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Fogging practices of Iowa counties for mosquito abatement

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FOGGING PRACTICES OF IOWA COUNTIES FOR MOSQUITO ABATEMENT

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Abstract

Global warming has been associated with an increase of mosquito-borne diseases. Mosquito-borne diseases currently have no prescription remedies. The counties across the state of Iowa will increase their fogging procedure, to supplement the increase in mosquitos and mosquito-borne diseases. This study examined which chemicals each county uses for mosquito abatement, the patterns and frequency of spraying, and what patterns of human exposure may be occurring. The county auditor was identified and recruited via email. The county auditors across the state forwarded the email message to the Environmental Health Director, in each county. At county level, they are not in control of the fogging procedure. The individual cities, within those counties, are the ones in control of the fogging procedure. The search engine Google was used to telephone and recruit city administrators across the state of Iowa. These city administrators would also identify, who specifically applies the fogging procedure. These individuals were recruited to partake in the applicator survey. The results showed applicators, across the state of Iowa, are not allowing their pesticide usage be public and research knowledge, rotating their pesticide usage, meeting the FIFRA certifications, and lacking the training for PPE. The state of Iowa should ensure all applicators are FIFRA certified, properly PPE trained, rotate their pesticides, and allow their usage be public and research available.

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CHAPTER I

INTRODUCTION

The state of Iowa is home to approximately 3 million citizens living within 99 counties. These 99 counties range from rural areas to metropolitan cities. In 2010, 36% of Iowa's population lives within a rural area, while about 64% of Iowa's population lives within an urban metropolitan city. These urban metropolitan cities include Des Moines, Cedar Rapids, Davenport, Sioux City, Iowa City, Waterloo, West Des Moines, Ames, Council Bluffs, Dubuque, and Ankeny. These 11 cities are home to roughly 963,000 residents, or roughly 32% of all Iowans (Brinkhoff, 2015). However, both the urban and rural regions of Iowa share a mutual concern about mosquitos.

Mosquitos are known to be carriers of Encephalitis, Yellow Fever, Dengue Virus, West Nile Virus (WNV), and Chikungunya. As a public health concern, the typical method of controlling the spread of these viruses among various county agencies is to fog. Fogging is the application or treatment of pesticides to exterminate adult mosquitos. Although known to be effective in controlling mosquito populations, it is debated as to whether the pesticides used in common abatement practices are also questionable in their effectiveness. However, it is known that the use of mosquito control pesticides have been associated with increased risks of cancers. Therefore, the counties of Iowa need to explore and find an alternative solution to mosquito control programs, which in the end are ineffective in controlling the mosquito population and the transmission of possible virus to the citizens of Iowa. Thus, the purpose of this cross-sectional study was to describe the chemicals that each county in the state of Iowa use for mosquito abatement and their procedures for triggering a spraying decision, allowing for an estimate of human exposure patterns throughout the state.

In 2015, The State Health Registry of Iowa estimated an incidence rate of 17,000 Iowans to be diagnosed with cancer (University of Iowa, 2015). In 1997, a long-term study of agricultural exposures and chronic cancers among commercial and private pesticide applicators in Iowa and North Carolina. In the first five years, an estimated 59,000 Iowans were enrolled in the study. Iowa also had roughly 32,000 private applicators, 22,000 spouses of private applicators, and 5,000 commercial applicators. The study involved telephone interviews, a mailed dietary questionnaire, and a collection of cheek cell sample from all consenting cohort members. The telephone interviewed about pesticide use since enrollment, current farming and work practices, and health changes. The dietary questionnaire asked about cooking practices and types of foods eaten, since cooking practices and diet can play a role in cancer and other health conditions. Lastly, the cheek cells were used to understand possible links between genetics, exposures, and disease. Currently, the study is in its 23rd year. Since 1997, cohort members have been linked annually or biennially to mortality and cancer registry incidence databases in both Iowa and North Carolina. Among 30,000 spouses of private applicators in the two states reported organophosphates use. An estimated 700 of those spouses were diagnosed with cancer. The study also showed any organophosphates use was associated with an elevated risk of breast cancer. While Malathion, the most commonly used organophosphate, was associated with increased risk of thyroid cancer. The pesticide *diazinon* was associated with ovarian cancer (Lerro, 2015).

West Nile Virus

West Nile Virus (WNV) was first found in a crow in Scott County, IA in the late summer of 2001. WNV is a mosquito-borne virus that can be transmitted to humans, which can cause encephalitis (inflammation of the brain) or meningitis (inflammation of the lining of the brain

and spinal cord) (CDC, 2015). The mosquito genus *Culex pippens* has caused roughly 40,000 known cases and 17,500 deaths within the United States. In 1999, the sentinel case of WNV appeared in New York City. Initially, there were only 62 reported cases of WNV. Shortly thereafter, WNV moved across the United States to California, then reaching Canada and Central America in 2002. In 2012 alone, there were roughly 5,500 cases of WNV in 48 states. It is speculated that the increase in climate temperatures influences the distribution of WNV to the western United States (Soverow, 2009). These increased surface temperatures have also allowed for an earlier transmission cycle between mosquitos through birds and an extended breeding season for mosquitos with more aggressive biting.

Several potential WNV vaccines (ChimeriVax-WN02 and WN-80E) have completed phase I or phase II human clinical trials. These results suggested good safety and immunogenicity. None of the vaccine candidates have progressed to phase III trials (Brandler, 2013). Currently, there are no specific drug treatments or vaccines against the virus. An alternative method to vaccines includes spraying of pesticides. Cities and counties around the Midwest use what is known as “ultra-low-volume spraying”, which sprays Pyrocide 7396 from trucks or planes. It is estimated that the average kill rate from using Pyrocide 7396 is roughly 21 to 45 percent. These pesticides have also been shown to kill birds, dragonflies and bats which naturally keep the mosquito population in check. It is also suggested mosquitoes are developing a resistance to commonly used pesticides. These pesticides are typically based on chemicals such as organophosphates, carbamates, pyrethroids, which disrupt natural hormonal systems in humans (Wartman, 2015).

Zika Virus

An additional mosquito virus that's affecting the United States is the zika virus. The zika virus is spread primarily through the bite of an infected *Aedes aegypti* or *Aedes albopictus*. In 1947, the zika virus was first discovered in a monkey in Uganda. Before 2015, zika virus outbreaks occurred in tropical Africa, Southeast Asia, and the Pacific Islands. In December 2015, the Commonwealth of Puerto Rico, reported its first confirmed locally transmitted zika case. Currently, local transmission of zika virus has been identified in two areas of Miami-Dade County in Florida. Nationally, there has been a total of 3,358 cases of zika virus. An estimated 3,314 cases were reported as travel-associated. While roughly 43 cases account for locally acquired mosquito-borne cases. As a result, state and territorial health departments are encouraged to report laboratory-confirmed cases to the CDC. The information provided will help the CDC improve their understanding of how and where zika is spreading. The zika virus can also be spread from a pregnant mother to her fetus, sexual intercourse with an infected person, blood transfusions, organ and tissue transplant, fertility treatment, and breastfeeding. An infected person with zika can exhibit either no symptoms or mild symptoms. The mild symptoms an infected person with zika might exhibit are a fever, rash, joint pain, conjunctivitis, muscle pain, or headaches. The symptoms of zika virus are common everyday symptoms, which puts additional people at-risk. A pregnant mother with zika virus can cause their fetus to exhibit a birth defect of the brain called microcephaly. These fetuses and infants infected with zika before birth, also exhibit defects of the eye, hearing deficits, and impaired growth. Additionally, there has been increased reports of Guillian-Barre syndrome in areas affected by zika. Guillian-Barre syndrome is an uncommon sickness of the nervous system, in which, a person's own immune system damages the nerve cells, causing muscle weakness or paralysis (CDC, 2016).

Chikungunya

An additional mosquito virus that affects citizens of Iowa includes chikungunya. Chikungunya is a mosquito-borne viral disease that is transmitted from human to human by the bite of an infected mosquito. This viral disease is characterized by an unexpected fever accompanied by joint pain. The joint pain usually lasts several days to several weeks. In some cases the joint pain persisted for several months, or even years. The mosquito species *Aedes aegypti* and *Aedes albopictus* are most commonly known to transmit chikungunya to humans. Both species are commonly found in the southeastern and southwest part of the United States. *Aedes albopictus* is also found through the Mid-Atlantic States and the lower Midwest. CDC officials believes chikungunya will behave similar to dengue virus, where imported cases have resulted in sporadic local transmission, but have not caused widespread outbreaks. None of the 200 imported cases of chikungunya between 2006 and 2013 have triggered a local outbreak. However, the added chikungunya-infected travelers coming to the United States increases the likelihood that local chikungunya transmission will occur (CDC, 2014). During January through October, a total of 272 imported cases were reported in Florida, compared to the 1,110 reported in the other 47 contiguous states. Among the imported cases, the most common countries of exposure include Haiti (38%) and the Dominican Republican (30%). In late 2014, Iowa had its first discovered case of chikungunya. A central Iowa male returned from a trip in the Caribbean, where he was bitten by a mosquito carrying chikungunya.

Today, there are no known specific treatments or vaccines for chikungunya. The prevention or reduction of chikungunya virus transmission depends on the control of mosquito vectors or interruption of human-vector contact. Actions should focus on individual protection against mosquito bites, symptomatic treatment of patients, and mosquito proliferation control.

Currently, Iowans generate roughly 3 million waste tires annually (DNR, 2016). Waste tires are seen as ideal breading grounds for mosquitoes. The reasons waste tires are ideal are due to their ability to retain water and their dark colored surfaces to absorb sunlight. In 1991, the state of Iowa provided clear direction on storage and disposal of waste tires to prevent breeding grounds for mosquitoes. The state of Iowa provides best management practices, which include: store as few waste tires as possible, schedule regular pickup of waste tires, keep tire piles covered to prevent entrapment of water, store waste tires in sunny areas, leave waste tires on rims, and do not burn or bury waste tires. The state of Iowa also allows the 99 counties to partake in fogging procedures to control mosquito populations.

Fogging

The use of fog spraying is a form of adulticiding. Adulticiding is the application or treatment of pesticides to exterminate adult mosquitos. The most common form of fogging includes applying pesticides by the use of truck-mounted ultra-low volume spray units driven on public roadways. These ultra-low volume sprays release droplets of synthetic pyrethroid, which stay in the air and kill adult mosquitos on contact. After spraying, pyrethroids settle onto the ground and flat surfaces. The chemical pyrethroid is easily broken down by sunlight, which allows the chemical to last only one or two days within the environment (Illinois Department of Public Health, 2007). Pyrthroids are applied at low levels to control mosquitos, which can aggravate humans with existing respiratory conditions (Walters, 2009). Citizens inhaling higher levels of pyrethroids may experience asthmatic breathing, sneezing, nasal stuffiness, headache, nausea, incoordination, tremors, convulsions, facial flushing and swelling, and burning and itching sensations. The use of pyrethroids has also been linked to hormonal disruption, childhood brain cancers, neurological damage, and thyroid damage. Today, more than 1,000 pyrethroids

have been developed, while only a few are used in the United States. The pyrthroids used in the United States include permethrin, resmethrin, and sumithrin.

Statement of the Problem, its Significance, and the Purpose of the Study

In North America, global warming is lengthening the transmission season of mosquito-borne diseases, such as WNV (Greer, 2008). The virus transmission to humans starts in the spring, with heavy infection in late summer or early autumn (Patz, 2003). It's predicted that the Midwest will experience warmer summers, drier conditions year-round, and milder winter seasons. These climate changes will result in an earlier spring. The earlier spring season would lengthen the transmission of WNV between mosquitos and birds. This lengthened transmission then would result in an increased incidence of human infection. Also, global warming would allow mosquitos to survive in superior numbers as winters become milder. These superior numbers will increase the transmission of WNV from mosquito to mosquito. Ultimately, resulting in an increased incidence rate of WNV (Chuang, & Wimberly, 2012). The counties within Iowa will increase their fogging procedures, to supplement the increase in mosquitos and WNV. The significance of this study is to minimize human health exposure to fogging procedures around the state of Iowa. Fogging procedures contain the chemical pyrethroid. Pyrthroids are applied at low levels to control mosquitos, which can aggravate existing respiratory conditions. Citizens inhaling higher levels of pyrethroids may experience asthmatic breathing, sneezing, nasal stuffiness, headache, nausea, incoordination, tremors, convulsions, facial flushing and swelling, and burning and itching sensations. Pyrethroids have shown to be linked to hormonal disruption, childhood brain cancers, and thyroid damage. Today, more than 1,000 pyrethroids have been developed, while only a few are used in the United States. The purpose of this study, will be to examine, which chemicals each county in the state of Iowa are

using for mosquito abatement and to determine the patterns and frequency of spraying and what patterns of human exposure may be occurring.

CHAPTER II

LITERATURE REVIEW

The state of Iowa is home to approximately 3 million citizens living within 99 counties. A main source of income for Iowa's citizens includes domestic farming. Throughout this chapter, the author will show how agriculture has an indirect effect on mosquito populations, the impacts of WNV, and how pyrethroids affect human health.

Iowa economically relies heavily on agriculture. In 2007, the Census of Agriculture indicates the Midwest region of the United States has a combined market value of crops and livestock products, of an estimated 77 billion dollars (Hatfield, 2012). The use of technological advances in agriculture have provided an increase in crop yield to provide for increased population growth. This economic prosperity comes with an externalized environmental cost, recent agricultural production practices produce significant gas emissions, which in turn, have contributed to global warming. The Environmental Protection Agency (EPA) estimates that 9% of all greenhouse gas emissions are caused by agriculture. Greenhouse gas emissions from agriculture have increased by 17% since 1990. A driving force for this increase has been the 54% increase in combined methane, CH_4 and nitrogen oxides, N_2O emissions from livestock manure management systems (EPA, 2015).

In addition to these agricultural practices, greenhouse gases from human economic and subsistence activities, such as combustion of fossil fuels for electricity, heat, and transportation have contributed significantly to global warming, in the 20th and emerging 21st century. As greenhouse gas emissions from human activities increase, gases such as: nitrous oxide, methane, carbon dioxide, and fluorinated gases build up in the atmosphere. As these gases accumulate in higher concentration in the lower atmosphere, they trap heat. The Earth's surface is heated by

absorbing solar energy, and heat is than radiated back into the atmosphere, where some of the heat is trapped by the greenhouse gases. Global Warming affects temperature, precipitation patterns, and humidity. These factors influence the distribution and spread of vector-borne diseases.

At first glance, it may seem like global warming wouldn't affect the spread of WNV from mosquitos. Rather, the 0.8°C increase in average global temperature over a century and one-half has added about 32°F, to the average yearly temperature of any given year. Based on a range of proxy measurements of temperature, the global average temperate over the last two decades has risen roughly 0.5°C. If the human activities, that generate emissions of greenhouse gases, continue the global average warming may be more than 4°C, by the end of the century (McMichael, 2011). The current total heat flux from Earth to space is an estimated 44.2 terawatts, but the relative contributions from residual primordial heat and radiogenic decay remain uncertain (Lazzaro, 2011). The Catastrophic Man-Made Global Warming Theory proposes that doubling CO_2 directly increases temperatures about 1°C, which then climate pessimists multiply this 3x to 5x more. These increases in warming temperatures cause a widespread distribution of mosquito, vector-borne diseases by increasing the range in which the mosquito can live, increasing the length of the breeding season, and increasing the activity and biting vigor of the mosquitos themselves. (Meyer, 2012).

The increased surface temperature allows for an earlier transmission cycle of WNV, between mosquito and birds. The earlier transmission cycle results in an increased incidence rate of WNV in humans. A recent case-crossover study compared the exposure at the time of WNV onset to an exposure at another time point. The 16,298 WNV cases in the United States suggested: that a 5°C increase in mean maximum weekly temperature was associated with a 32

to 50% increase in WNV incidence (Soverow, 2009). It's predicted that the Midwest, will experience warmer summers, drier conditions year-round, and milder winter seasons. These climate changes will result in an earlier spring. The earlier spring season would lengthen the transmission of WNV, between mosquitos and birds. This lengthened transmission than would result in an increased incidence of human infection (Chuang, & Wimberly, 2012).

WNV was originally isolated in 1937 from the blood of a flushed woman in the WNV province of Uganda. The virus is transmitted to humans through the bite of infected mosquitos, which acquire the virus after feeding on vertebrate hosts, such as birds. The intensity of transmission to humans depends on the numbers and on the feeding behaviors of infected mosquitos. In the United States, the principle genus species responsible for spreading WNV to humans includes *Culex pipens*, *Culex restuans*, *Culex quinquefasciatus*, and *Culex tarsalis*. In North America, the transmission of WNV increases during the warmer months, with peak activity from July through October (CDC, 2005). Between 1999 and 2004, 16,706 cases of WNV were reported in the United States with the initial illness being reported as early April and lasting to December. The early onset of WNV in April is solely due to the migration of birds to the northern portion of the United States (Hayes, 2006). Temperature also allows mosquitos to increase their viral load while shortening incubation periods. Humidity has also been shown to accelerate blood-feeding and reproduction (Shaman, 2007). A higher weekly cumulative temperature was associated with a 35-83% higher incidence of reported WNV over the next month. The increase in mean weekly dew point temperature was significantly associated with a 9-38% higher incidence of WNV over 3 weeks. Also, 1 day of heavy rainfall within a week was associated with a 29% increase in incidence (Soverow, 2009).

These increases of mosquitos capable of transmitting WNV pose an immediate threat to humans. The treatment of West Nile viral infections are symptomatic, meaning that as symptoms arise they are addressed. If patients with WNV show signs of meningoencephalitis, (cognitive decline, confusion, stiffness and pain in the neck, or loss of consciousness) they should be hospitalized for observation and supportive care. These hospitalizations will also help to rule out Central Nervous System infections or conditions such as: Herpesvirus infection, Guillen-Barre syndrome, and bacterial meningoencephalitis. The most frequent serious symptoms in West Nile encephalitis cases are neuronal dysfunction, respiratory failure, and cerebral edema.

Currently, there is no virus-specific therapy available and no population based, *controlled* studies examining the use of antiviral agents in humans. Treatments are focused on the management of symptoms wherein corticosteroids, anticonvulsants, or osmotic agents have been utilized. The *prophylactic* use of these drugs to prevent the development of symptoms has not been well studied. The use of these drugs are commonly employed to control the symptoms of WNV. Corticosteroids are chemicals that include steroid hormones, which are produced in the adrenal cortex of vertebrates and are used to reduce inflammation and calm the immune reaction. Numerous antiviral agents though have been studied in WNV-infected cell lines in vitro (test-tube). These antiviral agents were also studied in laboratory animals. In limited cases, these antiviral agents were administered experimentally to several patients with advanced West Nile encephalitis. These antiviral agents are classified into three general categories: purine and pyrimidine (ribavirin), interferon α, and human immunoglobulin (Campbell, 2002). Ribavirin is a guanosine equivalent with an in vitro activity against RNA and DNA viruses, including flaviviruses. Further, early evidence suggests that high ribavirin concentrations inhibit the replication and cytopathogenicity of WNV in human neural cells in vitro (Jordan, 2000).

Interferon α has proven, but limited, clinical efficacy on viral infections. Species-specific interferon reportedly protects spinal cord cells from being infected with WNV, while in vitro, when given before exposure to WNV. Interferon has also increased the survival of Vero cells (experimental in-vitro cell line derived from old world monkeys), when applied either before or after WNV inoculation (Anderson, 2002).

In vitro studies, have shown the potential clinical usefulness of these agents in WNV infection. Ribavirin provided limited evidence of a therapeutic effect in WNV-infected mice. The effectiveness of these and other agents against this virus *in vivo* (controlled human trials) has yet to be determined. There have also been no clinical trials in West Nile meningoencephalitis patients. Globally, only a small number of patients have ever received antiviral drugs for West Nile meningoencephalitis. In a retrospective Israeli study of 233 West Nile meningoencephalitis patients, including 37 who empirically received ribavirin, multi analysis showed that ribavirin had no effect on WNV mortality (Chowers, 2001).

There have been several potential WNV vaccine studies (ChimeriVax-WN02 and WN-80E), which have completed phase I or phase II human clinical trials. Neither ChimeriVax-WN02 nor WN-80E have been able to complete phase III of human clinical trials due to poor results in phase I and II. As a result of work to-date and because active research is continuing, there is no drug specific treatment protocol (outside of supportive care to address symptoms) or vaccine available for WNV. Prevention of infection, therefore; remains the best solution for counties across the United States. Public health departments seek to prevent the incidence of WNV and the increasing population of mosquitos, ideally this would be through the use of Integrated Pest Management, IPM programs. Given that the only really viable solution to the control of WNV is IPM; it is imperative that the IPM program minimize excessive use of

pesticides so that one environmental health problem, WNV, does not lead to another- excessive pesticide exposure.

In an ideal world, the mosquito control within the United States has evolved from reliance on insecticide applications for control of adult mosquitos (adulticide) to integrated pest management programs. These integrated pest management programs include surveillance, source reduction, larvicide, biological control, as well as public relations and education. The use of surveillance programs allows for tracking diseases harbored by wild bird and chicken flocks; vector-borne pathogens in mosquitos; and evaluation of adult and larval mosquito cycles and larval habitats. When established mosquito larval and adult thresholds are exceeded, control activities are initiated. Source reduction approaches strive for the elimination of larval habitats and encouragement of habitats unsuitable for larval development, thus, eventually decreasing adult population numbers. The use of public education is critical in considering source reduction as individual homeowners must participate in efforts to reduce standing water and harborage areas. There are counties across the United States, which have public school education programs to teach their children what they and their families can do to prevent mosquito proliferation.

The use of biological controls involves the use of predators that eat larvae and pupae. The commonly used biological controls include the mosquito fish, *Gambusia affinis* and *Gambusia holbrooki*. Mosquito fish have a drawback since they also feed upon other organisms such as tadpoles, zooplankton, aquatic insects, and other fish eggs (Courtenay, 1989). However, mosquito fish are the most common supplemental biological control agent for mosquito control. The main reason for mosquito fish being the most common biological control is they're easily raised. Another alternative to insecticides includes the use of mosquito traps. Mosquito traps use attractants such as compressed carbon dioxide, burning propane and octanol to attract mosquitos,

and fans to control airflow along with containers designed to entrap the mosquitos. Carbon dioxide exhalation on the part of animals is easily detected by mosquitos and is how they are able to zone in on their “prey”. However, the use of mosquito traps is expensive costing well over $1,000 each.

The use of mosquito fish and traps are not widely used in the state of Iowa. The state of Iowa allows the use of pesticides. Pesticides, used by state and local agencies to control mosquitos, must contain warning labels to minimize risks to human health and the environment. These pesticides are sprayed by public health employees or professional pesticide applicators, who are specifically trained to follow proper safety precautions and directions for their use. Pesticide applicators who mix, load, and apply the concentrated pesticides must use personal protective equipment (PPE). The use of PPE helps minimize exposure from the fogging device and while pumping pesticides into the spray equipment. Adulticides require small droplets of the pesticide to drift through areas where mosquitos are flying. The larger droplets of adulticide, which land on the ground can cause undesirable effects on non-targeted organisms. These organisms that are affected by the toxicity of the pesticide include birds, fish, wildlife, aquatic invertebrates, and honeybees. These pesticides are applied in a concentrated form such as 29.6 mL per acre. Typically, ground-level, ultra-low volume applicators produce droplets 8 to30 microns in size, with none greater than 50 microns. Further, large droplets in excess of 50 to 100 microns can damage automobile paint finishes, due to the solvent carriers used to disperse the pesticides. The pesticides responsible for these damages to automobile paint finishes include Malathion, Naled, and Fenthion. The pesticides used for mosquito control in ultra-low-volume are Malathion (Fyfanon, Atrapa, Prentox), Naled (Dibrom, Trumpet), fenthion (Batex),

permethrin (Permanone, AquaResilin, Biomist, Mosquito-Beater), resmethrin (Scourge), sumithrin (Anvil), and pyrethrins (Pyrenone, Pyronyl) (Rose, 2001).

Unfortunately, the undesired effects of permethrin, resmethrin, and sumithrin are a direct impact on human and wildlife health. When permethrin is applied to plants, it can last on the leaves between 1 and 3 weeks. Scientists applied permethrin to soil and then planted sugar beets, wheat, lettuce, and cotton. The scientists found trace amounts of permethrin residue in the edible parts of the plant, even 30 to 120 days after planting. Trace amounts have also been found in bananas, collard greens, squash, and watermelon. When permethrin is eaten it can cause sore throat, abdominal pain, nausea, and vomiting (NPIC, 2009). Permethrin was originally classified by the International Agency for Research on Cancer (IARC) as "not classifiable as to its carcinogenicity to humans" in 1991. The U.S. EPA later decided that permethrin was "likely to be carcinogenic to humans" if it was eaten. This decision was based upon the chemical structure of permethrin, how it is biotransformed and distributed in the body, and laboratory tests that indicated neoplasia (tumor development) in mice. The chemical structure of permethrin contains piperonyl butoxide a known carcinogen. The use of permethrin is also extremely toxic to fish and other animals that live in either salt or fresh water. The EPA has established regulations that prohibit the direct application to open water within 100 feet of lakes, streams, rivers, or bays (NPIC, 2009).

Resmethrin exhibits a half-life 30 days and is primarily broken down by sunlight. Scientists applied resmethrin to surfaces exposed to sunlight and observed a half-life of 20 to 90 minutes. The scientists then applied resmethrin to tomato and lettuce plants, where 55 to 82% of resmethrins chemical structure was broken down within 2 hours. Despite resmethrin being easily broken down within the environment, it possesses a severe threat to human health. Direct contact

with resmethrin can cause burning, itching, tingling, and numbness. The effects of absorbing it through the skin or breathing it include abnormal sensations of the face, dizziness, fatigue, and irritability to sound and touch. In the most severe cases, resmethrin has been associated with liver and thyroid problems, interfering with the immune and endocrine systems. The chemical resmethrin was classified by the U.S. EPA as "likely to be carcinogenic to humans." This classification was based on tests that showed increased liver tumors among female and male rats, which were fed resmethrin for 2 years. The chemical structure of resmethrin contains pipernyl butoxide, which the EPA classifies as a known carcinogen. Resmethrin has been found to be extremely toxic to honeybees, fish, and invertebrates, such as pink shrimp and water fleas (Stahl, 2002).

A scientist at the Mount Sinai School of Medicine discovered that sumithrin should be considered a hormonal disruptor (Go, 1999). Sumithrin has been shown to affect the endocrine systems in both humans and wildlife. The scientist's study indicated that pyrethroids disrupt the endocrine system by mimicking the effects of female hormone estrogen. This can result in breast cancer in women and a lowered sperm count among men. When estrogen levels were elevated, old cells were not removed from the body and cell proliferation occurred, either benign or malignant. The National Institute for Occupational Safety and Health Registry of Toxic Effects of Chemical Substances lists sumithrin as a kidney toxicant and suspected neurotoxicant. The product Anvil contains 10% sumthrin and 10% piperonyl butoxide, these two chemicals together ensure that Anvil is considered a carcinogen. Sumithrin is highly toxic to bees and fish. The label on Anvil, states "This product is toxic to fish. For terrestrial use, do not apply directly to water, or to areas where surface water is present or to intertidal areas below the mean high water mark." (CDC, 2015)

The effects of low-volume droplet dispersal of mosquito pesticides pose damages to automobiles and severe health risks to humans. There are several measures that an individual can undergo to protect themselves from mosquito spraying. These protective measures include staying indoors, close windows and doors, turn off air conditioners, wash exposed skin surfaces with soap, cover outdoor tables and play equipment or rinse them with soap and water after fogging, bring laundry, pet dishes, and toys inside, cover vegetable gardens, and cover ornamental fishponds (Citizens Campaign for the Environment, 2015). Re-entry intervals are set to protect people against poisoning by pesticides, if they enter a treated area too soon after application without PPE. The label on the pesticide container provides information on re-entry intervals (Canadian Centre for Occupational Health & Safety, 2016). These re-entry intervals can range from 10 minutes to several hours depending on the product.

FIFRA

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) is the Federal statute that governs the registration, distribution, sale, and use of pesticides in the United States. Before a pesticide may be sold or distributed in the United States, it must be registered with the EPA. The worker protection standards (40 CFR Part 170) requires that facilities that handle pesticides adopt workplace practices designed to reduce or eliminate exposure to pesticides and must establish procedures for responding to exposure-related emergencies. FIFRA prohibits registration of pesticides that generally pose unreasonable risks to people, including agricultural workers, or the environment. If EPA believes the risks to workers posed by a pesticide are excessive, it can take actions such as requiring additional label warnings or requiring labeling that mandates use of protective clothing. The FIFRA certification is required for restricted

pesticide use not for general category and applicators not applying to own land. The FIFRA certification is exempted for farmers and hired hands (EPA, 2015).

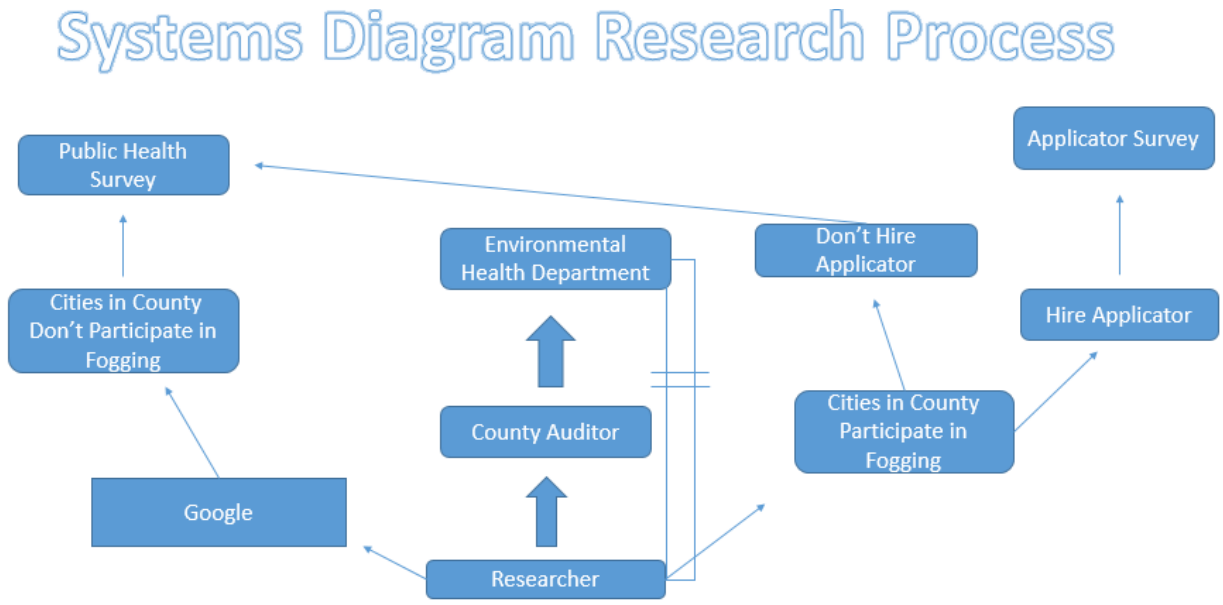
CHAPTER III

METHODOLOGY

The purpose of this cross-sectional study was to describe the chemicals that each county in the state of Iowa use for mosquito abatement and their procedures for triggering a spraying decision, allowing for an estimate of human exposure patterns throughout the state. The goals of the research was to identify what triggers an applicator to spray, are applicators properly FIFRA certified, are precautions consistently used to protect the public post spraying, and are pesticide chemicals properly rotated to prevent pesticide resistance in the target pest population?

Research Design

A cross-sectional research design will be used with a survey instrument employing both quantitative and qualitative questions. Spraying practices in the 99 counties of Iowa will be described. This is a questionnaire evaluation study. This questionnaire evaluation study involves the analysis of data collected from a population, at one specific point in time. The research will examine the amount of the chemicals used in the fogging practices and how often these chemicals are sprayed, as well as the criteria used to trigger fogging events. This data will be useful in determining which chemical or chemicals are most likely being released into the environment and available for human contact. This research design didn't need approval from the Institutional Review Board (IRB) since asking the counties and applicators questions about their jobs.



Initially, the researcher restricted the search to each public health department and/or city administrator. The researcher then used study procedure occurred between January 2016 and October 2016. The procedures used to conduct the research included survey questionnaires, on-line survey instruments, interview schedules, e-mail, telephone, and the use of an automobile for direct site visits. There referrals from these individuals to focus the study on only the individuals responsible for fogging in each of Iowa's 99 counties. The timing of the were two survey questionnaires. The first survey questionnaire will be used to examine which counties use fogging, to measure the frequency of their fogging, and how they decide to trigger a fogging event. The second questionnaire will be used to examine the applicators mode of treatment, the effectiveness of the fogging treatment, and if the pesticide can affect other organisms. The interview schedules were assigned to each county based on their schedules for ease of participation. The use of a telephone allowed the researcher to survey the applicator without having to drive directly to each county, if acceptable to the participant. The use of an automobile will be used in case the individual wants a face to face interview and cannot use an on-line

survey format. The consistent use of a single questionnaire and consistency in interview procedures and techniques will aid with reliability and validity, although it is acknowledged that in-person interviews or telephone interviews may yield more complete data than on-line questionnaires. The use of Iowa's Economic Development website will be used to classify each county as either rural or urban.

There were several methods used to recruit participants. Initially, each county auditor was sent an email requesting which cities in his or her county fog for mosquitoes. The county auditors that e-mailed back typically forwarded my email message to the environmental health department in their county. The environmental health department knew if the county was in charge of fogging or the individual cities. The environmental health department mentioned the individual cities, in which, they knew sprayed in their county. The telephone was then used to contact the city administer in these cities, to confirm that their city participated in a fogging procedure. An additional question was asked to the city administer to determine if the city sprays themselves or hire an applicator. After, the city participated in the questionnaire; the applicator was contacted to participate as well. The counties, where the environmental health department, did not know if cities sprayed within their county. The search engine Google was used to obtain a list of cities within that county. The list consisted of cities ranging from a population of around 100 people to several thousand. The search engine Google provided each cities city hall and city administers number. Then used a telephone to contact these individuals' cities to see if participated in a fogging procedure. If no city within that county used a fogging procedure, a representative of that county was still asked to participate on behave of that county. When a city within that county used a fogging procedure, I would ask them to participate in my survey. If the city refused, the remaining

cities with that county were. If that was the only city within the county that spray, the survey questions were answered with refused to answer.

The researcher will use the program JMP Statistical Discovery from SAS to analyze the information provided from the foggers of all 99 counties, in Iowa. The JMP Statistical links graphics, statistics, and data all together. JMP encourages the researcher to ask more questions, which improves chances of making breakthrough discoveries. JMP also allows the researcher to examine their data without having to rerun an analysis as new questions arise.

CHAPTER IV

RESULTS

Descriptive Univariate Analyses

Results presented in Table 1, show the number of Iowa's rural and urban counties, as identified by Iowa Department of Economic Development. These results were collected from responses to the questionnaire. The full applicator univariate analyses data can be found in the Appendices A on pgs. 62-77.

Table 1

Demographics: Iowa Counties and Location

	Rural	Urban	Total
Iowa	35	13	N=48

Table 2

Demographics: Job Title and Location

	Rural	Urban	Total
Demographics	36 (73.5%)	13(26.5%)	*N = 49
Job Title			
Wastewater Superintendent	1	0	1 (2.0%)
Street Superintendent	7	1	8 (16.3%)
Public Works Employee	0	1	1 (2.0%)
Public Works Director	3	2	5 (10.2%)
Parks Maintenance Specialist	0	1	1 (2.0%)
Parks & Rec Supervisor	0	1	1 (2.0%)
Operator in Charge	1	0	1 (2.0%)
Director of Health	1	0	1 (2.0%)
No Response	22	7	29 (59.2%)
No Job Title	1	0	1 (2.0%)

* One County gave two responses

As shown in Table 2, there were 35 (73.5%) rural counties and 13 (26.5%) urban counties in the sample. Most rural and urban applicators gave no response to, "*disclose the job title of the individual who oversees the fogging procedure*" (59.2%). The street superintendent is commonly the individual in charge of the fogging procedure in rural and urban counties (16.3%).

Table 3

Demographics: Certified Federal Insecticide Rodenticide Pesticide Handler and Location

	Rural	Urban	Total
Demographics	(n =13)	(n =6)	*N=19
Certified Federal Insecticide Rodenticide Pesticide Handler			
Yes	4	1	5 (26.3%)
No	7	5	12 (63.2%)
Other	2	0	2 (11.1%)

* 29 Participants did not answer the question

As show in Table 3, most pesticide applicators are not certified Federal Insecticide Rodenticide Pesticide handlers (63.2%).

Table 4

Demographics: PPE training and Location

Demographics	Rural (n =35)	Urban (n =13)	Total N=48
PPE Trained			
Yes	13	5	18 (37.5%)
No	0	1	1 (2.1%)
No Response	22	7	29 (60.4%)

As shown in Table 4, most applicators had no response to the question, "*are treatment handlers supervised and trained in the use of PPE*" (60.4%). While 37.5% of applicators responded that their treatment handlers are supervised and trained in PPE.

Table 5

Demographics: Pesticide Brand Name and Location

Demographics	Rural (n = 36)	Urban (n = 13)	Total *N = 49
Pesticide Brand Name			
Univar Environmental Sciences	1	1	2 (4.1%)
Permethrin	1	0	1 (2.0%)
Mosquito Mist One ULV	3	0	3 (6.1%)
Masterline Kontrol 4-4	2	1	3 (6.1%)
Kontrol 30-30 Concentrate	1	0	1 (2.0%)
Evoluer ULV 4	1	0	1 (2.0%)
Envion RTU	0	1	1 (2.0%)
Evolver 30/30	1	0	1 (2.0%)
Clarke-Biomist 4+4	4	1	5 (10.2%)
Clarke-Duet	0	1	1 (2.0%)
Anvil 2+2	1	2	3 (6.1%)
5% Skeeter Abate	1	0	1 (2.0%)
No Response	20	5	25 (51.0%)
Unsure	0	1	1 (2.0%)

*One County gave two responses

As shown in Table 5, the majority of rural and urban applicators had no response to, *"what pesticide they use in their fogging procedure"* (51.0%). Clarke-Biomist 4+4 is the most commonly used pesticide among applicators, who responded to the survey (10.2%).

Table 6

Demographics: Effectiveness and Location

	Rural	Urban	Total
	(n =13)	(n =6)	*N =19
Effectiveness of Pesticide			
Not Effective	1	0	1 (5.2%)
Between Not Effective and Moderately	1	0	1 (5.2%)
Moderately Effective	3	1	4 (21.1%)
Between Moderately Effective and Extremely	4	4	8 (42.1%)
Extremely Effective	4	1	5 (26.3%)

*29 Participants did not answer question

As shown in Table 6, most applicators rate the effectiveness of their pesticide as, "*between moderately effective and extremely effective*," (42.1%) and "*extremely effective*" (26.3%).

Table 7

Demographics: New Products and Location

	Rural	Urban	Total
	(n =13)	(n =6)	*N =19
Choose New Pesticide			
Yes	5	2	7 (36.8%)
No	8	4	12 (63.2%)

*29 Participants did not answer question

As shown in Table 7, most applicators wouldn't choose another pesticide if it were available and effective (63.2%). There were several applicators that would change their product for another pesticide, if it was available and effective (36.8%).

Table 8

Demographics: Application Indicators and Location

	Rural	Urban	Total
	(n =43)	(n =17)	*N =60
Application Indicators			
Public Input	7	1	8 (13.3%)
Land Study	1	0	1 (1.6%)
Standing Water	1	1	2 (3.3%)
Weather	5	2	7 (11.6%)
Mosquito Population	6	4	10 (16.6%)
Cost	1	0	1 (1.6%)
Entire Town	0	2	2 (3.3%)
No Response	22	7	29 (48.3%)

*10 Counties gave two responses
*1 Counties gave three responses

As shown in Table 8, most applicators had no response to, "*what indicators are used when deciding to fog*," (48.3%). "*Mosquito Population*" (16.6%) and "*Public Input*" (13.3%) were the two biggest indicators among applicators on when to fog.

Results presented in Table 9, shows the number of the urban and rural individual cities within Iowa's 99 counties, as mentioned by Iowa Economic Development. These results were collected from the **Public Health survey**. The full results of the Public Health Univariate Data can be found in the Appendices C on pgs. 109-130.

Table 9

Demographics: Iowa Counties and Location

	Rural	Urban	Total
Iowa	79	23	*N=102

* 3 Counties had 2 Individual Cities Participate

Table 10

Demographics: In Charge and Location

	Rural	Urban	Total
	(n =77)	(n =22)	*N=99
Department in Charge of Applying Pesticide			
Yes	15	8	23 (23.2%)
No	47	12	59 (59.5%)
Other	15	2	17 (17.1%)

* 3 Participants did not answer the question
* 3 Counties have 2 responses

As shown in Table 10, the majority of cities within Iowa's 99 counties are "*not in charge of applying their* pesticide" (59.5%). While the cities within Iowa's 99 counties are "*in charge of applying*" their pesticide accounts for 23.2%.

Table 11

Demographics: Mosquito Resistance to Pesticide Monitored

	Rural	Urban	Total
	(n =71)	(n =18)	*N=89
Mosquito Resistance to Pesticide Monitored?			
Yes	7	5	12 (13.5%)
No	64	13	77 (86.5%)

* 13 Participants did not answer the question
* 1 County gave both answers

As shown in Table 11, the majority of the state of Iowa's 99 counties don't monitor mosquito resistance to their pesticide (86.5%).

Bivariate Analyses

The Bivariate Analyses used to depict statistically significant data was ANOVA, Pearson's Chi-Square, and Likelihood ratios. These Bivariate Analyses showed no statistical significance, when examining the FIFRA certified by all questions, as well as, county by all questions. Since there was so statistical significance in these findings, the use of rural and urban to all questions was used. The use of rural and urban was used to help identify statistical trends within the data. The full Applicator Bivariate Analyses can be found in Appendices B pgs. 78-98.

Table 12

Applicator Data

	Rural	Urban
Brand Name used in Fogging Procedure	No Response (57.1%) Mosquito Mist One (8.6%) Clarke-Biomist 4+4 (8.6%)	No Response (38.5%) Anvil 2+2 (15.4%)
Ground or Aerial Treatment or Both	Ground (92.3%) Both Treatments (7.7%)	Ground (100%)
New Pesticides Available and Effective, Change Product	Yes (38.5%) No (61.5%)	Yes (33.3%) No (66.7%)
Are the Pesticides you use in Broad Spectrum, or for Specific Organisms	Broad Spectrum (23.1%) Specific Organisms (76.9%)	Broad Spectrum (16.7%) Specific Organisms (83.3%)
Are the Pesticides you use in rotation with other Pesticides	Yes (7.7%) No (92.3%)	Yes (16.7%) No (83.3%)
FIFRA Certified	Yes (30.8%) No (53.8%)	Yes (16.7%) No (83.3%)

PPE Training	No Response (62.9%) Yes (37.1%)	No Response (53.8%) Yes (38.5%)
Records kept regarding the use of the pesticide? (Application Rates, Sites, and Amount)	All 3 Records Kept (61.5%) Not all 3 Records Kept (38.5%)	All 3 Records Kept (80%) Not all 3 Records Kept (20%)
Pesticide affect other Organisms	Yes (38.5%) No (53.8%)	Yes (50.0%) No (33.3%)
Indicators used when deciding when and where to apply treatment	No Response (62.9%) Public Input (8.6%)	No Response (53.8%) Mosquito Population (15.4%)
Chosen Sites contain water sources	Yes (46.2%) No (46.2%)	Yes (66.7%) No (33.3%)

As shown in Table 12, a majority of both rural (76.9%) and urban (83.3%) applicators are using their pesticide for specific organisms. These rural (92.3%) and urban (83.3%) applicators are not rotating their specific organism pesticides. A majority of rural (61.5%) and urban applicators (80.0%) are keeping records regarding the use of their pesticide (application rates, sites, and amount).

The Bivariate Analyses showed statistical significance, when examining several public health questions by rural and urban. The use of Pearson's Chi-Square was used to determine statistical significance.

Table 13

Correlation Analyses by County Fogging: All Subjects (N=102)

Correlation analysis item	d*f*	Chi-Square	p-value
Urban Counties by County Fogging	1	5.414	0.0200

Urban Counties are more statistically likely to fog more than rural counties (p=0.0200).

*See Appendices D pg.131

Table 14

Correlation Analyses by Outside Hire: Rural and Urban (N=40)

Correlation analysis item	d*f*	Chi-Square	p-value
Rural Counties by Outside Hire	9	19.196	0.0236

Rural Counties are more statistically likely to use Mosquito Control of Iowa than urban counties (p=0.0236).

*See Appendices D pg. 136

Table 15

Correlation Analyses by Mosquito Resistance Monitored: Rural and Urban (N=89)

Correlation analysis item	d*f*	Chi-Square	p-value
Urban Counties by Monitored	1	3.952	0.0468

Urban Counties are more statistically likely to monitor mosquito resistance than rural counties (p=0.0468).

*See Appendices D pg.139

The Bivariate Analyses used to depict statistically significant data was ANOVA, Pearson's Chi-Square, and Likelihood ratios. These Bivariate Analyses showed no statistical significance, when examining rural and urban counties by being in charge of applying their pesticide, public notification, and what the recommended time period was for the public to stay inside. The full Public Health Bivariate Analyses can be found in Appendices D pgs. 131-146.

Table 16

Public Health Data

	Rural	Urban
In Charge of Applying Pesticide	Yes (19.5%) No (61%)	Yes (36.4%) No (54.5%)
New Pesticides Available and Effective, Change Product	Yes (7.90%) No (51.3%)	Yes (9.10%) No (68.2%)
FIFRA Certified	Yes (17.1%) No (64.5%)	Yes (19.0%) No (76.2%)
Public Notification	Not Notified (7.8%) Website, Newspaper, News Announcement (5.20%)	Website and Newspaper (18.2%) Website and News Announcement (13.6%)
Time Recommended for Public to Stay Inside	None (8.0%) Late Evenings (5.3%)	None (4.8%) Evenings (4.8%)
Public Told to do During Fogging	None (11.8%) Stay Inside (7.90%)	Stay Inside (18.2%) None (9.1%)

As shown in Table 16, the majority of both rural (51.3%) and urban (68.2%) Public Health officials "*wouldn't change their pesticide*" for a newer effective pesticide. 18.2% of urban public health officials "communicate with the public what to do during fogging" 18.2%. While 7.90% of rural Public Health officials "communicate with the public what to do during fogging".

CHAPTER V

CONCLUSIONS

In North America, global warming is lengthening the transmission season of mosquito-borne diseases, such as WNV (Greer, 2008). The virus transmission to humans starts in the spring, with heavy infection in late summer or early autumn (Patz, 2003). The communities across Iowa use pesticides to control the mosquito population and to reduce the likelihood of transmission of mosquito-borne disease to humans. The goals of the research were to identify what triggers an applicator to spray, are applicators properly FIFRA certified, are precautions consistently used to protect the public post spraying, and are pesticide chemicals properly rotated to prevent pesticide resistance in the target pest population? The two questionnaires revealed negative findings on what is occurring across the state of Iowa, in regards to mosquito abatement. There were 19 applicator responses out of 48 applicators to the applicator questionnaire. The applicators, who provided no response, should legally be required to respond. The community has the right to know what chemicals the applicator is spraying in the air. It's critical for the public to know what these chemicals are to ensure safety for themselves and their children, before spraying hours for precautionary measures. Besides the public, researchers should have the right to gather what chemical the applicator is using, to determine its implications on the public's health. The applicators across the state of Iowa are doing a great job of maintaining records pertaining to their pesticide (application rates, sites, and amounts). Since the applicators are maintaining this information, the information should be easily obtainable to researchers and the public.

Another alarming, data finding was a majority of pesticides used across the state of Iowa are not being rotated. The overuse of a specific organism's pesticide, without rotation, can cause mosquitoes to become resistant overtime. Ultimately, the pesticide would become ineffective while exposing the public to toxic chemicals. The Public Health insisted that a majority of counties are not monitoring mosquito resistance. The applicator questionnaire revealed an alarming finding about FIFRA certification and PPE training. The majority of applicators across the state of Iowa, are not FIFRA certified, as well as, providing proper PPE for fogging practices. These findings could also be a result of the applicator not properly understanding the questions. The FIFRA certification is required for restricted pesticide use not for general category and applicators not applying to own land. The FIFRA certification is exempted for farmers and hired hands. The Public Health questionnaire revealed that public input is an important factor, on deciding when to fog for mosquitoes. The two main triggers for applicators applying their pesticide are mosquito population and public input. These triggers are concerning for several reasons. The toxic pesticides are being released into the air, while mosquito's carrying no diseases, could be present. Ultimately, we are killing non-disease carrying mosquitoes and other harming the bee population. The bee population is critical for the human race survival, because the honeybee pollinates roughly one of every three bites of food. The mosquito applicators are providing positives for the state of Iowa. The pesticides the applicators are using were rated between moderately effective and extremely effective. The use of pesticides has not caused anyone to relocate across the state.

Recommendations

The questionnaire's data revealed a concerning picture, in regards to, mosquito abatement across the state of Iowa. The state of Iowa could partake in several recommended measures.

Initially, the state should ensure all mosquito applicators are FIFRA certified. The state of Iowa could ensure all mosquito applicators are FIFRA certified by having the applicator send in yearly reports. The applicators do a great job of maintaining records pertaining to their pesticide (application rate, sites, and amounts). There should be a change to the federal and/or state law to make baseline data, knowledge available to all people. This change in law would ensure the safety for the citizens. There also should be an increased measure in mosquito monitoring, because of the applicators not rotating their pesticide usage. The rotation of pesticide usage would help prevent mosquitoes from becoming resistant overtime. This rotation would also ensure that the citizens of Iowa are not exposed to the toxic pesticide, when the pesticide becomes ineffective in mosquito abatement. There also should be extension training for Public Health workers on IPM. The extension training would allow Public Health workers to incorporate IPM to reduce mosquito populations.

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APPENDICES

Applicator Questionnaire

Applicator Fogging Survey
*Required Question(s)

*1. What county do you identify with in Iowa?

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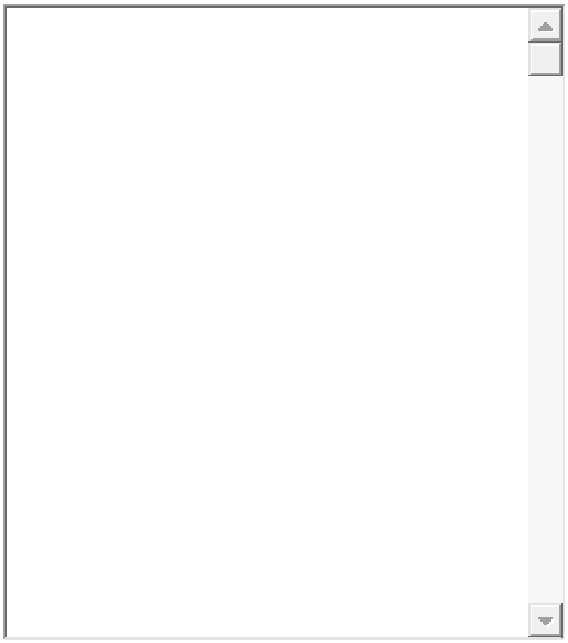
*2. What is the brand name of the insecticide you utilize in your fogging procedure?



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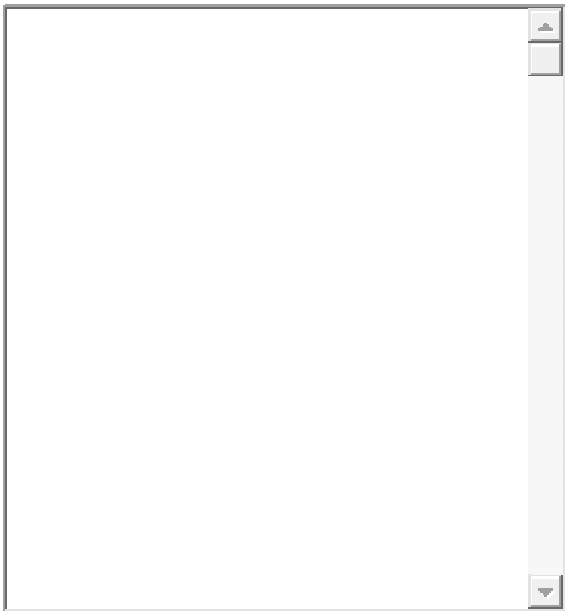
*3. On a scale, rate the effectiveness of your insecticide/fogging treatment based on your seasonal results.

Not Effective **Moderately Effective** **Extremely Effective**

- Comment:
- 

  500 characters left.

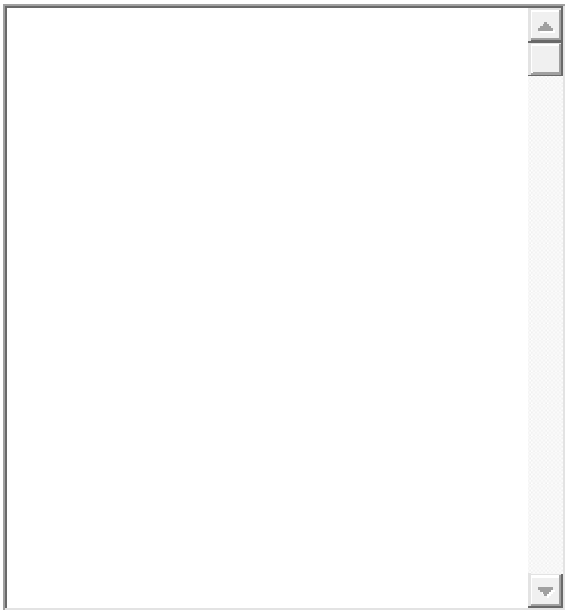
*4. What is the application rate of the treatment you use in gallons per acre?

350 characters left.

*5. Do you use ground or aerial treatment?

- Ground only
- Aerial only
- Both Ground and Aerial Treatment

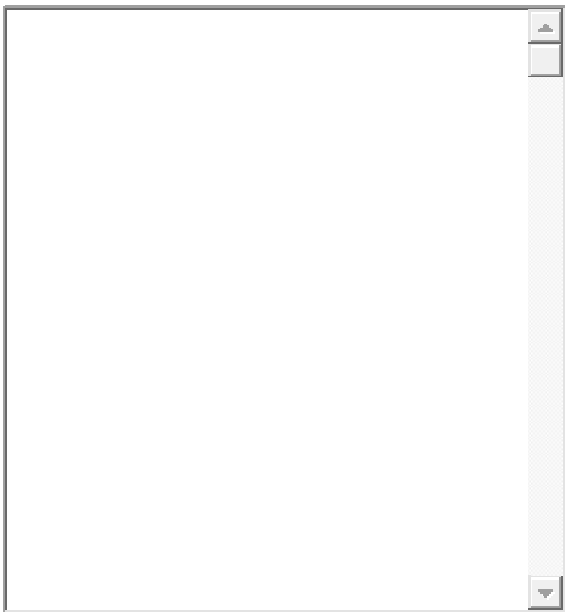
- Comment:

- 

  500 characters left.

*6. If other pesticides were available and effective, would you choose another product? If yes please provide a product preference in the comment box.

- Yes
- No

- Comment:
- 

  500 characters left.

*7. Are the pesticides you utilize used in a broad spectrum, or for specific individual organisms?

- ○ Broad Spectrum
- ○ Specific Organisms
- ○ Other

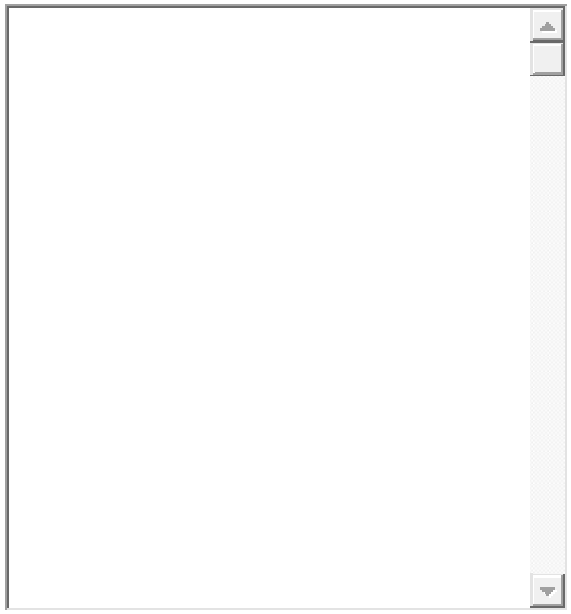
- Comment:
-

500 characters left.

*8. Is the pesticide used in rotation with other pesticides that have a different mode of action?

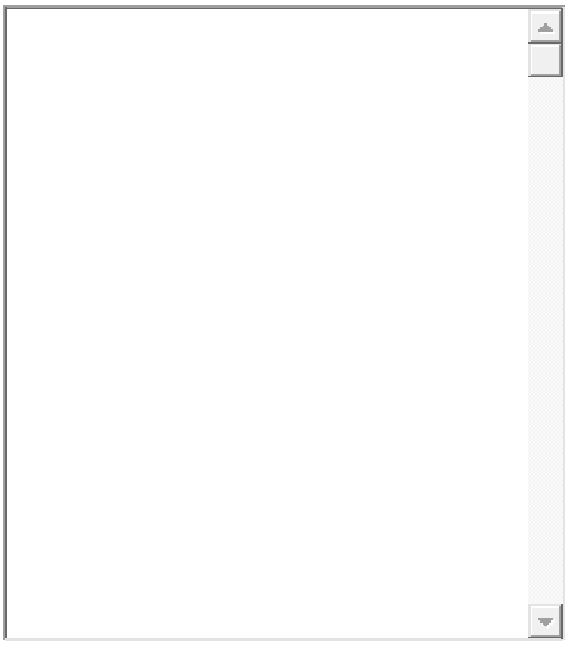
- ○ Yes
- ○ No
- ○ Other

- Comment:

- 

500 characters left.

✱9. What is the job title of the individual who oversees the fogging procedure?



350 characters left.

✱10. Do you have an individual(s) that is a Federal Insecticide Fungicide Rodenticide Act certified pesticide handler? If so, what is their job title?

- Yes
- No
- Other

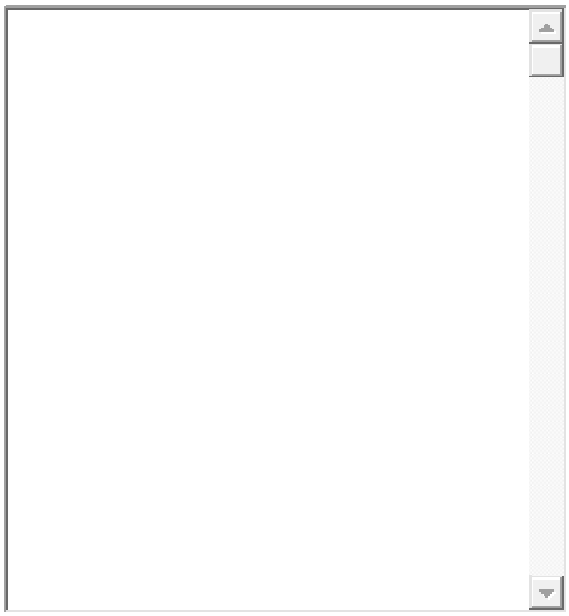
- Comment:
- 500 characters left.

✻11. Are treatment handlers supervised and trained in the use of personal protective equipment (PPE)? Are PPE provided? Is PPE training provided? If PPE training is provided, how often is training and who performs the training?

1000 characters left.

✻12. Are records kept regarding the use of this pesticide? (i.e. application rates, sites, dates, methods, personnel, budget) Please check all that those records include.

- ☐ Application Rates
- ☐ Sites
- ☐ Dates
- ☐ Methods
- ☐ Personnel
- ☐ Budget
- ☐ Amount
- ☐ None

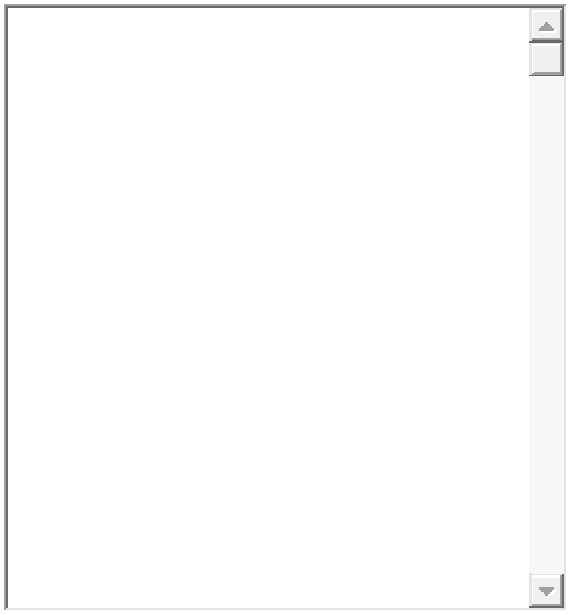
- Comment:
- 

  500 characters left.

✱13. Can your pesticide affect other organisms (i.e. insects, mammals, fish life) If yes, what types of organisms?

- Yes
- No
- Do not Know

- Comment:

- 

  500 characters left.

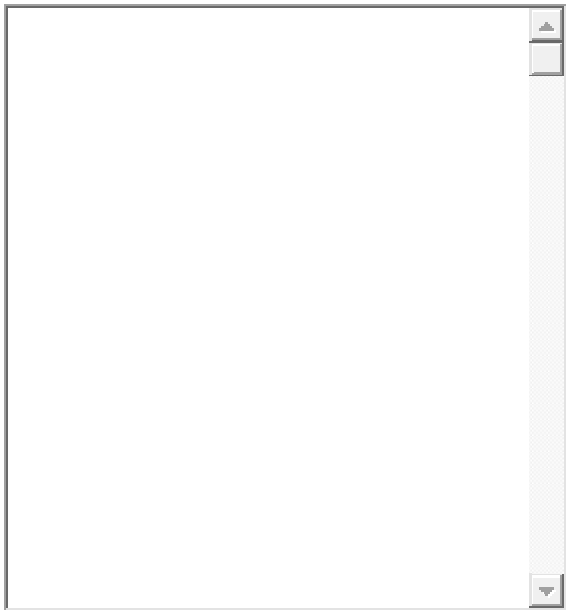
✻14. What are the indicators that are used on deciding when and where to apply treatment?

1000 characters left.

✱15. Do these chosen sites contain water sources?

- Yes
- No
- Other

- Comment:

- 

  500 characters left.

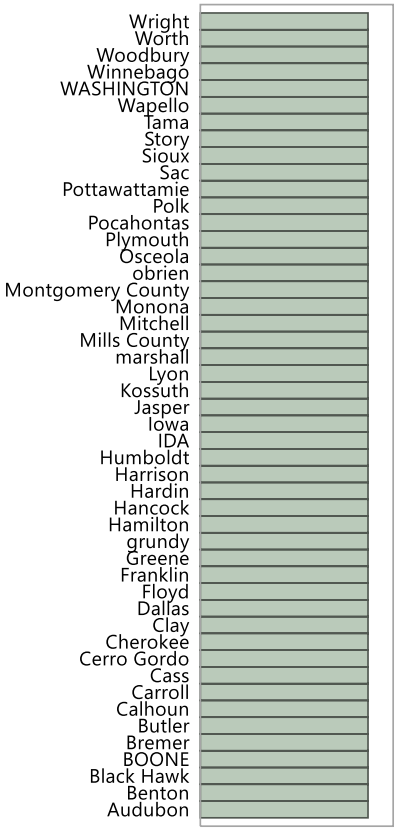
*16. What period of time (i.e. days, hours, minutes) is recommended to the public when advised to stay indoors/ avoid fogging operations?

Appendices A

Applicator Univariate Data

Distributions

What county do you identify with in Iowa?



Frequencies

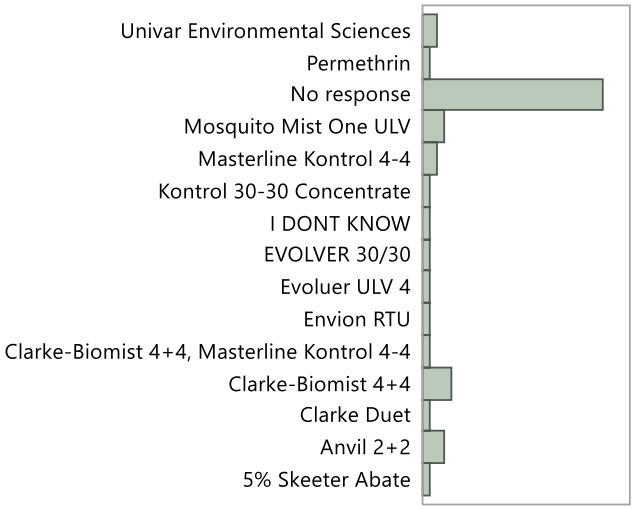
Level	Count	Prob
Audubon	1	0.02083
Benton	1	0.02083
Black Hawk	1	0.02083
BOONE	1	0.02083
Bremer	1	0.02083
Butler	1	0.02083
Calhoun	1	0.02083
Carroll	1	0.02083
Cass	1	0.02083
Cerro Gordo	1	0.02083
Cherokee	1	0.02083
Clay	1	0.02083
Dallas	1	0.02083
Floyd	1	0.02083
Franklin	1	0.02083

Level	Count	Prob
Greene	1	0.02083
Grundy	1	0.02083
Hamilton	1	0.02083
Hancock	1	0.02083
Hardin	1	0.02083
Harrison	1	0.02083
Humboldt	1	0.02083
IDA	1	0.02083
Iowa	1	0.02083
Jasper	1	0.02083
Kossuth	1	0.02083
Lyon	1	0.02083
Marshall	1	0.02083
Mills County	1	0.02083
Mitchell	1	0.02083
Monona	1	0.02083
Montgomery County	1	0.02083
Obrien	1	0.02083
Osceola	1	0.02083
Plymouth	1	0.02083
Pocahontas	1	0.02083
Polk	1	0.02083
Pottawattamie	1	0.02083
Sac	1	0.02083
Sioux	1	0.02083
Story	1	0.02083
Tama	1	0.02083
Wapello	1	0.02083
WASHINGTON	1	0.02083
Winnebago	1	0.02083
Woodbury	1	0.02083
Worth	1	0.02083
Wright	1	0.02083
Total	48	1.00000

N Missing	0

48 Levels

What is the brand name of the insecticide you utilize in your fogging procedure?



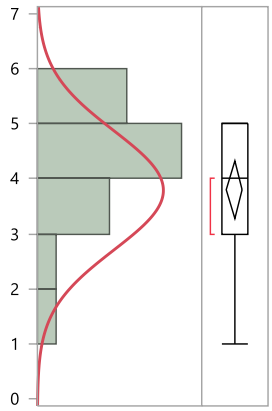
Frequencies

Level	Count	Prob
5% Skeeter Abate	1	0.02083
Anvil 2+2	3	0.06250
Clarke Duet	1	0.02083
Clarke-Biomist 4+4	4	0.08333
Clarke-Biomist 4+4, Masterline Kontrol 4-4	1	0.02083
Envion RTU	1	0.02083
Evoluer ULV 4	1	0.02083
EVOLVER 30/30	1	0.02083
I DONT KNOW	1	0.02083
Kontrol 30-30 Concentrate	1	0.02083
Masterline Kontrol 4-4	2	0.04167
Mosquito Mist One ULV	3	0.06250
No response	25	0.52083
Permethrin	1	0.02083
Univar Environmental Sciences	2	0.04167
Total	48	1.00000

N Missing 0

15 Levels

On a scale, rate the effectiveness of your insecticide/fogging treatment based on your seasonal results.



Normal(3.78947,1.08418)

Quantiles

100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	5
50.0%	median	4
25.0%	quartile	3
10.0%		2
2.5%		1
0.5%		1
0.0%	minimum	1

Summary Statistics

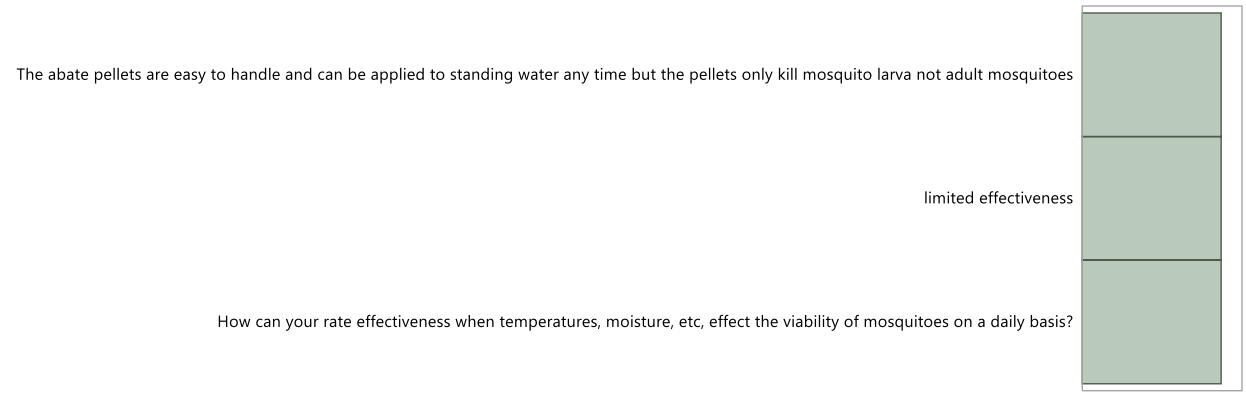
Mean	3.7894737
Std Dev	1.0841765
Std Err Mean	0.2487271
Upper 95% Mean	4.31203
Lower 95% Mean	3.2669174
N	19

Fitted Normal
Parameter Estimates

Type	Parameter	Estimate	Lower 95%	Upper 95%
Location	M	3.7894737	3.2669174	4.31203
Dispersion	Σ	1.0841765	0.8192174	1.6033068

-2log(Likelihood) = 55.9908499413495

Comments

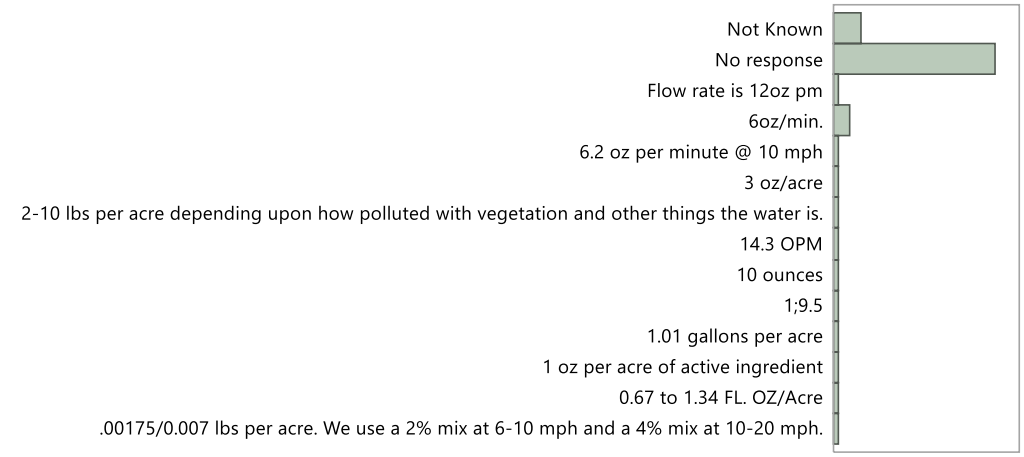


Frequencies

Level	Count	Prob
How can your rate effectiveness when temperatures, moisture, etc, effect the viability of mosquitoes on a daily basis?	1	0.33333
limited effectiveness	1	0.33333
The abate pellets are easy to handle and can be applied to standing water any time but the pellets only kill mosquito larva not adult mosquitoes	1	0.33333
Total	3	1.00000

N Missing 45
3 Levels

What is the application rate of the treatment you use in gallons per acre?



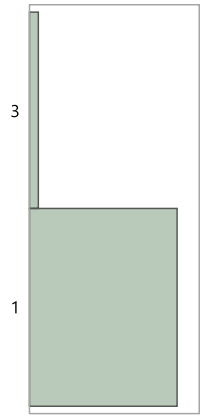
Frequencies

Level	Count	Prob
.00175/0.007 lbs per acre. We use a 2% mix at 6-10 mph and a 4% mix at 10-20 mph.	1	0.02083
0.67 to 1.34 FL. OZ/Acre	1	0.02083
1 oz per acre of active ingredient	1	0.02083
1.01 gallons per acre	1	0.02083
1;9.5	1	0.02083

Level	Count	Prob
10 ounces	1	0.02083
14.3 OPM	1	0.02083
2-10 lbs per acre depending upon how polluted with vegetation and other things the water is.	1	0.02083
3 oz/acre	1	0.02083
6.2 oz per minute @ 10 mph	1	0.02083
6oz/min.	3	0.06250
Flow rate is 12oz pm	1	0.02083
No response	29	0.60417
Not Known	5	0.10417
Total	48	1.00000

N Missing 0
14 Levels

Do you use ground or aerial treatment?

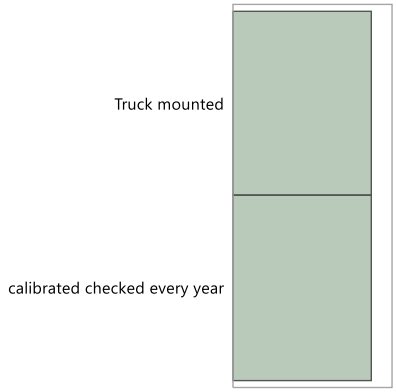


Frequencies

Level	Count	Prob
1	18	0.94737
3	1	0.05263
Total	19	1.00000

N Missing 29
2 Levels

Comments 2

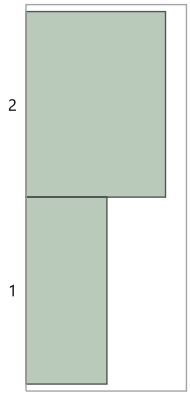


Frequencies

Level	Count	Prob
calibrated checked every year	1	0.50000
Truck mounted	1	0.50000
Total	2	1.00000

N Missing 46
2 Levels

If other pesticides were available and effective, would you choose another product? If yes please provide a product preference in the comment box.

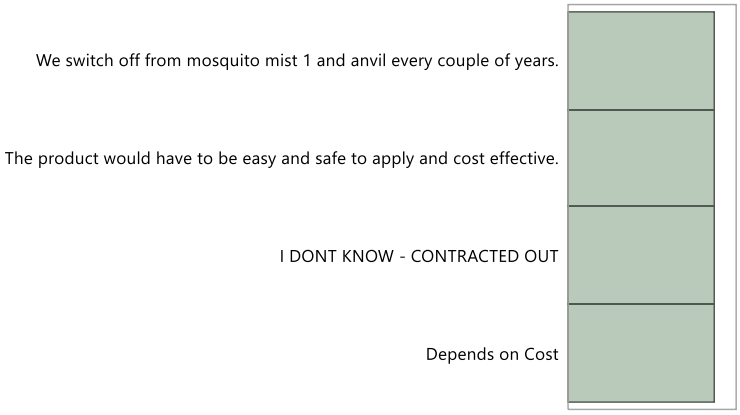


Frequencies

Level	Count	Prob
1	7	0.36842
2	12	0.63158
Total	19	1.00000

N Missing 29
2 Levels

Comments 3



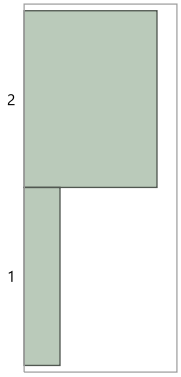
Frequencies

Level	Count	Prob
Depends on Cost	1	0.25000
I DONT KNOW - CONTRACTED OUT	1	0.25000

Level	Count	Prob
The product would have to be easy and safe to apply and cost effective.	1	0.25000
We switch off from mosquito mist 1 and anvil every couple of years.	1	0.25000
Total	4	1.00000

N Missing 44
4 Levels

Are the pesticides you utilize used in a broad spectrum, or for specific individual organisms?

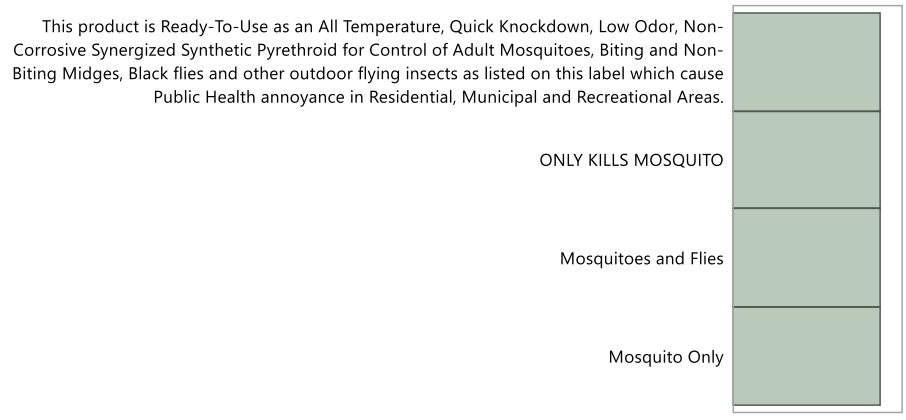


Frequencies

Level	Count	Prob
1	4	0.21053
2	15	0.78947
Total	19	1.00000

N Missing 29
2 Levels

Comments 4



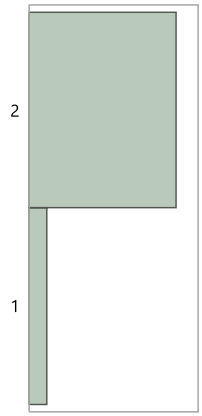
Frequencies

Level	Count	Prob
Mosquito Only	1	0.25000
Mosquitoes and Flies	1	0.25000
ONLY KILLS MOSQUITO	1	0.25000
This product is Ready-To-Use as an All Temperature, Quick Knockdown, Low Odor, Non-	1	0.25000

Level	Count	Prob
Corrosive Synergized Synthetic Pyrethroid for Control of Adult Mosquitoes, Biting and Non- Biting Midges, Black flies and other outdoor flying insects as listed on this label which cause Public Health annoyance in Residential, Municipal and Recreational Areas.		
Total	4	1.00000

N Missing 44
4 Levels

Is the pesticide used in rotation with other pesticides that have a different mode of action?

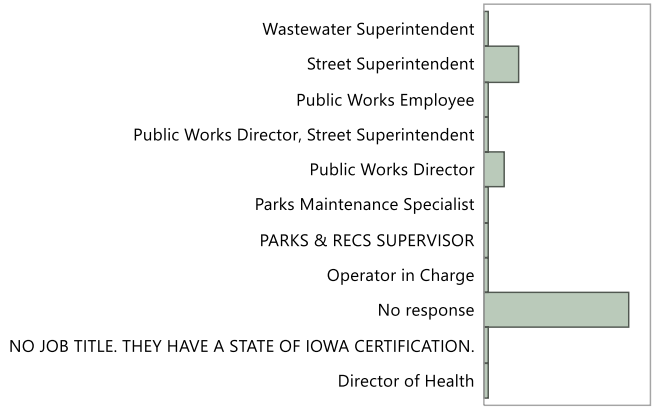


Frequencies

Level	Count	Prob
1	2	0.10526
2	17	0.89474
Total	19	1.00000

N Missing 29
2 Levels

What is the job title of the individual who oversees the fogging procedure?

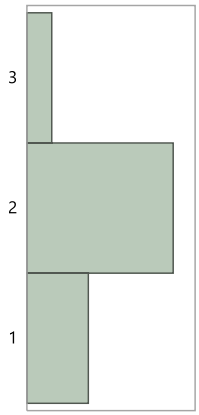


Frequencies

Level	Count	Prob
Director of Health	1	0.02083
NO JOB TITLE. THEY HAVE A STATE OF IOWA CERTIFICATION.	1	0.02083
No response	29	0.60417
Operator in Charge	1	0.02083
PARKS & RECS SUPERVISOR	1	0.02083
Parks Maintenance Specialist	1	0.02083
Public Works Director	4	0.08333
Public Works Director, Street Superintendent	1	0.02083
Public Works Employee	1	0.02083
Street Superintendent	7	0.14583
Wastewater Superintendent	1	0.02083
Total	48	1.00000

N Missing 0
11 Levels

Do you have an individual(s) that is a Federal Insecticide Fungicide Rodenticide Act certified pesticide handler? If so, what is their job title?



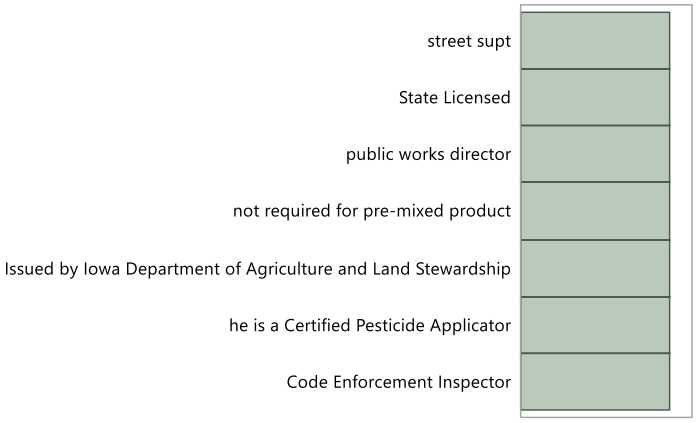
Frequencies

Level	Count	Prob
1	5	0.26316
2	12	0.63158
3	2	0.10526
Total	19	1.00000

N Missing 29

3 Levels

Comments 5



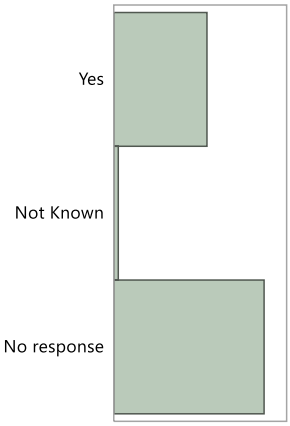
Frequencies

Level	Count	Prob
Code Enforcement Inspector	1	0.14286
he is a Certified Pesticide Applicator	1	0.14286
Issued by Iowa Department of Agriculture and Land Stewardship	1	0.14286
not required for pre-mixed product	1	0.14286
public works director	1	0.14286
State Licensed	1	0.14286
street supt	1	0.14286
Total	7	1.00000

N Missing 41

7 Levels

Are treatment handlers supervised and trained in the use of personal protective equipment (PPE)? Are PPE provided? Is PPE training provided? If PPE training is provided, how often is training and who performs the training?



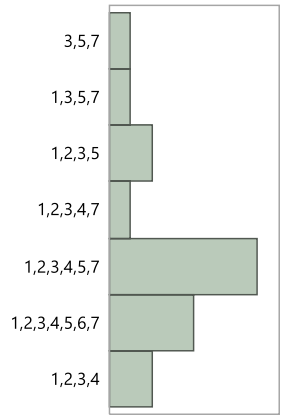
Frequencies

Level	Count	Prob
No response	29	0.60417
Not Known	1	0.02083

Level	Count	Prob
Yes	18	0.37500
Total	48	1.00000

N Missing 0
3 Levels

Are records kept regarding the use of this pesticide? (i.e. application rates, sites, dates, methods, personnel, budget) Please check all that those records include.

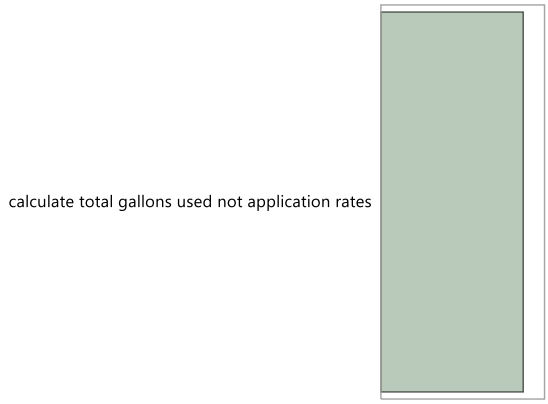


Frequencies

Level	Count	Prob
1,2,3,4	2	0.11111
1,2,3,4,5,6,7	4	0.22222
1,2,3,4,5,7	7	0.38889
1,2,3,4,7	1	0.05556
1,2,3,5	2	0.11111
1,3,5,7	1	0.05556
3,5,7	1	0.05556
Total	18	1.00000

N Missing 30
7 Levels

Comments 6

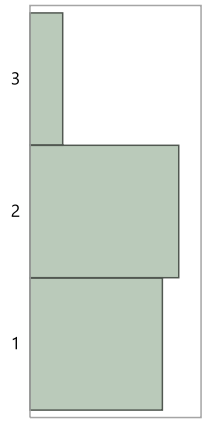


Frequencies

Level	Count	Prob
calculate total gallons used not application rates	1	1.00000
Total	1	1.00000

N Missing 47
1 Levels

Can your pesticide affect other organisms (i.e. insects, mammals, fish life) If yes, what types of organisms?

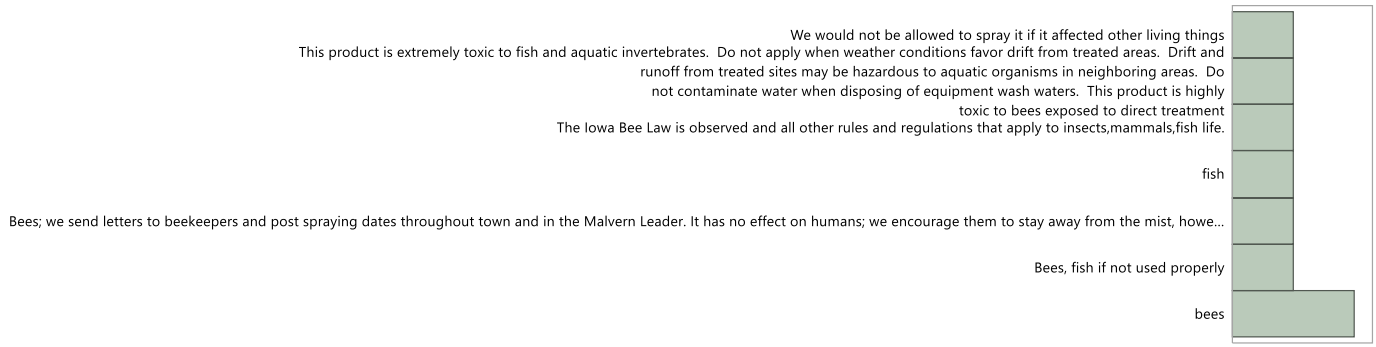


Frequencies

Level	Count	Prob
1	8	0.42105
2	9	0.47368
3	2	0.10526
Total	19	1.00000

N Missing 29
3 Levels

Comments 7



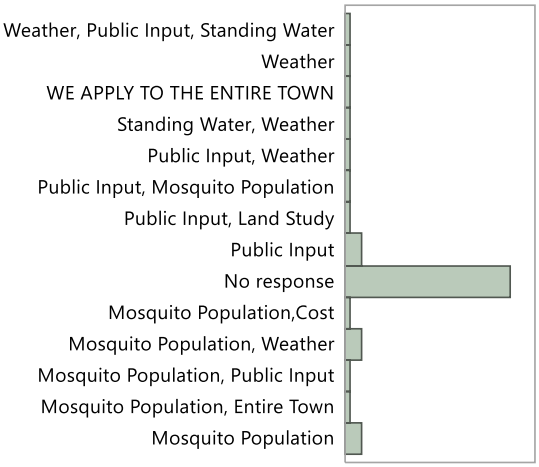
Frequencies

Level
Bees
Bees, fish if not used properly
Bees; we send letters to beekeepers and post spraying dates throughout town and in the Malvern Leader. It has no effect on humans; we
Fish
The Iowa Bee Law is observed and all other rules and regulations that apply to insects,mammals,fish life.

Level
This product is extremely toxic to fish and aquatic invertebrates. Do not apply when weather conditions favor drift from treated areas. D
runoff from treated sites may be hazardous to aquatic organisms in neighboring areas. Do
not contaminate water when disposing of equipment wash waters. This product is highly
toxic to bees exposed to direct treatment
We would not be allowed to spray it if it affected other living things
Total

N Missing 40
7 Levels

What are the indicators that are used on deciding when and where to apply treatment?

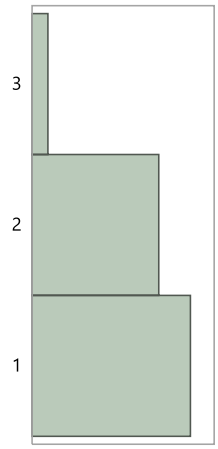


Frequencies

Level	Count	Prob
Mosquito Population	3	0.06250
Mosquito Population, Entire Town	1	0.02083
Mosquito Population, Public Input	1	0.02083
Mosquito Population, Weather	3	0.06250
Mosquito Population,Cost	1	0.02083
No response	29	0.60417
Public Input	3	0.06250
Public Input, Land Study	1	0.02083
Public Input, Mosquito Population	1	0.02083
Public Input, Weather	1	0.02083
Standing Water, Weather	1	0.02083
WE APPLY TO THE ENTIRE TOWN	1	0.02083
Weather	1	0.02083
Weather, Public Input, Standing Water	1	0.02083
Total	48	1.00000

N Missing 0
14 Levels

Do these chosen sites contain water sources?

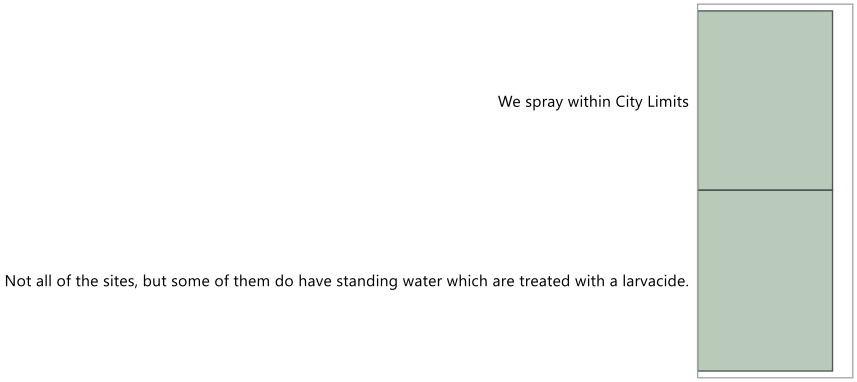


Frequencies

Level	Count	Prob
1	10	0.52632
2	8	0.42105
3	1	0.05263
Total	19	1.00000

N Missing 29
3 Levels

Comments 8

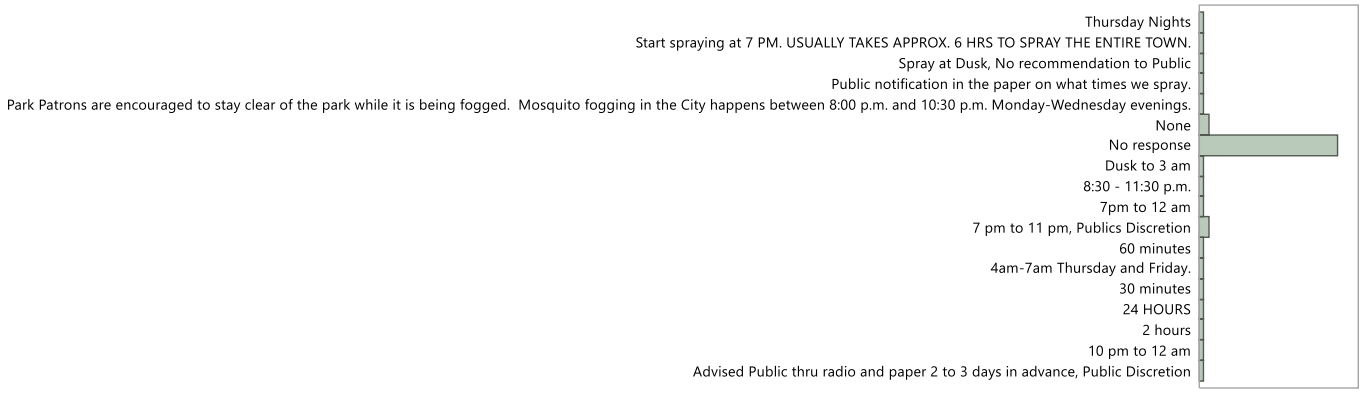


Frequencies

Level	Count	Prob
Not all of the sites, but some of them do have standing water which are treated with a larvacide.	1	0.50000
We spray within City Limits	1	0.50000
Total	2	1.00000

N Missing 46
2 Levels

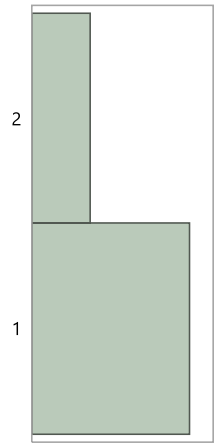
What period of time (i.e. days, hours, minutes) is recommended to the public when advised to stay indoors/ avoid fogging operations?



Frequencies

N Missing	0
18	Levels

Is your county classified as Rural or Urban?



Frequencies

Level	Count	Prob
1	35	0.72917
2	13	0.27083
Total	48	1.00000

N Missing	0
2	Levels

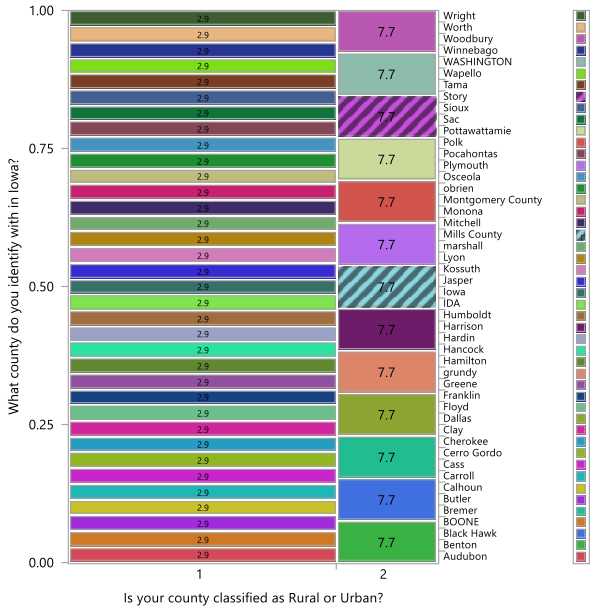
Appendices B

Applicator Bivariate Data

Fit Group

Contingency Analysis of What county do you identify with in Iowa? By Is your county classified as Rural or Urban?

Mosaic Plot



Tests

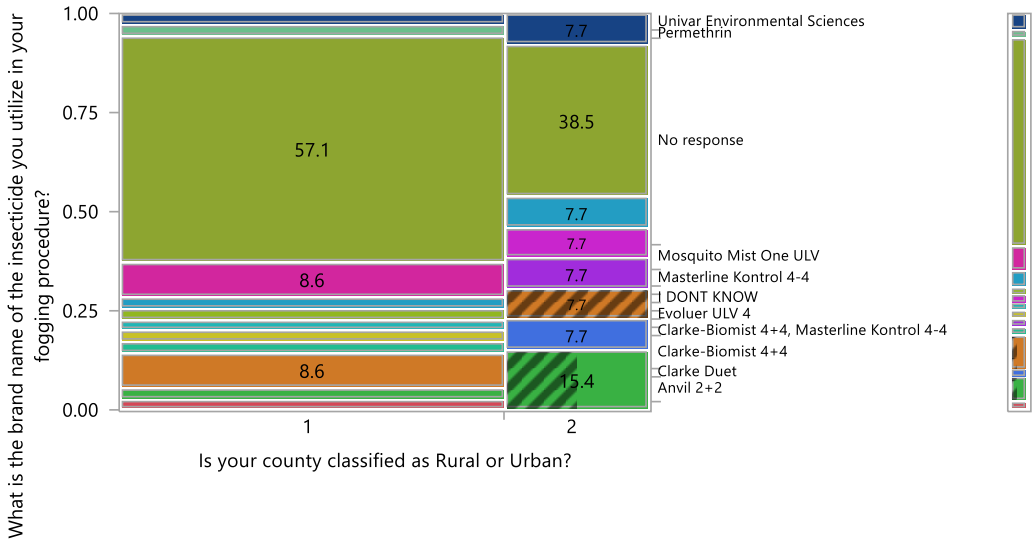
N	DF	-LogLike	RSquare (U)
48	47	28.036125	0.1509

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	56.072	0.1712
Pearson	48.000	0.4321

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 1, Pearson ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of What is the brand name of the insecticide you utilize in your fogging procedure? By Is your county classified as Rural or Urban?

Mosaic Plot



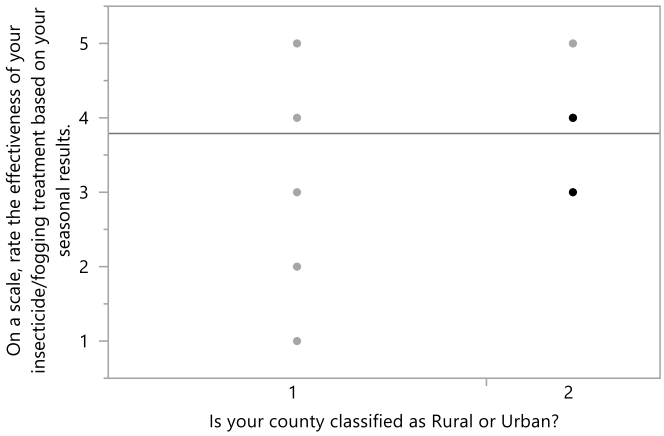
Tests

N	DF	-LogLike	RSquare (U)
48	14	8.5945923	0.0950

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	17.189	0.2462
Pearson	15.508	0.3444

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

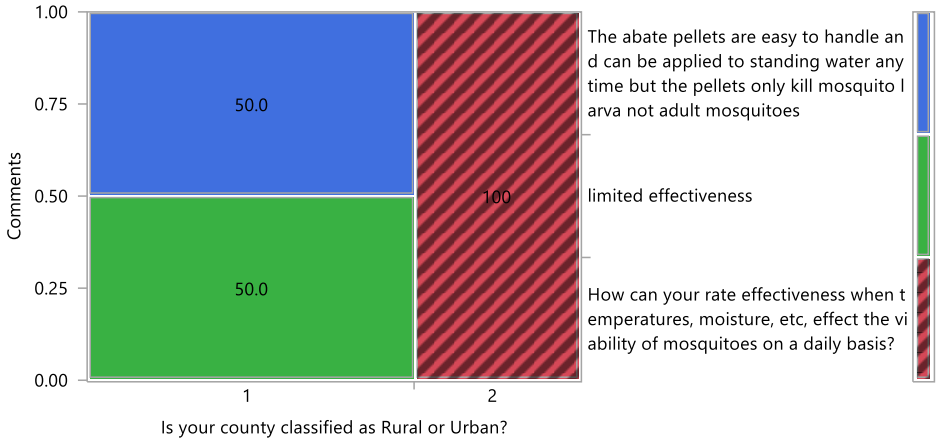
Oneway Analysis of On a scale, rate the effectiveness of your insecticide/fogging treatment based on your seasonal results. By Is your county classified as Rural or Urban?



Missing Rows 29

Contingency Analysis of Comments By Is your county classified as Rural or Urban?

Mosaic Plot



Tests

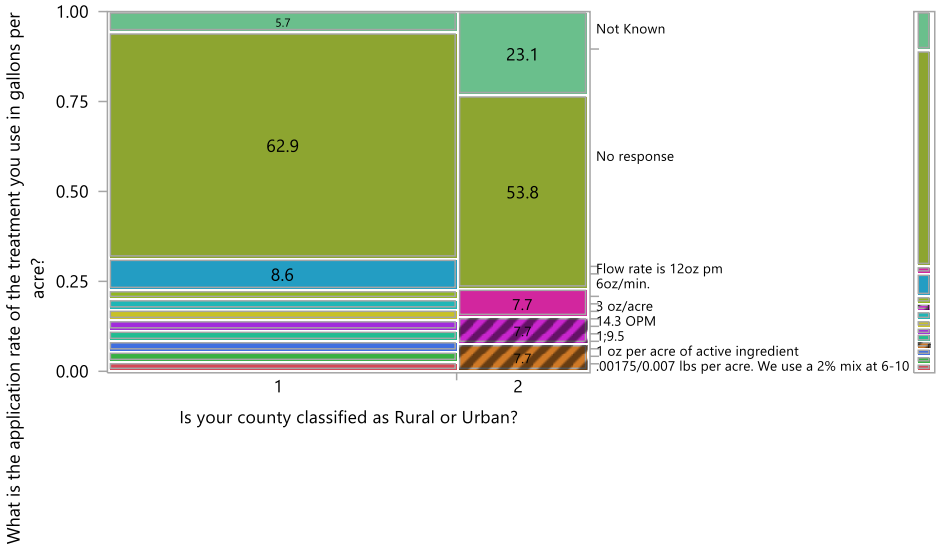
N	DF	-LogLike	RSquare (U)
3	2	1.9095425	0.5794

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	3.819	0.1481
Pearson	3.000	0.2231

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 1, Pearson ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of What is the application rate of the treatment you use in gallons per acre? By Is your county classified as Rural or Urban?

Mosaic Plot



Tests

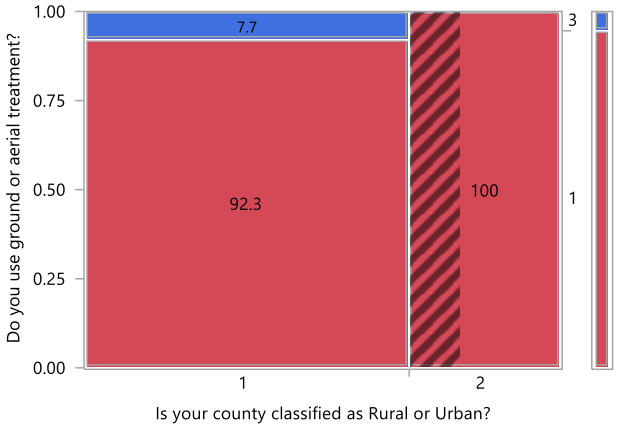
N	DF	-LogLike	RSquare (U)
48	13	8.6437923	0.1125

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	17.288	0.1865
Pearson	15.033	0.3053

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Do you use ground or aerial treatment? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Do you use ground or aerial treatment?

Count Total % Col % Row %	1	3	Total
1	12 63.16 66.67 92.31	1 5.26 100.00 7.69	13 68.42
2	6 31.58 33.33 100.00	0 0.00 0.00 0.00	6 31.58
Total	18 94.74	1 5.26	19

Tests

N	DF	-LogLike	RSquare (U)
19	1	0.39218711	0.1001

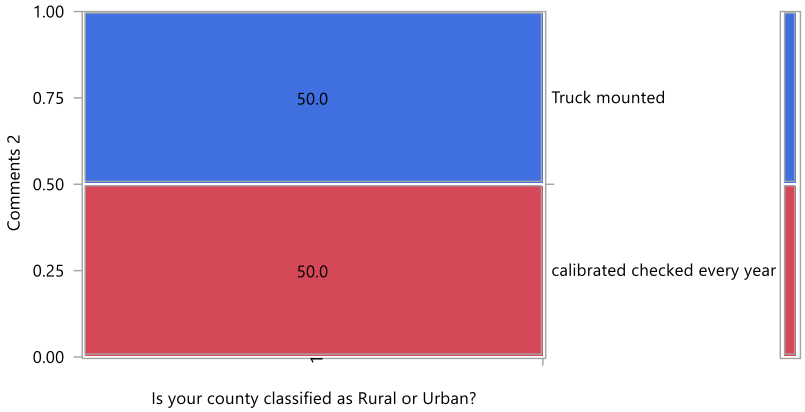
Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.784	0.3758
Pearson	0.487	0.4852

Warning: Average cell count less than 5, LR ChiSquare suspect.

Fisher's Exact Test	Prob	Alternative Hypothesis
Left	0.6842	Prob(Do you use ground or aerial treatment?=3) is greater for Is your county classified as Rural or Urban?=1 than 2
Right	1.0000	Prob(Do you use ground or aerial treatment?=3) is greater for Is your county classified as Rural or Urban?=2 than 1
2-Tail	1.0000	Prob(Do you use ground or aerial treatment?=3) is different across Is your county classified as Rural or Urban?

Contingency Analysis of Comments 2 By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Comments 2

Count Total % Col % Row %	calibrated checked every year	Truck mounted	Total
1	1 50.00 100.00 50.00	1 50.00 100.00 50.00	2 100.00
2	0 0.00 0.00 .	0 0.00 0.00 .	0 0.00
Total	1 50.00	1 50.00	2

Tests

N	DF	-LogLike	RSquare (U)
2	0	0	0.0000

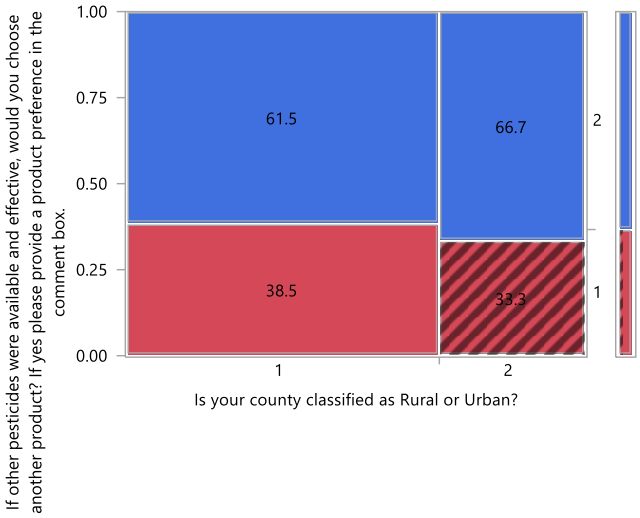
Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.000	.
Pearson	0.000	.

Warning: Average cell count less than 1, Pearson ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Fisher's Exact Test	Prob	Alternative Hypothesis
Left	1.0000	Prob(Comments 2=Truck mounted) is greater for Is your county classified as Rural or Urban?=1 than 2
Right	1.0000	Prob(Comments 2=Truck mounted) is greater for Is your county classified as Rural or Urban?=2 than 1
2-Tail	1.0000	Prob(Comments 2=Truck mounted) is different across Is your county classified as Rural or Urban?

Contingency Analysis of If other pesticides were available and effective, would you choose another product? If yes please provide a product preference in the comment box. By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By If other pesticides were available and effective, would you choose another product? If yes please provide a product preference in the comment box.

Count Total % Col % Row %	1	2	Total
1	5 26.32 71.43 38.46	8 42.11 66.67 61.54	13 68.42
2	2 10.53 28.57 33.33	4 21.05 33.33 66.67	6 31.58
Total	7 36.84	12 63.16	19

Tests

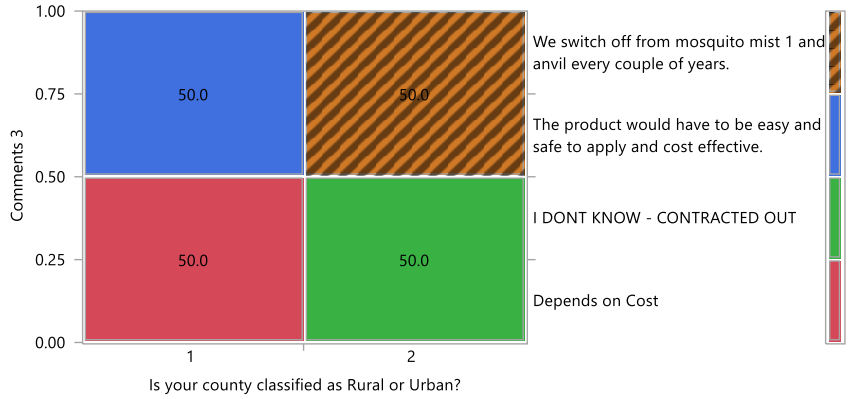
N	DF	-LogLike	RSquare (U)
19	1	0.02338500	0.0019

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.047	0.8288
Pearson	0.046	0.8295

Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Comments 3 By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Comments 3

Count Total % Col % Row %	Depends on Cost	I DONT KNOW - CONTRACTED OUT	The product would have to be easy and safe to apply and cost effective.	We switch off from mosquito mist 1 and anvil every couple of years.	Total
1	1 25.00 100.00 50.00	0 0.00 0.00 0.00	1 25.00 100.00 50.00	0 0.00 0.00 0.00	2 50.00
2	0 0.00 0.00 0.00	1 25.00 100.00 50.00	0 0.00 0.00 0.00	1 25.00 100.00 50.00	2 50.00
Total	1 25.00	1 25.00	1 25.00	1 25.00	4

Tests

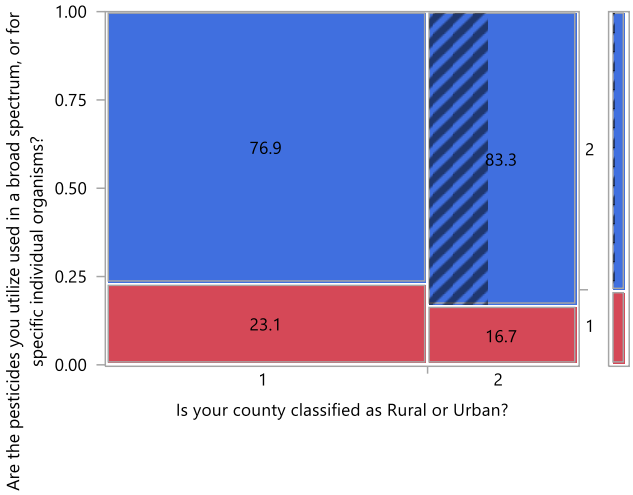
N	DF	-LogLike	RSquare (U)
4	3	2.7725887	0.5000

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	5.545	0.1360
Pearson	4.000	0.2615

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 1, Pearson ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Are the pesticides you utilize used in a broad spectrum, or for specific individual organisms? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Are the pesticides you utilize used in a broad spectrum, or for specific individual organisms?

Count Total % Col % Row %	1	2	Total
1	3 15.79 75.00 23.08	10 52.63 66.67 76.92	13 68.42
2	1 5.26 25.00 16.67	5 26.32 33.33 83.33	6 31.58
Total	4 21.05	15 78.95	19

Tests

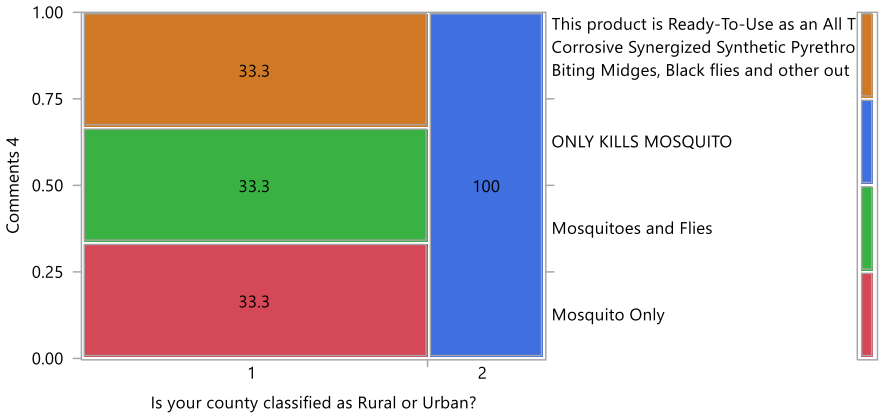
N	DF	-LogLike	RSquare (U)
19	1	0.05238904	0.0054

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.105	0.7462
Pearson	0.101	0.7500

Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Comments 4 By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Comments 4

Count Total % Col % Row %	Mosquito Only	Mosquitoes and Flies	ONLY KILLS MOSQUITO	This product is Ready-To-Use as an All Temperature, Quick Knockdown, Low Odor, Non- Corrosive Synergized Synthetic Pyrethroid for Control of Adult Mosquitoes, Biting and Non- Biting Midges, Black flies and other outdoor flying insects as listed on this label which cause Public Health annoyance in Residential, Municipal and Recreational Areas.	Total
1	1 25.00 100.00 33.33	1 25.00 100.00 33.33	0 0.00 0.00 0.00	1 25.00 100.00 33.33	3 75.00

2	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 25.00 100.00 100.00	0 0.00 0.00 0.00	1 25.00
Total	1 25.00	1 25.00	1 25.00	1 25.00	4

Tests

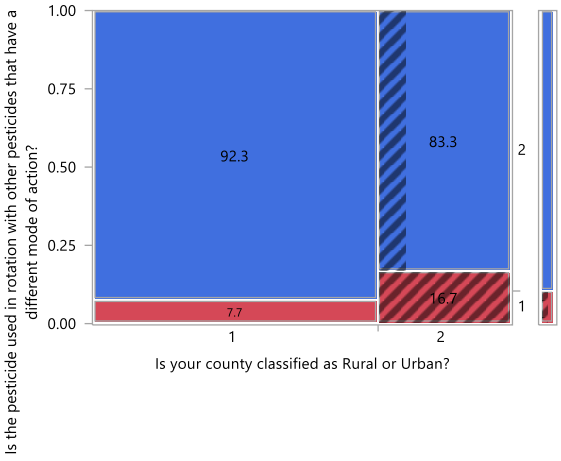
N	DF	-LogLike	RSquare (U)
4	3	2.2493406	0.4056

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	4.499	0.2124
Pearson	4.000	0.2615

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 1, Pearson ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Is the pesticide used in rotation with other pesticides that have a different mode of action? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Is the pesticide used in rotation with other pesticides that have a different mode of action?

Count Total % Col % Row %	1	2	Total
1	1 5.26 50.00 7.69	12 63.16 70.59 92.31	13 68.42
2	1 5.26	5 26.32	6 31.58

	50.00 16.67	29.41 83.33	
Total	2 10.53	17 89.47	19

Tests

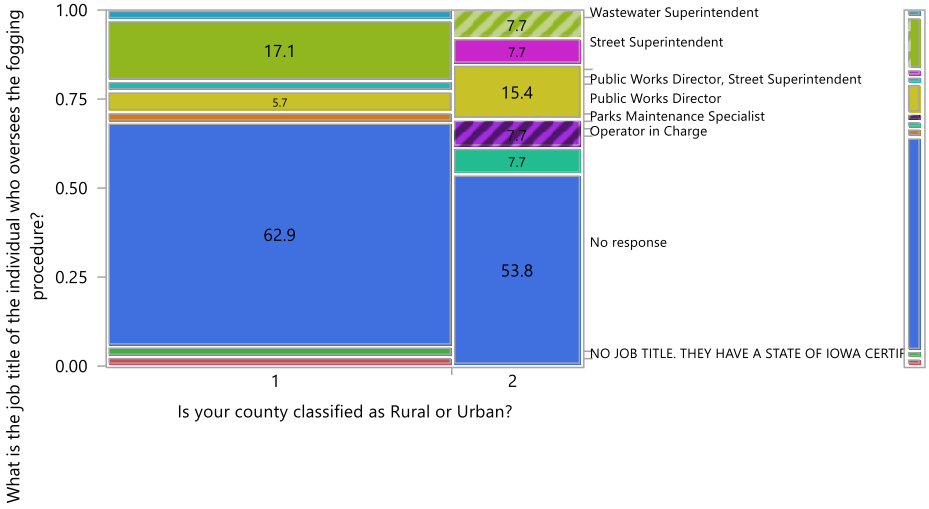
N	DF	-LogLike	RSquare (U)
19	1	0.16459029	0.0257

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.329	0.5661
Pearson	0.351	0.5535

Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of What is the job title of the individual who oversees the fogging procedure? By Is your county classified as Rural or Urban?

Mosaic Plot



Tests

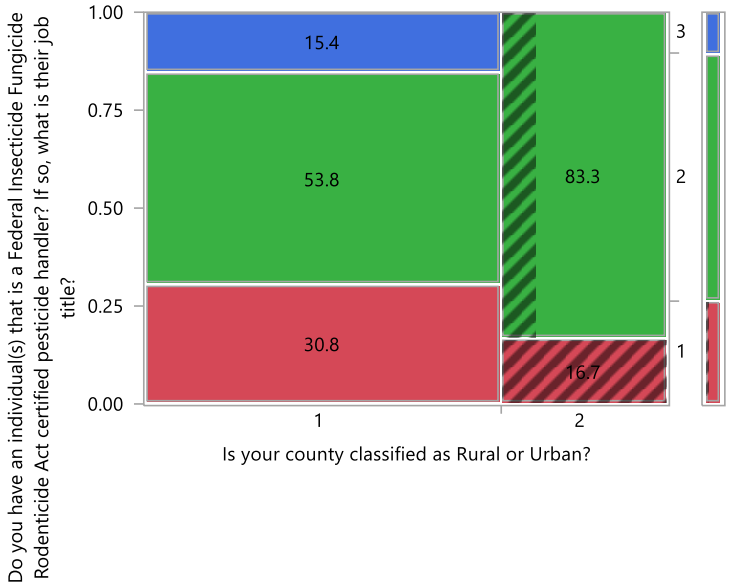
N	DF	-LogLike	RSquare (U)
48	10	6.3654477	0.0923

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	12.731	0.2391
Pearson	11.706	0.3052

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Do you have an individual(s) that is a Federal Insecticide Fungicide Rodenticide Act certified pesticide handler? If so, what is their job title? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Do you have an individual(s) that is a Federal Insecticide Fungicide Rodenticide Act certified pesticide handler? If so, what is their job title?

Count Total % Col % Row %	1	2	3	Total
1	4 21.05 80.00 30.77	7 36.84 58.33 53.85	2 10.53 100.00 15.38	13 68.42
2	1 5.26 20.00 16.67	5 26.32 41.67 83.33	0 0.00 0.00 0.00	6 31.58
Total	5 26.32	12 63.16	2 10.53	19

Tests

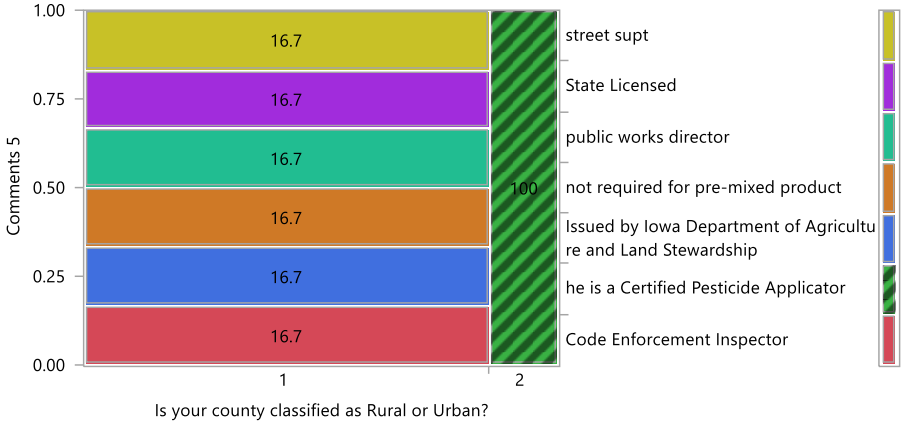
N	DF	-LogLike	RSquare (U)
19	2	1.1971108	0.0717

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	2.394	0.3021
Pearson	1.799	0.4069

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Comments 5 By Is your county classified as Rural or Urban?

Mosaic Plot



Tests

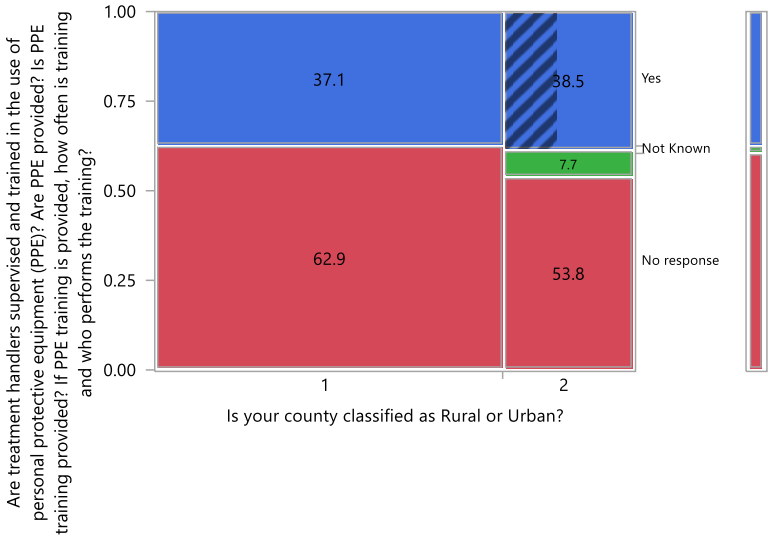
N	DF	-LogLike	RSquare (U)
7	6	2.8708142	0.2108

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	5.742	0.4527
Pearson	7.000	0.3208

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 1, Pearson ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Are treatment handlers supervised and trained in the use of personal protective equipment (PPE)? Are PPE provided? Is PPE training provided? If PPE training is provided, how often is training and who performs the training? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Are treatment handlers supervised and trained in the use of personal protective equipment (PPE)? Are PPE provided? Is PPE training provided? If PPE training is provided, how often is training and who performs the training?

Count Total % Col % Row %	No response	Not Known	Yes	Total
1	22 45.83 75.86 62.86	0 0.00 0.00 0.00	13 27.08 72.22 37.14	35 72.92
2	7 14.58 24.14 53.85	1 2.08 100.00 7.69	5 10.42 27.78 38.46	13 27.08
Total	29 60.42	1 2.08	18 37.50	48

Tests

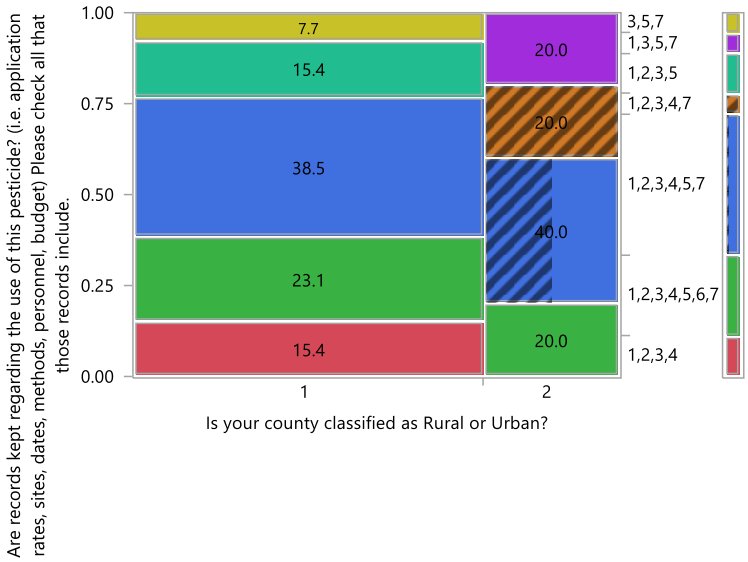
N	DF	-LogLike	RSquare (U)
48	2	1.3736902	0.0380

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	2.747	0.2532
Pearson	2.824	0.2436

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.

Contingency Analysis of Are records kept regarding the use of this pesticide? (i.e. application rates, sites, dates, methods, personnel, budget) Please check all that those records include. By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Are records kept regarding the use of this pesticide? (i.e. application rates, sites, dates, methods, personnel, budget) Please check all that those records include.

Count Total % Col % Row %	1,2,3,4	1,2,3,4,5,6,7	1,2,3,4,5,7	1,2,3,4,7	1,2,3,5	1,3,5,7	3,5,7	Total
1	2 11.11 100.00 15.38	3 16.67 75.00 23.08	5 27.78 71.43 38.46	0 0.00 0.00 0.00	2 11.11 100.00 15.38	0 0.00 0.00 0.00	1 5.56 100.00 7.69	13 72.22
2	0 0.00 0.00 0.00	1 5.56 25.00 20.00	2 11.11 28.57 40.00	1 5.56 100.00 20.00	0 0.00 0.00 0.00	1 5.56 100.00 20.00	0 0.00 0.00 0.00	5 27.78
Total	2 11.11	4 22.22	7 38.89	1 5.56	2 11.11	1 5.56	1 5.56	18

Tests

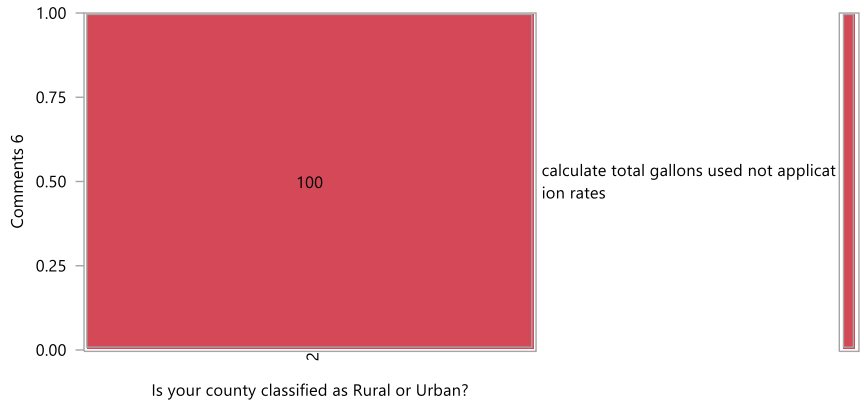
N	DF	-LogLike	RSquare (U)
18	6	4.1979327	0.1395

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	8.396	0.2105
Pearson	7.141	0.3080

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Comments 6 By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Comments 6

Count Total % Col % Row %	calculate total gallons used not application rates	Total
1	0 0.00 0.00 .	0 0.00
2	1 100.00 100.00 100.00	1 100.00
Total	1 100.00	1

Tests

N	DF	-LogLike	RSquare (U)
1	0	0	.

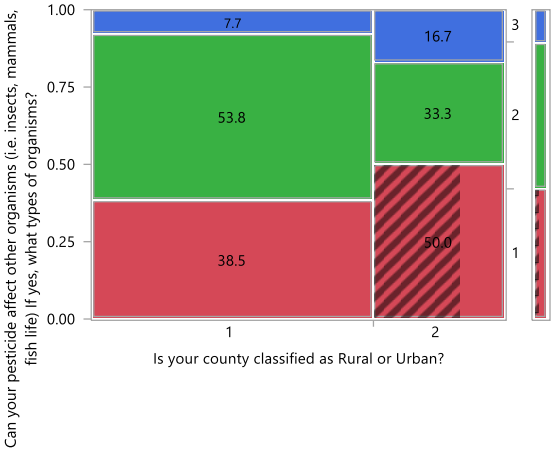
Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.000	.
Pearson	0.000	.

Warning: Average cell count less than 1, Pearson ChiSquare suspect.

Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Can your pesticide affect other organisms (i.e. insects, mammals, fish life) If yes, what types of organisms? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Can your pesticide affect other organisms (i.e. insects, mammals, fish life) If yes, what types of organisms?

Count Total % Col % Row %	1	2	3	Total
1	5 26.32 62.50 38.46	7 36.84 77.78 53.85	1 5.26 50.00 7.69	13 68.42
2	3 15.79 37.50 50.00	2 10.53 22.22 33.33	1 5.26 50.00 16.67	6 31.58
Total	8 42.11	9 47.37	2 10.53	19

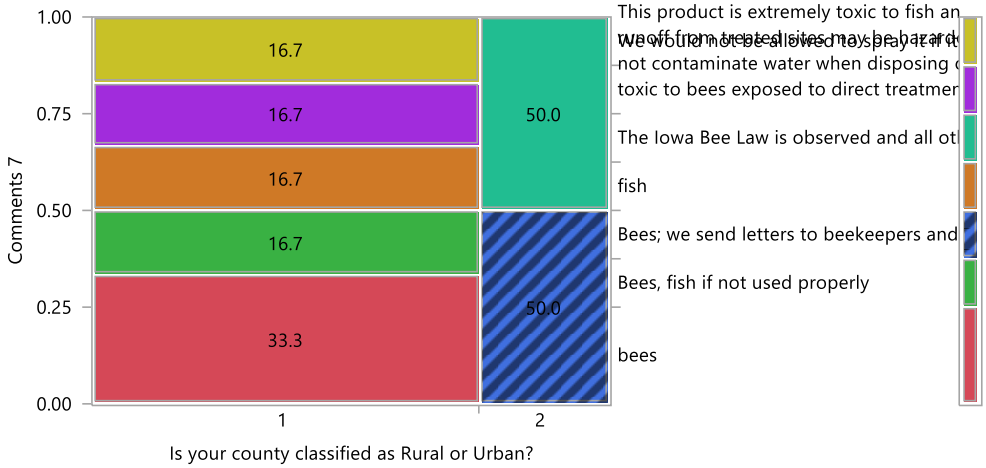
Tests

N	DF	-LogLike	RSquare (U)
19	2	0.40328608	0.0222

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.807	0.6681
Pearson	0.809	0.6674

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Comments 7 By Is your county classified as Rural or Urban?
Mosaic Plot



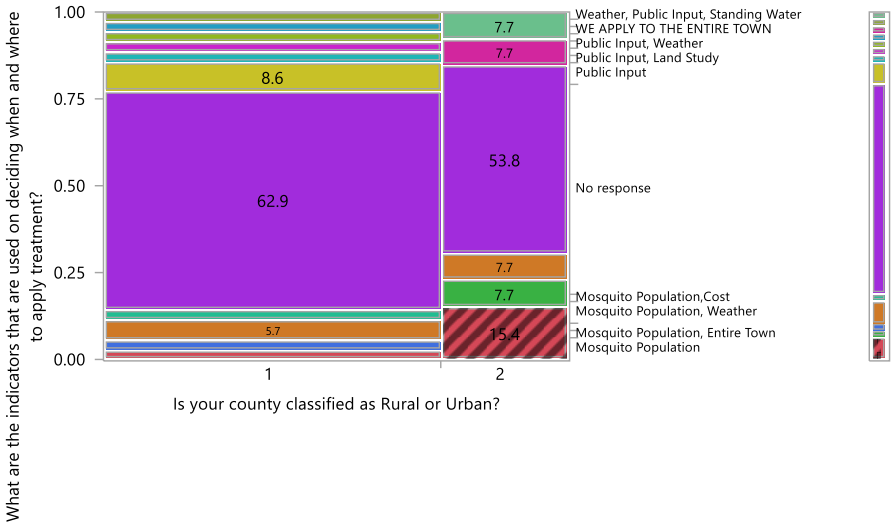
Tests

N	DF	-LogLike	RSquare (U)
8	6	4.4986812	0.2950

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	8.997	0.1737
Pearson	8.000	0.2381

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 1, Pearson ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of What are the indicators that are used on deciding when and where to apply treatment? By Is your county classified as Rural or Urban?
Mosaic Plot



Tests

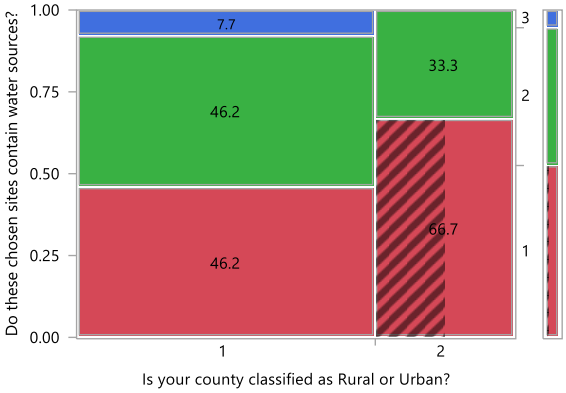
N	DF	-LogLike	RSquare (U)
48	13	8.1897657	0.1046

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	16.380	0.2292
Pearson	14.358	0.3491

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Do these chosen sites contain water sources? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Do these chosen sites contain water sources?

Count Total % Col % Row %	1	2	3	Total
1	6 31.58 60.00 46.15	6 31.58 75.00 46.15	1 5.26 100.00 7.69	13 68.42
2	4 21.05 40.00 66.67	2 10.53 25.00 33.33	0 0.00 0.00 0.00	6 31.58
Total	10 52.63	8 42.11	1 5.26	19

Tests

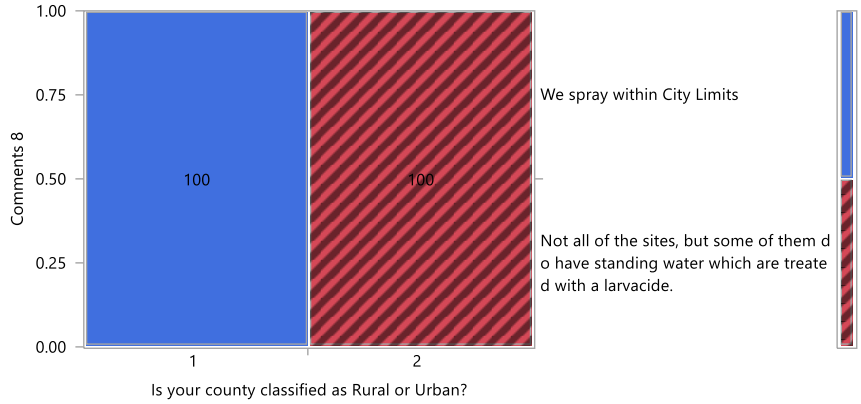
N	DF	-LogLike	RSquare (U)
19	2	0.62064431	0.0381

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	1.241	0.5376
Pearson	0.950	0.6219

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Comments 8 By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Comments 8

Count Total % Col % Row %	Not all of the sites, but some of them do have standing water which are treated with a larvacide.	We spray within City Limits	Total
1	0 0.00 0.00 0.00	1 50.00 100.00 100.00	1 50.00
2	1 50.00 100.00 100.00	0 0.00 0.00 0.00	1 50.00
Total	1 50.00	1 50.00	2

Tests

N	DF	-LogLike	RSquare (U)
2	1	1.3862944	1.0000

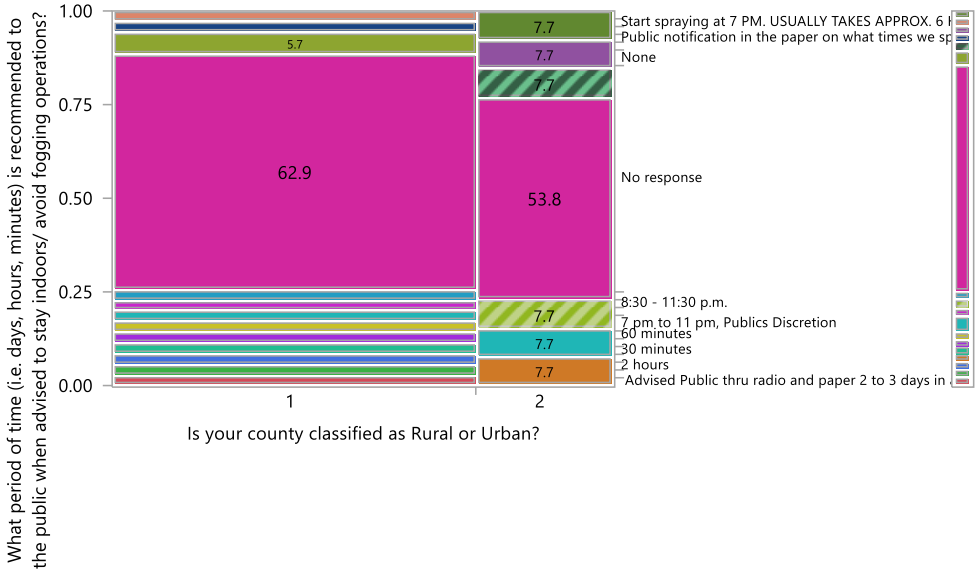
Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	2.773	0.0959
Pearson	2.000	0.1573

Warning: Average cell count less than 1, Pearson ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Fisher's Exact Test	Prob	Alternative Hypothesis
Left	0.5000	Prob(Comments 8=We spray within City Limits) is greater for Is your county classified as Rural or Urban?=1 than
Right	1.0000	Prob(Comments 8=We spray within City Limits) is greater for Is your county classified as Rural or Urban?=2 than
2-Tail	1.0000	Prob(Comments 8=We spray within City Limits) is different across Is your county classified as Rural or Urban?

Contingency Analysis of What period of time (i.e. days, hours, minutes) is recommended to the public when advised to stay indoors/ avoid fogging operations? By Is your county classified as Rural or Urban?

Mosaic Plot



Tests

N	DF	-LogLike	RSquare (U)
48	17	10.622556	0.1244

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	21.245	0.2155
Pearson	18.578	0.3533

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

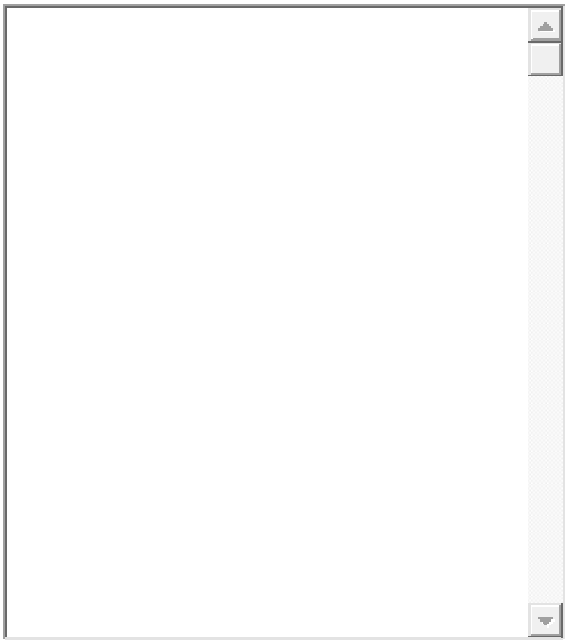
Public Health Questionnaire

*Required Question(s)

*1. What county do you identify with in Iowa?

350 characters left.

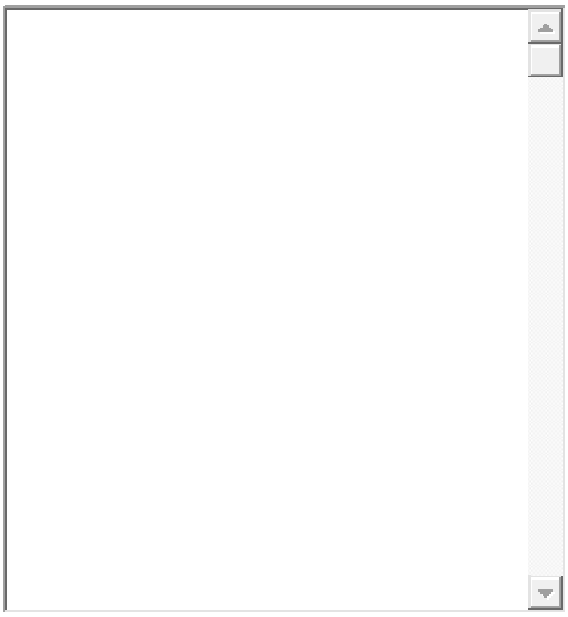
*2. What is the brand name of the insecticide you utilize in your fogging procedure?



350 characters left.

✱3. On a scale, rate the effectiveness of your insecticide/fogging treatment based on your seasonal results.

Not Effective		**Moderately Effective**		**Extremely Effective**
○	○	○	○	○

- Comment:
- 

  500 characters left.

*4. What is the application rate of the treatment you use in gallons per acre?

350 characters left.

*5. Do you use ground or aerial treatment?

- Ground only
- Aerial only
- Both Ground and Aerial Treatment

- Comment:

-

  500 characters left.

✻6. If other pesticides were available and effective, would you choose another product? If yes please provide a product preference in the comment box.

- Yes
- No

- Comment:
-

  500 characters left.

*7. Are the pesticides you utilize used in a broad spectrum, or for specific individual organisms?

- Broad Spectrum
- Specific Organisms
- Other

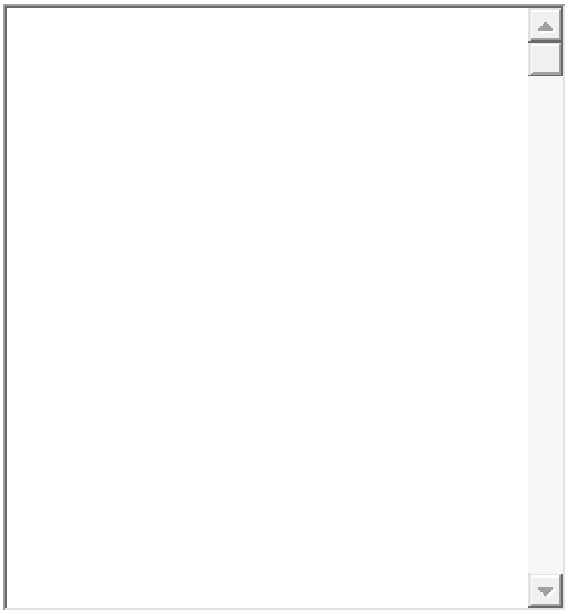
- Comment:
-

500 characters left.

*8. Is the pesticide used in rotation with other pesticides that have a different mode of action?

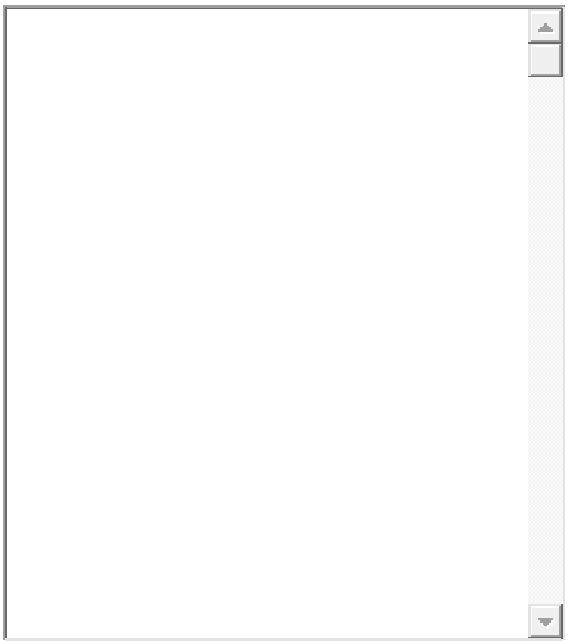
- Yes
- No
- Other

- Comment:

- 

500 characters left.

*9. What is the job title of the individual who oversees the fogging procedure?



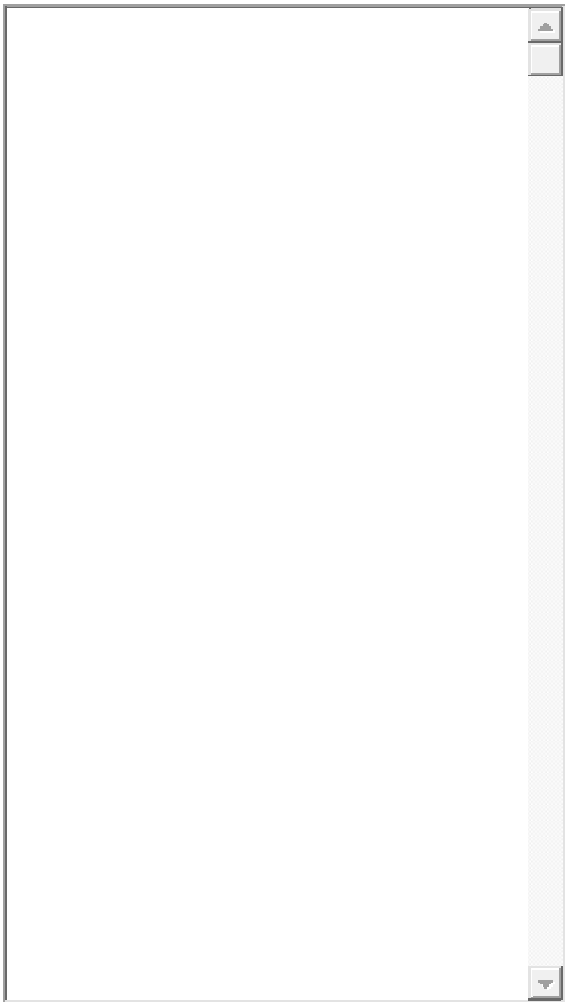
350 characters left.

*10. Do you have an individual(s) that is a Federal Insecticide Fungicide Rodenticide Act certified pesticide handler? If so, what is their job title?

- Yes
- No
- Other

- Comment:
- 500 characters left.

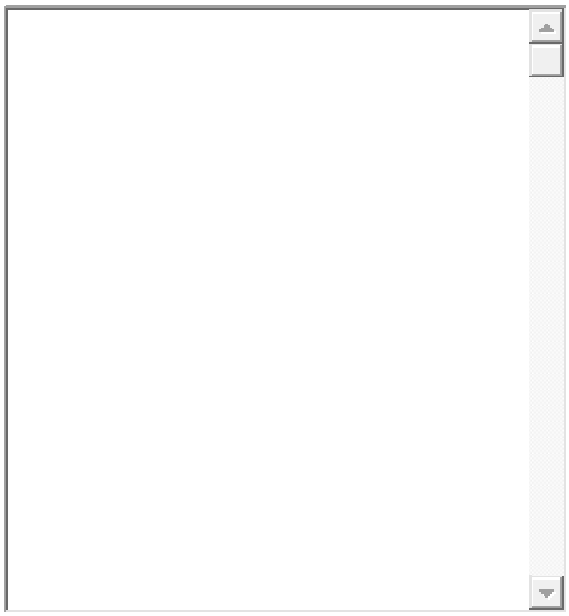
✻11. Are treatment handlers supervised and trained in the use of personal protective equipment (PPE)? Are PPE provided? Is PPE training provided? If PPE training is provided, how often is training and who performs the training?



1000 characters left.

✻12. Are records kept regarding the use of this pesticide? (i.e. application rates, sites, dates, methods, personnel, budget) Please check all that those records include.

- ☐ Application Rates
- ☐ Sites
- ☐ Dates
- ☐ Methods
- ☐ Personnel
- ☐ Budget
- ☐ Amount
- ☐ None

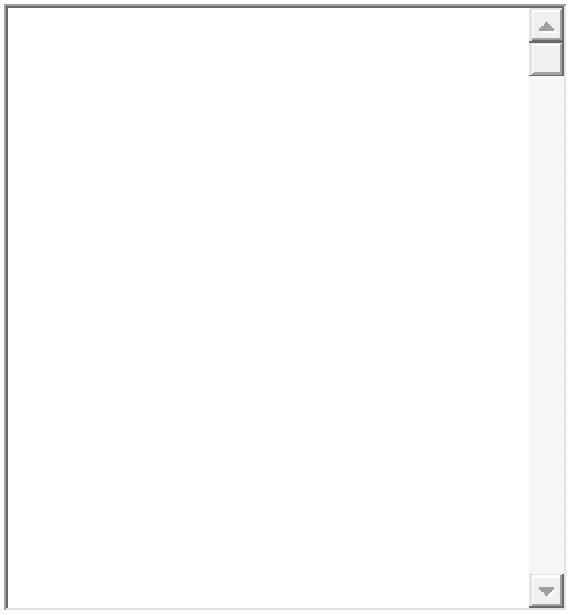
- Comment:
- 

  500 characters left.

✱13. Can your pesticide affect other organisms (i.e. insects, mammals, fish life) If yes, what types of organisms?

- Yes
- No
- Do not Know

- Comment:

- 

  500 characters left.

✻14. What are the indicators that are used on deciding when and where to apply treatment?

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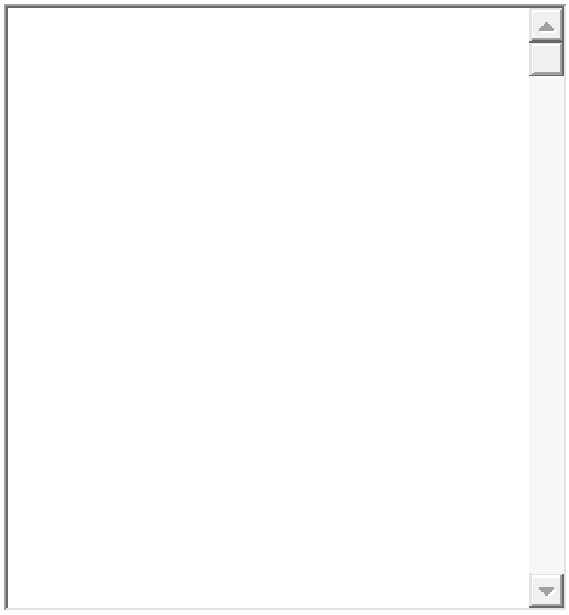
✱15. Do these chosen sites contain water sources?

- Yes
- No
- Other

- Comment:

- 

  500 characters left.

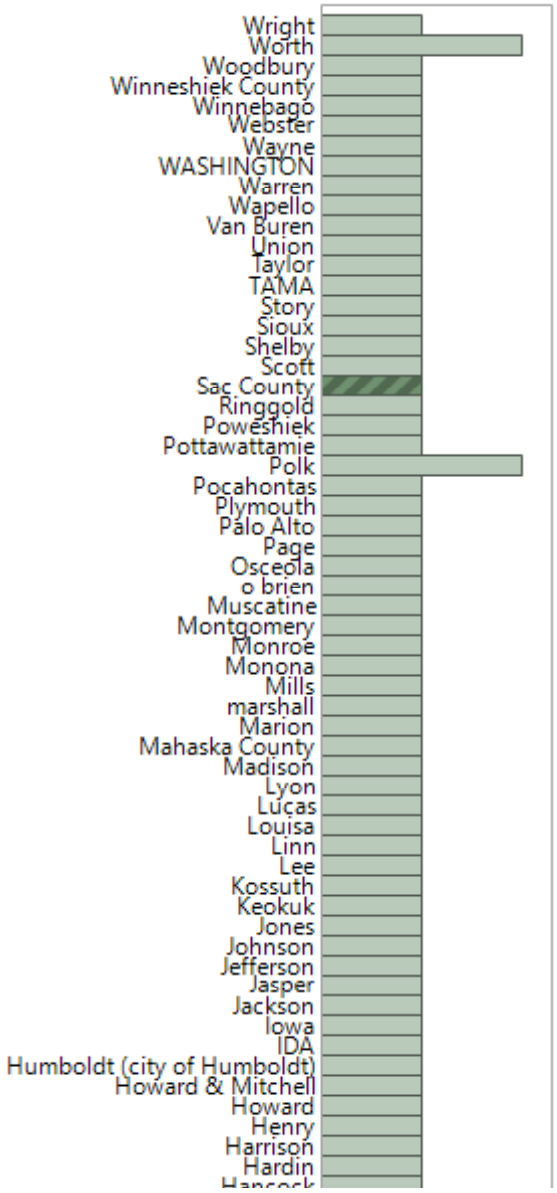
✻16. What period of time (i.e. days, hours, minutes) is recommended to the public when advised to stay indoors/ avoid fogging operations?

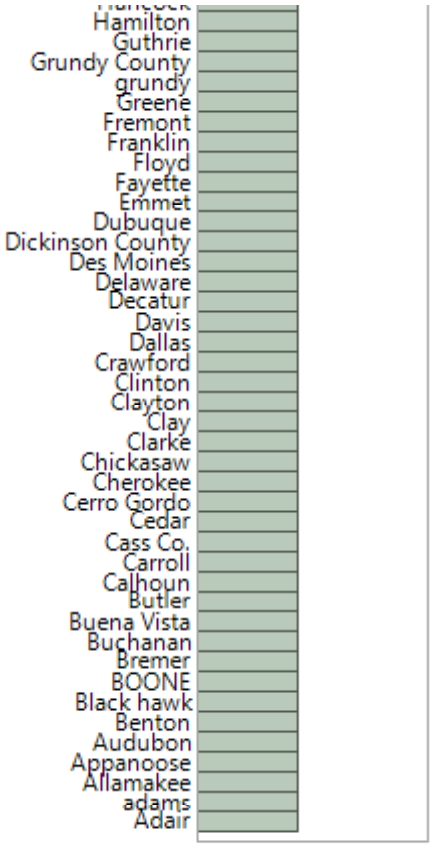
Appendices C

Public Health Univariate Data

Distributions

What county do you identify with in Iowa?





Frequencies

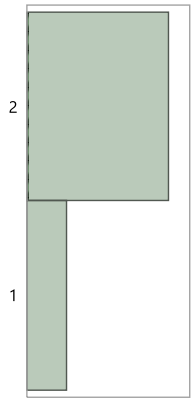
Level	Count	Prob
Adair	1	0.00980
Adams	1	0.00980
Allamakee	1	0.00980
Appanoose	1	0.00980
Audubon	1	0.00980
Benton	1	0.00980
Black hawk	1	0.00980
BOONE	1	0.00980
Bremer	1	0.00980
Buchanan	1	0.00980
Buena Vista	1	0.00980
Butler	1	0.00980
Calhoun	1	0.00980
Carroll	1	0.00980
Cass Co.	1	0.00980
Cedar	1	0.00980
Cerro Gordo	1	0.00980
Cherokee	1	0.00980
Chickasaw	1	0.00980
Clarke	1	0.00980
Clay	1	0.00980
Clayton	1	0.00980
Clinton	1	0.00980

Level	Count	Prob
Crawford	1	0.00980
Dallas	1	0.00980
Davis	1	0.00980
Decatur	1	0.00980
Delaware	1	0.00980
Des Moines	1	0.00980
Dickinson County	1	0.00980
Dubuque	1	0.00980
Emmet	1	0.00980
Fayette	1	0.00980
Floyd	1	0.00980
Franklin	1	0.00980
Fremont	1	0.00980
Greene	1	0.00980
Grundy	1	0.00980
Grundy County	1	0.00980
Guthrie	1	0.00980
Hamilton	1	0.00980
Hancock	1	0.00980
Hardin	1	0.00980
Harrison	1	0.00980
Henry	1	0.00980
Howard	1	0.00980
Howard & Mitchell	1	0.00980
Humboldt (city of Humboldt)	1	0.00980
IDA	1	0.00980
Iowa	1	0.00980
Jackson	1	0.00980
Jasper	1	0.00980
Jefferson	1	0.00980
Johnson	1	0.00980
Jones	1	0.00980
Keokuk	1	0.00980
Kossuth	1	0.00980
Lee	1	0.00980
Linn	1	0.00980
Louisa	1	0.00980
Lucas	1	0.00980
Lyon	1	0.00980
Madison	1	0.00980
Mahaska County	1	0.00980
Marion	1	0.00980
Marshall	1	0.00980
Mills	1	0.00980
Monona	1	0.00980
Monroe	1	0.00980
Montgomery	1	0.00980
Muscatine	1	0.00980
o brien	1	0.00980
Osceola	1	0.00980
Page	1	0.00980
Palo Alto	1	0.00980
Plymouth	1	0.00980

Level	Count	Prob
Pocahontas	1	0.00980
Polk	2	0.01961
Pottawattamie	1	0.00980
Poweshiek	1	0.00980
Ringgold	1	0.00980
Sac County	1	0.00980
Scott	1	0.00980
Shelby	1	0.00980
Sioux	1	0.00980
Story	1	0.00980
TAMA	1	0.00980
Taylor	1	0.00980
Union	1	0.00980
Van Buren	1	0.00980
Wapello	1	0.00980
Warren	1	0.00980
WASHINGTON	1	0.00980
Wayne	1	0.00980
Webster	1	0.00980
Winnebago	1	0.00980
Winneshiek County	1	0.00980
Woodbury	1	0.00980
Worth	2	0.01961
Wright	1	0.00980
Total	102	1.00000

N Missing 0
100 Levels

Does your county fog for mosquitoes?

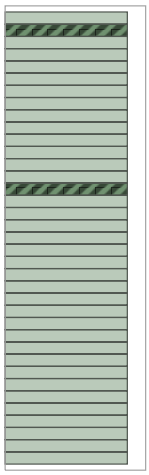


Frequencies

Level	Count	Prob
1	22	0.21569
2	80	0.78431
Total	102	1.00000

N Missing 0
2 Levels

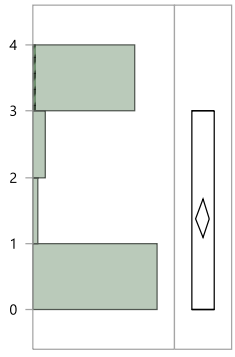
Comments



Total Cases	102
Total Responses	37
Levels	37

Empty	71
Responding	31
Single Item	25
Multiple Item	6

How many times does your department fog?



Quantiles

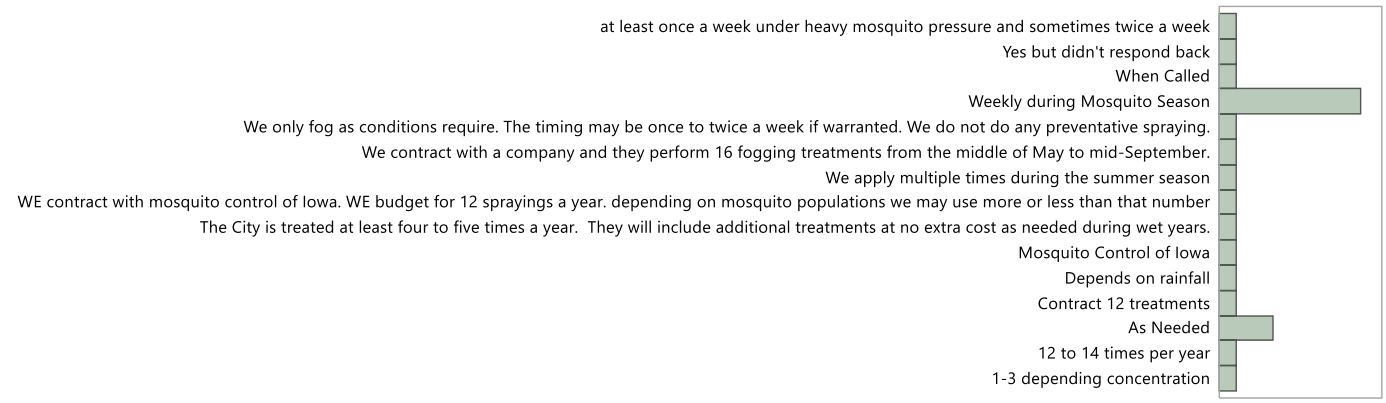
100.0%	maximum	3
99.5%		3
97.5%		3
90.0%		3
75.0%	quartile	3
50.0%	median	0
25.0%	quartile	0

10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.38
Std Dev	1.4549116
Std Err Mean	0.1454912
Upper 95% Mean	1.668686
Lower 95% Mean	1.091314
N	100

Comments 2



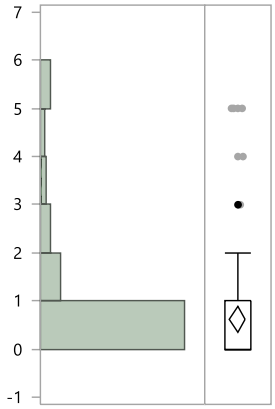
Frequencies

Level	Count	Share of Responses	Rate Per Case
1-3 depending concentration	1	0.0417	0.0098
12 to 14 times per year	1	0.0417	0.0098
As Needed	3	0.1250	0.0294
Contract 12 treatments	1	0.0417	0.0098
Depends on rainfall	1	0.0417	0.0098
Mosquito Control of Iowa	1	0.0417	0.0098
The City is treated at least four to five times a year. They will include additional treatments at no extra cost as needed during wet years.	1	0.0417	0.0098
WE contract with mosquito control of Iowa. WE budget for 12 sprayings a year. depending on mosquito populations we may use more or less than that number	1	0.0417	0.0098
We apply multiple times during the summer season	1	0.0417	0.0098
We contract with a company and they perform 16 fogging treatments from the middle of May to mid-September.	1	0.0417	0.0098
We only fog as conditions require. The timing may be once to twice a week if warranted. We do not do any preventative spraying.	1	0.0417	0.0098
Weekly during Mosquito Season	8	0.3333	0.0784
When Called	1	0.0417	0.0098
Yes but didn't respond back	1	0.0417	0.0098
at least once a week under heavy mosquito pressure and sometimes twice a week	1	0.0417	0.0098

Total Cases	102
Total Responses	24
Levels	15

Empty	78
Responding	24
Single Item	24
Multiple Item	0

How many times in the Spring season does your department fog?



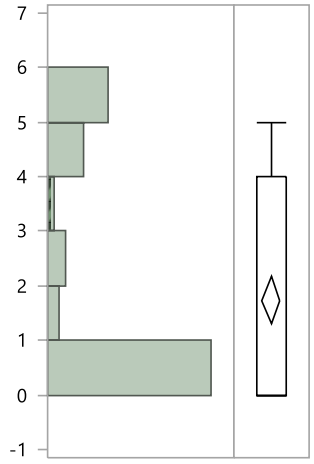
Quantiles

100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		3
75.0%	quartile	1
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	0.6326531
Std Dev	1.3423149
Std Err Mean	0.1355943
Upper 95% Mean	0.9017702
Lower 95% Mean	0.3635359
N	98

How many times in the Summer season does your department fog?



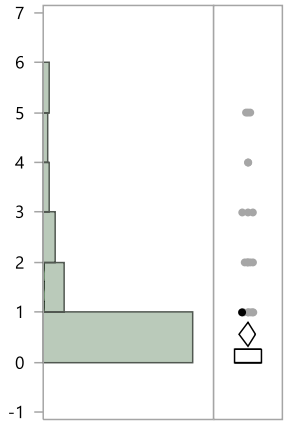
Quantiles

100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		5
75.0%	quartile	4
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	1.7346939
Std Dev	2.1373026
Std Err Mean	0.2159002
Upper 95% Mean	2.1631959
Lower 95% Mean	1.3061918
N	98

How many times in the Fall season does your department fog?



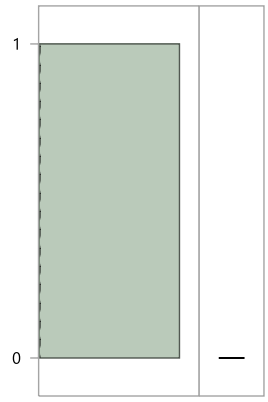
Quantiles

100.0%	maximum	5
99.5%		5
97.5%		5
90.0%		2
75.0%	quartile	0.25
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	0.5510204
Std Dev	1.1938196
Std Err Mean	0.120594
Upper 95% Mean	0.7903661
Lower 95% Mean	0.3116747
N	98

How many times in the Winter season does your department fog?



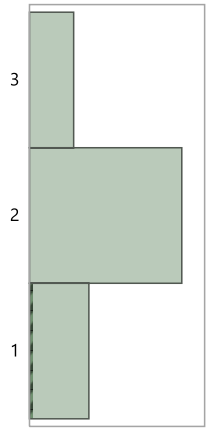
Quantiles

100.0%	maximum	0
99.5%		0
97.5%		0
90.0%		0
75.0%	quartile	0
50.0%	median	0
25.0%	quartile	0
10.0%		0
2.5%		0
0.5%		0
0.0%	minimum	0

Summary Statistics

Mean	0
Std Dev	0
Std Err Mean	0
Upper 95% Mean	0
Lower 95% Mean	0
N	98

Is your department in charge of applying insecticide/fogging treatment?

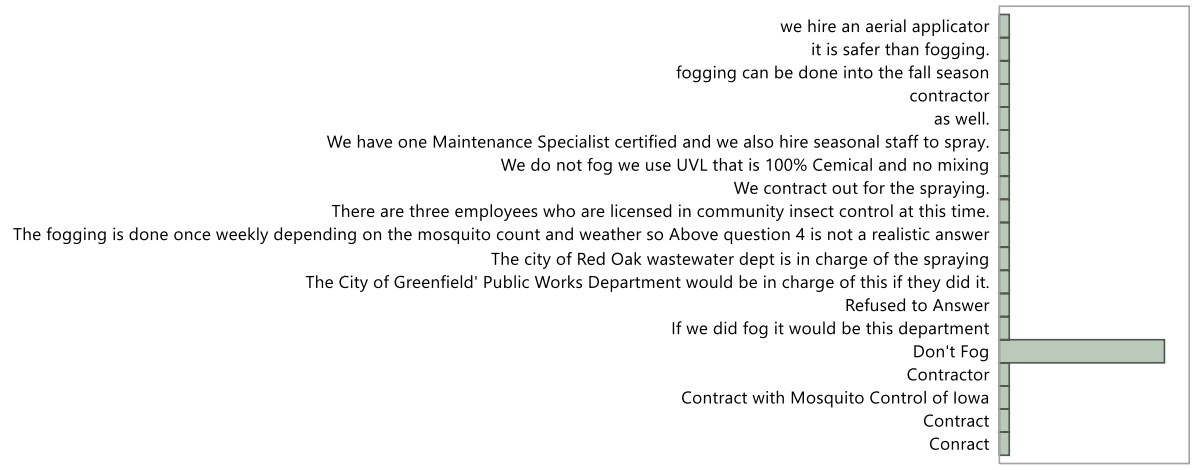


Frequencies

Level	Count	Prob
1	23	0.23232
2	59	0.59596
3	17	0.17172
Total	99	1.00000

N Missing	3
3	Levels

Comments 3



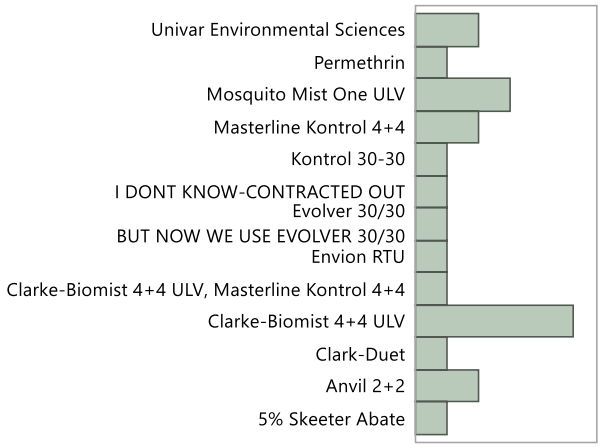
Frequencies

Level	Count	Share of Responses	Rate Per Case
Conract	1	0.0286	0.0098
Contract	1	0.0286	0.0098
Contract with Mosquito Control of Iowa	1	0.0286	0.0098
Contractor	1	0.0286	0.0098
Don't Fog	17	0.4857	0.1667
If we did fog it would be this department	1	0.0286	0.0098
Refused to Answer	1	0.0286	0.0098
The City of Greenfield' Public Works Department would be in charge of this if they did it.	1	0.0286	0.0098
The city of Red Oak wastewater dept is in charge of the spraying	1	0.0286	0.0098
The fogging is done once weekly depending on the mosquito count and weather so Above question 4 is not a realistic answer	1	0.0286	0.0098
There are three employees who are licensed in community insect control at this time.	1	0.0286	0.0098
We contract out for the spraying.	1	0.0286	0.0098
We do not fog we use UVL that is 100% Cemical and no mixing	1	0.0286	0.0098
We have one Maintenance Specialist certified and we also hire seasonal staff to spray.	1	0.0286	0.0098
as well.	1	0.0286	0.0098
Contractor	1	0.0286	0.0098
fogging can be done into the fall season	1	0.0286	0.0098
it is safer than fogging.	1	0.0286	0.0098
we hire an aerial applicator	1	0.0286	0.0098

Total Cases	102
Total Responses	35
Levels	19

Empty	70
Responding	32
Single Item	30
Multiple Item	2

If Yes, what is the brand name of the insecticide you utilize in your fogging procedure?

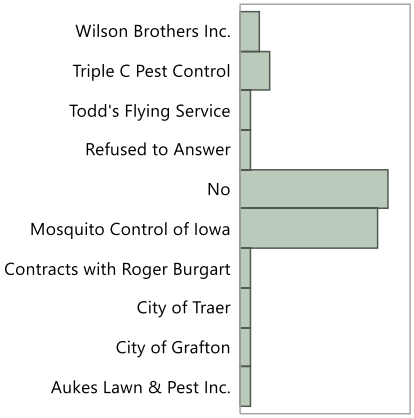


Frequencies

Level	Count	Prob
5% Skeeter Abate	1	0.04545
Anvil 2+2	2	0.09091
Clark-Duet	1	0.04545
Clarke-Biomist 4+4 ULV	5	0.22727
Clarke-Biomist 4+4 ULV, Masterline Kontrol 4+4	1	0.04545
Envion RTU	1	0.04545
Evolver 30/30	1	0.04545
BUT NOW WE USE EVOLVER 30/30		
I DONT KNOW-CONTRACTED OUT	1	0.04545
Kontrol 30-30	1	0.04545
Masterline Kontrol 4+4	2	0.09091
Mosquito Mist One ULV	3	0.13636
Permethrin	1	0.04545
Univar Environmental Sciences	2	0.09091
Total	22	1.00000

N Missing 80
13 Levels

If No, do you have an outside hire? If so, who?

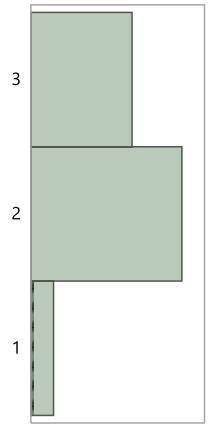


Frequencies

Level	Count	Prob
Aukes Lawn & Pest Inc.	1	0.02500
City of Grafton	1	0.02500
City of Traer	1	0.02500
Contracts with Roger Burgart	1	0.02500
Mosquito Control of Iowa	14	0.35000
No	15	0.37500
Refused to Answer	1	0.02500
Todd's Flying Service	1	0.02500
Triple C Pest Control	3	0.07500
Wilson Brothers Inc.	2	0.05000
Total	40	1.00000

N Missing 62
10 Levels

If other pesticides were available and effective, would you choose another product? If yes, please provide a product preference in the comment box.

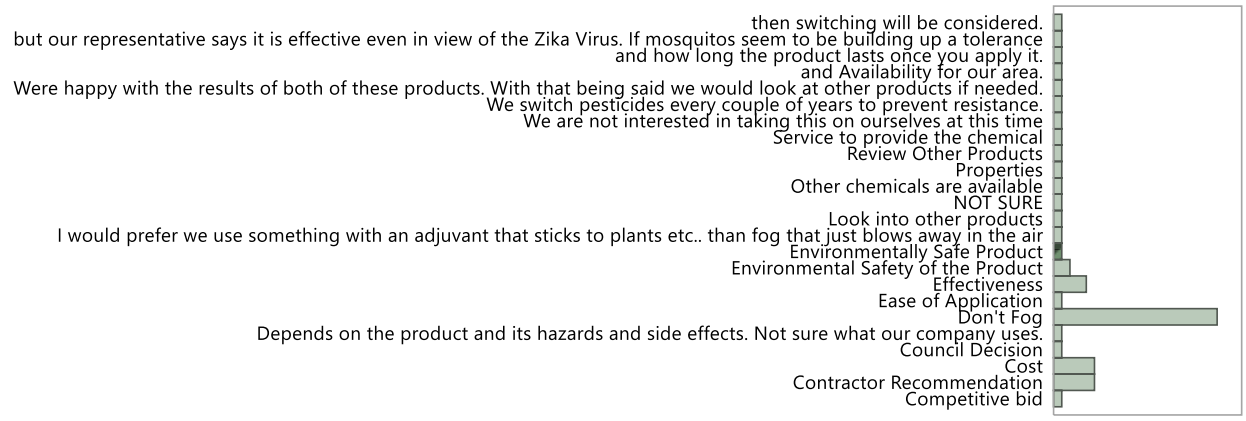


Frequencies

Level	Count	Prob
1	8	0.08163
2	54	0.55102
3	36	0.36735
Total	98	1.00000

N Missing 4
3 Levels

Comments 4



Frequencies

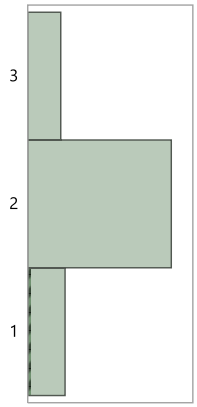
Level	Count	Share of Responses	Rate Per Case
Competitive bid	1	0.0182	0.0098
Contractor Recommendation	5	0.0909	0.0490
Cost	5	0.0909	0.0490
Council Decision	1	0.0182	0.0098
Depends on the product and its hazards and side effects. Not sure what our company uses.	1	0.0182	0.0098
Don't Fog	20	0.3636	0.1961
Ease of Application	1	0.0182	0.0098
Effectiveness	4	0.0727	0.0392
Environmental Safety of the Product	2	0.0364	0.0196
Environmentally Safe Product	1	0.0182	0.0098
I would prefer we use something with an adjuvant that sticks to plants etc.. than fog that just blows away in the air	1	0.0182	0.0098
Look into other products	1	0.0182	0.0098
NOT SURE	1	0.0182	0.0098
Other chemicals are available	1	0.0182	0.0098
Properties	1	0.0182	0.0098
Review Other Products	1	0.0182	0.0098
Service to provide the chemical	1	0.0182	0.0098
We are not interested in taking this on ourselves at this time	1	0.0182	0.0098
We switch pesticides every couple of years to prevent resistance.	1	0.0182	0.0098
Were happy with the results of both of these products. With that being said we would look at other products if needed.	1	0.0182	0.0098
and Availability for our area.	1	0.0182	0.0098
and how long the product lasts once you apply it.	1	0.0182	0.0098
but our representative says it is effective even in view of the Zika Virus. If mosquitos seem to be building up a tolerance	1	0.0182	0.0098
then switching will be considered.	1	0.0182	0.0098

Total Cases	102
Total Responses	55

Levels	24

Empty	57
Responding	45
Single Item	39
Multiple Item	6

Do you have an individual(s) that is a Federal Insecticide Fungicide Rodenticide Act certified pesticide handler? If so, what is their job title?

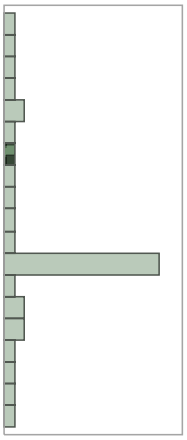


Frequencies

Level	Count	Prob
1	17	0.17526
2	65	0.67010
3	15	0.15464
Total	97	1.00000

N Missing	5
3	Levels

Comments 5



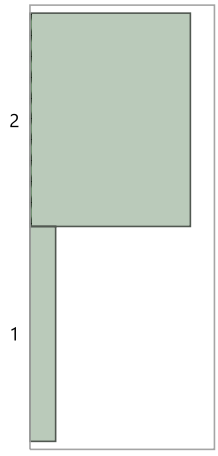
Frequencies

Level	Count	Share of Responses	Rate Per Case
All of my public works employees have their Commercial Pesticide Applicator license through the Iowa Department of Agriculture and Land Stewardship	1	0.0278	0.0098
City not Individual	1	0.0278	0.0098
Code Enforcement Inspector. The person in this position enforces nuisance codes in the city.	1	0.0278	0.0098
Commercial Pesticide License	1	0.0278	0.0098
Contractor Does	2	0.0556	0.0196
Environmental Public Health Director	2	0.0556	0.0196
Forest and Right of Way Pest Management" certified.	1	0.0278	0.0098
NA	15	0.4167	0.1471
Not Required with Pre-Mixed Product	1	0.0278	0.0098
Not within the City.	1	0.0278	0.0098
One is a Street Foreman	1	0.0278	0.0098
Parks Maintenance Specialist	1	0.0278	0.0098
Public Works Director	1	0.0278	0.0098
Refused to Answer	1	0.0278	0.0098
State Licensed	2	0.0556	0.0196
Street Superintendent	1	0.0278	0.0098
We do have 3 individuals in the Roads Dept that are "Aquatic	1	0.0278	0.0098
We have three employees who are Iowa Dept. of Ag and Land Stewardship Commercial Pesticide Applicators who are in the Street Dept.	1	0.0278	0.0098
two are Street Laborers.	1	0.0278	0.0098

Total Cases	102
Total Responses	36
Levels	19

Empty	69
Responding	33
Single Item	31
Multiple Item	2

Is mosquito resistance to the pesticide being monitored in your county?

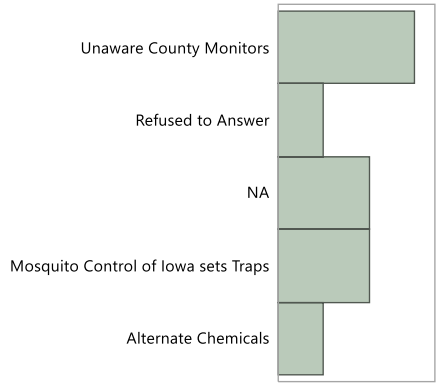


Frequencies

Level	Count	Prob
1	12	0.13483
2	77	0.86517
Total	89	1.00000

N Missing 13
2 Levels

Comments 6

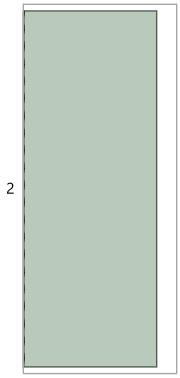


Frequencies

Level	Count	Prob
Alternate Chemicals	1	0.11111
Mosquito Control of Iowa sets Traps	2	0.22222
NA	2	0.22222
Refused to Answer	1	0.11111
Unaware County Monitors	3	0.33333
Total	9	1.00000

N Missing 93
5 Levels

Have these treatments ever caused the public to relocate? If so, what is causing the relocation?

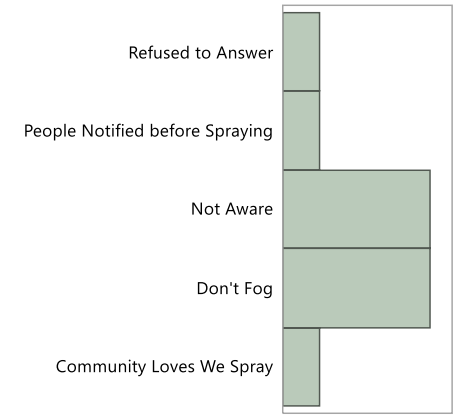


Frequencies

Level	Count	Prob
2	99	1.00000
Total	99	1.00000

N Missing 3
1 Levels

Comments 7



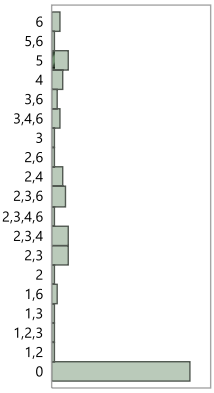
Frequencies

Level	Count	Share of Responses	Rate Per Case
Community Loves We Spray	1	0.0909	0.0098
Don't Fog	4	0.3636	0.0392
Not Aware	4	0.3636	0.0392
People Notified before Spraying	1	0.0909	0.0098
Refused to Answer	1	0.0909	0.0098

Total Cases	102
Total Responses	11
Levels	5

Empty	91
Responding	11
Single Item	11
Multiple Item	0

How is the public notified of fogging operations?



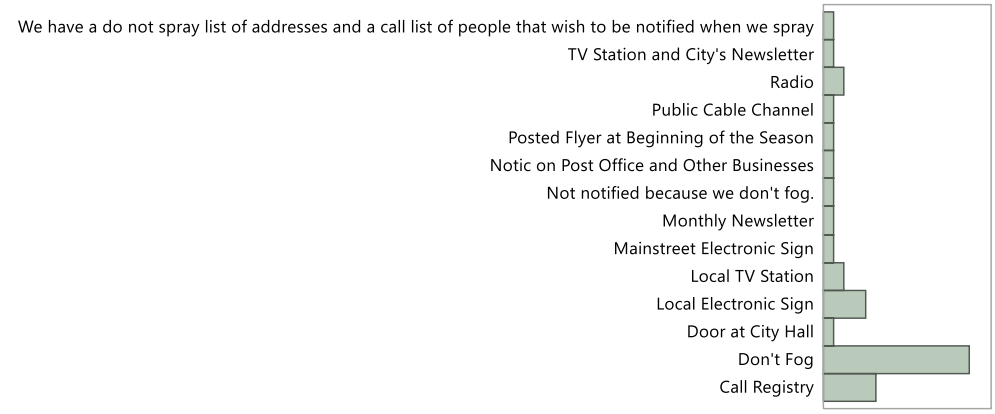
Frequencies

Level	Count	Prob
0	50	0.50505
1,2	1	0.01010
1,2,3	1	0.01010
1,3	1	0.01010
1,6	2	0.02020
2	1	0.01010
2,3	6	0.06061
2,3,4	6	0.06061
2,3,4,6	1	0.01010
2,3,6	5	0.05051
2,4	4	0.04040
2,6	1	0.01010
3	1	0.01010
3,4,6	3	0.03030
3,6	2	0.02020
4	4	0.04040
5	6	0.06061
5,6	1	0.01010
6	3	0.03030
Total	99	1.00000

N Missing	3

19 Levels

Column 23



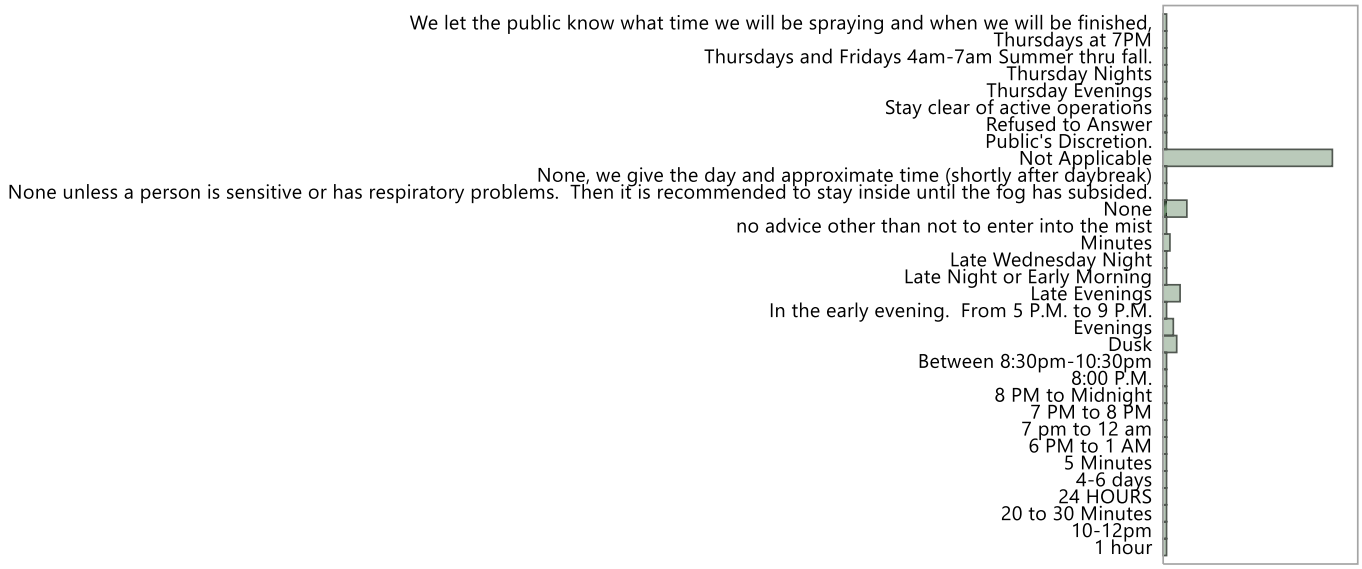
Frequencies

Level	Count	Share of Responses	Rate Per Case
Call Registry	5	0.1389	0.0490
Don't Fog	14	0.3889	0.1373
Door at City Hall	1	0.0278	0.0098
Local Electronic Sign	4	0.1111	0.0392
Local TV Station	2	0.0556	0.0196
Mainstreet Electronic Sign	1	0.0278	0.0098
Monthly Newsletter	1	0.0278	0.0098
Not notified because we don't fog.	1	0.0278	0.0098
Notic on Post Office and Other Businesses	1	0.0278	0.0098
Posted Flyer at Beginning of the Season	1	0.0278	0.0098
Public Cable Channel	1	0.0278	0.0098
Radio	2	0.0556	0.0196
TV Station and City's Newsletter	1	0.0278	0.0098
We have a do not spray list of addresses and a call list of people that wish to be notified when we spray	1	0.0278	0.0098

Total Cases	102
Total Responses	36
Levels	14

Empty	67
Responding	35
Single Item	34
Multiple Item	1

What period of time (i.e. days, hours, minutes) is recommended to the public when advised to stay indoors/ avoid fogging operations?



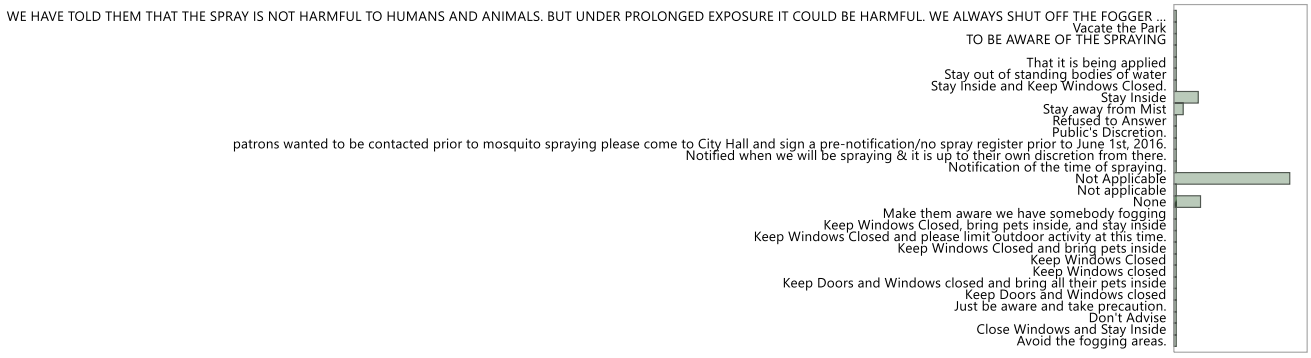
Frequencies

Level	Count	Prob
1 hour	1	0.01042
10-12pm	1	0.01042
20 to 30 Minutes	1	0.01042
24 HOURS	1	0.01042
4-6 days	1	0.01042
5 Minutes	1	0.01042
6 PM to 1 AM	1	0.01042
7 pm to 12 am	1	0.01042
7 PM to 8 PM	1	0.01042
8 PM to Midnight	1	0.01042
8:00 P.M.	1	0.01042
Between 8:30pm-10:30pm	1	0.01042
Dusk	4	0.04167
Evenings	3	0.03125
In the early evening. From 5 P.M. to 9 P.M.	1	0.01042
Late Evenings	5	0.05208
Late Night or Early Morning	1	0.01042
Late Wednesday Night	1	0.01042
Minutes	2	0.02083
no advice other than not to enter into the mist	1	0.01042
None	7	0.07292
None unless a person is sensitive or has respiratory problems. Then it is recommended to stay inside until the fog has subsided.	1	0.01042
None, we give the day and approximate time (shortly after daybreak)	1	0.01042
Not Applicable	49	0.51042
Public's Discretion.	1	0.01042
Refused to Answer	1	0.01042
Stay clear of active operations	1	0.01042
Thursday Evenings	1	0.01042

Level	Count	Prob
Thursday Nights	1	0.01042
Thursdays and Fridays 4am-7am Summer thru fall.	1	0.01042
Thursdays at 7PM	1	0.01042
We let the public know what time we will be spraying and when we will be finished,	1	0.01042
Total	96	1.00000

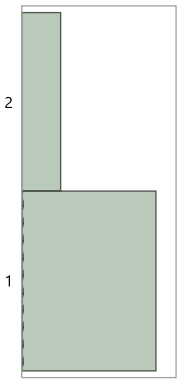
N Missing 6
32 Levels

What is the public told to do during the fogging operations?



N Missing 4
29 Levels

Is your county classified as Rural or Urban?



Frequencies

Level	Count	Prob
1	79	0.77451
2	23	0.22549
Total	102	1.00000

N Missing 0
2 Levels

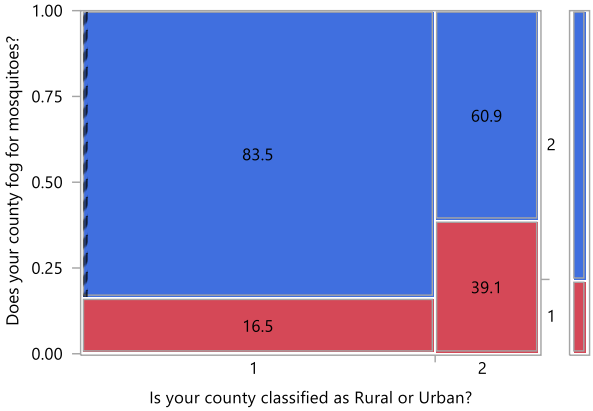
Appendices D

Public Health Bivariate Data

Fit Group

Contingency Analysis of Does your county fog for mosquitoes? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Does your county fog for mosquitoes?

Count Total % Col % Row %	1	2	Total
1	13 12.75 59.09 16.46	66 64.71 82.50 83.54	79 77.45
2	9 8.82 40.91 39.13	14 13.73 17.50 60.87	23 22.55
Total	22 21.57	80 78.43	102

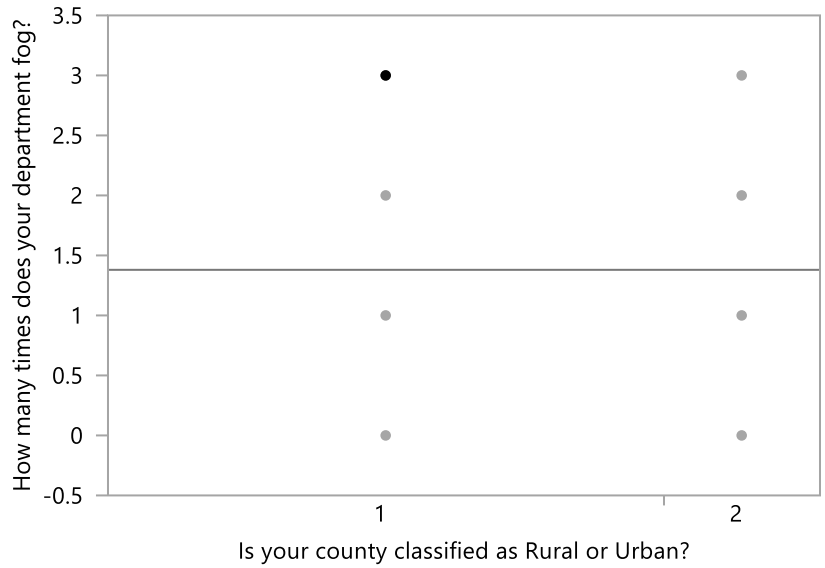
Tests

N	DF	-LogLike	RSquare (U)
102	1	2.4627933	0.0463

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	4.926	0.0265*
Pearson	5.414	0.0200*

Fisher's Exact Test	Prob	Alternative Hypothesis
Left	0.0242*	Prob(Does your county fog for mosquitoes?=2) is greater for Is your county classified as Rural or Urban?=1 than 2
Right	0.9939	Prob(Does your county fog for mosquitoes?=2) is greater for Is your county classified as Rural or Urban?=2 than 1
2-Tail	0.0401*	Prob(Does your county fog for mosquitoes?=2) is different across Is your county classified as Rural or Urban?

Oneway Analysis of How many times does your department fog? By Is your county classified as Rural or Urban?



Missing Rows 2

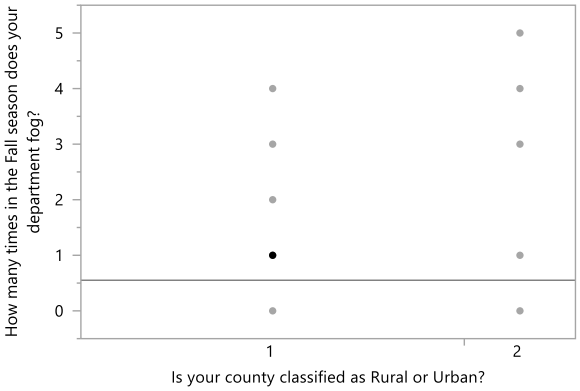
Oneway Analysis of How many times in the Spring season does your department fog? By Is your county classified as Rural or Urban?

Missing Rows 4

Oneway Analysis of How many times in the Summer season does your department fog? By Is your county classified as Rural or Urban?

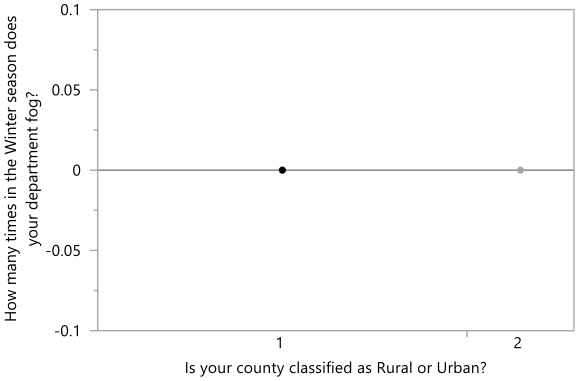
Missing Rows 4

Oneway Analysis of How many times in the Fall season does your department fog? By Is your county classified as Rural or Urban?



Missing Rows 4

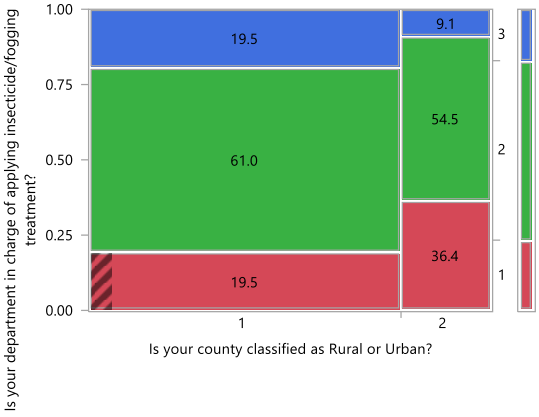
Oneway Analysis of How many times in the Winter season does your department fog? By Is your county classified as Rural or Urban?



Missing Rows 4

Contingency Analysis of Is your department in charge of applying insecticide/fogging treatment? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Is your department in charge of applying insecticide/fogging treatment?

Count Total % Col % Row %	1	2	3	Total
1	15 15.15 65.22 19.48	47 47.47 79.66 61.04	15 15.15 88.24 19.48	77 77.78
2	8 8.08 34.78 36.36	12 12.12 20.34 54.55	2 2.02 11.76 9.09	22 22.22
Total	23 23.23	59 59.60	17 17.17	99

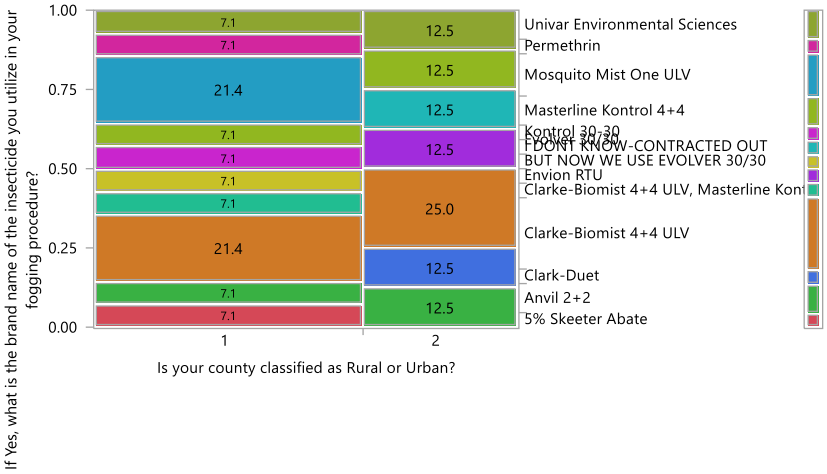
Tests

N	DF	-LogLike	RSquare (U)
99	2	1.6243605	0.0173

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	3.249	0.1970
Pearson	3.296	0.1924

Contingency Analysis of If Yes, what is the brand name of the insecticide you utilize in your fogging procedure? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By If Yes, what is the brand name of the insecticide you utilize in your fogging procedure?

Tests

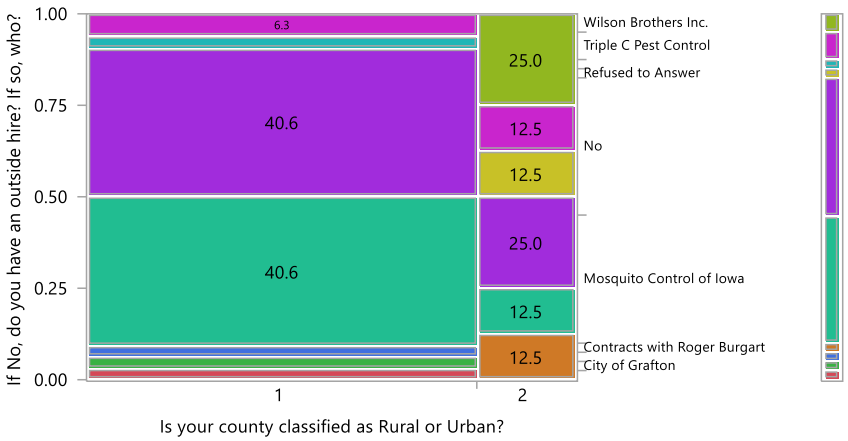
N	DF	-LogLike	RSquare (U)
22	12	6.8966576	0.1314

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	13.793	0.3141
Pearson	10.332	0.5868

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 1, Pearson ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of If No, do you have an outside hire? If so, who? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By If No, do you have an outside hire? If so, who?

Count Total % Col % Row %	Aukes Lawn & Pest Inc.	City of Grafton	City of Traer	Contracts with Roger Burgart	Mosquito Control of Iowa	No	Refused to Answer	Todd's Flying Service	Triple C Pest Control	Wilson Brothers Inc.	Total
1	1 2.50 100.00 3.13	1 2.50 100.00 3.13	1 2.50 100.00 3.13	0 0.00 0.00 0.00	13 32.50 92.86 40.63	13 32.50 86.67 40.63	0 0.00 0.00 0.00	1 2.50 100.00 3.13	2 5.00 66.67 6.25	0 0.00 0.00 0.00	32 80.00
2	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 2.50 100.00 12.50	1 2.50 7.14 12.50	2 5.00 13.33 25.00	1 2.50 100.00 12.50	0 0.00 0.00 0.00	1 2.50 33.33 12.50	2 5.00 100.00 25.00	8 20.00
Total	1 2.50	1 2.50	1 2.50	1 2.50	14 35.00	15 37.50	1 2.50	1 2.50	3 7.50	2 5.00	40

Tests

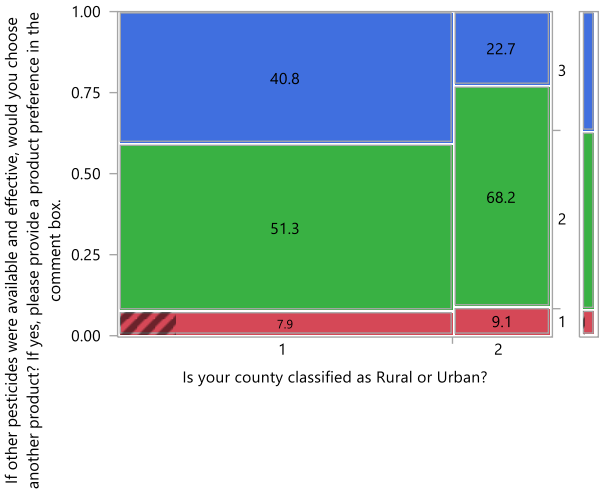
N	DF	-LogLike	RSquare (U)
40	9	8.6139765	0.1319

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	17.228	0.0453*
Pearson	19.196	0.0236*

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of If other pesticides were available and effective, would you choose another product? If yes, please provide a product preference in the comment box. By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By If other pesticides were available and effective, would you choose another product? If yes, please provide a product preference in the comment box.

Count Total % Col % Row %	1	2	3	Total
1	6 6.12 75.00 7.89	39 39.80 72.22 51.32	31 31.63 86.11 40.79	76 77.55
2	2 2.04 25.00 9.09	15 15.31 27.78 68.18	5 5.10 13.89 22.73	22 22.45
Total	8 8.16	54 55.10	36 36.73	98

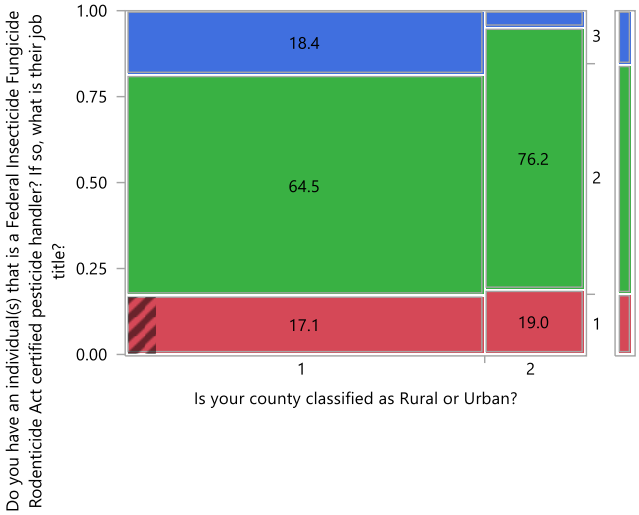
Tests

N	DF	-LogLike	RSquare (U)
98	2	1.2780937	0.0145

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	2.556	0.2786
Pearson	2.426	0.2973

Contingency Analysis of Do you have an individual(s) that is a Federal Insecticide Fungicide Rodenticide Act certified pesticide handler? If so, what is their job title? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Do you have an individual(s) that is a Federal Insecticide Fungicide Rodenticide Act certified pesticide handler? If so, what is their job title?

Count Total % Col % Row %	1	2	3	Total
1	13 13.40 76.47 17.11	49 50.52 75.38 64.47	14 14.43 93.33 18.42	76 78.35
2	4 4.12 23.53 19.05	16 16.49 24.62 76.19	1 1.03 6.67 4.76	21 21.65
Total	17 17.53	65 67.01	15 15.46	97

Tests

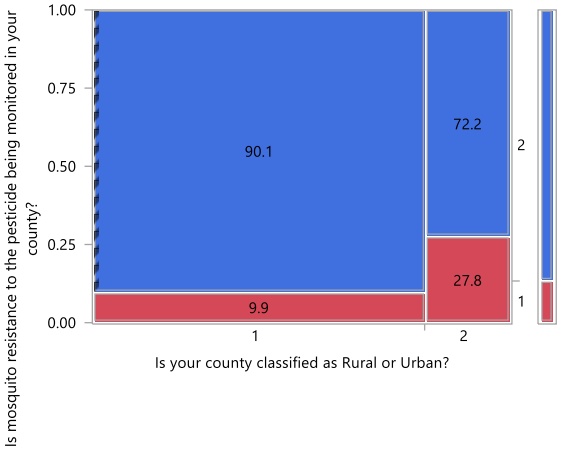
N	DF	-LogLike	RSquare (U)
97	2	1.4526433	0.0174

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	2.905	0.2340
Pearson	2.358	0.3076

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.

Contingency Analysis of Is mosquito resistance to the pesticide being monitored in your county? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Is mosquito resistance to the pesticide being monitored in your county?

Count Total % Col % Row %	1	2	Total
1	7 7.87 58.33 9.86	64 71.91 83.12 90.14	71 79.78
2	5 5.62 41.67 27.78	13 14.61 16.88 72.22	18 20.22
Total	12 13.48	77 86.52	89

Tests

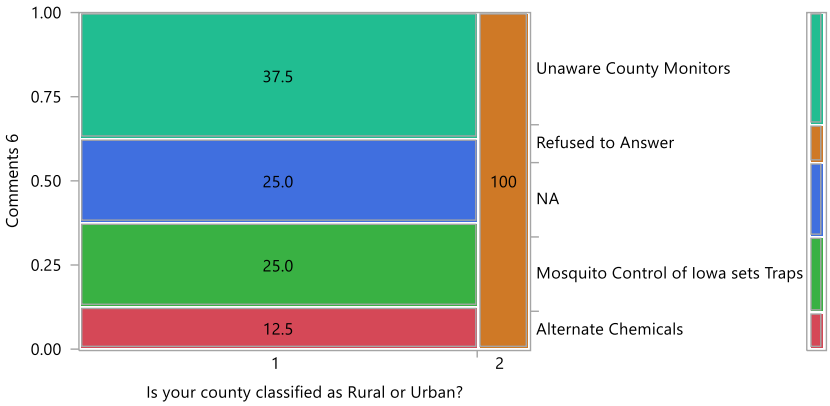
N	DF	-LogLike	RSquare (U)
89	1	1.7011963	0.0483

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	3.402	0.0651
Pearson	3.952	0.0468*

Fisher's Exact Test	Prob	Alternative Hypothesis
Left	0.0611	Prob(Is mosquito resistance to the pesticide being monitored in your county?=2) is greater for Is your county classified as Rural or Urban?=1 than 2
Right	0.9869	Prob(Is mosquito resistance to the pesticide being monitored in your county?=2) is greater for Is your county classified as Rural or Urban?=2 than 1
2-Tail	0.0611	Prob(Is mosquito resistance to the pesticide being monitored in your county?=2) is different across Is your county classified as Rural or Urban?

Contingency Analysis of Comments 6 By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Comments 6

Count Total % Col % Row %	Alternate Chemicals	Mosquito Control of Iowa sets Traps	NA	Refused to Answer	Unaware County Monitors	Total
1	1 11.11 100.00 12.50	2 22.22 100.00 25.00	2 22.22 100.00 25.00	0 0.00 0.00 0.00	3 33.33 100.00 37.50	8 88.89
2	0 0.00 0.00 0.00	0 0.00 0.00 0.00	0 0.00 0.00 0.00	1 11.11 100.00 100.00	0 0.00 0.00 0.00	1 11.11
Total	1 11.11	2 22.22	2 22.22	1 11.11	3 33.33	9

Tests

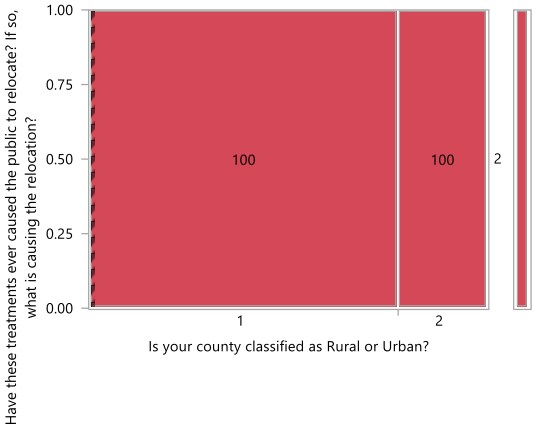
N	DF	-LogLike	RSquare (U)
9	4	3.1394889	0.2290

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	6.279	0.1793
Pearson	9.000	0.0611

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 1, Pearson ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of Have these treatments ever caused the public to relocate? If so, what is causing the relocation? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By Have these treatments ever caused the public to relocate? If so, what is causing the relocation?

Count Total % Col % Row %	2	Total
1	77 77.78 77.78 100.00	77 77.78
2	22 22.22 22.22 100.00	22 22.22
Total	99 100.00	99

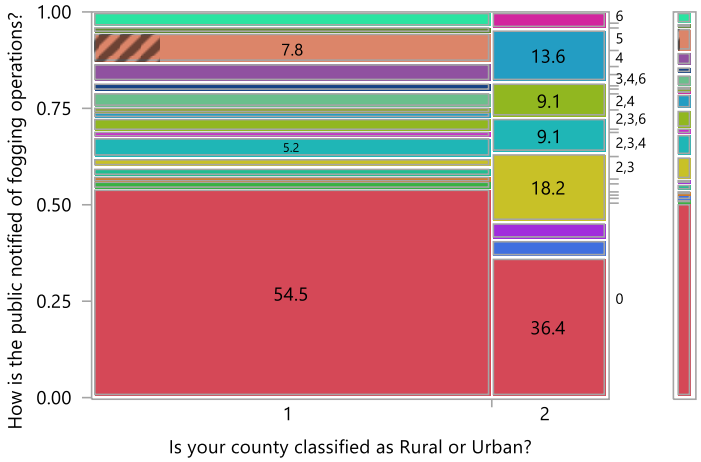
Tests

N	DF	-LogLike	RSquare (U)
99	0	0	.

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	0.000	.
Pearson	0.000	.

Contingency Analysis of How is the public notified of fogging operations? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By How is the public notified of fogging operations?

Tests

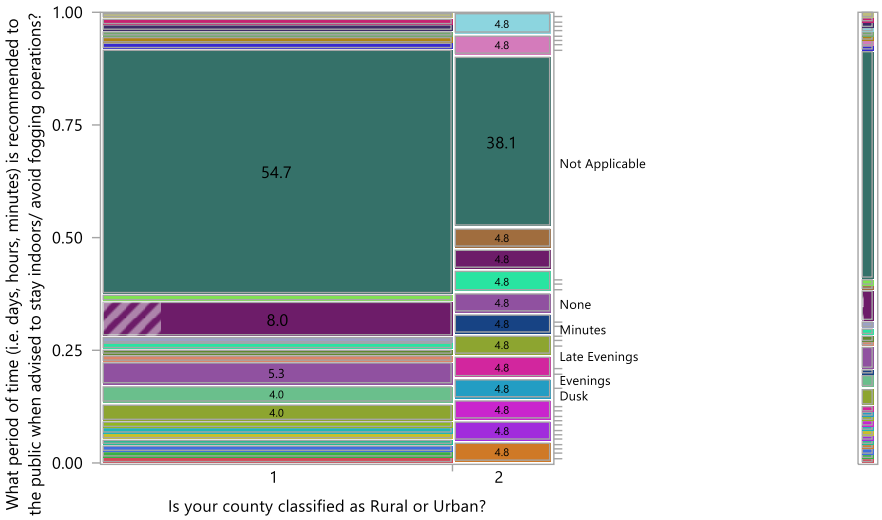
N	DF	-LogLike	RSquare (U)
99	18	17.204851	0.0866

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	34.410	0.0112*
Pearson	33.409	0.0149*

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of What period of time (i.e. days, hours, minutes) is recommended to the public when advised to stay indoors/ avoid fogging operations? By Is your county classified as Rural or Urban?

Mosaic Plot



Contingency Table

Is your county classified as Rural or Urban? By What period of time (i.e. days, hours, minutes) is recommended to the public when advised to stay indoors/ avoid fogging operations?

Tests

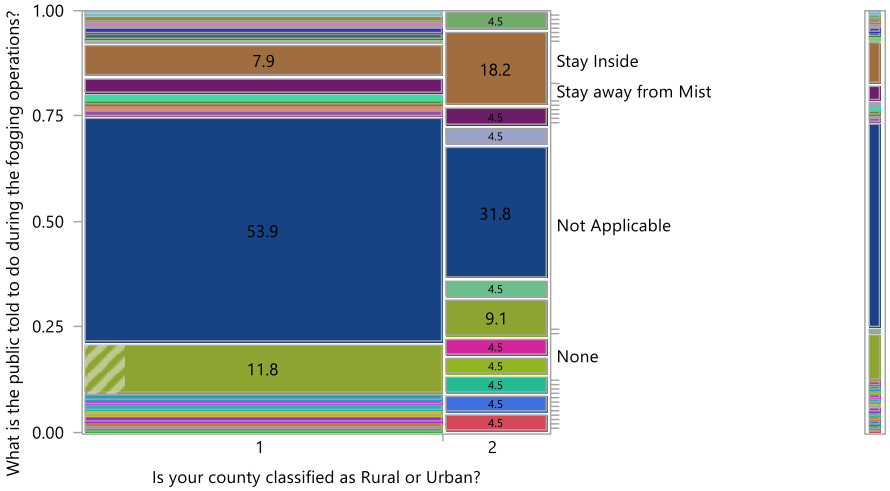
N	DF	-LogLike	RSquare (U)
96	31	19.615178	0.0910

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	39.230	0.1473
Pearson	39.820	0.1331

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.

Contingency Analysis of What is the public told to do during the fogging operations? By Is your county classified as Rural or Urban?

Mosaic Plot



Tests

N	DF	-LogLike	RSquare (U)
98	28	18.053333	0.0866

Test	ChiSquare	Prob>ChiSq
Likelihood Ratio	36.107	0.1399
Pearson	36.163	0.1385

Warning: 20% of cells have expected count less than 5, ChiSquare suspect.
Warning: Average cell count less than 5, LR ChiSquare suspect.