

Waterborne Pathogens from Non-Human Sources and their Public Health Implications



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Autochthonous (Native) vs. Allochthonous Pathogens

Autochthonous pathogens live naturally in aquatic environments!

- *Vibrio vulnificus*, *V. parahaemolyticus*, *V. cholerae* (non-O1/O139)
- *Plesiomonas shigelloides*
- *Naegleria fowleri*
- *Legionella pneumophila*
- *Pfiesteria* spp.
- *Karenia brevis*



Autochthonous vs. Allochthonous Pathogens

These pathogens enter water bodies via pollution.

- *Campylobacter* spp.
- *Salmonella*
- Pathogenic *E. coli*
- *Giardia*
- *Cryptosporidium*
- *Yersinia enterocolitica*
- *Leptospira interrogans*
- *Francisella tularensis*
- Schistosomes*
- *Toxoplasma gondii*

*also complete their life cycle in aquatic hosts

“Naturalized” Pathogens?

- **Certain strains/species of fecal indicator bacteria are good survivors in aquatic environments.**
- **Some are capable of growth under the right conditions (algae, sediments).**
- **Need more information about pathogens!**



Cladophora algae, Lake Michigan

Campylobacteriosis

(*C. jejuni*, *C. coli*, *C. lari*)

- **Severe gastroenteritis (diarrhea, fever, cramping, nausea, vomiting) for ~ 1 week**
- **Rarely causes septicemia (immunocompromised)**
- **Guillane-Barre syndrome (1 campy case in 1,000)**
- **GBS is an autoimmune disease with central nervous system involvement**
- **Inflammatory bowel disease, reactive arthritis, and irritable bowel syndrome**
- **Estimated 2.4 million infections/year in U.S. and 124 deaths (CDC)**

Accidental Tourists

Many of these “accidental tourists” are zoonotic pathogens

- Transmitted from animals to humans



Hosts & Pathogens

Campylobacter



Salmonella



Francisella tularensis

Yersinia enterocolitica



Salmonella

Toxoplasma gondii

Campylobacter



Salmonella

Pathogenic E. coli



Salmonella

Cryptosporidium

Cryptosporidium

Pathogenic E. coli



Giardia

Toxoplasma gondii

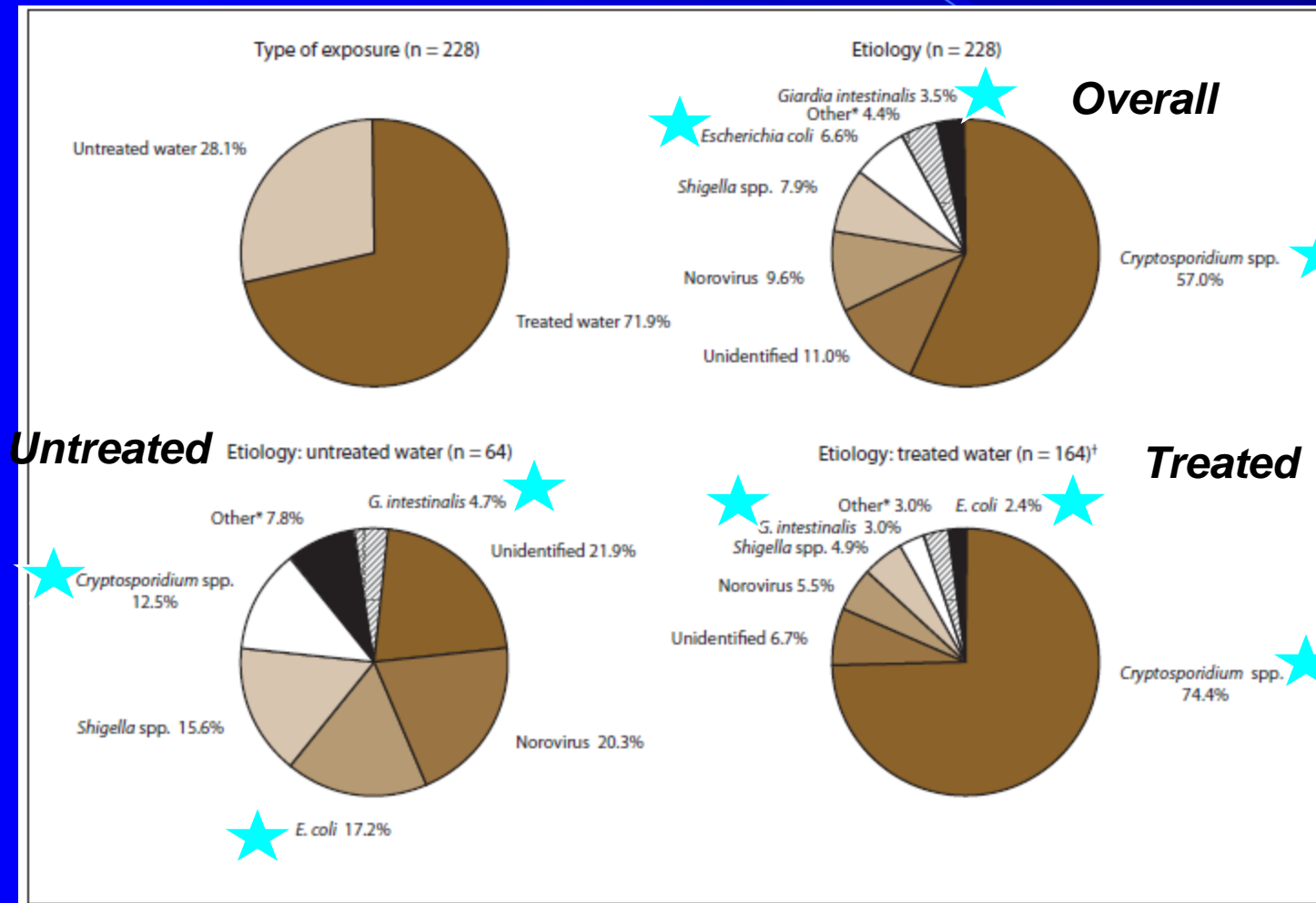


CDC 2007-2008 Surveillance Summary (U.S.)

Recreational Water Outbreaks

- 134 outbreaks, up from 78 in 2005-06
- *Cryptosporidium* was dominant etiological agent in treated water (and caused 44.8% of all 134 outbreaks)
- *Legionella pneumophila* dominant in potable water

2007-08 Recreational Water Outbreaks



The Cost

Annual Estimated Cost in U.S. for hospitalization*:

- *Cryptosporidium*
 - \$46 million
- *Giardia*
 - \$34 million



*CDC Surveillance Summary 2009-2010 MMWR 61:
2012

Case in Point: Poultry Fecal Contamination

Poultry Production in U.S.: A Steady Increase Over the Past Decade.

1990 - 2010 (USDA figures)

- **Broilers up 47% to 8.6 billion birds in 2010**
- **Highest producers are AL, AR, GA, MS, NC**



What's In That Stuff?

(Poultry Feces)

- *E. coli* (~1,200 CFU/g poultry litter)
- Enterococci (~51,000/g poultry litter)
- *Campylobacter jejuni*, *C. coli*
- *Salmonella enterica*
- Pathogenic *E. coli* strains like 0157:H7



And There's a Lot of It!

- Up to 0.5 lbs soiled litter per pound of meat produced
- = 340 tons annually from a farm with 4 houses



What Do We Do With It?

- For the most part, it is “land-applied.”
- ~1.6 billion kg/year in U.S.
- Phosphate, nitrogen, heavy metals spread along with bacteria



The Dilemma: How to Specifically Detect Poultry Litter Contamination: QPCR for *Brevibacterium* LA35

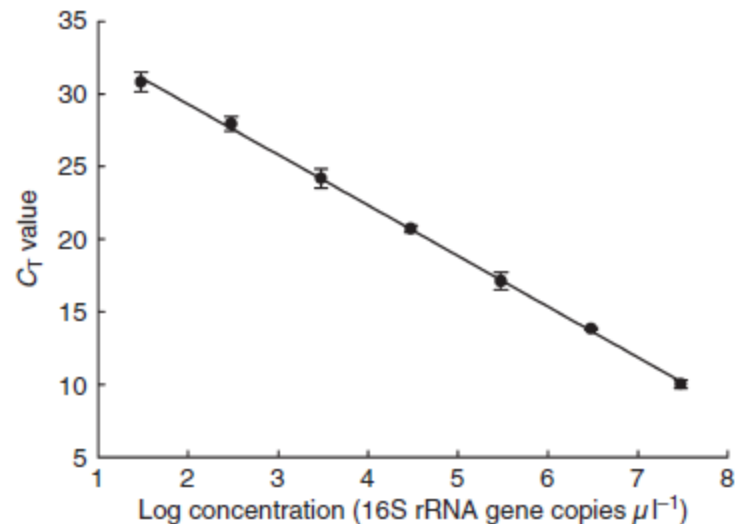


Figure 1 A representative standard curve of C_T values vs. poultry litter marker gene concentration in plasmid pLA35. The mean and standard deviation of triplicate samples is graphed vs. LA35 16S rRNA gene copies per microlitre.

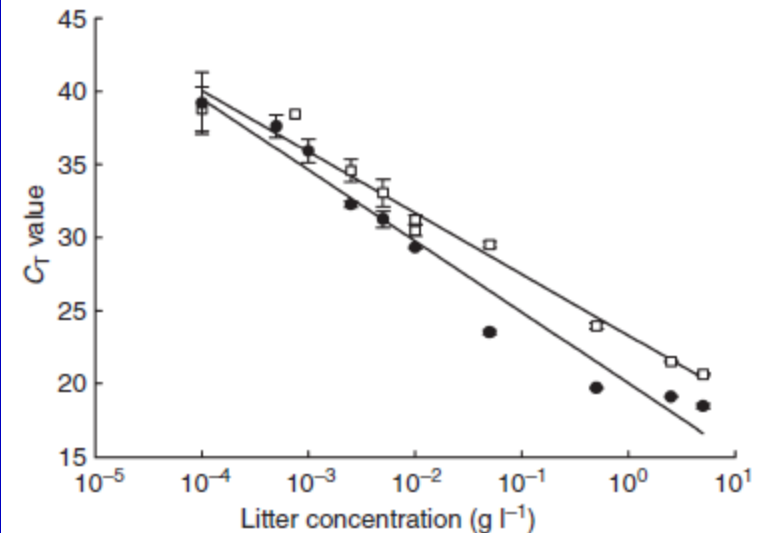


Figure 2 Used poultry litter samples were seeded into water to determine the qPCR detection limit in terms of gram of litter per litre of water. Mean and standard deviation of triplicate measurements at each concentration are shown for litter samples A (\square) and B (\bullet).

Illinois River Watershed LA35 Detections/All Samples

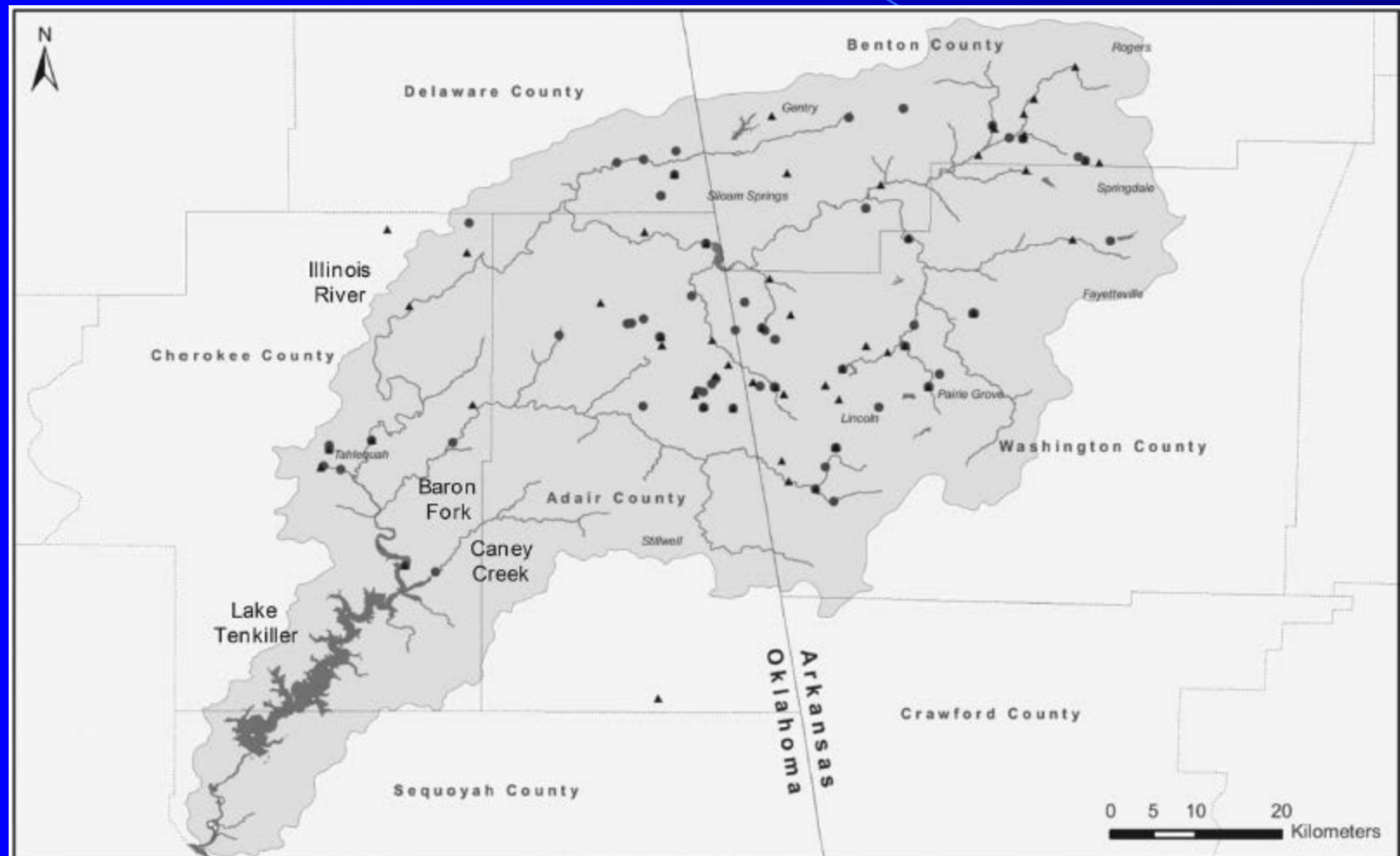


FIG. 1. Map of the Illinois River watershed, showing major water bodies and sampling locations in which the marker gene was detected by qPCR or by nested PCR (●) and those in which it was not detected by either assay (▲).

Strategies to Minimize Health Risk from Zoonoses*

- **Control prevalence and density of zoonotic pathogens in animal and environmental reservoirs**
- **Minimize contact of waste with surface and ground water**
- **Employ multiple barriers for treatment and distribution systems; plan for extreme weather**
- **Ensure that strategies protect the most susceptible groups, e.g. children, immunocompromised**

***Adapted from Gannon, V. 2004. Control of zoonotic waterborne pathogens in animal reservoirs. In Waterborne Zoonoses, WHO**

- **Better understanding of ecology of waterborne pathogens will allow us to better achieve all of the above goals**



Questions?
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