precise as ground-based spraying--avoiding, say, homes which request not to be sprayed.

Appendix 4

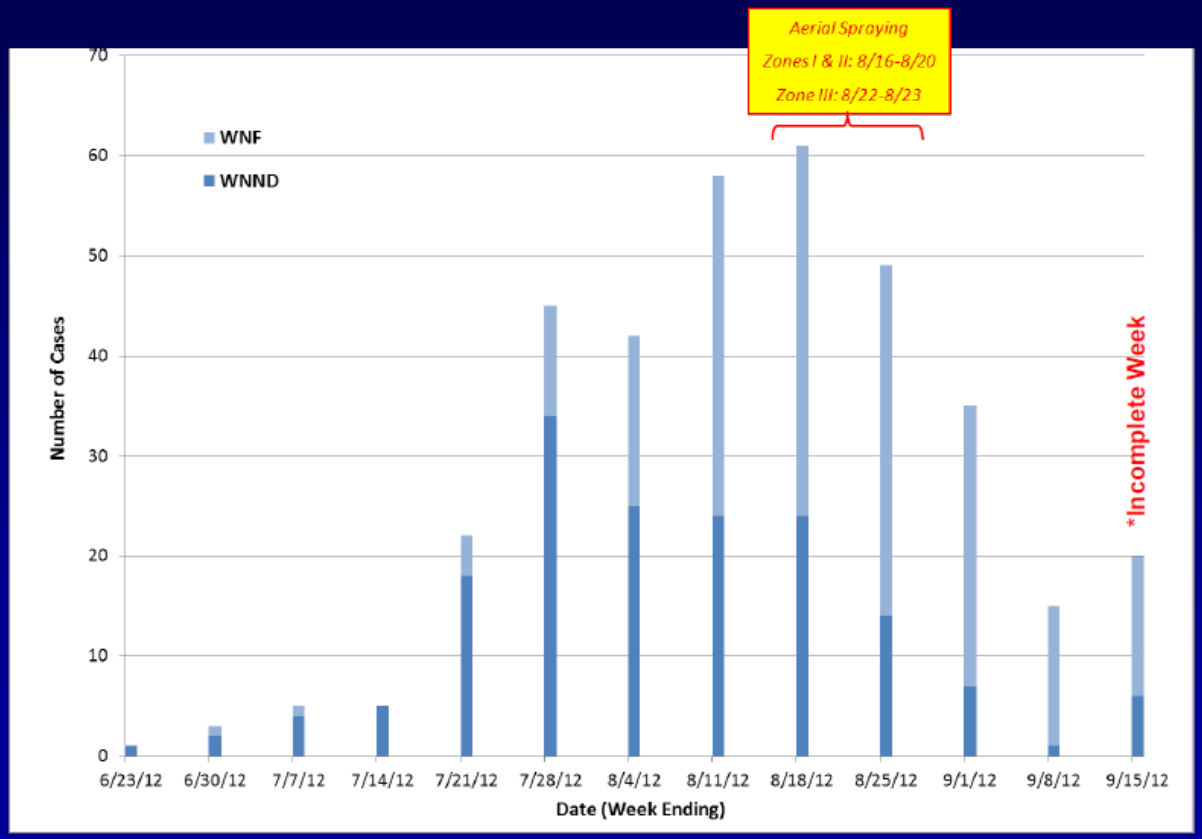
Dallas County Health Department Data on Human Cases

Outbreak Timeline (1)

1. 5/24: Seasonal WNV DCHHS press conference
2. 6/5: 1st confirmed WNV+ mosquito pool, collected 5/30; 1st Health Advisory issued
3. 6/20: 1st confirmed human WNV case reported; 2nd WNV press conference held
4. 7/9: Total 10 WNV cases
5. 7/13: 1st reported death; 3rd press conference
6. 7/19: 2nd reported death; 4th press conference
7. 7/23: Total 36 WNV cases
8. 7/25: Total 64 cases; 2nd WNV Health Advisory; DCHHS conference call with CDC, TX DSHS
9. 7/27: 3rd reported death; 5th Press Conference; 7/30: 4th and 5th deaths reported
10. 8/2: Total 115 cases; 3rd WNV Health Advisory
11. 8/3: 6th death; 8/6 – 8/9: 7th ,8th and 9th deaths
12. 8/9: State of Emergency declared in County
13. 8/10: Total 181 cases; County press conference for plans for aerial spraying measures
14. 8/15: 11 Cities opt to participate in aerial spraying
15. 8/16, 8/17: 1st pass spraying, truncated by rain
16. 8/19: Completion 1st pass aerial, N Dallas
17. 8/20: 2nd pass aerial completed over N Dallas
18. 8/21: Southern cities deadline to decide participation in aerial spraying
19. 8/22: 1st pass aerial spraying, S Dallas cities
20. 8/23: 2nd pass aerial spraying, S Dallas cities
21. 8/27, 8/29: 12th and 13th deaths reported
22. 9/6, 9/11: 14th and 15th deaths reported
23. Continued ground-spraying response (3 consecutive nights) to WNV+ mosquito traps and newly identified human cases.
24. WNF and WNND Cases, Dallas County: by Week of DCHHS Confirmation (N = 361, as of 5 pm 9/13/12)
25. Date of Confirmation represents earliest date which sufficient supporting clinical information has been received, in addition to positive test result, for announcement of human case to municipalities.
26. *Incomplete Week

WNF and WNND Cases, Dallas County: by Week of DCHHS Confirmation

(N = 361, as of 5 pm 9/13/12)



Date of Confirmation represents earliest date which sufficient supporting clinical information has been received, in addition to positive test result, for announcement of human case to municipalities.