State Zoonotic Disease Program Structure in the United States: Implications for Local Public Health

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Abstract

Objective: The purpose of this research was to assess the current status of zoonotic disease biosurveillance in the United States.

Methods: A questionnaire was administered to 53 state zoonotic disease program representatives in the United States and Puerto Rico. The questionnaire assessed the structure of zoonotic disease biosurveillance in the respective states, current biosurveillance activities such as testing arthropods for pathogens, information provided to local public health on zoonotic disease, and opinions of the current state of zoonotic disease surveillance. A website assessment was conducted to identify fact sheets that are provided by states on vectors of diseases of public health significance. A Model Zoonotic Disease program was developed to help guide local public health on developing local biosurveillance programs.

Results: One or more representatives from total of 36/53 (68%) states and Puerto Rico responded to the survey. Eighty-five percent of the responding states have programs designed to track zoonotic diseases. Of the responding states, 52% test arthropods for pathogens of public health concern. Responding states stated that they disagree that their states are currently doing enough to prevent known or emerging zoonotic diseases.

Conclusions: The current landscape of zoonotic disease surveillance does not proportionally reflect the distribution of zoonotic diseases. All states would be expected to have a designated program to respond to zoonotic diseases and conduct surveillance. In order to align with current expectations of biosurveillance, states should develop better state programs or provide locals with the means to develop their own programs.

Keywords: Zoonotic Disease, Biosurveillance, One Health, Arbovirus, Local Public Health
State Zoonotic Disease Program Structure in the United States: Implications for Local Public Health

Biosurveillance is defined as “the science and practice of managing human, animal, plant, food, and environmental health-related data and information for early warning of threats and hazards, early detection of events, and rapid characterization of the event so that effective actions can be taken to mitigate adverse health, social, and economic effects” (U.S. Department of Homeland Security, 2012, p. 12). Under Homeland Security Presidential Directive 21, public health has been tasked with developing a biosurveillance system that is able to provide early warning systems for disease outbreaks (Bush, 2007). The defunding of the ODH ZDP has further moved public health in Ohio away from this goal.

As of April 2013, the Ohio Department of Health (ODH) had discontinues its statewide mosquito arbovirus testing program. Funding for mosquito, tick, and other insect identification services were ceased at the same time (Wymyslo, 2013). Former State Public Health Veterinarian Administrator with the ODH Zoonotic Disease Program (ZDP) Kathleen Smith stated her concerns with the defunding of the zoonotic disease program, yet the funding was still cut from the budget (Smith, 2013). As a result, there is now a gap in essential public health services that must be filled by local health departments. Their services include the identification of disease carrying insects and active biosurveillance of vector-borne diseases (Wymyslo, 2013).

The funding issues that have negatively impacted the state ZDP could pose similar issues for local jurisdictions. The National Association of County & City Health Officials state that only 48% of health districts in the country provide vector control programs. Ohio spends less than the median for the nation per capita on all public health services (National Association of County & City Health Officials, 2013). At the state level in Ohio, the request to fund the ZDP
was stated to have been $800,000 (Smith, 2013). If local health departments were to fund their own ZDP, the resulting cost would escalate well beyond the $6,400 per health district that the state was previously funding. To compensate for the lack of a state program, local health departments would require additional staff, new testing equipment, and a reduction of resources from currently existing programs. Despite these challenges related to funding issues, biosurveillance must continue to be performed in Ohio.

The national biosurveillance strategy includes vector surveillance due to the relationship between human, animal, and environmental health (Centers for Disease Control and Prevention [CDC], 2011). Despite the recommendations given by the West Nile Virus Work Group at the state level (2005) and the Centers for Disease Control and Prevention at the national level (2013c), mosquito surveillance never became a prominent program in all health departments. Similar recommendations have been made for tick-borne disease surveillance, especially in geospatial areas susceptible to environmental conditions that facilitate habitats suitable to ticks (Institute of Medicine, 2011; Khatchikian et al., 2012). While local health departments have known of the risk of vector borne disease, they have largely not followed the recommendations to develop their biosurveillance capacity.

“One Health” is defined by the American Veterinary Medical Association as “the collaborative effort of multiple disciplines-working locally, nationally, and globally – to attain optimal health for people, animals and our environment” (American Veterinary Medical Association, 2008, p. 13). One Health, in a practical sense, is a collaboration between human medicine, animal medicine, and environmental health that may be able to strengthen our current biosurveillance methods and improve the health of our planet. Through One Health, zoonotic disease biosurveillance may be strengthened so that it can reach the goals put forth in HSPD-21.
**Purpose of Research**

The purpose of this research is to compare the state zoonotic disease programs in the United States to assess to current status of zoonotic disease biosurveillance in the nation. This will be conducted through a literature review to assess the recommendations that have been given on previous zoonotic disease outbreaks, current zoonotic disease issues in the country, and the relationship of One Health to the current biosurveillance capacity. State level deficiencies will be analyzed to assess their impact on local public health jurisdiction. A guidance document on dealing with zoonotic disease causing vectors will also be developed to help local health jurisdictions strengthen their biosurveillance capacity.

**Literature Review**

Zoonoses – diseases transferred to humans through animal vectors – are a serious threat to population health. Over 60% of all diseases that can be transferred to humans are zoonotic in nature and 75% of the emerging pathogens have a zoonotic route of transmission. Around 22% of zoonotic diseases are transmitted to humans by vectors, which are organisms that transfer disease without being the cause of the disease themselves (American Veterinary Medical Association, 2008; Taylor, Latham, & Woolhouse, 2001).

Many of the current emerging and re-emerging infectious disease threats are vector-borne diseases transferred to humans from arthropods. These diseases are commonly known as arboviruses (Gubler, 2002; Weaver & Reisen, 2010). The rate of neuroinvasive arbovirus infections – such as West Nile Virus - in the United States is 0.16 cases per 100,000 population. Lyme disease – an arbovirus spread by ticks – has over 10 cases per 100,000 population (CDC, 2013a). Zoonotic diseases, transmitted from all forms of life, have also been a historical threat to human health and will continue to be a threat.
Historical Zoonotic Issues

Plague is the most famous and prolific of all zoonotic disease. Caused by the bacteria *Yersinia pestis*, plague is a serious and life threatening illness that has impacted human health for thousands of years. Individuals infected by plague will have symptoms of fever, headache, chills and weakness. Additional symptoms may result depending on the route of transmission to the individual. Bubonic plague, characterized by painful lymph nodes called buboes, is likely transmitted by infected flea bites. Septicemic plague, characterized by abdominal pain, shock, and possible bleeding from the skin, is likely caused by handling infected animals or being bitten by a flea. Pneumonic plague, characterized by pneumonia, may be caused by inhaling infected droplets through person to person interaction (CDC, 2012; Raoult, Mouffok, Bitam, Piarroux, & Drancourt, 2013). Plague is still a serious concern and is considered to be a class “A” reportable disease in Ohio and must be reported to ODH the same day it is identified (Lawriter, 2014).

Plague is suspected to be the cause of three pandemics over the last 2,000 years. The first is known as the Justinian plague. The Justinian plague pandemic started in 541 CE, originated in Africa and then spread to the Mediterranean region. This pandemic had historical implications, preventing the re-conquering of the Roman Empire. By the time the plague concluded in 767 CE, *Yersinia pestis* may have been responsible for the death of 40 to 100 million people from across Eurasia and northern Africa (Ligon, 2006; Raoult et al., 2013; Rollins, Rollins, & Ryan, 2003).

The second recorded plague related pandemic was responsible for the death of an estimated one-third of the world’s population (Ligon, 2006; Rollins et al., 2003). This plague was named the *Black Death* due to the characteristic bubos present on the afflicted, and the high mortality rate. The plague affected Eurasia from the 1330s to the mid-1400s with recurring
episodes of disease until the 1700s. It is believed that the Black Death was likely spread by fleas infected with *Yersinia pestis* that were brought to Europe from China through the fur trade. The plague would have spread from the city to the outlying inhabited areas as people fled the disease-ridden cities, carrying the disease (Ligon, 2006).

The Chinese plague pandemic in the 1890s was important as it provided a better understanding of the etiology of previous plagues. The fluid from the lungs of those afflicted with the Chinese plague was examined and found to cause the plague in other organisms when exposed. This information, in conjunction with the dead rats found in areas impacted by the disease, led Alexandre Yersin to identify the microorganism responsible for the zoonotic transmission of the disease. Further experiments helped to identify the rat flea as being responsible for the transmission from animal to human (Ligon, 2006; Prentice & Rahalison, 2007; Rollins et al., 2003).

*Yersinia pestis* infections remain a class “A” reportable disease in Ohio due to the risk plague may cause if it begins to infect the population (Lawriter, 2014). Modern concerns also are due to the potential of plague being used as a biological weapon. Early experiments of plague weaponization were conducted by Unit 731 of the Japanese army in China during World War II by using clay bombs full of infected fleas (Ligon, 2006; Prentice & Rahalison, 2007). During the Cold War, extensive research efforts were carried out by Russia to weaponize plague, which continued until the early 1990s (Ligon, 2006; Prentice & Rahalison, 2007). Following the terrorist attacks on 9/11, there were concerns that plague may still be used as an agent of bioterrorism. Subsequently, the Laboratory Response Network (LRN) has been established to rapidly identify *Yersinia pestis*. *Yersinia pestis* is of particular interest as an agent of
Modern Zoonotic Issues

West Nile Virus (WNV) was first identified in New York City in 1999. After its initial identification, the entire United States public health system mobilized to develop a response to the impending public health emergency. Workgroups were initiated to develop a guide that would assist the system from the local to the federal level in its response (CDC, 2013c; West Nile Virus Workgroup, 2005). WNV spread throughout the country after 1999, becoming enzootic in birds, but with only nine states having confirmed human cases identified by 2001 (CDC, 2013b, 2013c; RAND Health, 2005). However, the landscape quickly changed, with 39 states having cases of WNV by the summer of 2002. In 2002, there were 4156 cases of WNV in the United States with 284 of those cases dying (CDC, 2013b, 2013c; West Nile Virus Workgroup, 2005). By 2004, the virus had reached most of the continental United States (CDC, 2013b).

West Nile Virus is a virus spread by arthropod vectors. A virus that is spread by arthropods is called an arbovirus. The virus has been shown to infect birds and mammals such as humans, and horses in addition to mosquitoes. WNV is spread by numerous species of mosquitoes. The primary mosquito vectors are of the *Culex* genus. In the Northern region of the United States, the responsible species is *Culex pipiens*, in the west the primary vector is *Culex tarsalis*, and in the south the primary vector is *Culex quinquefasciatus* (CDC, 2013c; Petersen, Brault, & Nasi, 2013; Stoto et al., 2005). The disease is most common in the summer months, with 94% of human cases of the disease being reported between July and September (CDC,
The highest incidence of WNV infection had occurred in the Department of Homeland Security Regions 6, 7, and 8 (CDC, 2013b, 2013c; RAND Health, 2005).

Individuals are infected by the arbovirus when an infected mosquito feeds on a human or animal. The virus is then transferred from the mosquito to the human or animal host, potentially resulting in severe illness. The virus has an incubation period of 2 to 15 days and 70-80% of the human cases are asymptomatic. There are two case classifications of WNV: neuroinvasive and non-neuroinvasive. The non-neuroinvasive form of WNV, often called West Nile Fever, presents with general symptoms such as headaches, weakness, and gastrointestinal symptoms. The more severe form, West Nile Neuroinvasive disease, occurs in less than 1% of infected individuals. The neuroinvasive disease is more severe in its presentation, and can result in encephalitis, meningitis, and acute flaccid paralysis. The fatality rate for individuals with West Nile Neuroinvasive disease is approximately 10%, with the elderly having a mortality rate nearing 20% (CDC, 2013c; Ohio Department of Health, 2014a; Petersen et al., 2013).

Over 37,000 people were diagnosed with WNV between the years of 1999 to 2012 (CDC, 2013b). The disease went from not being present in the U.S. to being considered endemic in just 13 years. RAND Health conducted a retrospective review of the public health response to WNV (2005) and found that one of the largest complaints during the crisis by the local officials was a lack of adequate response at the federal level. At the federal level, many of the response efforts included developing the guidelines to address WNV, and helping state and local jurisdictions to develop and sustain their own surveillance and response programs (CDC, 2013b; RAND Health, 2005; West Nile Virus Workgroup, 2005).
**Current Threats to Capabilities**

Poor funding for mosquito control programs was a concern for public health officials in Ohio as far back as 2001 (Shockman, 2001). After WNV became an epidemic, mosquito control efforts were funded by Centers for Disease Control and Prevention (CDC) bioterrorism grants, likely in order to establish biosurveillance tools that would be maintained and sustained at the local level (Eddy, Stull, & Balster, 2013; RAND Health, 2005). Current funding cuts have impacted mosquito and other arthropod control programs. The Ohio Department of Health no longer provides testing for arboviruses in humans nor in arthropods or animals, and now relies on eight local mosquito control districts for its vector collection and testing (Ohio Department of Health, 2013; Wymyslo, 2013, 2014). The current recommendations of the Ohio Arbovirus Task Force (2014) state that arbovirus testing in the state be centralized to a central location, such as the Ohio Department of Health. In addition, the recommendations are given that there should be active environmental surveillance efforts to test arthropods for emerging infectious diseases such as Heartland virus. Performing surveillance in this method would help Ohio to reach the goals set forth in Homeland Security Presidential Directive 21 (Bush, 2007; Ohio Arbovirus Task Force, 2014).

North Carolina is in a similar situation due to the defunding of the North Carolina Department of Environment and Natural Resources Public Health Pest Management (PHPM) program in 2011. Since the defunding of the PHPM program, concerns have been growing that the state mosquito control programs may disappear as well due to the lack of state funding (Del Rosario, Richards, Anderson, & Balanay, 2014). Del Rosario, Richards, Anderson, and Balanay (2014) concluded that the defunding of the PHPM section may cause the elimination of mosquito
control agencies and thus a resurgence in mosquito borne disease, resulting in both socioeconomic costs and the potential for the loss of life.

A review of the literature indicated no studies that investigated the current status of state zoonotic disease programs throughout the United States. The American Mosquito Control Association (2013) stated that the CDC has cut the amount of grant money given to state health departments by 74% over the last decade. In an investigation of the vector control workforce’s needs, the Association of State and Territorial Health Officials (2007) stated that 66% of the respondents said that they did not have the adequate resources to conduct field surveillance and vector control initiatives.

**One Health**

Collaborative relationships between veterinary medicine, human medicine, and environmental health during the initial stages of the WNV epidemic in New York City could have resulted in its quicker identification as a zoonotic disease (Kahn, 2006). Animal surveillance of WNV was later included in the CDC’s (2013c) guidelines after the disease was identified to have been zoonotic in nature and spread throughout the United States by birds. Due to a fragmented system of biosurveillance, veterinarians are not usually required to report animal disease to local health departments (Allen, 2012). The lack of communication between various health officials may slow the response to a zoonotic disease outbreak as it did with WNV, monkeypox, and SARS (RAND Health, 2005).

In order for biosurveillance to function properly, a “bottom up” approach must be established with emphasis on the relationships between environmental health, veterinary medicine, and human medicine being strengthened and enhanced (Eddy et al., 2013; Kahn, 2006). Animals can be used as a means sentinel surveillance for emerging infectious diseases
and by tightening the bonds of One Health, surveillance systems could become robust at the local level by combining existing public health tracking systems with veterinary health tracking systems to create predictive models of disease (Glickman et al., 2006; Gubernot, Boyer, & Moses, 2008).

**Methods**

**Design**

An internet-based survey was conducted using Qualtrics to determine the structure of Zoonotic Disease Programs at the state level. Information posted on the websites of the state health departments was also included. This was carried out to assess: 1) the type of zoonotic disease information that is provided to the public and, 2) information that could be utilized by local health departments. An analysis of scientific literature, governmental documents, and grey literature was conducted to develop a framework to develop a Model Zoonotic Disease Program for Local Health Departments. The study was approved by the Wright State University Institutional Review Board before the data collection commenced.

**Study Sample**

**Survey.**

The survey was sent to the “Designated and Acting State Public Health Veterinarians” identified by the National Association of State Public Health Veterinarians. In states that had multiple designated contacts, surveys were sent to all contacts. A closed population results in a probability survey from which statistical meaning may be derived. All fifty states were included in this survey to compare the structure of Ohio to the rest of the country. Puerto Rico was also included due to the availability of a contact for its zoonotic disease program. While they are protectorates of the United States, American Samoa, Commonwealth of the Northern Mariana
Islands, Federated States of Micronesia, Guam, Marshall Islands, and Republic of Palau were not included in the study due to a lack of contact information for a state zoonotic disease representative.

Each state was surveyed to assess the following:

- The presence and operation of a state zoonotic disease program;
- The presence and operations of a vector-borne division of the zoonotic disease program;
- If the state zoonotic disease program representative thinks that enough is being done to prevent currently known zoonotic diseases;
- If the representative thinks that enough is being done to prevent emerging zoonotic diseases.

Questions were also asked to assess the availability of fact sheets and/or guidance documents on the following vectors of disease or public health nuisance: rodents (rats and mice), bats, flies, mosquitoes, fleas, ticks, mites, and roaches. These vectors were chosen due to their being mentioned in three textbooks on environmental health that are often used in preparation for the National Environmental Health Association’s REHS examination. The three books are

*Environmental Health* by M.T. Morgan (2003), *Environmental Health* by D.W. Moeller (2011), and *Environmental Engineering* by Salvato, Nemerow, Agardy, & Salvato (2003). The three books would likely be present in an environmental health professional’s office. Additionally, a question was asked to provide the charter/mission statement for the state zoonotic disease program.
**Website assessment.**

The state health department websites were evaluated to assess if any guidance documents and/or fact sheets were available on the vectors noted above. The presence of a designated zoonotic disease program, information on testing and identification, and a statement indicating that the public should contact their local health department was also recorded.

**Model zoonotic disease program.**

The literature review helped to lay the framework for a Model Zoonotic Disease Program (MZDP) for Local Health Departments. The MZDP is intended to be the first draft for use by local health departments. Future revisions would be developed in coordination with other public health stakeholders.

**Data Collection**

**Survey.**

Prior to conducting the survey, an introductory email was sent to each of the state veterinarians to introduce the project, and provide information on the principal investigator and faculty advisor. The contact person was informed that participation in the survey is completely voluntary and that they could withdraw from the study at any time.

A second email was sent describing the study, and providing a link to the Qualtrics survey. After two weeks, a reminder email was sent to the state veterinarians who had not responded to the survey. A final email reminder was sent one week after the first reminder. One week after the final email was sent, the study was concluded to be over. Any non-responders were considered to not wish to take part in the study.

After the survey period was concluded, the responses were collected by using the export function of Qualtrics as a CSV file. The states were then characterized by the Department of
Health and Human Services Regions. The states were combined into regions in order to protect
the information of the state veterinarians. This file was imported into excel to conduct
quantitative and qualitative analysis of the date.

**Website assessment.**

The state websites for states that did not complete the internet survey were surveyed to
assess public information that is available on their zoonotic disease programs. All of these
results were recorded into a Microsoft Excel spreadsheet to simplify data analysis. Results were
recorded as a “0” for a “No” and as a “1” for a “Yes”.

**Data Analysis**

**Survey.**

The data was analyzed in order to find any patterns. Summary statistics were developed
for each question, including percentages. For the questions that are Likert-like, the mode was
calculated. Questions which were qualitative in nature such as ‘mission statement’ were
analyzed to see similarities between the mission statements. In addition, the number of state
health departments that provided a mission statement was also summarized.

**Model zoonotic disease program.**

Qualitative assessment was used to find the best practices for dealing with specific
vectors. Consistency between sources was used as a measure for best practices. Based on this
review, information and guidelines were developed to advise local health departments on how to
comply with Ohio pesticide rules. Further, potential strategies to minimize cost were
recommended when developing a zoonotic disease program.
Website assessment.

Descriptive statistics were generated for the website assessment. The data were analyzed to determine the proportion of states lacking fact sheets on specific vectors. The data were then combined with the fact sheet information provided during the survey. An analysis was performed to find the descriptive statistics of the entirety of the United States.

Results

The survey was sent to 53 state zoonotic disease program representatives. Of the 53 state zoonotic disease program representatives, 42 responded to the survey but only 36 surveys were completed, resulting in a completion rate of 86%. State public health officials from 36 states and Puerto Rico had one or more representatives respond to the survey. Table 1 displays the states that responded to the survey and the states that had more than one response.

Table 1

Respondents to the Zoonotic Disease Program Survey

<table>
<thead>
<tr>
<th>Responding States</th>
<th>Non-Responding States</th>
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<tbody>
<tr>
<td>Alaska</td>
<td>Alabama</td>
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<tr>
<td>Arizona</td>
<td>Delaware</td>
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<tr>
<td>Arkansas*†</td>
<td>Florida</td>
</tr>
<tr>
<td>Arkansas*†</td>
<td>Georgia</td>
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<tr>
<td>California†</td>
<td>Hawaii</td>
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<td>Colorado</td>
<td>Iowa</td>
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<td>Connecticut</td>
<td>Iowa</td>
</tr>
<tr>
<td>Idaho*†</td>
<td>Maine</td>
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<tr>
<td>Illinois†</td>
<td>Missouri</td>
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<tr>
<td>Indiana</td>
<td>New Hampshire</td>
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<td>Oklahoma</td>
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<td>Louisiana</td>
<td>Pennsylvania</td>
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<tr>
<td>Maryland</td>
<td>Tennessee</td>
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<tr>
<td>Massachusetts</td>
<td>Washington</td>
</tr>
</tbody>
</table>

Note. States indicated with an asterisk had more than one response. States indicated with a † had one or more incomplete responses.
The next section of the survey focused on assessing the current zoonotic disease programs of the states that were surveyed. Seventy five percent of the respondents said that their states have a designated Zoonotic Disease Program. Forty-five percent of states without a designated zoonotic disease program reported that zoonotic diseases are tracked by other programs, resulting in approximately 85% of the responding states having programs to track zoonotic diseases.

Out of 39 respondents, 35 state representatives’ informed that their states have a rabies program. Around 79% of states with zoonotic disease programs had a vector-borne disease division in their state department of health. Arthropods are tested for disease in 77% of the vector-borne disease divisions. All of the states that test arthropods for disease stated that they conduct testing on mosquitos, and 23% of the states conduct testing on ticks.

In states where state-level arthropod testing is not available, nearly three fourths of those states do not require local health departments to test arthropods for disease. Arthropod identification services are not provided in 55% of the states, and of those states, 95% do not require local health departments to conduct identification either.

Figure 1 displays the types of fact sheets that are provided at the state level online or by other means. All of the state respondents said that mosquito fact sheets are available; none of the states provided fact sheets for roaches.
Figure 1. Percentage of states providing fact sheets for specific vectors of public health significance based on the internet survey.

In order to bridge the gaps in the states that did not respond to the survey, the website analysis was combined with the survey to develop Figure 2, which displays the percentage of states that have fact sheets on specific public health vectors.

Figure 2. Percentage of states providing fact sheets for specific vectors of public health significance combining the internet survey and the website assessment.
Capabilities of current zoonotic disease biosurveillance efforts were assessed by using a Likert scale opinion question. Table 2 displays the results of the questions. The question asked opinions using the scale of strongly disagree, disagree, neither agree nor disagree, agree, and strongly disagree. These were converted to a numerical scale of 1 to 5 with 1 being strongly disagree and 5 being agree.

Table 2

<table>
<thead>
<tr>
<th>State Public Health Representative Opinions on Zoonotic Disease Prevention Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>Enough is being done in my state to prevent currently known zoonotic diseases</td>
</tr>
<tr>
<td>Enough is being done in my state to prevent emerging, novel zoonotic diseases</td>
</tr>
<tr>
<td>Local Health Departments in my state are equipped to prevent currently known zoonotic diseases</td>
</tr>
<tr>
<td>Local Health departments in my state are equipped to prevent emerging, zoonotic diseases</td>
</tr>
<tr>
<td>My state provides adequate guidance to local health departments so that local health departments can develop their own zoonotic disease program</td>
</tr>
</tbody>
</table>

Discussion

State public health officials from 36 states and Puerto Rico responded to the survey. The survey showed that only 85% of the responding states currently have a program to track zoonotic diseases. With 75% of emerging infectious diseases being zoonotic in nature (American Veterinary Medical Association, 2008), there is a large gap in current state level biosurveillance capabilities. Only 67% of the responding states have a vector-borne disease division that focuses on diseases that are spread by arthropods. Of the responding states, 52% test arthropods for disease-causing pathogen such as West Nile Virus or Lyme disease. Ticks are tested for disease pathogens in only 23% of the states that reported conducted testing, resulting in 12% of all responding states performing surveillance on ticks in the responding states.
At the state level, the results of the survey suggest that there are large gaps in current surveillance efforts. Preventing the spread of and tracking emerging infectious disease is a primary directive in public health. With 75% of emerging infectious diseases being zoonotic in nature, state health departments should be taking a leading role in developing surveillance systems that can monitor these diseases as they arrive into their states. However, many states are not taking a leading role. Lyme disease is estimated to have approximately 300,000 human cases in a year, yet only 12% of the responding states test ticks for the disease pathogens. Without an arthropod surveillance system, emerging infectious diseases such as Chikungunya may not be identified as having arrived in a state until multiple citizens have fallen ill. If the states do not provide a surveillance system, local public health may be responsible to monitor these diseases.

Responding state zoonotic disease program representatives indicated that they disagree that enough is currently being done in their states to prevent both currently known zoonotic disease and emerging, novel zoonotic diseases. Previous epizoonotic events have shown that there were issues with the ability of state and nationals to respond in an appropriate manner and the results suggest that the historical problems have not been properly addressed (RAND Health, 2005).

In responding states that did not provide testing of arthropods, approximately 75% reported that they do not require local health jurisdictions to test for disease pathogens. Without being required to test for disease, many local health jurisdictions will not be properly equipped to develop their own zoonotic disease programs due to funding limitations (Association of State and Territorial Health Officials, 2007; National Association of County & City Health Officials, 2013). Jurisdictions that do have the funding available to conduct their own arthropod surveillance efforts and a larger zoonotic disease program may still be limited by the guidance
provided by the state health officials. State public health officials neither agree nor disagree that local health jurisdictions are equipped to deal with currently known zoonotic diseases and disagree that locals are equipped to deal with emerging zoonotic diseases. With biosurveillance being expected to take a “bottom-up” approach, the response of the state representatives indicates that locals are not equipped to carry out proper biosurveillance (Eddy et al., 2013).

States are not consistent in the fact sheets that are provided to the public and to local health jurisdictions. While the Centers for Disease Control and Prevention has many fact sheets available, it may benefit local jurisdictions to have information provided by their state that are tailored to the citizens of that state. Mosquitoes, ticks, and bats are the most common vectors that have fact sheets provided by the states, possibly due to the direct transmission of disease pathogens by these vectors. Mechanical vectors, such as roaches, had only 2% of states provide fact sheets on the risks and how to prevent roaches from becoming a public health issue. States that responded to the survey had an average response of “neither agree nor disagree” when asked if their respective states provide enough guidance to local health jurisdictions to develop a local zoonotic disease program. State zoonotic disease representatives responded in manner that suggests their states can provide better guidance to local health departments regarding zoonotic diseases.

The emerging concept of One Health has not been formalized as yet in the United States. However, when strengthening biosurveillance capacity, instituting One Health concepts of the interactions between, human medicine, veterinary medicine, and environmental health can be used as a guide to bridge the three disciplines. When West Nile Virus was first being identified in the United States, many of the One Health concepts were being used. Human medicine tracked the incidences of clinical WNV cases, veterinary medicine tracked WNV cases in
animals, and environmental health assessed infections in mosquitoes (RAND Health, 2005). Unfortunately, the surveillance methods used for WNV never became a fundamental program provided by public health. In order to properly protect the health of the public, biosurveillance must continue to be enhanced in order to comply with HSPD-21, whether it be using a bottom-up approach or a top-down approach (Bush, 2007; Eddy et al., 2013).

With the many governmental officials stating that surveillance should occur using the bottom-up approach, local health jurisdictions need to have the proper guidance to deal with zoonotic diseases (Eddy et al., 2013). A document has been developed to attempt to help local health jurisdictions be able to develop their own zoonotic disease program as Appendix A. The Model Zoonotic Disease Program guidance document is a draft of a more comprehensive form that may be provided by state officials as well as local health jurisdictions.

**Limitations.**

There were many limitations to this project. Some of the stakeholders raised questions as to the definition of terms used in the survey such as “zoonotic disease program” and were concerned that the survey results could be misinterpreted. Future studies will be sure to explicitly define what terms mean so that there are not confounding factors when analyzing the data. When conducting the website assessments, there were many sites that were difficult to navigate and resulted in data that may not have had a complete picture of the actual information provided at the state level. Future research will need to focus on conducting a survey that includes all of the states in order to develop a more accurate picture.
Conclusions

Current biosurveillance is not in line with Homeland Security Presidential Directive 21. Most current and emerging infectious diseases are zoonotic in nature, but the current landscape of zoonotic disease surveillance does not proportionally reflect the distribution of zoonotic diseases. All states would be expected to have a designated program to respond to zoonotic diseases and conduct surveillance, but only 85% of the states that responded to the survey have programs tracking zoonotic disease and 52% of the responding states performing pathogen testing on arthropods.

In order to become aligned with HSPD-21, states should develop better methods of zoonotic disease surveillance, or provide the means to local jurisdictions to do so. As of July 14, 2014, the Ohio Department of Health (2014b) will once again begin to conduct mosquito arbovirus testing. Other states that have had biosurveillance programs reduced in capabilities may not be as concerned as the citizens and public health officials in Ohio were after the funding cuts that impacted the zoonotic disease program in Ohio. For areas that do not have a proper state program, a Model Zoonotic Disease program has been developed to help guide local health jurisdictions to create their own surveillance programs. Developing a local zoonotic disease program and implementing One Health into the functions of local public health could enable relationships between public health and veterinary medicine that are not currently established outside of rabies programs.

Future Research

The survey conducted in this project can be used as the start of a better survey of state health department and their capabilities. Stakeholders such as the Association of State Public Health Veterinarians or the National Pest Management Association could be used to gather better
data and develop a better survey. In addition, the stakeholders can help to collaborate on strengthening the Model Zoonotic Disease Program to facilitate the bottom-up approach of biosurveillance.
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Appendices

Appendix A. A Model Zoonotic Disease Program for Local Health Departments

Background

As of April of 2013, the Ohio Department of Health (ODH) had ceased conducting mosquito arbovirus testing. Funding for mosquito, tick, and other insect identification services were ceased at the same time (Wymyslo, 2013). Former State Public Health Veterinarian Administrator with the Ohio Department of Health Kathleen Smith stated her concerns with the defunding of the zoonotic disease program, yet the funding was still reduced to the program (Smith, 2013). As a result, there is a gap that now must be filled by local health departments for identifying insects and conducting vector-borne disease surveillance (Wymyslo, 2013).

Despite the recommendations given by the West Nile Virus Work Group (2005) and the Centers for Disease control and Prevention (2013c), surveillance data of arboviruses never did become a persistent program in all health departments. Concerns about tick-borne illness generated recommendations to develop stronger geospatial surveillance to identify at-risk populations, but was not instituted (Institute of Medicine, 2011; Khatchikian et al., 2012).

ODH has provided a reference guide for tick-borne diseases, but has not generated any reference guides for local health departments to differentiate species of mosquitoes. In order to help local health departments in implementing a Zoonotic Disease Program (ZDP), this guidance document has been created with possible strategies and goals of a local ZDP.

Foundations of a Zoonotic Disease Program

Funding.

The funding issues that have negatively impacted the state ZDP could pose concerns for local jurisdictions as well. The National Association of County & City Health Officials state that
only 48% of health districts in the country provide vector control programs, and Ohio spends less than the median for the nation per capita on health services (National Association of County & City Health Officials, 2013). One method of attempting to circumvent the funding issue is to add the tracking, surveillance, and abatement of specific vectors into already-funded programs.

Health jurisdictions that have a solid waste program may have county regulations that prohibit rat harborage conditions. Jurisdictions that have a housing program may implement regulations that prohibit infestations of rodents or arthropods. Throughout this guidance document there will be suggestions for implementation of the ZDP into existing programs.

**Personnel.**

There may be situations where the jurisdiction needs to apply pesticides in order to eradicate vectors of diseases of public health concern. In order to legally apply pesticides as an employee of a governmental agency, the applicator must have a commercial applicator license or be directly supervised by an individual that holds a commercial applicator license (Lawriter, 2005). This includes the application of both regulated and non-regulated pesticides (such as mosquito dunks or other off-the-shelf pesticides).

Supervisors of environmental public health personnel should acquire their commercial applicator license. Personnel that are lower than the supervisor may acquire a commercial applicator license as well so that they have a better understanding of the regulations when applying pesticides. Study aids and materials are available from the Ohio Department of Agriculture.

**Integrated Pest Management (IPM).**

Modern pest management is based on holistic methods designed to prevent access of pests into a facility rather than kill pests that have become an infestation. IPM is a move away
from the historical methods of spraying pests with chemicals and a move towards eliminating the conditions that allow a pest to survive and thrive. The overall aim of IPM is to develop a long-lasting sustainable method of dealing with pests while limiting the use of chemical interventions to only situations where there is no other option.

**Basic steps of IPM.**

*Develop and set action threshold.*

Prior to any actions being taken, thresholds must be developed for when specific pest populations become large enough that action must be taken. These thresholds will differ from pest to pest and from setting to setting depending on the hazard that the pests pose.

*Pest identification and monitoring.*

After thresholds have been developed, the pest populations must be properly identified and their populations monitored to observe when they reach the action thresholds. Accurate identification is necessary to ensure that any prevention or control practice that is carried out will reduce the population of the targeted pest appropriately.

*Prevention.*

Basic sanitation is the simplest way to limit public health pests. Eliminating harborage conditions that would allow for pests to flourish is necessary when developing a pest control program. Biological controls -such as picking vegetation that repel or are immune to predating pests can be planted in an area – and cultural controls – such as modifying the way a plot of land is treated from year to year – are useful tools in preventing infestations.

*Control.*

When a pest has been identified to breach an action threshold, control measures must be taken to limit the hazards caused by the offending pest. Mechanical controls should be instituted
before chemical interventions take place. When all other options have been exhausted, chemical interventions should occur with the pesticide with a narrow spectrum of affected pests. Monitoring of the pest population should continue until the population decreases below the action threshold. Non-specific pesticides should be a last resort effort to control a pest population that exhibits a substantial hazard.

*Uses of IPM in this guide.*

The pests that are discussed in this guide will be organized by the four basic principles of IPM. Action thresholds will be based on the risk of disease classified by the Ohio Administrative Code. Identification and monitoring will provide information on the morphology of the species and potential surveillance methods. Prevention will discuss techniques to limit the physical habitat of the pest. Control will focus on more of the chemical interventions that are possible.

**Pest Management Suggestions**

**Rodents.**

Rodents of public health concern are usually of three different species: the Norway rat (*Rattus norvegicus*), the roof rat (*Rattus Rattus*), and the house mouse (*Mus musculus*). Rodents have been shown to not only cause disease in humans, but are also implicated in the life cycle of other zoonotic diseases. Rodents will often damage property and contaminate food. Rodent infestations can cause structural damage to the facilities they take residence in due to gnawing and burrowing.

Rodents also are divided into two types of rodents based on their environment. Commensal rodents are those rodents that are often found in close proximity to humans. Zoonotic disease concerns of commensal rodents arise due to the close proximity to humans.
Sylvatic rodents are rodents that reside in the wild. Sylvatic rodents may be part of a zoonotic transmission of a disease from one species to another.

**Diseases.**

Class “A” diseases that rodents may transmit include plague and tularemia. Class “B” diseases that rodents may transmit include hantavirus, leptospirosis, Lyme disease, and yersiniosis. Human cases of class “A” diseases should result in immediate action to assess the location that the afflicted individual resides for rodents, and eliminate the population if population. Class “B” instances should result in an assessment of the residence of the individual to see if pest management is necessary. If these diseases are identified in companion animals, an investigation should occur to look for the vectors of disease.

**Identification.**

In general, it is difficult to mistake a rodent from other vectors of disease. To properly manage rodent infestations, the species of rodent should be identified. The CDC developed the following guide for identifying rodents.
Other signs that may indicate a rodent infestation include rodent droppings in food storage areas, especially in dark, secluded areas such as under the sink or in the cupboards. Rodents may use materials such as shredded paper to create nests. Chew marks of food packages or the physical structure of the facility may suggest a rodent infestation. UV lights may be used to find urine markings in suspected rodent harborage areas to help confirm the infestation.

**Prevention.**

Sanitation is a necessity when controlling rodent populations. The first step to rodent control is ensuring that waste is properly managed. In health jurisdictions that enforce a solid waste program, adding language into the regulations for the elimination of rodent harborages can help prevent rodent infestations from becoming an issue. By eliminating food sources from the solid waste, a rodent infestation is less likely to occur.

A solid waste program can also be useful in enforcing the abatement of accumulation of yard waste such as tree clippings, construction and demolition debris. Solid waste that is stored directly on the ground could provide a habitat for rodent nesting area. Keeping wastes at least six inches off the ground will limit the risk of rodent harborages. Other debris such as old appliances or automobiles may also provide harborage for rodents.

Infestations in a residence or facility can be prevented by sealing any openings to the outside, such as holes around pipes, ventilation exhausts without screens, or even under doors with missing or damaged weather stripping. Eliminating the openings to the outside in facilities and residences can limit pest access into the building.

**Control.**

Rodent infestations that cannot be prevented by eliminating their food supply and nesting locations must be exterminated. There are two primary ways to exterminate rodents: trapping and
rodenticides. Trapping of rodents can either be lethal or non-lethal. Lethal traps are often the conventional snap traps that are readily available. Non-lethal traps are commonly designed so that when a rodent enters the trap, it cannot leave from the entrance. If non-lethal traps are used, it is possible that the released rodents may come back into the infested building.

Rodenticides are deadly to rodents and can also be deadly to humans and companion animals. If chemical interventions must be carried out, only tamper resistant bait stations should be utilized. One common chemical in bait stations is red squill. Red squill will cause the rodent heart muscles paralysis, resulting in its death. Anticoagulants, such as warfarin, are used to poison foods that rodents typically eat. The warfarin causes hemorrhage, resulting in rodent death.

**Mosquitos.**

Mosquitos pass through four distinct life stages. The stages are: egg, larva, pupa, and adult. A specific environment, standing water, is necessary for the first three stages. Female mosquitos lay their eggs either in standing water, or in locations where standing water is likely to accumulate. The eggs are long and slender, dark in color, and are approximately 1/40 of an inch. Female mosquitos can lay eggs in batches of 50 – 400 or even singly, with each female being able to lay multiple batches of eggs. A blood meal must be taken by the female mosquito to lay a batch of eggs (Moeller, 2011; Morgan, 2003; Ohio Department of Agriculture, 2011).

Mosquito eggs usually hatch within 2 to 3 days, depending on the species. The larva, commonly referred to as wigglers, hatch from the eggs. Larval mosquitos feed on organic matter that is in the water and come to the surface of the water. At the larval stage the mosquitos can be able to be observed in standing bodies of water, often appearing to move back and forth near the surface of the water. Within 7 to 10 days, the larvae mature into pupae, which have with a
‘comma’ shape. Pupae are referred to as “tumblers” due to the way they move in the water. Adult mosquitos emerge within two to three days from the pupa stage. An adult female mosquito can be ready to take a blood meal within one or two days of becoming an adult (Moeller, 2011; Morgan, 2003; Ohio Department of Agriculture, 2011).

**Diseases.**

Class “A” diseases that mosquitoes may transmit include yellow fever. Class “B” diseases that rodents may transmit include LaCrosse virus disease, Powassan virus disease, St. Louis encephalitis virus disease, West Nile virus infection, Western equine encephalitis virus disease, Other Arthropod-borne diseases, and malaria. Human cases of class “A” diseases should result in immediate action to assess the location that the afflicted individual resides for mosquitos, and eliminate the population if necessary. Class “B” instances should result in an assessment of the residence of the individual to see if pest management is necessary. If these diseases are identified in companion animals, an investigation should occur to look for the vectors of disease.

**Identification.**

While there are multiple species of mosquitoes in the United States, most of the mosquitoes appear to be similar to one another in morphology. Mosquitoes are commonly characterized by their slender appearance, one set of wings, and three pairs of legs. Commonly, mosquitoes are 3/16 of an inch in length. Mosquitoes have a long, needle-like mouth part called a proboscis. Male mosquitoes use the proboscis to feed on plant nectar but the female mosquito uses the proboscis to feed on blood. By taking a human blood meal, female mosquitoes can transmit human disease organisms (Moeller, 2011; Morgan, 2003; Ohio Department of Agriculture, 2011).
Prevention.

The progression from egg to adult mosquito can occur within ten days, or multiple months depending on the environmental conditions. Cold weather will slow the mosquito life cycle. Mosquitos are the most prolific in the warm months, coming to a precipice in late summer (Ohio Department of Agriculture, 2011). Mosquito infestation prevention measures must be taken throughout the year, but the most concentrated efforts should occur before the summer months begin and then continue through the summer.

Basic sanitation methods should be utilized to reduce mosquito breeding areas. By utilizing solid waste regulations, a health jurisdiction can work throughout the year to eliminate breeding sites for mosquitos. Any area that allows stagnant water to accumulate could create a breeding ground for mosquitos. Scrap tires provide conditions that can cause the pooling of stagnant water and are often in close proximity to humans. Removing these scrap tires can be
difficult due to the disposal fee necessary and limited number of places that will dispose of tires. The Ohio Environmental Protection agency manages the Scrap Tire program and licenses facilities that can transport or destroy scrap tires. Contacting the OEPA can help guide local jurisdictions in working with the community to abate mosquito nuisances (Ohio Department of Agriculture, 2011; Ohio Environmental Protection Agency, n.d.).

Environmental controls can also be used to limit the risk of mosquitoes breeding in stagnant water. Specific species of fish will predate on mosquitoes, reducing their populations. Introducing the *Gambusia affinis*, the mosquito fish, has been used extensively in mosquito abatement activities (Moeller, 2011; Ohio Department of Agriculture, 2011).

Individuals that are commonly in the outdoors can use commercial products that contain DEET as a repellant. When applying DEET, the directions should always be followed and only used in concentrations to cover exposed skin and clothing. DEET based products are not to be used under clothing articles. Only use products with an EPA registration number to ensure that the product has effective ingredients.

**Control.**

Controlling the mosquito larva is the best way to eliminate mosquito nuisances. When prevention methods fail to limit mosquito populations, chemical intervention may be necessary. Standing water can be examined for presence of mosquito larva by collecting the water in a light colored cup. When larvae are present, interventions should be made. The first step is to try to eliminate the breeding conditions. If the breeding conditions cannot be eliminated, a pesticide may be used. *Bacillus thuringiensis israeliensis* (BTI) is a bacteria that targets mosquito larva. BTI can be applied to stagnant water by using what are commonly known as “mosquito drips”. Depending on the manufacturer, one mosquito dunk briquette can be used to treat 100 ft².
Mosquito dunks are the most common method to eliminate larval mosquitos, but other pesticides, such as Altosid and Abate may be necessary in certain conditions and require the application by a licensed pest control operator.

If the larval mosquitos cannot be eliminated before becoming adults, adulticide may need to be used. Controlling adult mosquitos would become necessary when there are cases of vector-borne disease in a specific geographic area. Ultra-low volume application is the best method of treating for adult mosquitoes. ULV application uses a much lower concentration of pesticide than other treatment scenarios. Chloropyrifos is a restricted use pesticide that may be used by public health officials to eliminate adult mosquito populations if there is a serious health hazard in the community (Morgan, 2003; Ohio Department of Agriculture, 2011; Salvato et al., 2003).

Part of the mosquito control strategy should entail surveillance. Mosquito surveillance can be based on public health nuisance complaints or can be more robust, including trapping mosquitos in areas that have stagnant water and sending them to a private laboratory to test for arboviruses. Multiple health jurisdictions may wish to combine their resources in order to develop a Mosquito Control District in order to save costs and be more effective with treatments in an emergency situation.

**Ticks.**

With the elimination of the tick identification services provided by ODH, local health jurisdictions can identify tick species and inform the public about diseases spread by specific species. There are four tick species that are common in Ohio: the Brown Dog Tick, the American Dog tick, the Lone Star tick, and the Blacklegged tick.
### Tick Species

<table>
<thead>
<tr>
<th>Tick Species</th>
<th>Associated Human Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brown Dog Tick</td>
<td>Rocky Mountain Spotted Fever</td>
</tr>
<tr>
<td>American Dog Tick</td>
<td>Rocky Mountain Spotted Fever, Tularemia</td>
</tr>
<tr>
<td>Lone Star Tick</td>
<td>Erlichiosis/Anaplasmosis, Q Fever, Rocky Mountain Spotted Fever</td>
</tr>
<tr>
<td>Black Legged Tick</td>
<td>Lyme Disease, babesiosis, Erlichiosis/Anaplasmosis</td>
</tr>
</tbody>
</table>

### Diseases.

Tularemia is a class “A” reportable disease associated with all ticks. Class “B” diseases that rodents may transmit include Lyme disease, Ehrlichiosis/Anaplasmosis, Q Fever, babesiosis, and Rocky Mountain spotted fever. Human cases of tularemia and Lyme disease should result in immediate action to assess the location that the afflicted individual resides for tick harborage conditions, and eliminate the harborage conditions if a population of black legged ticks is present. Other tick-born disease cases should result in an assessment of the residence of the individual to see if pest management is necessary or if environmental controls can be instituted. If these diseases are identified in companion animals, an investigation should occur to look for the vectors of disease.

### Identification.

Identifying the species of tick is necessary to decide on the risk to human health. Health jurisdictions will need access to moderately powered microscopy, considering the adults are between 1/16 of an inch and 1/8 of an inch, depending on the species. The hard-bodies ticks are differentiated by coloration differences and markings on their backs. As with mosquitos, the
female ticks are the predominate transmitters of disease due to the need to take a blood meal to reproduce.

Brown dog tick adults are approximately 1/8 of an inch in length, but can reach ½ an inch in female ticks that have recently fed. Coloration can change depending on the feeding state of the tick. Unfed brown dog ticks appear to be having a reddish brown coloration with fed females being bluish gray. Brown dog ticks primarily attach to dogs, but may feed on humans, especially considering the close proximity that humans have to companion animals. Brown dog ticks are also unique in that they can complete their life cycle indoors; further increasing the risk to the tick feeding on humans if a dog is not present.

American dog tick adult males are around 1/8 of an inch in length, with the female being larger at 3/16 of an inch when unfed and 5/8 of an inch when fed. Male American dog ticks have a gray mottled coloration on its bag that extends the length of its body. The unfed female has a gray mottled crest slightly below its head and appears to be gray in appearance when she has fed. Brown dog ticks feed on many types of mammals and are commonly found in areas of overgrown fauna. The pregnant female can lay several thousand of eggs after it has taken a blood meal.

The Lone Star Tick adult male is approximately 1/8 inch in length. The adult female is 1/8 of an inch in length when unfed and around 7/16 of an inch when fed. The male lone star tick is brown in color with white markings near the rear of its body. The female lone star tick is brown with a silver colored spot in the middle of its body which gives the species its name of the lone star tick. When fed, the female appears to be black in appearance. The lone star tick is often found in areas of overgrown, low vegetation.
The adult blacklegged tick male is approximately 1/16 of an inch in length. The female is around 1/8 of an inch in length when unfed and around ¼ of an inch when fed. The blacklegged tick is the smallest species of tick of importance in Ohio. The male tick is a dark brown with no other markings. The female is dark brown with a red coloration on its rear half when unfed and gray in color when fed. The blacklegged tick is found commonly on deer, giving them their other name of the “deer tick”, and a close proximity to humans during hunting season. The blacklegged ticks are often found in forested areas.

**Prevention.**

Ticks are at their largest populations from mid spring to the end of the summer. During these months, individuals should avoid walking through tall vegetation. If it is not possible to avoid the vegetation, proper clothing should be worn.

Wear clothing that is both difficult for a tick to attach onto and protects your skin if a tick does try to feed, such as long sleeved shirts and pants. Tucking the cuff of your pants into socks and shirt into pants creates a barrier so ticks cannot get inside of your pants or shirt and attach in an area that is more difficult to see. While in the areas of tall vegetation, frequently inspecting pant legs and other clothing for ticks allows the tick to be removed.

Upon exiting the area, a thorough inspection of clothing and exposed skin should occur to ensure that no ticks have become attached. If a tick is found to be attached, do not apply heat or other chemicals to try to get the tick to detach, due to the risk that the tick will release additional saliva due to stress, thereby increasing the risk of disease transmission. A tick should be removed by grabbing the attached tick as close to the skin as possible with tweezers and pulling it straight out. After removal, the area should be washed with soapy water. The tick can be preserved in the
freezer or in a solution of 70% or higher alcohol and retained for four weeks in case signs of tick-borne disease occur.

Companion animals should not be allowed to roam in areas of high vegetation. Dogs should be kept on leashes when being walked, especially if it is in an area of high vegetation. The same protocols of tick removal can be conducted on a dog or other companion animal.

Environmental controls are also necessary to limit the interactions between humans, companion animals, and ticks. Local regulations may be used to force the abatement of overgrown vegetation on properties. Yard litter should be limited and tall weeds, grass, and bushes should be kept trimmed to limit tick harborages. Small mammals, such as rodents, help to disburse ticks to new environments. Rodent controls can be used to help prevent the movement of ticks into vegetation near human dwellings.

Control.

Due to the dispersal methods of ticks, pesticides are not often useful when sprayed outside. Surveillance, such as flagging, can be used to decide on what vegetation should be eliminated from an area. Flagging for ticks involves using a piece of cotton, flannel, or other fabric, attached to a wooden or plastic pole. The cloth is either hung at one end in a flag configuration and dragged, or is attached to the middle and dragged by a rope tied to each end of the wooden or plastic pole. A flag consists of one or two poles attached to a cotton or flannel piece of fabric with the fabric draped so that it resembles a flag, or hung in the middle of the pole, and then dragged by ropes attached to the end of the pole. The flagging procedure should be conducted slowly and methodically. Moving too fast will result in attached ticks becoming dislodged or missing ticks altogether. The flag should be checked for ticks every thirty seconds to assure that collected ticks are not lost due to dislodgement. Any ticks that are found from
flagging should be examined to identify the species, and then decide on environmental changes that could occur in the area to limit human exposure to those ticks.

**Other vectors of concern.**

<table>
<thead>
<tr>
<th>Vector</th>
<th>Diseases</th>
<th>Prevention</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bats</td>
<td>Rabies</td>
<td>Removing bats from residences; sealing routes of entry into the residence</td>
<td>Capture; bats should only be euthanized if a human exposure is suspected, due to bats controlling mosquito populations</td>
</tr>
<tr>
<td>Flies</td>
<td>Typhoid, cholera, shigella (via mechanical means)</td>
<td>Sanitation</td>
<td>Indoors - pyrethrins</td>
</tr>
<tr>
<td>Fleas</td>
<td>Plague, typhus</td>
<td>Sanitation, treating companion animals</td>
<td>Sanitation, permethrin, various other pesticides</td>
</tr>
<tr>
<td>Mites</td>
<td>Nuisance; allergies</td>
<td>Sanitation</td>
<td>Heat treatment via clothes dryer</td>
</tr>
<tr>
<td>Roaches</td>
<td>Allergies; salmonella, E.coli (via mechanical means)</td>
<td>Sanitation, sealing routes of entry into the residence</td>
<td>Roach baits, Boric acid</td>
</tr>
<tr>
<td>Bed Bugs</td>
<td>Nuisance; secondary infections from scratching bites</td>
<td>Developing a procedure to not place items or sit where bed bugs may take residence; restricting those whit bed bug infestations from being on upholstered furniture; sealing routes of entry into the residence</td>
<td>Heat treatment, permethrin, pyrethrins</td>
</tr>
</tbody>
</table>
Appendix B. IRB Communication

DATE: May 15, 2014

TO: Dustin Ratliff, PI, M.P.H. Student
    Community Health
    Mark Gebhart, M.D., Faculty Advisor

FROM: Julie Carstens, M.P.A.
      Director of Compliance, IRB-WSU

SUBJECT: SC# 5535
'State Zoonotic Disease Program Structure in the U.S.: Implications for Local Public Health'

Your study does not meet the definitions for human subjects research. Therefore the proposal submitted does not need approval from the Wright State University Institutional Review Board.

If you have any questions or require additional information, please call Jodi Blackidge, Program Facilitator at 775-3974.

Thank you!
Appendix C. Survey Questions

Default Question Block

1. What state are you a representative of?
   - Alabama
   - Alaska
   - Arizona
   - Arkansas
   - California
   - Colorado
   - Connecticut
   - Delaware
   - Florida
   - Georgia

2. Does your state have a Zoonotic Disease Program?
   - Yes
   - No

2a. Are zoonotic diseases tracked by another program in your state?
   - Yes
   - No

3. Does your state have a rabies program?
   - Yes
   - No

4. Does your state have a vector-borne division in the Zoonotic Disease Program (or its equivalent)?
   - Yes
   - No

4a. Does the vector-borne division conduct testing on arthropods for disease?
   - Yes
   - No
Are mosquitoes tested for disease?
- Yes
- No

Are ticks tested for disease?
- Yes
- No

Is testing for disease the responsibility of local health departments?
- Yes
- No

4b. Does the state provide arthropod identification services?
- Yes
- No

Are arthropod identification services the responsibility of local health departments?
- Yes
- No

5. Are guidance documents and/or fact sheets provided by your state to inform the public and/or local health departments about the following pests and vectors?

Please check the pests that guidance documents and/or fact sheets are provided.

- Rodents
- Bats
- Flies
- Mosquitoes
- Fleas
- Ticks
- Mites
- Roaches
- None of these options
6. The following statements are to assess the current capability of zoonotic disease programs in your state:

<table>
<thead>
<tr>
<th>Statement</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enough is being done in my state to prevent currently known zoonotic diseases</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
</tr>
<tr>
<td>Enough is being done in my state to prevent emerging, novel zoonotic diseases</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
</tr>
<tr>
<td>Local Health Departments in my state are equipped to prevent currently known zoonotic diseases</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
</tr>
<tr>
<td>Local Health departments in my state are equipped to prevent emerging, zoonotic diseases</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
</tr>
<tr>
<td>My state provides adequate guidance to local health departments so that local health departments can develop their own zoonotic disease program</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
<td>⬜</td>
</tr>
</tbody>
</table>

What is the mission of your state’s zoonotic disease program (or its equivalent)?

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For any questions or concerns about this survey, please contact Dustin Ruffin at dustin.ruffin@wright.edu
## Appendix D. List of Competencies Met in CE

### Tier 1 Core Public Health Competencies

#### Domain #1: Analytic/Assessment
- Identify the health status of populations and their related determinants of health and illness (e.g., factors contributing to health promotion and disease prevention, the quality, availability and use of health services)
- Describe the characteristics of a population-based health problem (e.g., equity, social determinants, environment)
- Use variables that measure public health conditions
- Use methods and instruments for collecting valid and reliable quantitative and qualitative data
- Identify sources of public health data and information
- Identify gaps in data sources
- Adhere to ethical principles in the collection, maintenance, use, and dissemination of data and information
- Describe the public health applications of quantitative and qualitative data
- Collect quantitative and qualitative community data (e.g., risks and benefits to the community, health and resource needs)
- Use information technology to collect, store, and retrieve data
- Describe how data are used to address scientific, political, ethical, and social public health issues

#### Domain #2: Policy Development and Program Planning
- Gather information relevant to specific public health policy issues
- Describe how policy options can influence public health programs
- Explain the expected outcomes of policy options (e.g., health, fiscal, administrative, legal, ethical, social, political)
- Gather information that will inform policy decisions (e.g., health, fiscal, administrative, legal, ethical, social, political)
- Describe the public health laws and regulations governing public health programs
- Participate in program planning processes
- Incorporate policies and procedures into program plans and structures

#### Domain #3: Communication
- Communicate in writing and orally, in person, and through electronic means, with linguistic and cultural proficiency
- Solicit community-based input from individuals and organizations

#### Domain #4: Cultural Competency
- N/A

#### Domain #5: Community Dimensions of Practice
- Identify stakeholders
- Collaborate with community partners to promote the health of the population
- Maintain partnerships with key stakeholders
- Describe the role of governmental and non-governmental organizations in the delivery of community health services

#### Domain #6: Public Health Sciences
- Describe the scientific evidence related to a public health issue, concern, or, intervention
- Retrieve scientific evidence from a variety of text and electronic sources
- Discuss the limitations of research findings (e.g., limitations of data sources, importance of observations and interrelationships)
- Describe the laws, regulations, policies and procedures for the ethical conduct of research (e.g., patient confidentiality, human subject processes)
- Partner with other public health professionals in building the scientific base of public health
Domain #7: Financial Planning and Management

Describe the local, state, and federal public health and health care systems
Describe the organizational structures, functions, and authorities of local, state, and federal public health agencies
Operate programs within current and forecasted budget constraints
Contribute to the preparation of proposals for funding from external sources

Domain #8: Leadership and Systems Thinking

Describe how public health operates within a larger system
Participate with stakeholders in identifying key public health values and a shared public health vision as guiding principles for community action
Describe the impact of changes in the public health system, and larger social, political, economic environment on organizational practices

Concentration Competencies

Emergency Preparedness:

Demonstrate the understanding of model leadership in emergency conditions
Use research and/or evaluation science methodologies and instruments to collect, analyze and interpret quantitative and qualitative data
Demonstrate an understanding of the protection of worker health and safety