

Environmental Water Quality  
Impacts of Antibiotic Resistant  
Bacteria of Human Health  
Concern Originating from  
Animal Agriculture



Kimberly Blauth

UNC-CH

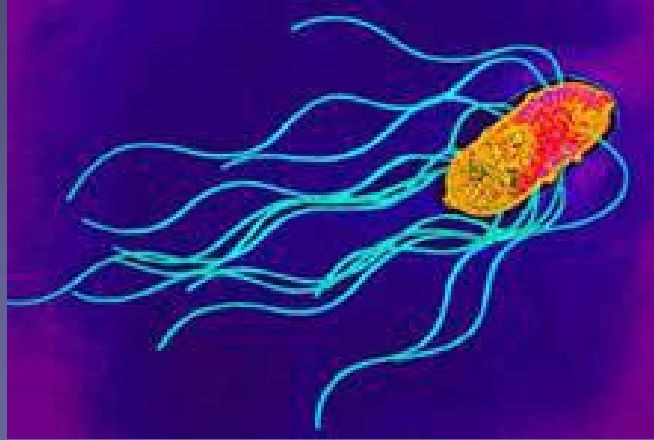


USDA-CSREES National Water Conference

# Microbes in the Environment

- Bacteria and other microorganisms are ubiquitous in the environment
- Most of these organisms are harmless to humans, but
- Some are human pathogens, and
- Many are infectious at relatively low doses

# Pathogens



- Some human pathogens are naturally occurring in nature
- Many are the result of pollution or other sources of contamination
- Bacteria that cause enteric (gastrointestinal) illness, such as *Salmonella*, are often present as the result of fecal contamination of food or water

# Antibiotic Resistant Bacteria: the new pathogen?

- Many bacteria with resistance traits are not human pathogens, but they are not risk-free either
- Bacteria have the ability to confer genetic information via conjugation and other mechanisms of gene transfer
- Pathogens can acquire resistance from commensal or non-pathogenic bacteria and become “super bugs”

# Acquisition of Antibiotic Resistance

- Due to selective pressure, the more exposure to antibiotics, the more likely bacteria will acquire resistance genes
- Human and animal GI tracts make good mixing pots for genetic transfer and selection of mutants
- Fecal matter can contain high concentrations of resistant bacteria which can then enter the environment

# Sources of fecal contamination

- There are many potential sources of fecal contamination



- Human waste streams are of particular concern
- However, with increasing understanding of zoonotic pathogens, animal waste streams are also of concern

# Animal Agriculture in NC

- In North Carolina there are 9.6 million pigs and >18 million chickens (US Dept. of Agric., 2003)
  - 2003 NC pop est. ~8.4 Million, Raleigh ~317,000
- With increasing human populations and demand for land, as well as other factors, these animals have been condensed into Concentrated (Confined) Animal Feeding Operations (CAFOs)
- These facilities can have hundreds to thousands of animals in a relatively small area

# Use of antibiotics in food animals

- To maintain health and consistent growth of the animals
- They are often administered in sub-therapeutic doses through the feed
- Many are the same or in the same class as those used for human health



# Antibiotic Resistance in Food Animals

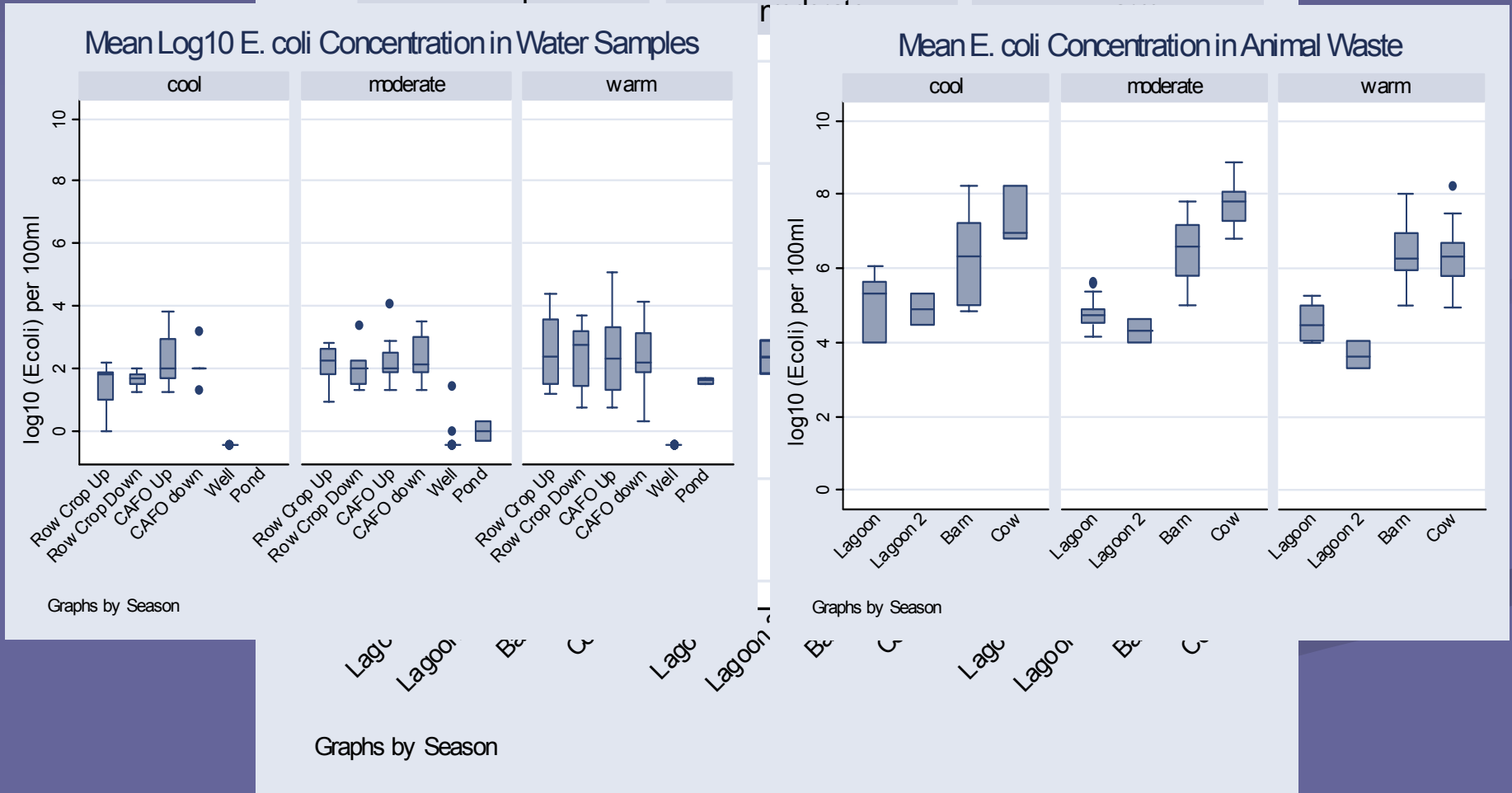
- Most research to date has focused on AR transmission to people via food
- Little exploration of potential human health risks from AR bacteria in the environment

# Research Overview

- Quantify enteric bacteria (*Salmonella*, *Enterococcus* and *Escherichia coli*)
  - On the farm
    - CAFOs (i.e. swine farms and cattle)
    - non animal farms (i.e. row crops)
  - In ground and surface water on and around the farm
  - Seasonal Sampling
- Analyze the bacteria for Antibiotic Resistance traits

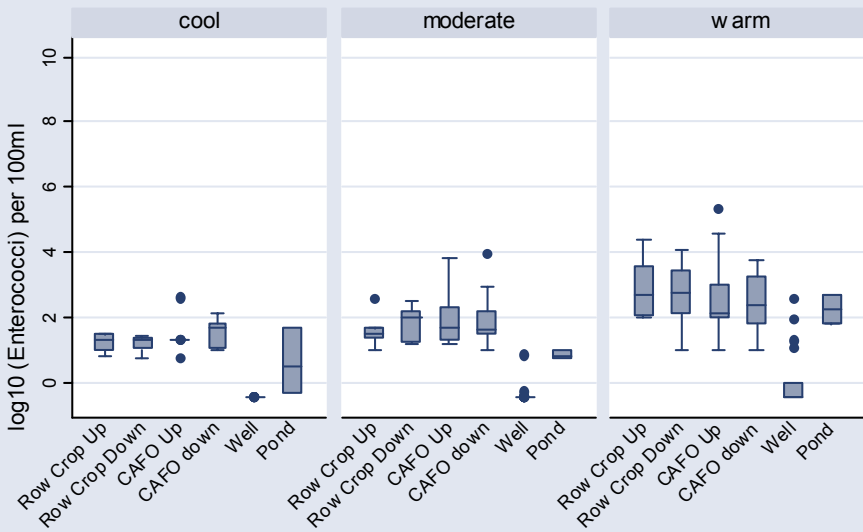
# Log<sub>10</sub> *E. coli* Concentrations by Season

## Mean *E. coli* Concentration in Animal Waste



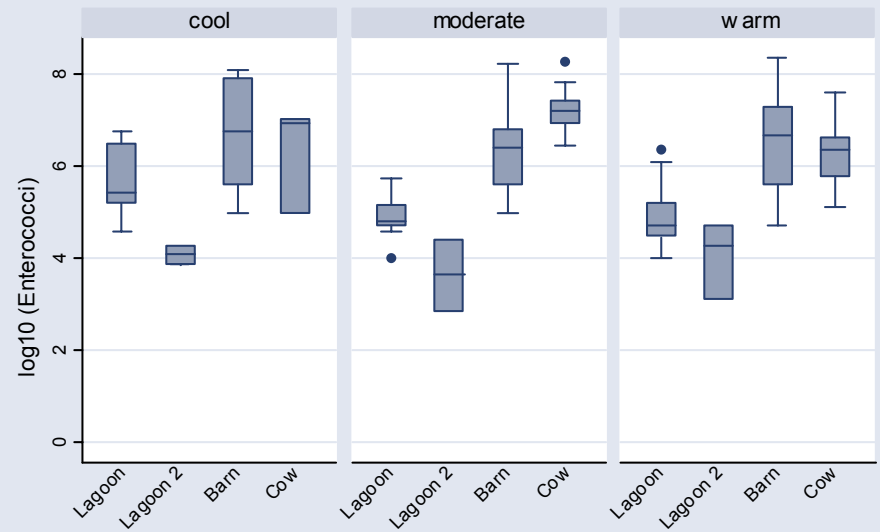
# Log<sub>10</sub> Enterococci Concentrations by Season

## Mean Enterococci Concentration in Water Samples



Graphs by Season

## Mean Enterococci Concentration in Animal Waste

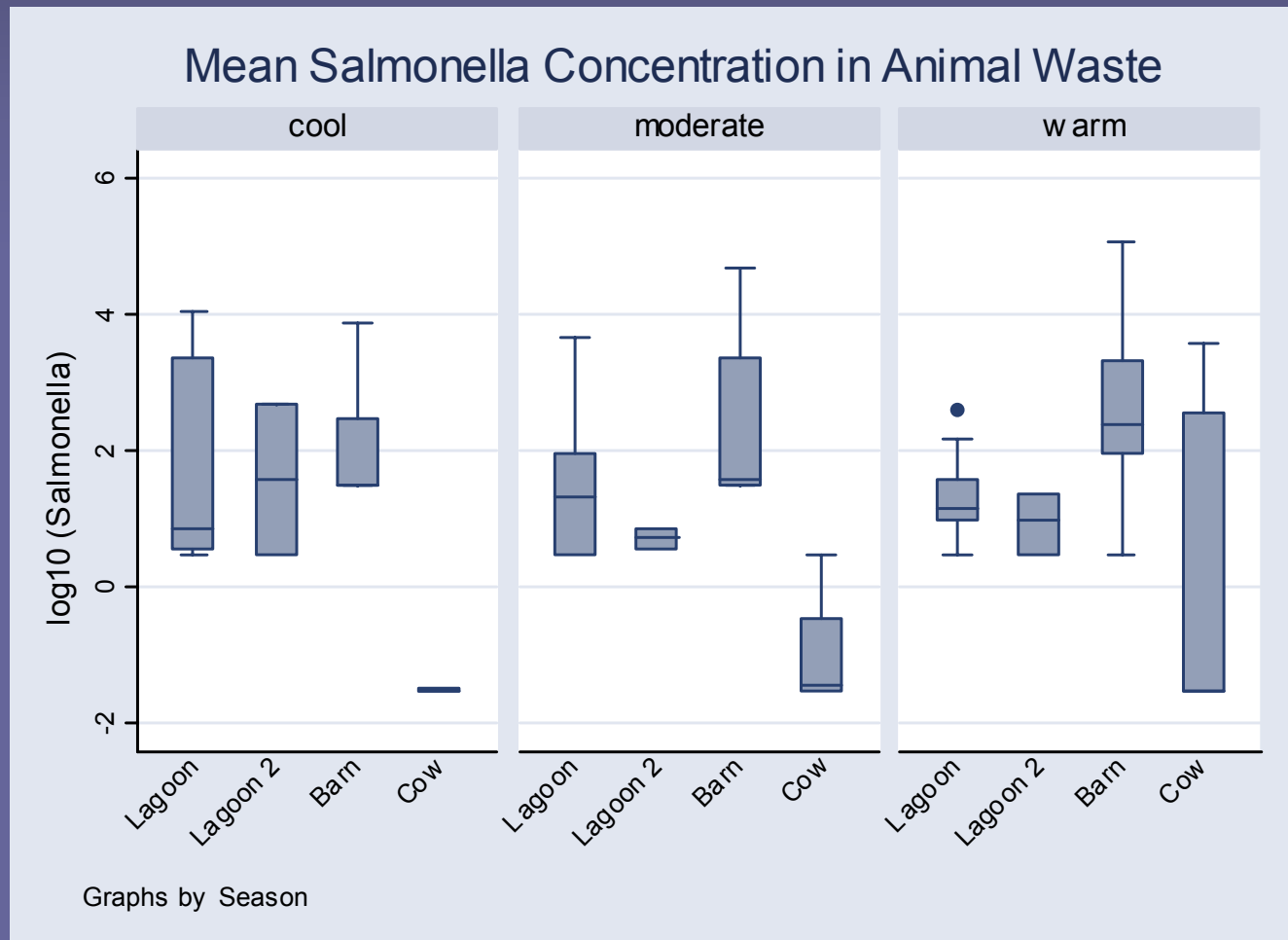


Graphs by Season

# Salmonella in Water

- Salmonella concentrations in surface water ranged from the lower detection limit of 0.03 cfu/100ml to the upper detection limit of 4.87 cfu /100ml
- Most samples were found to be between 0 and 1 cfu/100 ml
- Only one set of samples was found to reach the detection limit
- Salmonella was not found in ground water samples

# Log<sub>10</sub> Salmonella Concentrations by Season in Animal Waste



# Antibiotic Resistant Isolates

- Our study is still in progress
- Of the subset of environmental *E. coli* isolates examined to date many have been found to be resistant to one or more antibiotics
- These include isolates from both animal wastes and surface water

# AR Bacteria in Environmental Water

- **Lisa Casanova et al.** (not yet published) studied ground and surface water in 2 NC counties with high CAFO density
- In ground water, few bacteria were found and of those found none were found to have resistance
- In Surface water:

<b>Surface Water</b>						
Organism	# of sites	# pos sites	# of AR pos sites	# isolates AR tested	# MAR isolates	% isolates with MAR
E. coli	37	27	10	91	5	<b>5.5%</b>
Salmonella	37	15	4	51	3	<b>5.9%</b>
Enterococci	37	28	22	113	23	<b>20%</b>

# AR of On Farm Bacterial Isolates

- Michelle Sullivan, Otto Simmons et al (not yet published) examined prevalence of AR bacteria on Swine CAFOs
- On four study farms *Salmonella* and *E. coli* isolates were collected from different stages of waste treatment.
- On 3 of 4 farms 100% of *E. coli* isolates were resistant to 1 or more antibiotics and on the 4<sup>th</sup> 91% were resistant to multiple antibiotics
- For *Salmonella*, 2 of 4 farms had 100% of tested isolates resistant; the others 57% and 85%

# Conclusions

- There are significant concentrations of enteric bacteria in environmental waters
  - including the pathogen Salmonella
- Our research is still in progress, but it is already evident that antibiotic resistant bacteria are present in animal waste streams
- The impact of AR bacteria is still under review but there are low levels of AR bacteria found in surface waters
- It is still unclear as to the human exposure risks and human health impacts of AR bacteria originating from Animal Agriculture

# Future/continued Research

- Complete current collection and AR characterization of bacterial isolates
- Conduct epidemiological and risk assessment analyses to identify any human health risks from environmental exposure to these AR bacteria

# Acknowledgements

- This research was a collaboration with following:
  - Lynn Worley-Davis – NC State University
  - Dr. Otto “Chip” Simmons III – UNC –Chapel Hill
  - Dr. Mark Sobsey – UNC – Chapel Hill
  - Dr. Mike Williams – NC state University
  - Dr. Chris Ohl- Wake Forest University Medical Center
  - Victor Varela - Wake Forest University Medical Center
- Lisa Casanova and Michelle Sullivan for providing their research data for this presentation
- Other Important Partners
  - CDC/NCDHHS – funding agencies
  - Frontline Farmer Organization
  - Sobsey Laboratory

Questions??