Master of Public Health
Culminating Experience:
A Master’s Report
Presentation

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January 14th, 2014
EXAMINING *CULEX TARSALIS* (DIPTERA: CULICIDAE) POPULATION CHANGES WITH SATELLITE VEGETATION INDEX DATA
Background

- Arboviruses
- Rift Valley Fever
- *Culex tarsalis*
- Normalized Difference Vegetation Index (NDVI)
Arboviruses

• Arboviruses in the United States
  o West Nile virus (WNV): leading cause of domestically acquired arboviral disease in people
  o Other arboviruses cause seasonal outbreaks and sporadic cases
  o Majority of arboviruses infections are asymptomatic

• Foreign arboviruses
  o Rift Valley fever (RVF) virus

• Disease surveillance, vector control and public education

• References: Center for Disease Control and Prevention, 2013c; Dar, 2013; Gubler, 2002
Rift Valley Fever

• Viral disease of domesticated animals and humans

• Significant economic losses and trade reductions: disease and abortion in domesticated animals

• Livestock outbreaks increase contact between diseased animals and humans

• No vaccines are currently available for human use. Limited vaccine use in animals.

• References: Center for Disease Control and Prevention, 2013a
Rift Valley Fever

- Incubation period of 2-6 days
- Human cases:
  - Asymptomatic or a mild illness
  - Ocular disease, blurred and decreased vision
  - Encephalitis
  - Hemorrhagic fever
- Overall human mortality rate: 1%

References: Center for Disease Control and Prevention, 2013a
Rift Valley Fever

• Affects sheep, cattle, goats, buffalo, camels, monkeys, gray squirrels

• Primary amplifying hosts: sheep and cattle

• Viremia without disease: adult cats, dogs, horses and some monkeys

• Incubation: 12 hours to 3 days

• Reference: Rift Valley Fever, 2006
Rift Valley Fever

- Lambs: biphasic fever, anorexia, lymphadenopathy, weakness, hemorrhagic diarrhea, abdominal pain, death
- Calves: fever, anorexia, depression and death
- Adults: abortion
  - Sheep: fever, weakness, melena, vomiting, nasal discharge
  - Cattle: fever, anorexia, weakness, excessive salivation, fetid diarrhea, icterus
- Post-mortem: hepatic necrosis, petechial and ecchymotic hemorrhages
- Livestock mortality rates: 10-20% in adults and 70-100% in young

- References: Rift Valley Fever, 2006; Center for Disease Control and Prevention, 2013a
**Culex tarsalis**

- Transmits: West Nile virus, Western Equine Encephalomyelitis virus, St. Louis Encephalitis virus and, in vitro, Rift Valley Fever virus
- Studies examining populations of *Culex* spp. and NDVI are few:
  - *Culex* spp. may not always track NDVI data because habitat includes artificial bodies of water with human activity
  - Good correlation between both *Aedes* and *Culex* spp. populations in RVF endemic regions in Africa
- Strong relationship between NDVI and populations of other mosquito species, such as *Anopheles* spp. (Diptera: Culicidae)
- More research is needed to determine if *Culex* spp. population dynamics are related to NDVI in additional regions

References: Turell et al., 2010; Reisen et al., 1993; Reisen et al., 2003; Gargan et al., 1988; Britch et al., 2008; Linthicum et al, 1987, 1990; Dambach et al., 2012; Liu and Chen, 2006; Rueda et al., 2010
Normalized Difference Vegetation Index (NDVI)

- Satellite imagery to measure and monitor plant growth, vegetative cover, and biomass production
- Linked to temperature, rainfall, and plant productivity
- Unit-less but numerically ranges from -1 to 1
  - $\geq 0.5 = \text{dense vegetation}$
  - $\leq 0 = \text{no vegetation}$

References: Department of the Interior, 2010; University of Reading, 2002; Britch et al., 2008; Chuang et al., 2012; Liu et al., 2006; Shililu et al., 2003; Gleiser et al., 1997; Apiwathnasorn et al., 2006
NDVI

• NDVI anomaly value: the time-specific numerical difference of the measure compared to the long term average
  o Used to examine the deviation of NDVI from the long term mean

• Potentially be used to develop advanced warning systems for droughts, famines and mosquito population changes

• Because mosquito populations have been correlated to rainfall and/or temperature, many studies have examined the relationship between specific mosquito populations and NDVI

• References: Department of the Interior, 2010; University of Reading, 2002; Britch et al., 2008; Chuang et al., 2012; Liu et al., 2006; Shiliu et al., 2003; Gleiser et al., 1997; Apiwathnasorn et al., 2006
Objective

• To examine *Cx. tarsalis* population change in Fort Riley, Kansas, in relation to the time of year and patterns of change in NDVI

• May be useful in predicting future changes in *Cx. tarsalis* populations in order to develop and evaluate vector population control methods
  - Limit transmission of potential emerging diseases to humans and susceptible wildlife or livestock
Materials and Methods

- Mosquito population surveillance data:
  - U.S. Army preventive medicine teams at Fort Riley
  - Number and position of traps varied by year but some trap locations were constant over all of the years
  - Identification of species and sex

- Female mosquitoes per trap-night index for each week and month of the study

- Data was collected by month for 1995-2000 and by week for 2001-2011 from NASA Goddard Space Flight Center

- References: Lester and Pike, 2003; Masuoka et al., 2009; Chuang et al. 2011; Cleckner et al., 2011
Materials and Methods

• Mosquito trap data are typically not normally distributed
  o log-transformation ln (x+1), where x was the number of female Cx. tarsalis collected by one trap in one night

• Analyzed using linear regression via STATA 12.1

• Monthly: at the simultaneous dates and lagging one month behind

• Weekly: at the simultaneous dates and a two-week and a four-week lag

• Only May through October was analyzed
Results and Discussion
Figure 1: Monthly Comparison of Mosquitoes/Trap Night to NDVI
Figure 2: Weekly Comparison of Mosquitoes/Trap Night to NDVI
## Analysis of the Natural log of mosq/TN for the Average Monthly Data Set

<table>
<thead>
<tr>
<th>Time</th>
<th>Analysis</th>
<th>Results</th>
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<tbody>
<tr>
<td><strong>Simultaneous</strong></td>
<td>Avg NDVI anomaly</td>
<td>No relationship (p=0.107)</td>
</tr>
<tr>
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<td>Year and month of year</td>
<td>Significant relationship (p&lt;0.05)</td>
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<tr>
<td><strong>One Month Lag</strong></td>
<td>Avg NDVI anomaly</td>
<td>No relationship (p=0.356)</td>
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<td></td>
<td>Year and month of year</td>
<td>Significant relationship (p&lt;0.05)</td>
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<tr>
<td>Time</td>
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<tr>
<td>Simultaneous</td>
<td>NDVI anomaly</td>
<td>p=0.058 - positive coefficient</td>
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<td>Year and week of year</td>
<td>Significant (p&lt;0.05)</td>
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<tr>
<td>Two Week Time Lag</td>
<td>NDVI anomaly</td>
<td>p=0.054 - negative coefficient</td>
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<td>Year and week of year</td>
<td>Significant (p&lt;0.05)</td>
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<td>Four Week Time Lag</td>
<td>NDVI anomaly</td>
<td>No significant difference (p=0.604)</td>
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<tr>
<td></td>
<td>Year and month of year</td>
<td>Year: significant (p&lt;0.05)</td>
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<tr>
<td></td>
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<td>Week: not significant (p=0.052)</td>
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Summary of Results and Discussion

• The year 2007 was always statistically higher than 2000 (in the weekly analysis)

• No relationship between the ln of the mosq/TN and NDVI anomaly for the monthly averages but trended toward significance for the weekly averages

• Results approached significance for the ln of the weekly mosq/TN as it tended to increase with NDVI anomaly (p=0.058) and tended to decrease with the two-week lag of NDVI anomaly (p=0.054)
Discussion

- The NDVI Anomaly values with both a two week and a four week lag had negative coefficients
  - Model lag is not representative of the true relationship
  - The high NDVI is just predictive of regressing subsequent movement of the NDVI toward the long term mean

- The relationship between weather, NDVI and mosquito populations is complex and further investigation is needed
Discussion

• The results are in contrast to research performed with mosquito population data from several U.S. military installations that found:

  “the NDVI signal may actually be visible late in the previous month or early in the current month and so be useful operationally as a warning regarding potential mosquito-borne disease activity” (Britch et al., 2008)

• Time lags between the NDVI and mosquito trap night data were intended to identify any value of NDVI as a leading indicator of mosquito numbers
  o However, Britch et al. (2008) did hypothesize that Culex species may not always track NDVI data because their habitat includes bodies of water associated with human activity, such as storm drains and containment ponds
Conclusions

• Mosquito-borne diseases threaten human and animal health alike

• An understanding of vector population change and vector epidemiology is crucial in minimizing these diseases and managing disease transmission

• Our resources are more efficiently used when paired with this knowledge
Conclusions

• Future studies:
  o NDVI to strike rate and with mosquito population numbers
  o Population numbers based on terrain, such as availability of shade and still water sources
  o Geographical movement and population numbers of host species

• Both host and mosquito populations are important in predicting outbreaks of disease
MPH Classes Utilized:

- Fundamental Concepts of Emerging Infectious Diseases
- Veterinary Public Health
- Veterinary Epidemiology
- Intermediate Epidemiology
- Statistical Methods for the Natural Sciences


Acknowledgements

• Drs. Britch and Linthicum

• Dr. Scott McVey
Questions so Far?
EDUCATING THE PUBLIC ABOUT ZOONOSES THROUGH THE RILEY COUNTY EXTENSION AGENCY: A FIELD EXPERIENCE REPORT
Introduction

• Case of H3N2 influenza at the Riley County Fair in 2009

• Educating the public about infectious disease and zoonoses

• Focus on diseases possibly contracted at the fair plus from household pets and food-borne illnesses

• Swine flu: initiating factor but not the keystone of the project
Project Design

• Designing and creating the source of information to be displayed to the public at the Riley County Fair

• Considerations:
  o Encouraging interactions
  o Efficient demonstration of a large amount of material
  o Education of all ages
  o Diversity
  o Attractiveness
  o Durability
  o Presented in a language understood by various ages and educational status
Interactive Informational Board

- Purpose: to present a large amount of information in an engaging way

- Anthrax
- Avian Flu
- Baylisascaris
- Cat Scratch Disease
- Cryptosporidium
- Giardia
- Leptospororosis
- Lyme Disease
- Orf
- Plague

- Rabies
- Rocky Mountain Spotted Fever
- Roundworms
- Salmonella
- Swine Flu
- Toxoplasmosis
- Tularemia
- West Nile Virus
Skunks are the main reservoir of _____ in Kansas, although most US cases are from infected bats.
Purpose: to educate children on basic zoonotic prevention facts and engage their parents in a discussion about zoonotic diseases

The Children’s Discovery Wheel was a plastic wheel that each child could spin and answer a question for a prize (a sticker or a glow-stick.)

These questions were intended for five (5) to ten (10) year olds

Many return visits from county fair youth participants
- What is a Zoonotic Disease?
- What do you do after petting animals before eating?
- What do you do if you find a baby animal outside?
- What is a Zoonotic Disease?
- What do you do if an animal is acting strange?
- What do you do if an animal bites you?
- What is a Zoonotic Disease?
- What do you do after petting animals and finding a baby animal?
**Transmission Routes of Zoonotic Diseases**

**Aerosol:**
When an infected animal coughs, or sneezes, infected droplets can be passed through the air. A person can contact a zoonotic disease by inhaling these droplets. Dust or soil contaminated with feces, urine, saliva or bacteria can also be inhaled, transmitting disease.

**Oral:**
Eating or drinking after handling animals or feces without washing your hands can result in transmission of pathogens. Also, consumption of contaminated food or water, such as unpasteurized milk or undercooked meat, can transmit disease.

**Direct Contact:**
Transmission can occur when a pathogen directly touches an open wound or mucous membrane. Bites and scratches are common causes.

**Vectors:**
Mosquitoes, fleas and ticks can pass pathogens from wildlife, pets, and livestock to people.

**Fomites:**
Fomites are objects that have been contaminated by an infected animal. These objects can transfer a pathogen to a person.

DID YOU KNOW?!? Certain diseases can be passed from sick people to animals too!
PREVENTION OF ZOONOTIC DISEASES

From Our Animals:

- Wash hands with soap after handling any animal.
- Become familiar with common diseases in the pets and livestock you own.
- Teach children proper handling of pets and provide supervision. Teach children to wash their hands with soap after handling pets.
- Vaccinate all pets, including indoor only pets, for rabies and other diseases as directed by your veterinarian.
- Take extra precautions around any animal that is acting unusual. If the animal is a pet/livestock, seek veterinary care immediately.
- Separate any sick livestock to minimize transmission in the herd and reduce environmental contamination.
- Seek veterinary care for any sick animal.

DID YOU KNOW?!?
Children, the elderly, and immunocompromised individuals are at greater risk for contracting a zoonotic disease.

In the Outdoors:

- Do not keep, feed, or adopt wild animals as pets.
- Wear long sleeves and pants during dawn and dusk when insect activity is greatest. Use insect repellent and remove ticks promptly.
- Wear gloves when handling sick or dead wildlife.
- Cover sandboxes.
- Reduce rodent habitats around your home by removing brush, rock piles, wood piles and possible food sources.
- Properly cook game before consuming.
- Do not drink from untreated water sources, such as lakes, rivers, or streams.

In the Kitchen:

- Promptly refrigerate or freeze perishable foods.
- Use a meat thermometer to ensure proper cooking of meat.
- Fruits and vegetables should be washed before eating, cutting or cooking.
- Raw meat, poultry, seafood, and their juices should be kept away from other foods.
- Wash hands for at least 20 seconds with warm, soapy water before and after handling raw meat, poultry, fish, shellfish, produce or eggs.
FREE DISEASE AND FOOD SAFETY INFORMATION

[Five pamphlets in clear holders, each with a different title:
1. Zoonotic Diseases of Dogs and Cats
2. Zoonotic Diseases of Exotic Pets
3. Zoonotic Diseases of Wildlife
4. Food Safety
5. Zoonotic Diseases of Large Animals]

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Informational Handouts

Pets:

• Rabies
• Toxoplasmosis
• Cat Scratch Disease

Exotic Pets:

• Salmonella
• Psittacosis
• Tularemia

Image from http://usherp.org/tag/baby-turtle-ban/
Informational Handouts

Large Animal:

- Cryptosporidium
- Orf
- Food-borne Diseases

Wildlife:

- Rabies
- Tularemia
- Baylisascaris
- Leptospiroisis

Orf Image from CDC
Informational Handouts – Foodborne

- Due to public awareness this may have been the public’s main interest and therefore a limited amount of information was included.

- Preventative measures rather than individual food-borne illness agents.

- The top five agents were listed as well as common symptoms (Centers for Disease Control and Prevention, 2013d).
Fun Facts for Kids!

- Dogs provide many services for humans, including hunting, farm work, security and assisting the blind and disabled.
- Dogs can hear sounds four times farther away than humans can hear.
- Cats sleep an average of 13-14 hours a day.
- A cat uses its whiskers to help detect objects and navigate in the dark.

For Additional Information:

- http://www.cdc.gov/24-7/cdcfastfacts/zoonotic.html
- http://www.cdc.gov/healthypets/

Zoonotic Diseases of Dogs and Cats

Important things to know about zoonotic diseases in your pets, symptoms to look for and prevention tips!

All images courtesy of Kellie Lewis Photography.

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What is a Zoonotic Disease?

-Zoonotic diseases are diseases or infections that can be naturally transmitted from animals to humans. Some diseases can also be transmitted from humans to animals.

-These agents can be viruses, bacteria, fungi, parasites, or prions.

-Diseases can be contracted from pets (including exotic pets), horses, livestock, or wildlife. Some diseases can be transmitted through food.

-This brochure will focus on a few common zoonotic diseases in dogs and cats.

Some Diseases To Know About:

Rabies:
Common pets: Any mammal, including indoor only pets.
Animal Symptoms: Acts unusual, either vicious and attacks with out provocation, or is dumb acting.
Human Symptoms: Initially anxiety, fever, and headache. Develops into excitia bleesness and light or sound sensitivity. Eventually, delirium, seizures, coma and death can occur.

Toxoplasmosis:
Common pets: Cats.
Animal Symptoms: Typically no symptoms.
Human Symptoms: Many people have no signs. Some have flu-like signs and vision problems. Pregnant women can transmit the parasite to their child, whom may then be born with serious eye and brain damage.

Cat Scratch Disease
Common pets: Cats.
Animal Symptoms: No symptoms.
Human Symptoms: Mild infection at the site of bite or scratch, swollen lymph nodes, fever, headache, poor appetite. Rarely, more severe complications can occur.

How Do I Prevent These Diseases?

- Wash hands with soap after handling any animal.
- Become familiar with common diseases in the pets you own.
- Teach children proper handling of pets and provide supervision. Teach children to wash their hands with soap after handling pets.
- Vaccinate all pets, including indoor only pets, for rabies and other diseases as directed by your veterinarian.
- Take extra precautions around children, the elderly, or any immunocompromised individuals, as these groups are more susceptible to disease.
- Take extra precautions around any animal that is acting unusual. If the animal is a pet, seek veterinary care immediately.
- Seek veterinary care for any sick animal.
- Seek health care immediately if you suspect any zoonotic disease.

Other zoonotic diseases occur. Tell your healthcare provider about all animal contact, including any pets.
Fun Facts for Kids!

- There are around 2000 different plant types used to make food today.
- China is the world's largest producer of garlic.
- India is the world's largest producer of bananas.
- Around 8% of children and 2% of adults have some kind of food allergy; this occurs when the body's immune system incorrectly assumes a certain food protein is harmful and attacks it.
- 2/3 of the blueberries produced in the US are from Michigan and New Jersey.

For Additional Information:

- http://www.cdc.gov/24-7/cdcfastfacts/zoonotic.html
- http://www.cdc.gov/healthypets/

Food Safety

Important things to know about foodborne illness, symptoms to look for and prevention tips!

All images courtesy of Kellie Lewis Photography.

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What is a Foodborne Illness?

- Commonly called food poisoning, foodborne illness is any illness resulting from the consumption of contaminated food.

- Most foodborne diseases are caused by bacteria but they can also be caused by viruses or parasites.

- Foodborne illness can occur from any food, including meat and fish, fruits and vegetables. Foodborne illness may result from commercially produced food, organic food, locally grown food and any other production method.

- This brochure will focus on the top five causes of foodborne illness, symptoms and how to prevent illness.

Causes and Symptoms:

The five most common causes of foodborne illness are:

1. Norovirus
2. Salmonella (non-typhoidal)
3. Clostridium perfringens
5. Staphylococcus aureus

Other common causes of foodborne illness include Toxoplasma gondii, E. coli, and Listeria.

Symptoms of foodborne illness include vomiting, diarrhea, abdominal pain, fever, chills. More severe signs can occur. These include weakness, blurred vision, dizziness, paralysis, headache, and tingling or numbness of the skin.

Although most cases of foodborne illness are mild, they can result in hospitalization or death.

Prevention:

- Raw and cooked perishable foods—foods that can spoil—should be refrigerated or frozen promptly. Refrigerators should be set at 40 degrees or lower and freezers should be set at 0 degrees.

- A meat thermometer should be used to ensure foods are cooked to the appropriate internal temperature:
  +145 degrees for roasts, steaks, and chops of beef, veal, pork, and lamb, followed by 3 minutes of rest time after the meat is removed from the heat source
  +160 degrees for ground beef, veal, pork, and lamb
  +165 degrees for poultry

- Fruits and vegetables should be washed under running water just before eating, cutting, or cooking. A produce brush can be used under running water to clean fruits and vegetables with firm skin.

- Raw meat, poultry, seafood, and their juices should be kept away from other foods.

- People should wash their hands for at least 20 seconds with warm, soapy water before and after handling raw meat, poultry, fish, shellfish, produce, or eggs.
Results

- Majority of time was spent with children and the Children’s Discovery Wheel
  - Parents were happy that their children had some answer and many of them added on to my answers when the children did not know

- Several fair patrons were unaware of what zoonotic diseases are and stopped to discuss
  - Rabies and the various influenzas

- The Pet Handout was the most popular with approximately 50 distributed
  - At least 15 copies of all of the other handouts were taken
Results

• All of the material remained available to the public for the duration of the fair, with the exception of the Children’s Discovery Wheel

• Offer this display to the other Kansas counties for use at their fairs, farm shows, and other events in which the public may interact with animals

• Project Expansion
  o Images
  o “Hot Topic” diseases
  o Something for the children to take home

• Could be used in the future to distinguish how much the public knows about public health and in what areas
Results

• Deepened my understanding of zoonotic disease and food-borne illness

• Strengthened my knowledge about how to educate both children and adults
MPH Classes Utilized:

- Veterinary Public Health
- Fundamental Concepts of Emerging Infectious Diseases
- Multidisciplinary Concepts of Food Safety and Security
- Social and Behavioral Principles of Public Health
Acknowledgements

• Ginny Barnard and Riley County Extension Agency

• Kellie Lewis Photography
Any Questions?

Thank you for your time and attention.
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<th>Mosq/TN</th>
<th>NDVI</th>
<th>NDVI Lag</th>
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