

The background of the slide is a microscopic image showing several large, oval-shaped eggs with a thick, textured outer shell and a darker, granular interior. One egg is particularly prominent in the upper left. Another smaller, elongated egg is visible in the lower center. The overall color is a muted olive green.

# **SOIL-TRANSMITTED HELMINTHES: A TRIAD OF WORMS, ANIMALS, & HUMANS**

**Deborah K. Glaum, DVM**

MPH Student

Kansas State University

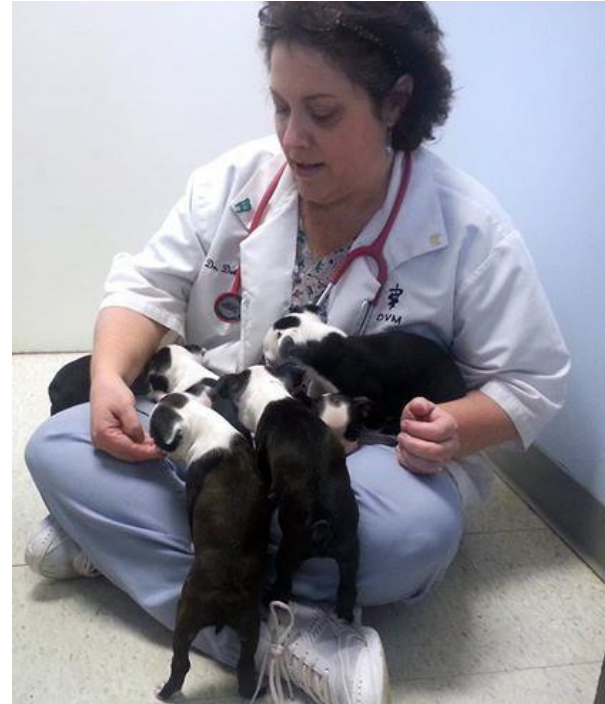
[dkglaum@juno.com](mailto:dkglaum@juno.com)

# Introduction

BS Agriculture Kansas State University 1986

DVM Kansas State University 1989

Practiced in Amarillo, TX and Olathe, KS



SCIENCE

## Scientists Make a Gross Discovery After Examining the Body of Richard III Found Under a Parking Lot

Sep. 4, 2013 7:26am | Associated Press

255  
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LONDON (AP) — Not only was Richard III the hunchback king was probably infected with parasitic worms that grew up to a foot in length.

Researchers who dug up Richard III's



3, 2013. The remains of England's King Richard III which were found in a dig in Leicester England in Sept 2012. Not only was Richard III one of England's most reviled monarchs, but it now turns out the hunchback king was probably infected with parasitic worms that grew up to a foot in length. Credit: University of Leicester

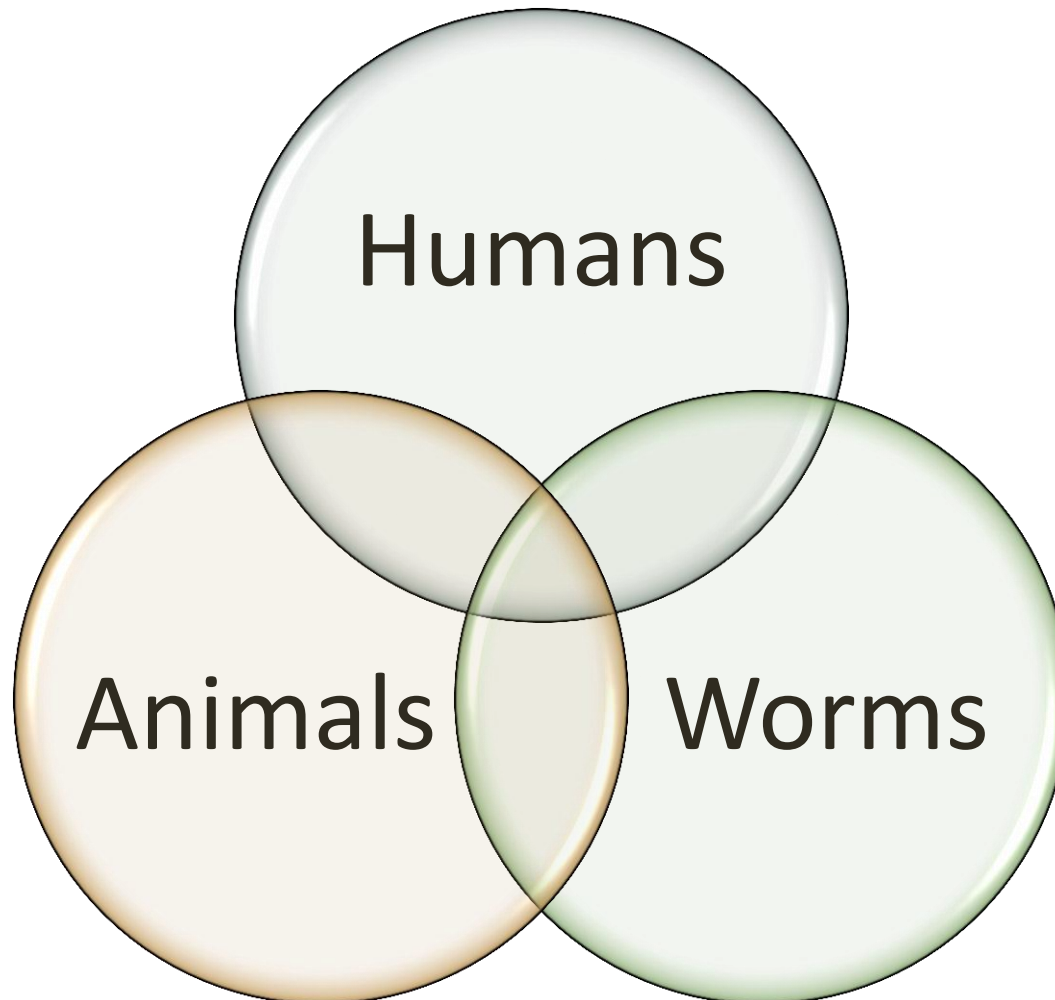
“The bare mention of the question will make those of you with nosogeographical interests--or, better, helminthogeographical interests--warily scratch a mental ear and mull over a remark that ends ‘where angels fear to tread.’”

Norman R. Stoll, *This Wormy World*

# Basic Definitions

- **ZP—zoonotic parasitism**
- **Zoonosis—disease transmitted between humans & animals**
- **Parasitism—non-mutual symbiotic relationship**
- **Soil-transmitted helminthes (STH)—parasites whose infectious stages are found in contaminated soil**

# Zoonotic STH's—A Triad



---

*"Parasitic infections affect millions around the world causing seizures, blindness, infertility, heart failure, and even death. They're more common in the US than people realize and yet there is so much we don't know about them. We need research to learn more about these infections and action to better prevent and treat them."*

**Tom Frieden, MD, MPH -**

Director of the Centers for

Disease Control and Prevention

# Neglected Parasitic Infections in the United States

Monica E. Parise, MD

May 6, 2014

01 of 13



## Neglected Parasitic Infections in the United States

Parasitic infections are a global public health problem and often affect the poorest people in low-income countries. However, US residents may also acquire parasitic infections in the United States, in their country of origin, or during international travel. The Centers for Disease Control and Prevention (CDC) has prioritized 5 parasitic infections for public health action in the United States: Chagas disease, cysticercosis, toxocariasis, toxoplasmosis, and trichomoniasis. Referred to as the "neglected parasitic infections (NPIs) in the United States," these infections share common characteristics in that they affect large numbers of people and are often underrecognized, and preventive or curative interventions are often lacking.

*Image from Dreamstime / CDC / Wikimedia Commons*

[www.cdc.gov](http://www.cdc.gov)

TABLE 1

## Gastrointestinal Parasitic Infections in Dogs and Cats in North America That Are Transmissible to People

### DOGS

### CATS

#### Helminths

##### Nematodes

*Toxocara canis*

*Ancylostoma caninum*

*Ancylostoma braziliense*

##### Nematodes

*Toxocara cati*

*Ancylostoma tubaeforme*

*Ancylostoma braziliense*

##### Cestodes

*Dipylidium caninum*

*Echinococcus multilocularis*

*Echinococcus granulosus*

*Taenia serialis*

*Taenia multiceps*

##### Cestodes

*Dipylidium caninum*

*Echinococcus multilocularis*

#### Protozoa

*Giardia duodenalis (intestinalis)*

*Cryptosporidium canis*

*Giardia duodenalis (intestinalis)*

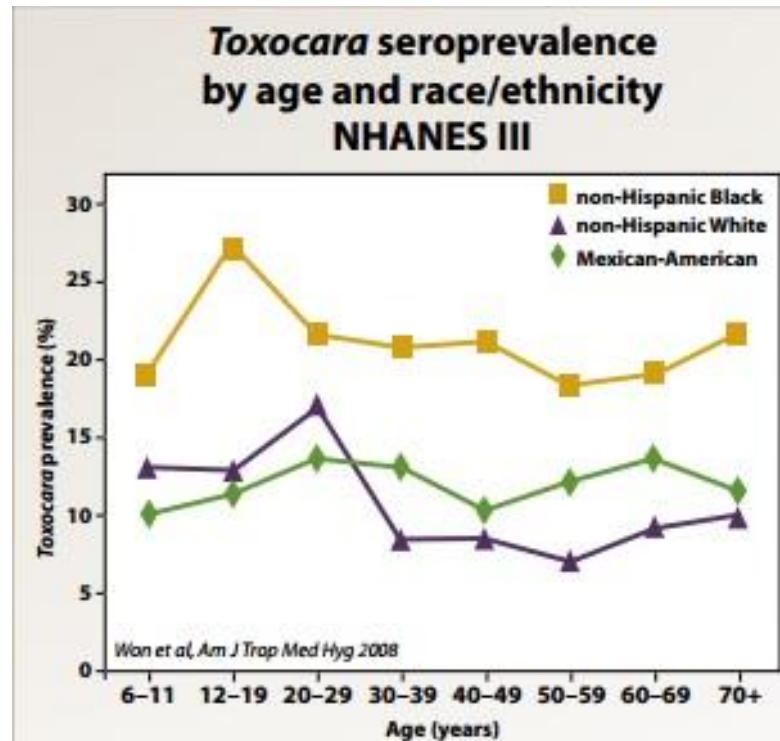
*Cryptosporidium felis*

*Toxoplasma gondii*

This partial list of parasitic infections in dogs or cats omits some zoonotic parasites adapted to other mammalian hosts that occasionally and facultatively infect dogs or cats (e.g. *Baylisascaris procyonis*, a common intestinal helminth of raccoons that occasionally infects dogs).

Table 1: Gastrointestinal Parasitic Infections in Dogs and Cats in North America That Are Transmissible to People  
Peter M. Schantz, VMD, PhD

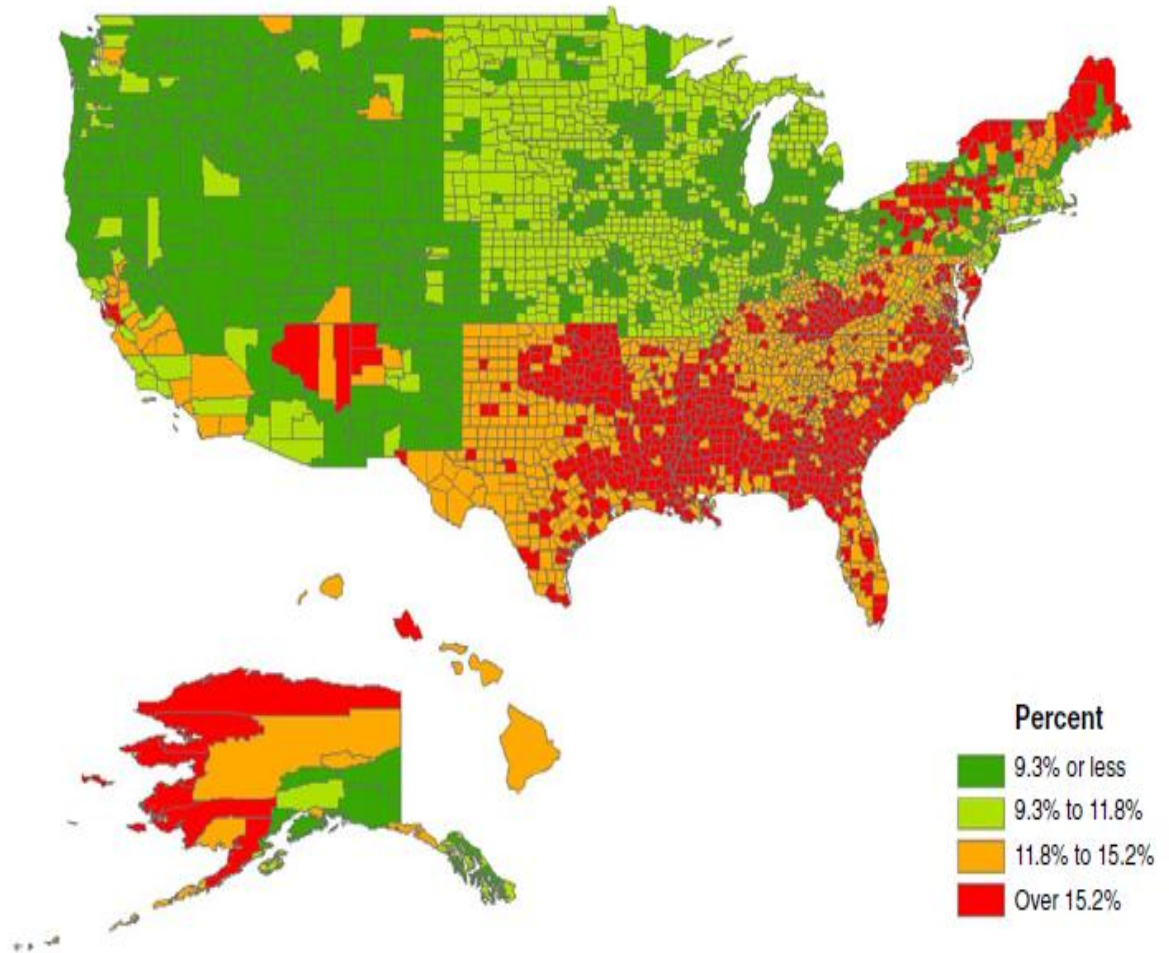
# NHANES III—1988-1994



*Almost 14% of the U.S.  
population has been  
exposed to the parasite.*

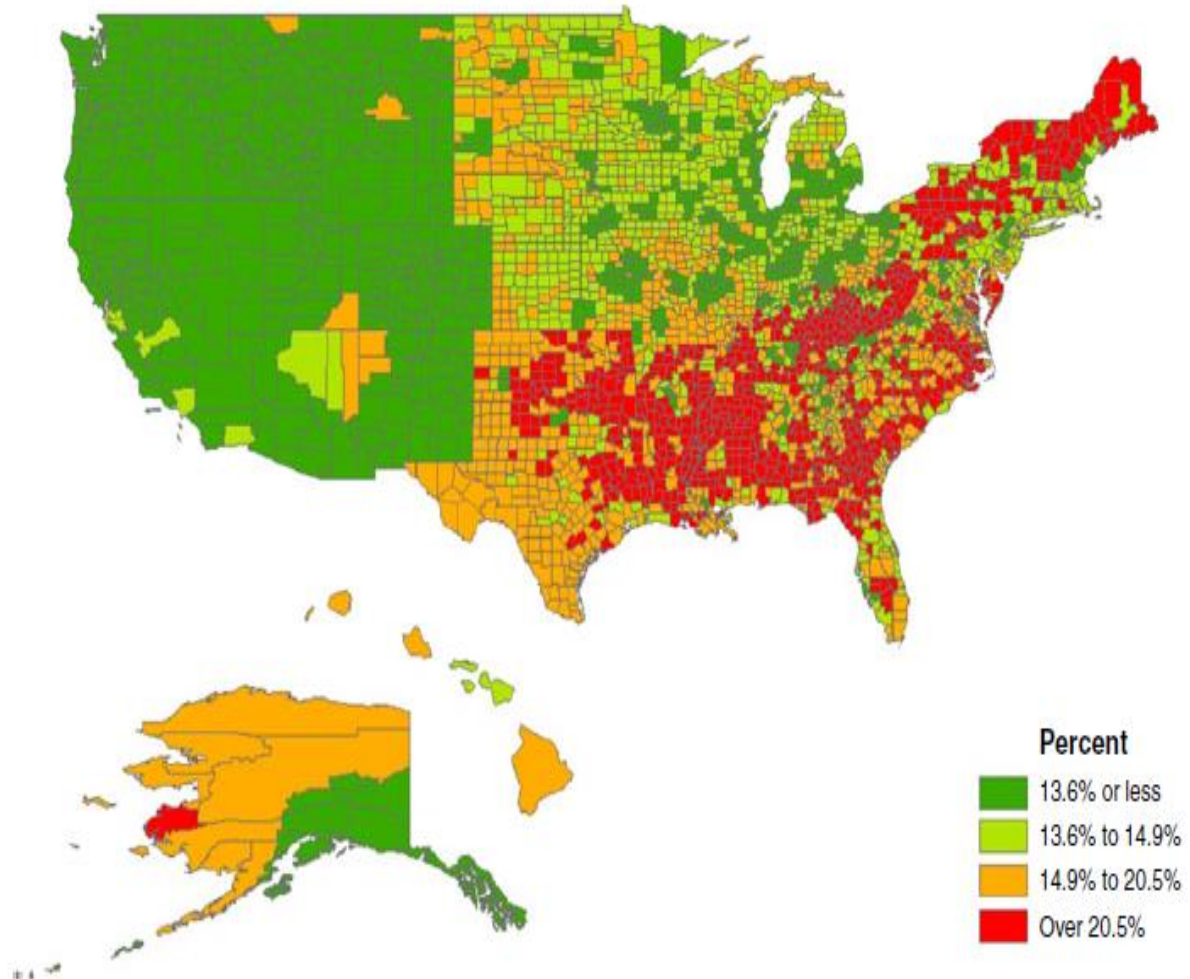
# NHANES III—1988-1994

Fig. 2 Estimated county infection rates (percents for females), United States, 1988-1994

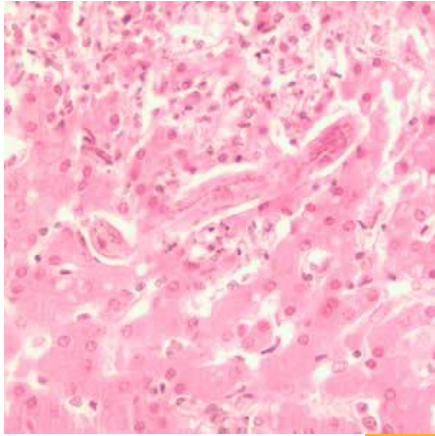


# NHANES III—1988-1994

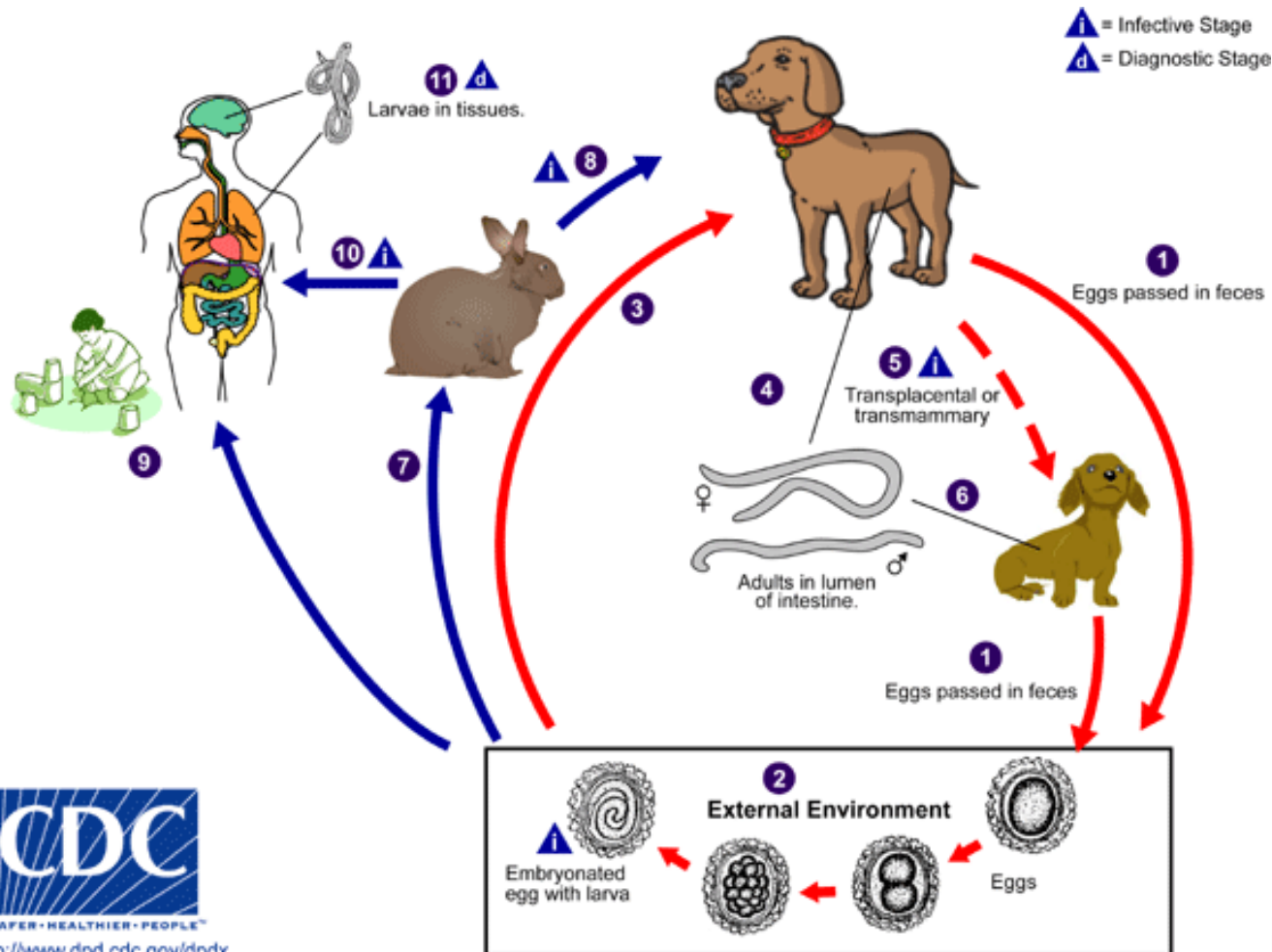
Fig. 1 Estimated county infection rates (percents for males), United States, 1988-1994



# Ascarids/Roundworms



# Ascarids/Roundworms



# Transmission and Exposure Risks

- Exposure due to pets and pet-related hygiene behaviors



# Transmission and Exposure Risks

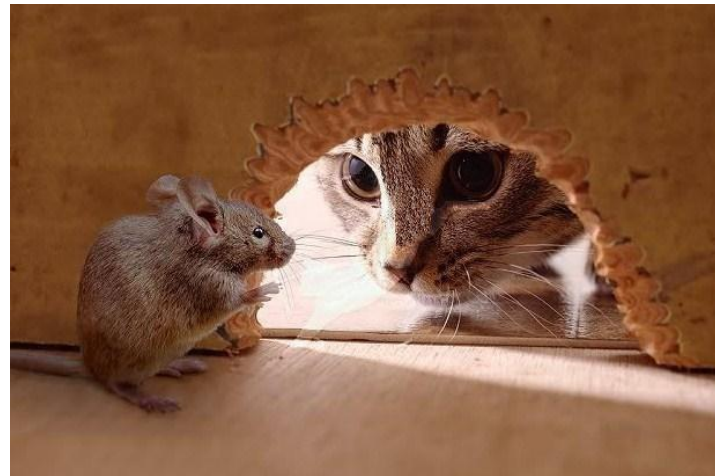


- Exposure due to wildlife and free-ranging dogs



# Transmission and Exposure Risks

- Exposure due to contaminated food



# Transmission and Exposure Risks

- Exposure due to human factors
  - Immunosuppression
  - Poverty
  - Housing & sanitation
  - Low education
  - High soil exposure
  - Local food habits



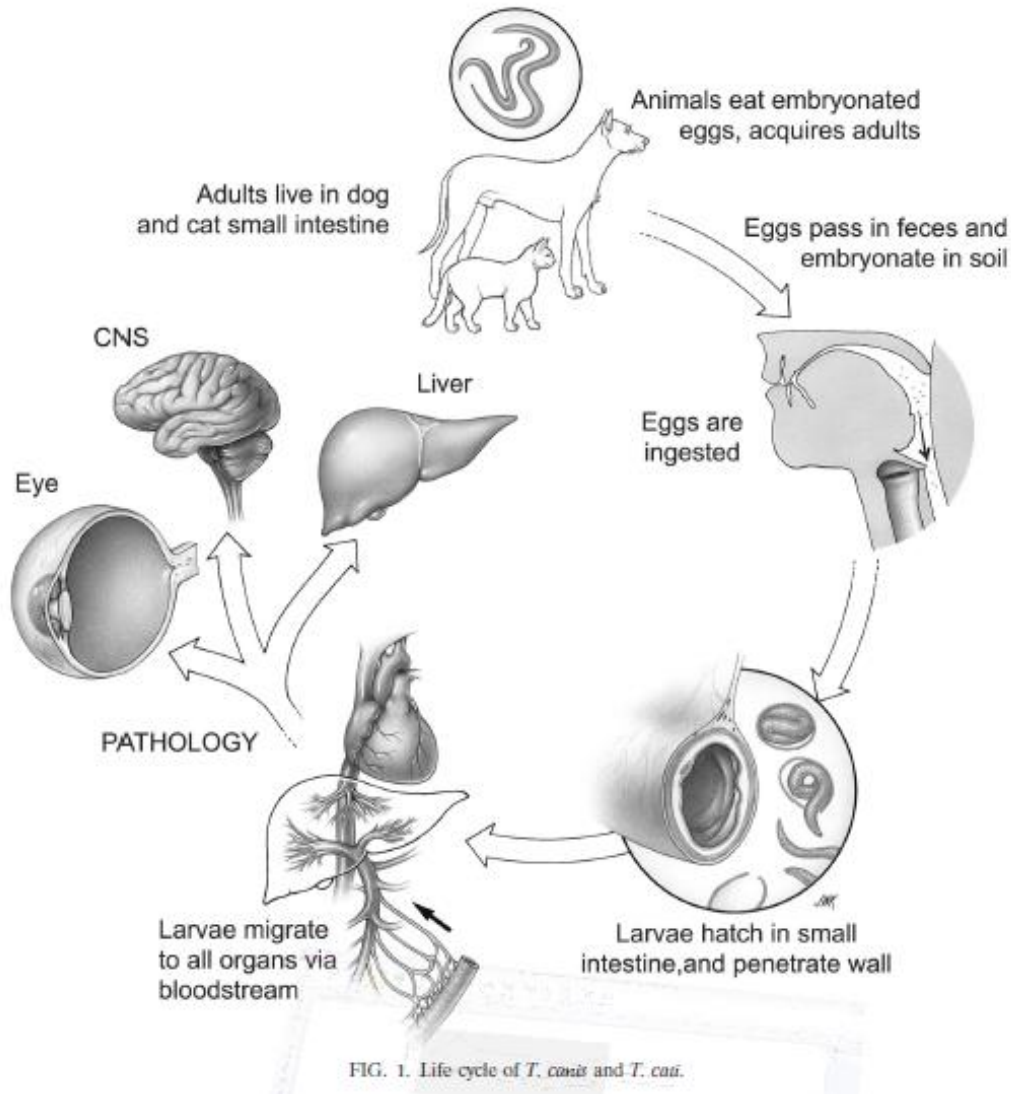
# Children at Risk

- Pica: “the craving to eat nonfood items, such as dirt, paint chips, and clay.”



- Soil-ingestion (geophagia): “the consumption of soil resulting from various behaviors, including, but not limited to, mouthing objects or dirty hands, eating dropped food, and intentionally consuming soil.”

# Ascarids/Roundworms



# Transmission and Exposure Risks

NEGLECTED PARASITIC INFECTION:

## Toxocariasis



Each year in the United States at least **70 people are blinded** by the parasite that causes toxocariasis; most of them are children.



Learn more: [www.cdc.gov/parasites/npi/](http://www.cdc.gov/parasites/npi/)

# Ascarids/Roundworms

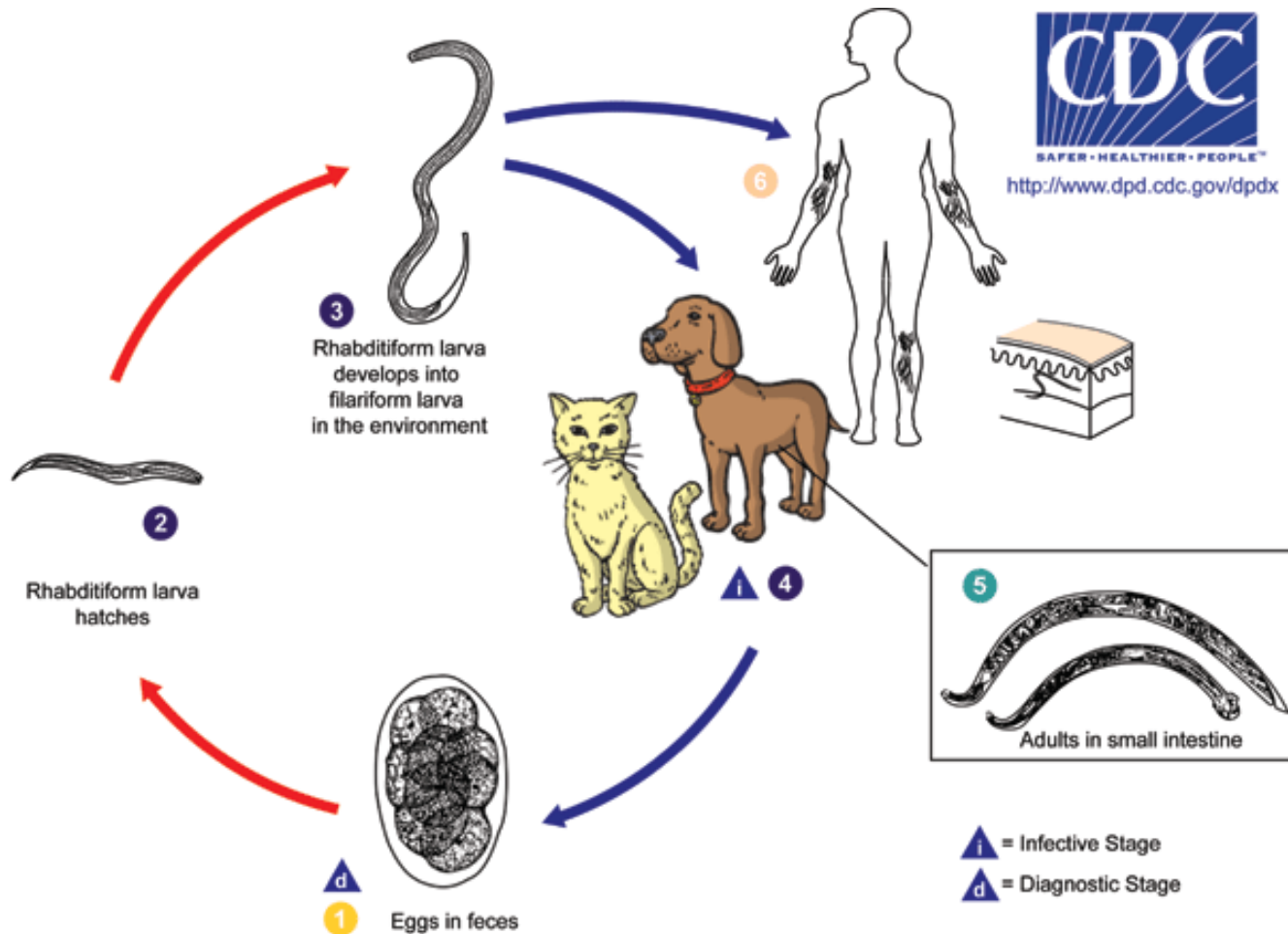
“Nonetheless, the substantial rates of *T. canis* infection in children that we and others have observed suggest that unrecognized childhood *T. canis* infections, if associated with adverse health or neuropsychological effects, may constitute an important public health problem.”

Marmor, et al.

# Ancylostamids/Hookworms



# Ancylostoma/Hookworms



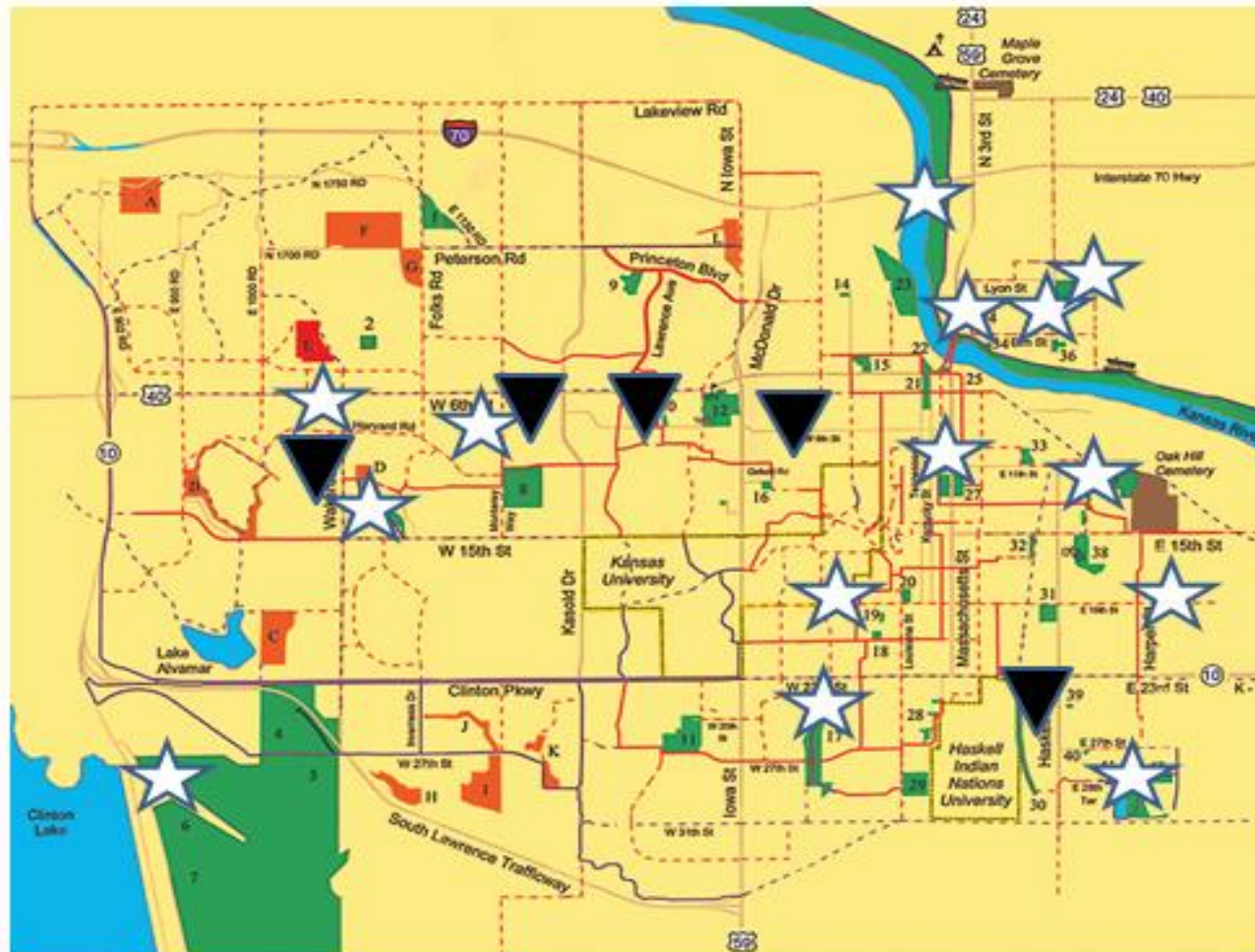
# Internship

- Lawrence-Douglas County Health Department (LDCHD) in Lawrence, Kansas
- Summer/Fall 2013
- *Are public spaces contaminated with dog feces?*
- *Do pets have parasites?*
- Surveys/fecal exams

# Internship



# Lawrence, Kansas Data



Fecal  
Collection



Veterinary  
Information

# Fecal Samples—Selected Areas

| <u>Setting</u>  | <u>Sample</u>          | <u>Parasites</u> | <u>Type</u> |
|-----------------|------------------------|------------------|-------------|
| Farmer's Market | Dessicated/decomposing | n/a              |             |
|                 | d/d                    | n/a              |             |
|                 | d/d                    | n/a              |             |



# Fecal Samples—Selected Areas

| <u>Setting</u> | <u>Sample</u>          | <u>Parasites</u> | <u>Type</u> |
|----------------|------------------------|------------------|-------------|
|                |                        |                  |             |
| Walnut         | Dessicated/decomposing | n/a              |             |
|                | d/d                    | n/a              |             |
|                |                        |                  |             |
| John Taylor    | d/d                    | n/a              |             |
|                | d/d                    | n/a              |             |
|                | d/d                    | n/a              |             |
|                |                        |                  |             |
| Brook Creek    | d/d                    | n/a              |             |
|                | d/d                    | n/a              |             |
|                | d/d                    | n/a              |             |
|                | d/d                    | n/a              |             |
|                | d/d                    | n/a              |             |

# Fecal Samples—Selected Populations

| <u>Setting</u> | <u>Dog</u> | <u>Sex</u> | <u>Age (Yrs)</u> | <u>Parasites</u> | <u>Type</u>                |
|----------------|------------|------------|------------------|------------------|----------------------------|
| Senior         | Cookie     | F          | 1-5              | Y                | 3+ Ancylostoma, 3+ Eimeria |
|                | Hera       | FS         | >10              | N                |                            |
|                | Jill       | FS         | 6-10             | N                |                            |
|                | Millie     | FS         | 6-10             | N                |                            |
|                | Bailey     | FS         | 1-5              | N                |                            |
|                | Bella      | FS         | 1-5              | N                |                            |
|                |            |            |                  |                  |                            |
| Childcare      | Sheridan   | FS         | 1-5              | N                |                            |
|                | Hagan      | FS         | 1-5              | N                |                            |
|                | Bella      | FS         | 1-5              | N                |                            |
|                |            |            |                  |                  |                            |
| LDCHD          | Lucy       | FS         | 6-10             | N                |                            |
|                | Zoey       | FS         | 1-5              | N                |                            |
|                | Zoey       | FS         | 6-10             | N                |                            |
|                | Frieda     | FS         | 6-10             | Y                | 1+ Paragonimus             |

# Fecal Samples—Selected Areas

|              |       |   |                |
|--------------|-------|---|----------------|
| Prairie Park | Fresh | N |                |
|              | Fresh | N |                |
|              | Fresh | Y | 1+ Ancylostoma |
|              | Fresh | N |                |
|              | Fresh | N |                |
|              | Fresh | N |                |
|              | Fresh | N |                |
|              | Fresh | N |                |
|              | Fresh | N |                |
|              | Fresh | N |                |
|              | Fresh | N |                |
|              | Fresh | N |                |
|              | Fresh | N |                |
|              | Fresh | N |                |
|              | Fresh | N |                |
|              | Fresh | Y | 1+ Ancylostoma |
|              | Fresh | Y | 1+ Isospora    |

# Fecal Samples—Selected Areas

|                      |                        |   |                                              |
|----------------------|------------------------|---|----------------------------------------------|
| Naismith Valley Park | Fresh                  | N |                                              |
|                      | Fresh                  | N |                                              |
|                      | Fresh                  | N |                                              |
|                      | Fresh                  | Y |                                              |
|                      | Fresh                  | Y | 4+ Toxocara, 2+ Trichuris,<br>2+ Ancylostoma |
|                      |                        |   |                                              |
| Riverfront           | Dessicated/decomposing | N |                                              |
|                      | Fresh                  | N |                                              |
|                      | Fresh                  | N |                                              |
|                      | Fresh                  | Y | 1+ Toxocara                                  |

# Fecal Samples—Selected Areas

- All parks were contaminated
- Dog owners less likely to clean up pet stool in “nature parks”
- “Nature parks” do not have posted rules or pick-up stations like dog parks

# Fecal Samples—Selected Populations

| <u>Setting</u> | <u>Dog</u> | <u>Sex</u> | <u>Age (Yrs)</u> | <u>Parasites</u> | <u>Type</u> |
|----------------|------------|------------|------------------|------------------|-------------|
| Doggy Daycare  | Pablo      |            |                  | N                |             |
|                | Molly      |            |                  | N                |             |
|                | Zoey       |            |                  | Y                | 1+ Toxocara |
|                | Kirby      | MN         | 1-5              | N                |             |
|                | Luna       |            |                  | N                |             |
|                | Reba       |            |                  | N                |             |
|                | Annabelle  |            |                  | N                |             |
|                | Poppy      |            |                  | N                |             |
|                | Gracie     |            |                  | N                |             |
|                | Salvador   |            |                  | N                |             |
|                | Phin       |            |                  | N                |             |
|                | Gus        |            |                  | N                |             |
|                | Bonnie     |            |                  | N                |             |
|                | Minnie     | FS         | 1-5              | N                |             |
|                | Rico       |            |                  | N                |             |
|                | Mookie     |            |                  | N                |             |
|                | Digby      |            |                  | N                |             |

# Fecal Samples—Selected Populations

| <u>Setting</u> | <u>Dog</u> | <u>Sex</u> | <u>Age (Yrs)</u> | <u>Parasites</u> | <u>Type</u>    |
|----------------|------------|------------|------------------|------------------|----------------|
| MuttRun        | Buster     | MN         | >10              | N                |                |
|                | Alfie      |            |                  | N                |                |
|                | Marco Polo |            |                  | N                |                |
|                | Lana       |            |                  | N                |                |
|                | Tucker     |            |                  | N                |                |
|                | Donner     | MN         | >10              | N                |                |
|                | Echo       |            |                  | Y                | 2+ Ancylostoma |
|                | Stella     | FS         | 1-5              | N                |                |
|                | Buddha     |            |                  | N                |                |
|                | Charlie    |            |                  | N                |                |
|                | Rook       |            |                  | N                |                |
|                | Lola       | FS         | <1               | N                |                |
|                | Sophie     |            |                  | N                |                |
|                | Katie      |            |                  | N                |                |
|                | Socrates   | MN         | 1-5              | N                |                |
|                | Abby       |            |                  | Y                | 1+ Isospora    |
|                | Tashama    |            |                  | N                |                |
|                | Marley     | FS         | 1-5              | N                |                |
|                | Baxter     | MN         | 1-5              | N                |                |
|                | Captain    |            |                  | N                |                |
|                | Gracie     |            |                  | N                |                |
|                | Sam        |            |                  | N                |                |
|                | Bella      |            |                  | N                |                |
|                | Beatrice   |            |                  | N                |                |

# Fecal Samples—Selected Populations

Routine veterinary care + Routine heartworm preventative



Less parasitism



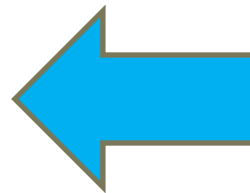
It's not  
rocket science!

# Interviews with Veterinarians

| <u>Facility</u>                                                               | <u>Year</u> | <u># Tests</u> | <u># Positive for parasites</u> | <u>Format</u>      |
|-------------------------------------------------------------------------------|-------------|----------------|---------------------------------|--------------------|
| Animal Hospital of Lawrence                                                   | 2012        | 616            | 39+ for rounds/hooks/or both    | book               |
| Bradley Animal Hospital                                                       |             |                | estimate 10-15%                 | book               |
| Clinton Parkway Animal Hospital--NR                                           |             |                |                                 |                    |
| Gentle Care Animal Hospital                                                   |             |                | estimate 10-15%                 | computer*          |
| Lawrence Veterinary Hospital--NR                                              |             |                |                                 |                    |
| Lewis Veterinary Clinic                                                       |             |                |                                 | individual records |
| Wakarusa Veterinary Hospital                                                  | 2008        | 1179           | 119                             | spreadsheet*       |
|                                                                               | 2009        | 1172           | 125                             |                    |
|                                                                               | 2010        | 1167           | 121                             |                    |
|                                                                               | 2011        | 1192           | 116                             |                    |
|                                                                               | 2012        | 1194           | 120                             |                    |
| * Computerized records of results of individual tests not readily accessible. |             |                |                                 |                    |
| NR--no response                                                               |             |                |                                 |                    |

# Interviews with Veterinarians

- Roundworms/Hookworms/Both: 6-15%
- Recordkeeping
  - Written
  - Computerized
- Hard to access data

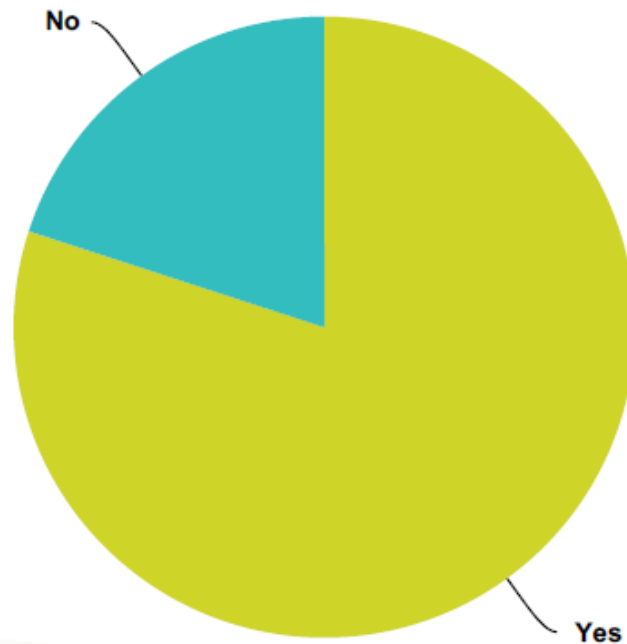


# Surveys of Pet Owners

Lawrence-Douglas County KS Canine Fecal Study

**Q12 Are you aware that some parasites will infect humans as well as dogs?**

Answered: 35 Skipped: 0

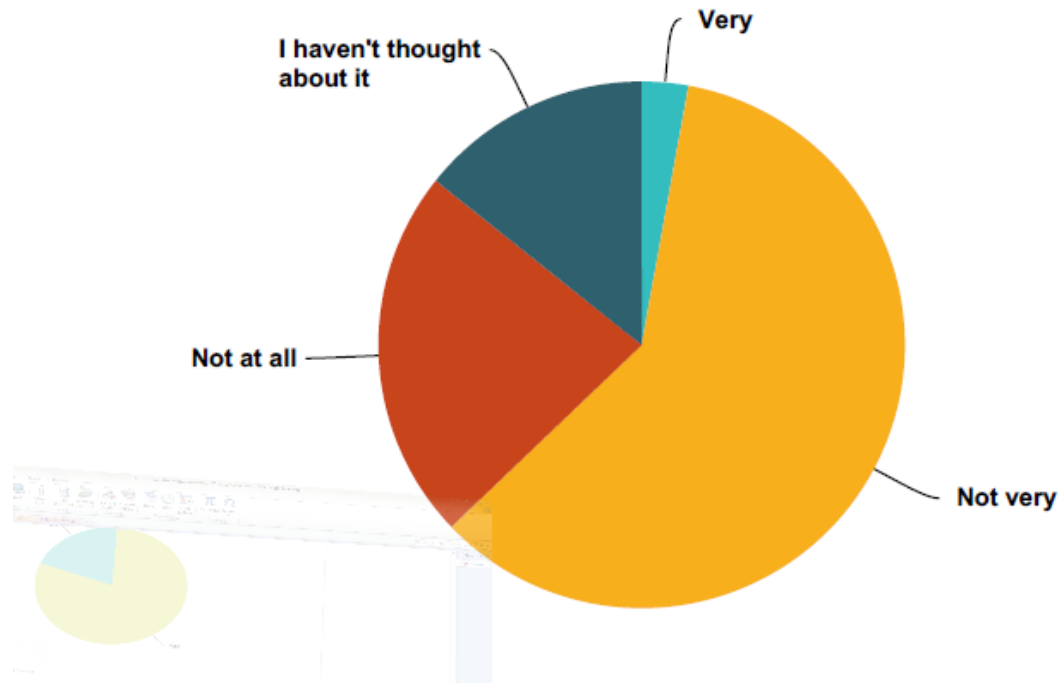


# Surveys of Pet Owners

Lawrence-Douglas County KS Canine Fecal Study

**Q13** How concerned are you that you or your family may be infected by parasites from your dog?

Answered: 35 Skipped: 0

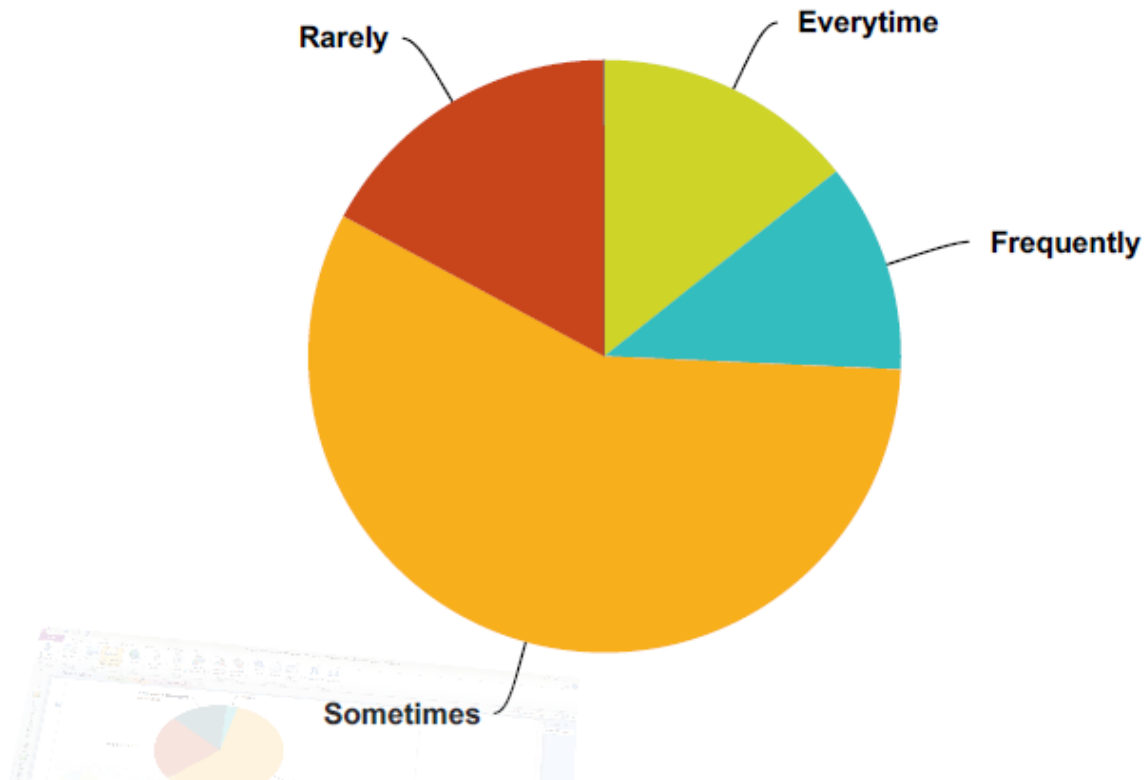


# Surveys of Pet Owners

Lawrence-Douglas County KS Canine Fecal Study

## Q5 Do you wash your hands after contact with your pet?

Answered: 35 Skipped: 0

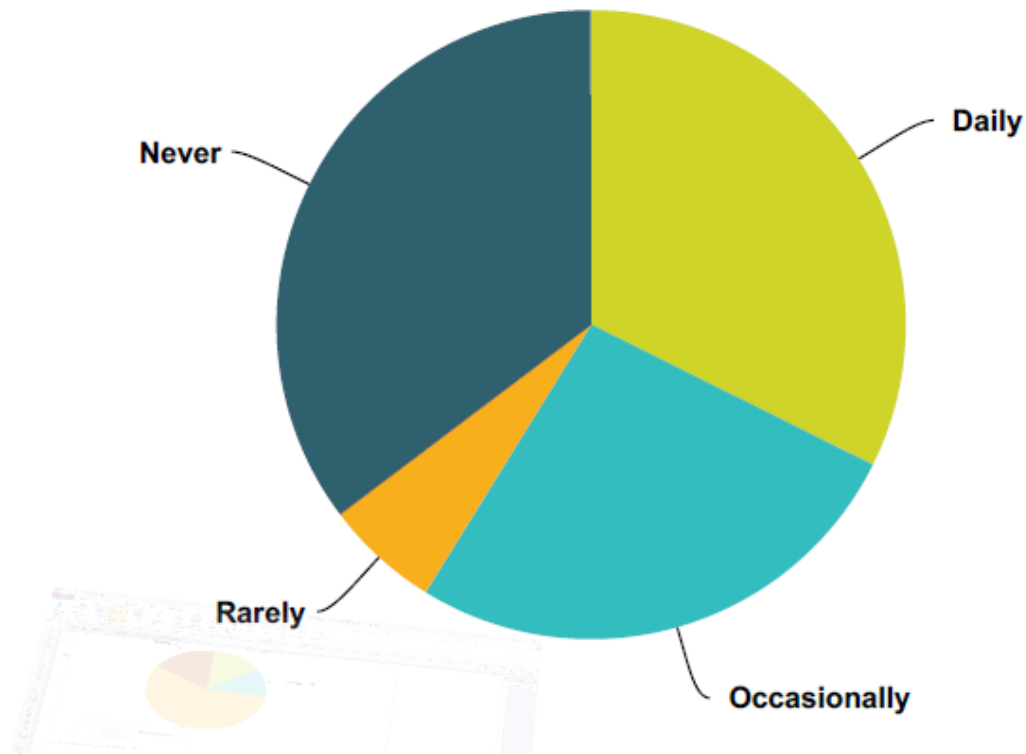


# Surveys of Pet Owners

Lawrence-Douglas County KS Canine Fecal Study

**Q7 How often does your dog sleep in your bed (or a family member's)?**

Answered: 34 Skipped: 1

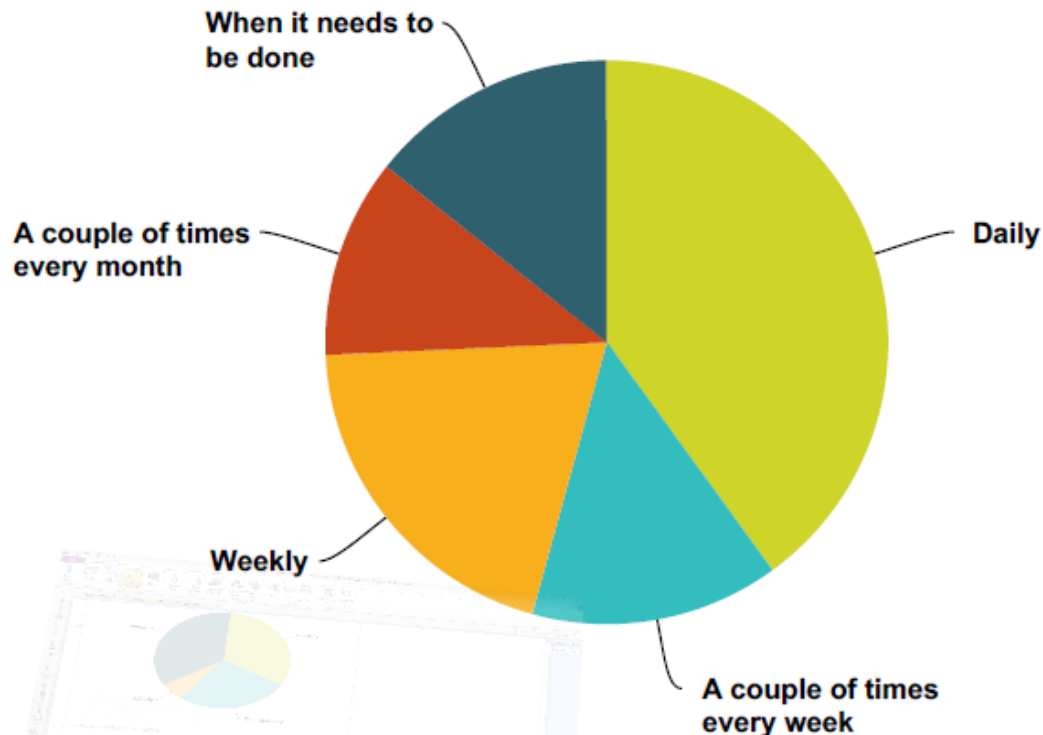


# Surveys of Pet Owners

Lawrence-Douglas County KS Canine Fecal Study

## Q8 How often do you scoop your dog's feces in your yard?

Answered: 35 Skipped: 0

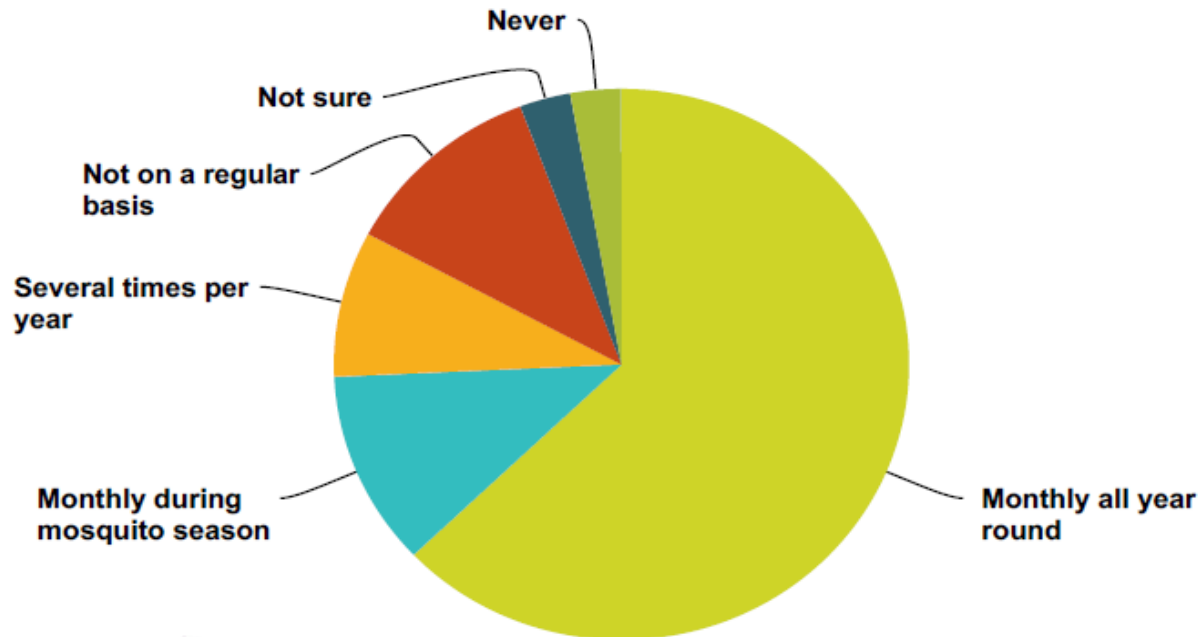


# Surveys of Pet Owners

Lawrence-Douglas County KS Canine Fecal Study

**Q17 How often do you give heartworm preventive medication to your dog?**

Answered: 35 Skipped: 0



# Barriers to Addressing ZP

“I was thinking of installing one of those automatic garage door openers over the weekend. The directions say ‘make certain the garage door is square and straight and the garage floor is level.’ Directions always read like that. Is everything in your [house] straight, square and level? If my house was straight, square and level, I would never have to fix anything. What we all need are directions that tell us what to do when everything is crooked, off-center and all screwed up.”

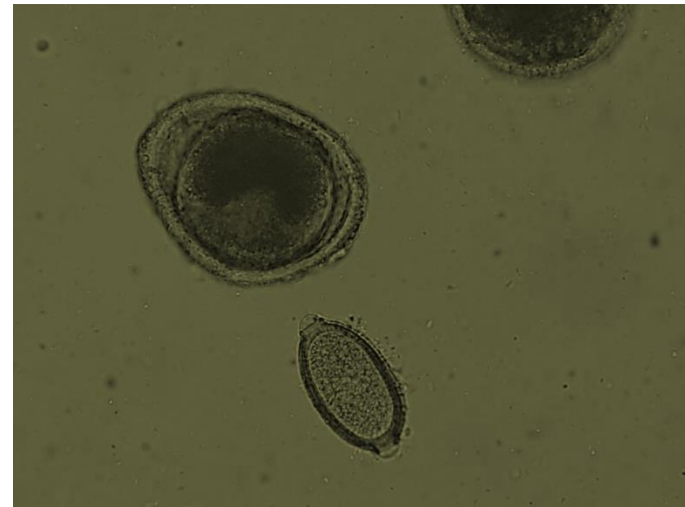
Andy Rooney

# “Wicked Problems”

- “Wicked Problem”—a term coined by urban planners at UC-Berkley in 1973
- Are complex => difficult to define clearly
- Are constantly changing
- Have multi-causal natures
- Lead to conflicting goals
- Involve social & individual behaviors

# Misconceptions about STH's

- Worms are not present if you do not see them (?!)
- ZP is only a problem in tropical climates
- Easily-controlled means  
well-controlled



# Lack of Awareness

- **Human healthcare providers:**
  - **Many do not ask about pet ownership—78-90%**
  - **May not make understanding zoonotic diseases a priority in practice**
  - **May not live in same community as patients**
  - **May not understand culture of their patients**

# Lack of Quantitative Facts

- **Collecting information**
  - Different agencies for animals & humans
  - Different testing methods
  - Rare (?) diseases do not get priority
  - Different communities get different priorities
- **Understanding information**
  - Common metrics may not be useful \*
  - Confounding factors \*\*

\* Payne, Turner and Morgan, 2009.

\*\* Torgerson and Macpherson, 2011.

# Diverse Views

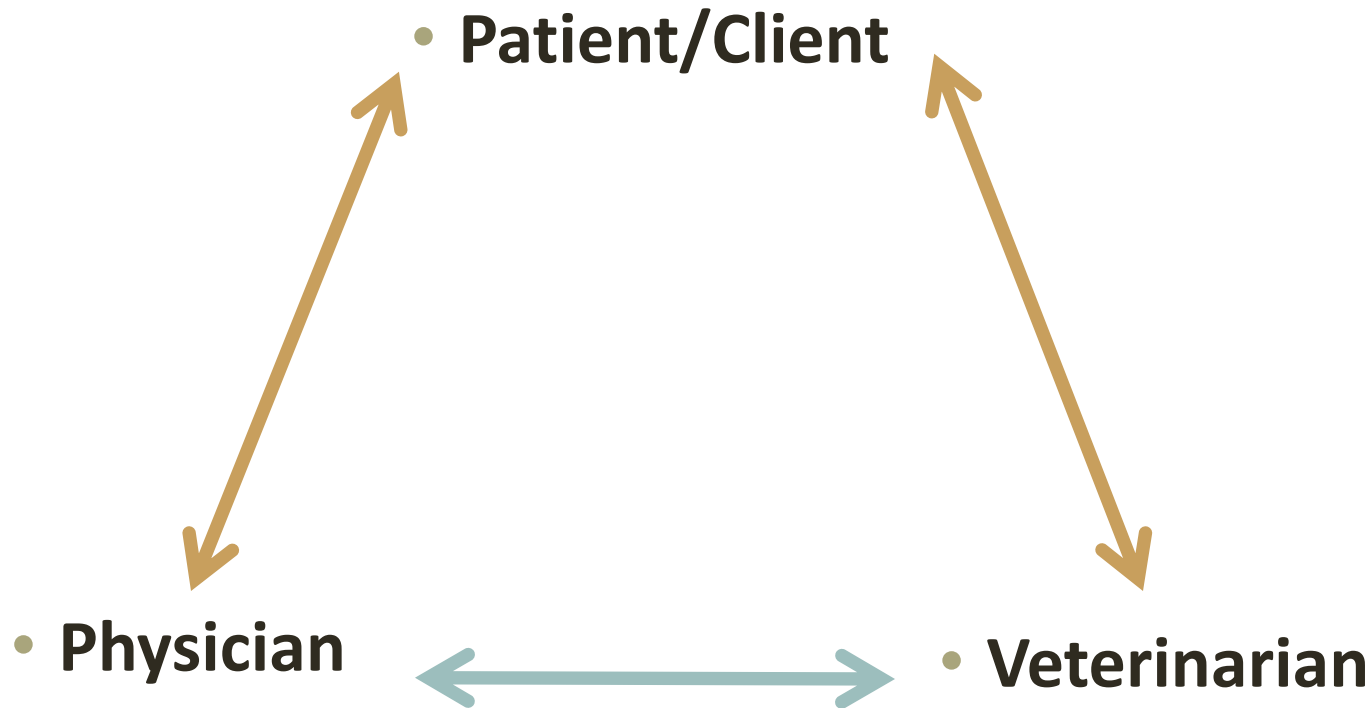
- Is ZP relevant?
  - NHANES III showed 13.9% *Toxocara* seroprevalence \*
  - Health, social & economic effects \*\*
  - Biases lead to under-reporting \*\*\*
- Different goals:
  - Human healthcare
  - Veterinary profession
  - Agricultural authorities

\* Hotez and Wilkins, 2009.

\*\* Torgerson and Macpherson, 2011.

\*\*\* Hotez et al. 2008.

# Lack of Communication



# People and pets

## Summary points

---

Over 90% of pet owners regard their pet as a valued family member

---

Reluctance to part with a pet may lead to non-compliance with health advice

---

Pets may be of particular value to older people and patients recovering from major illness

---

The death of a pet may cause great distress to owners, especially when the pet has associations with a deceased spouse or former lifestyle

---

Many people would welcome advice and support to enable them to reconcile or manage pet ownership and health problems whenever possible

# ZP is a “Wicked Problem”

- Paradox of disease control
  - Successful interventions => decreased attention
  - Parasitism receives <1% of global research funding
- Changing environments
  - Climate
  - Urban wildlife
- Priority given to unrelated (?) issues
  - Chronic diseases vs. infectious diseases
  - Social issues
  - Government policies

# **ZP is a “Wicked Problem”**

**Neglected Zoonotic Diseases?**

**Or**

**“Diseases of Neglected Populations?”**

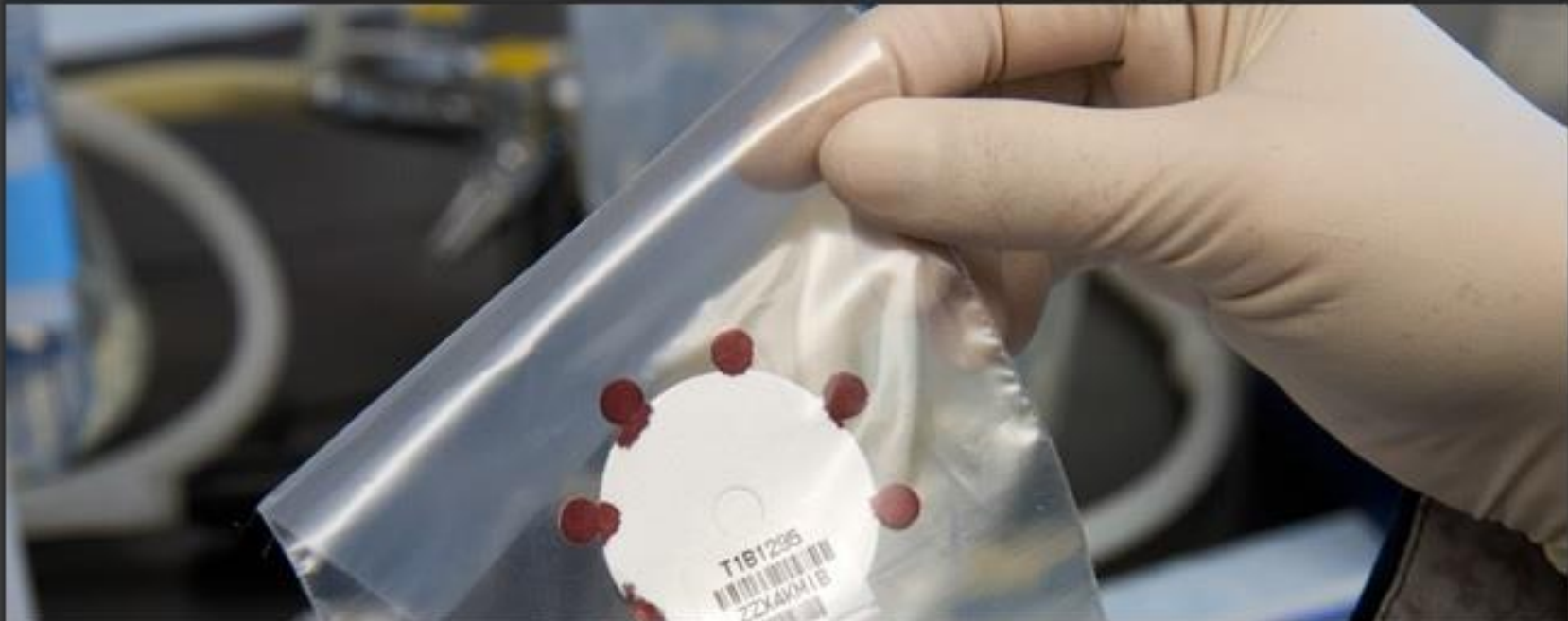
# Neglected Parasitic Infections in the United States

Monica E. Parise, MD

May 6, 2014



02 of 13



## **NPIs: Key Gaps in Prevention and Control**

Additional work is needed in 3 major areas to advance prevention and control of NPIs in the United States: (1) better estimates of disease burden and a better understanding of how to reduce the risk of acquiring NPIs, (2) improved diagnostic tests and medications, and (3) expansion of programs that provide proven interventions.<sup>[1]</sup>

*Image courtesy of CDC Foundation / David Snyder*

[www.cdc.gov](http://www.cdc.gov)

**The Solution...**

**A Multidisciplinary Approach**

# One Health Framework

“Between animal and human medicine there is no dividing line—nor should there be. The object is different but the experience obtained constitutes the basis of all medicine.”

Rudolph Virchow

# One Health Framework

“Two tenets at the core of the One Health concept are the belief that human and animal health are irrevocably entwined and that the improvement of both requires close collaboration between the medical and veterinary professions with support from allied disciplines.”

Doble and Fevre, 2010.

# One Health Framework

GOALS  
ATTRIBUTES

HUMAN

Race      Gender      Age  
Genotype Behavior  
Immune status  
Nutritional status

Increase immunity  
Increase DZ resistance

WORMS

Decrease  
transmission

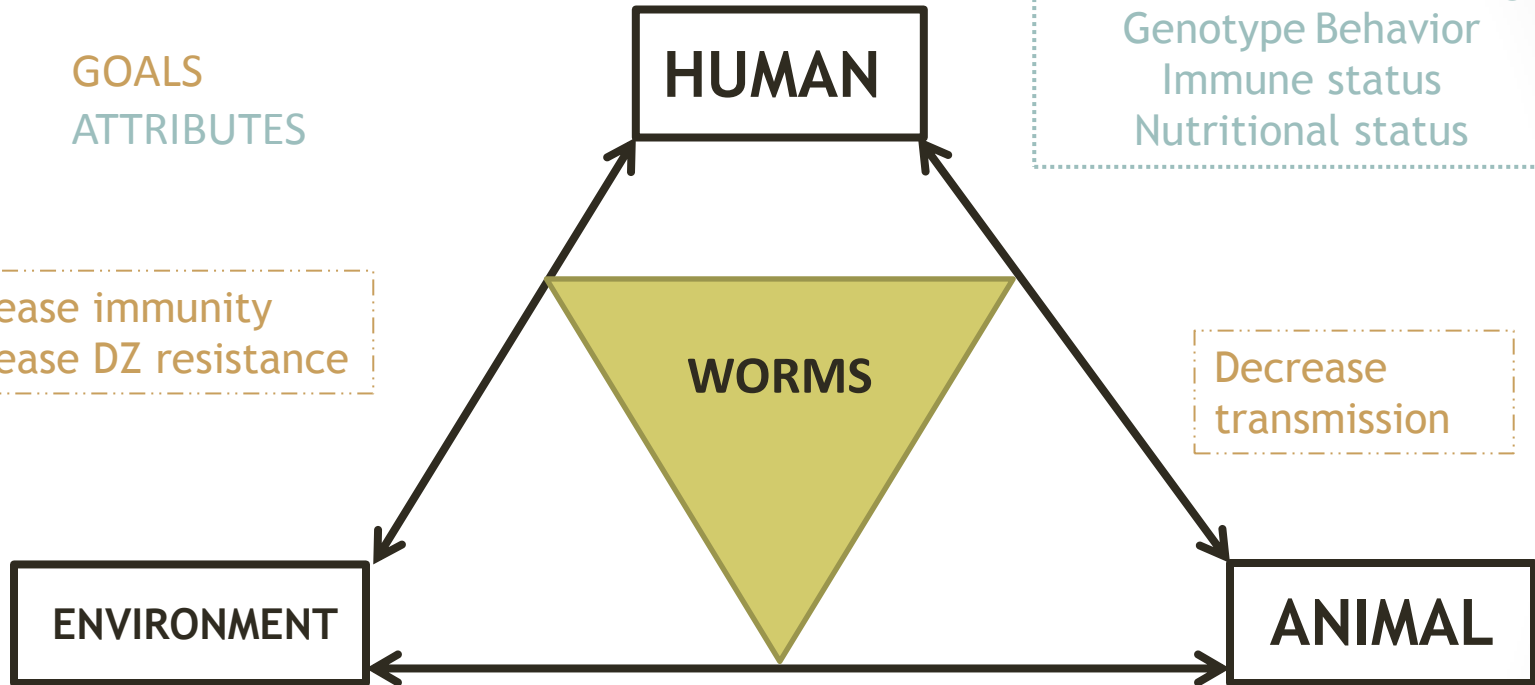
ENVIRONMENT

Location- latitude/altitude  
Macroclimate  
Microclimate (housing)  
Insect exposure      Diet  
Water supply      Pollution  
Cohort      Occupation      Culture

Decrease reservoir  
Decrease exposure

ANIMAL

Companion  
Wildlife  
Food  
Free-ranging  
Exotic



# One Health Framework



- COMMUNICATION
- COLLABORATION
- DATA COLLECTION
- EDUCATION

# One Health: Who is Responsible?

- **Veterinarians**
  - Promote pet's health
  - Focus on preventive care
  - Provide client education
- **Human healthcare**
  - Add zoonotic diseases as Rule/Out's
  - Promote sanitary habits
  - Understand family dynamics (including pets)

# One Health: Who is Responsible?

- **Academia**
  - Educate new parasitologists
  - Focus on research
  - Serve as a resource
- **Animal Industry**
  - Promote food safety
  - Invest in new technology/treatments

# One Health: Who is Responsible?

- **Public Health Community**
  - Keep accurate statistics
  - Lobby to increase priority
  - Create resource for knowledge & cooperation
  - Reach out to marginalized populations
- **Local government**
  - Provide safe environments
  - Enact legislation

# One Health: Who is Responsible?



# One Health: Who is Responsible?

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## Powerful Insights Into Real Clinical Cases

View renowned global presenters as they explore relevant case workups at the 4th Annual International Webconference on Human and Companion Animal Vector-Borne Diseases. Learn the implications of diseases that may seem secondary but are being diagnosed more frequently ... and spreading.

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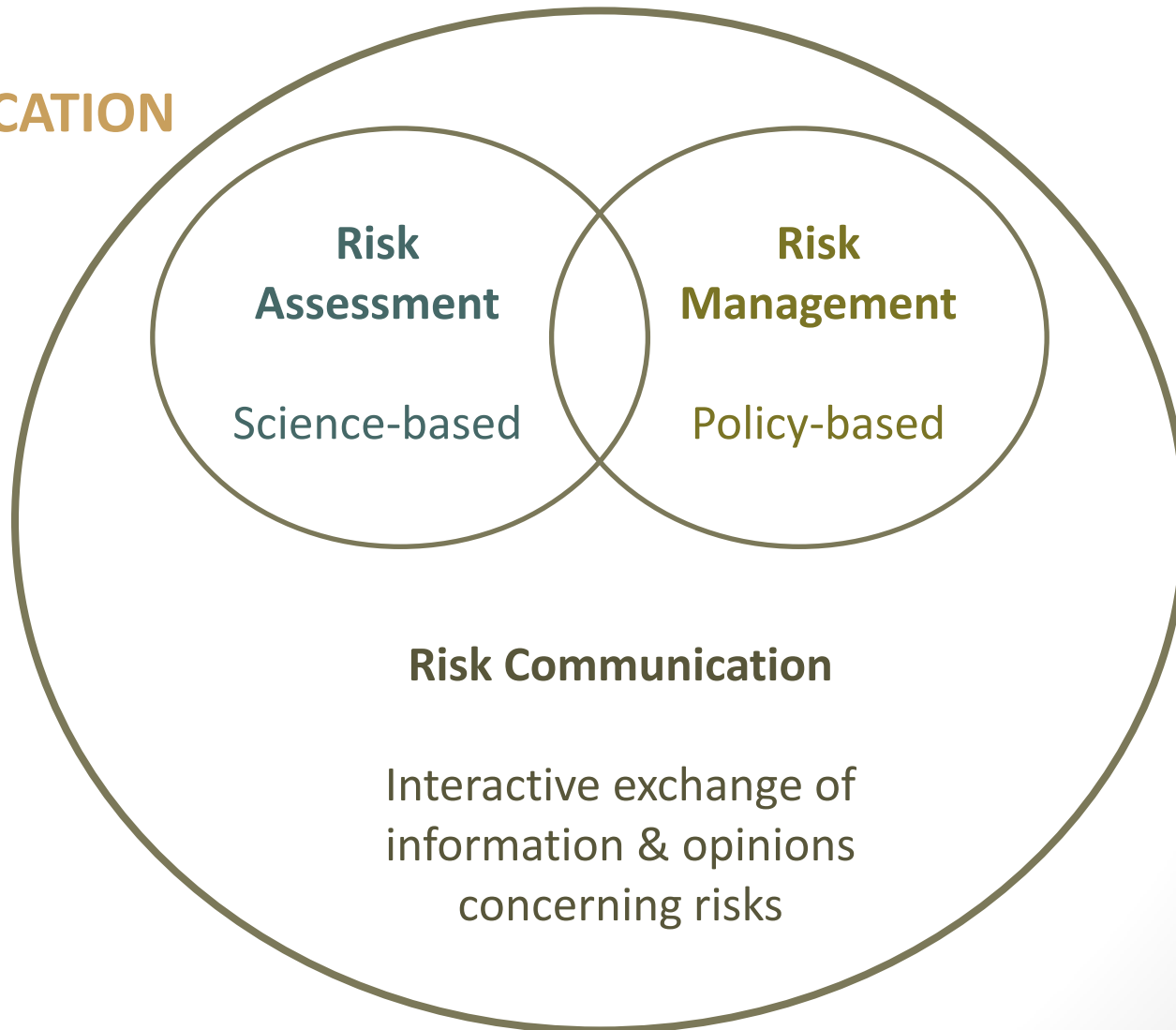
## Attending is Easy

- ✓ Preregister using the link below
- ✓ Login Instructions Will Be Sent By Email After You Preregister
- ✓ Session Begins 8:00 pm EDT
- ✓ Choose As Many Cases As You Wish
- ✓ Each Case Discussion Is About 30 Minutes
- ✓ 30-Minute Panel Discussion

<http://www.cvbd2015us.com/>

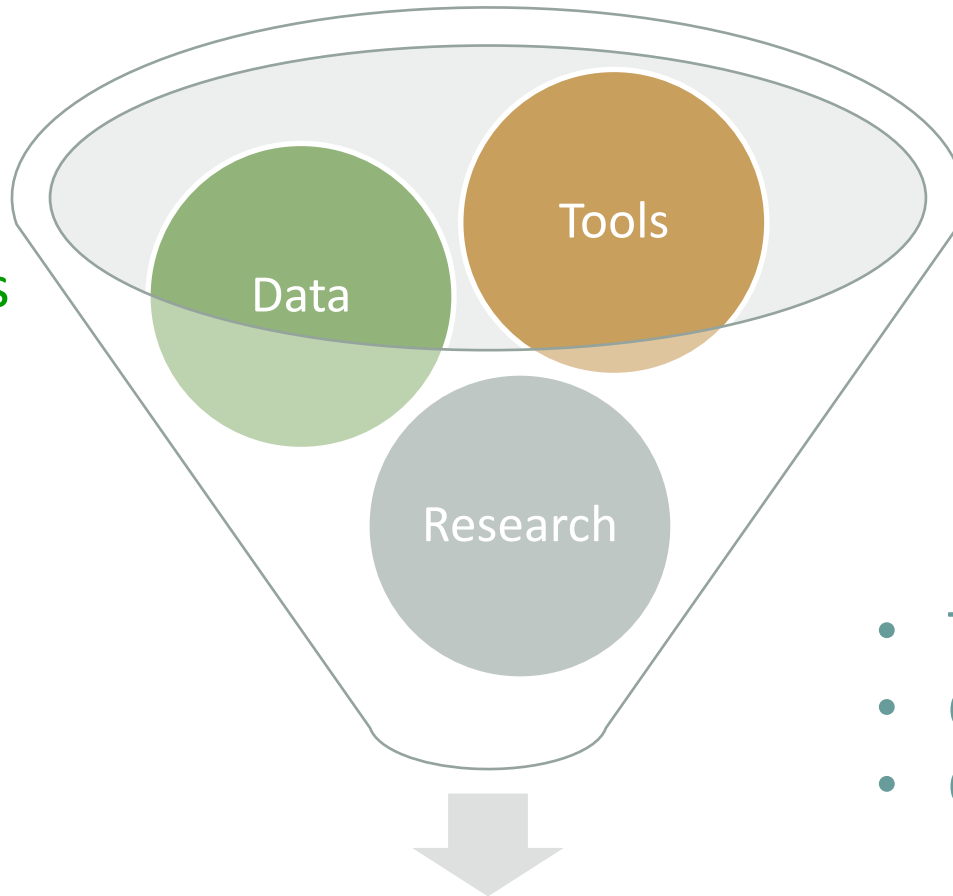
# Risk Analysis Framework

## HAZARD IDENTIFICATION



# Risk Assessment

- Risk factors
- Regional



- GIS
- PQF
- Fecal exam

- Targeted
- Co-morbidities
- Confounding

**SCIENCE-BASED**

# Risk Management

## People:

- Surveillance
- Treatment
- Education
- Sanitation

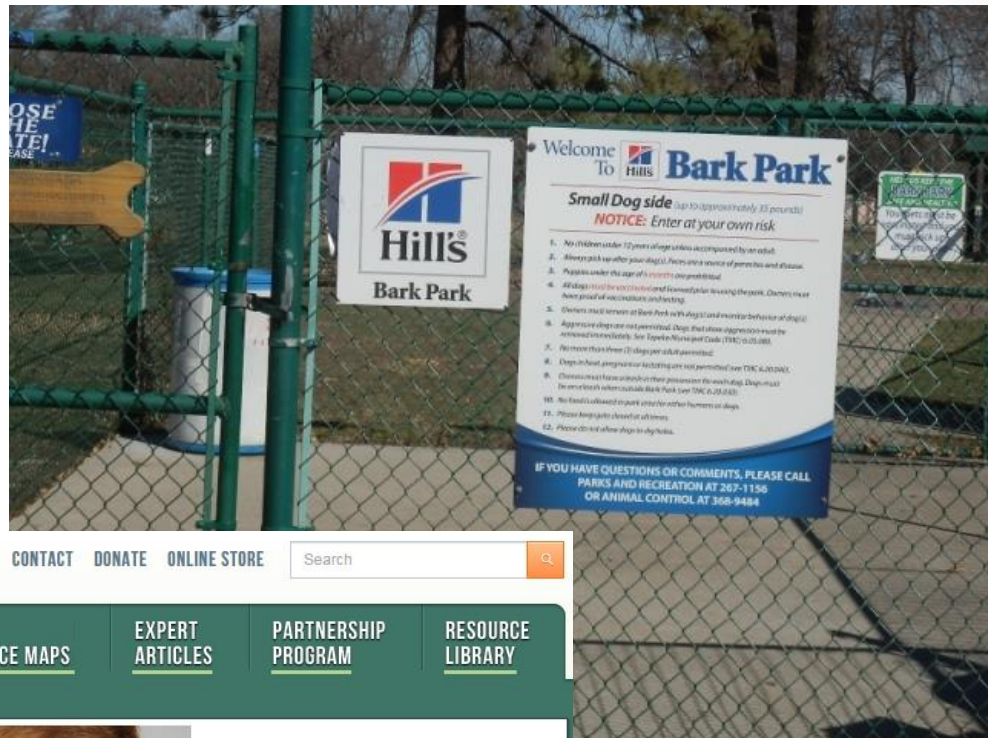


## Dogs:

- Routine fecal analysis
- Chemoprophylaxis
- Surveillance



# Risk Management



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## CAPC RECOMMENDS YEAR ROUND PROTECTION

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LEARN HOW TO EDUCATE CLIENTS  
ON THE INFECTION RISKS  
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**PPP:  
Public  
Private  
Partnerships**

# Risk Management



Legislation

Public services



# Risk Management

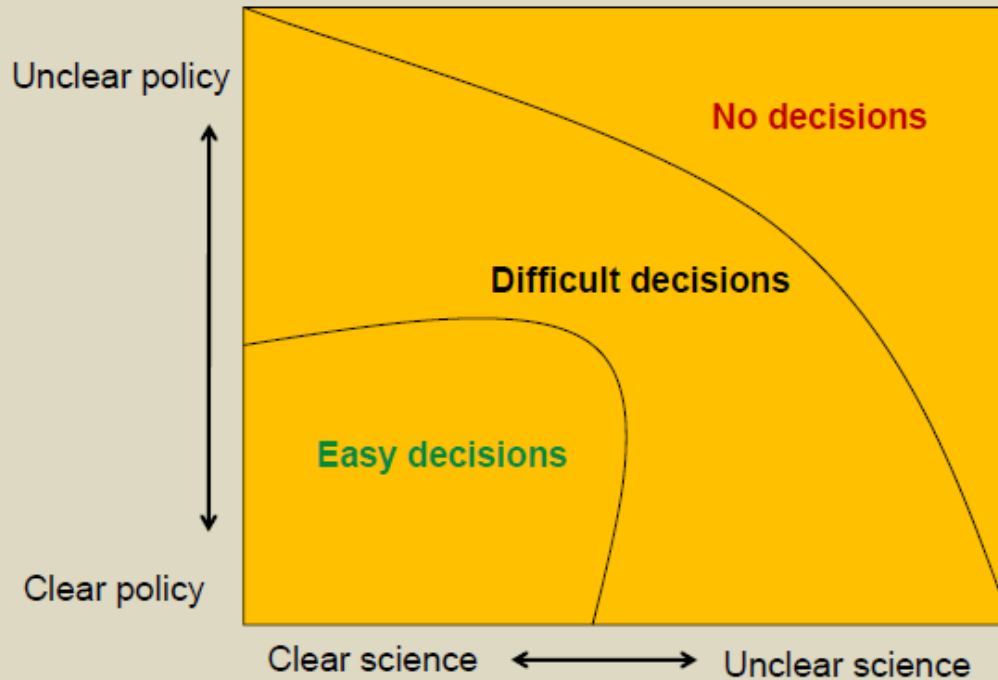
Medical Ecology—manipulating the environment

- Special surfaces
- Barriers
- Long grass
- Controlling feeding stations
- Feces disposal



# Risk Management

## The regulatory predicament



# Risk Communication



WOMEN??



# Risk Communication

“Helminthiases do not have the journalistic value of great pandemics like flu or plague, although they may have an as yet unrecognized relation to them; they do not, for the most part, present dramatic clinical cases, but to make up for their lack of drama, they are unremittingly corrosive.”

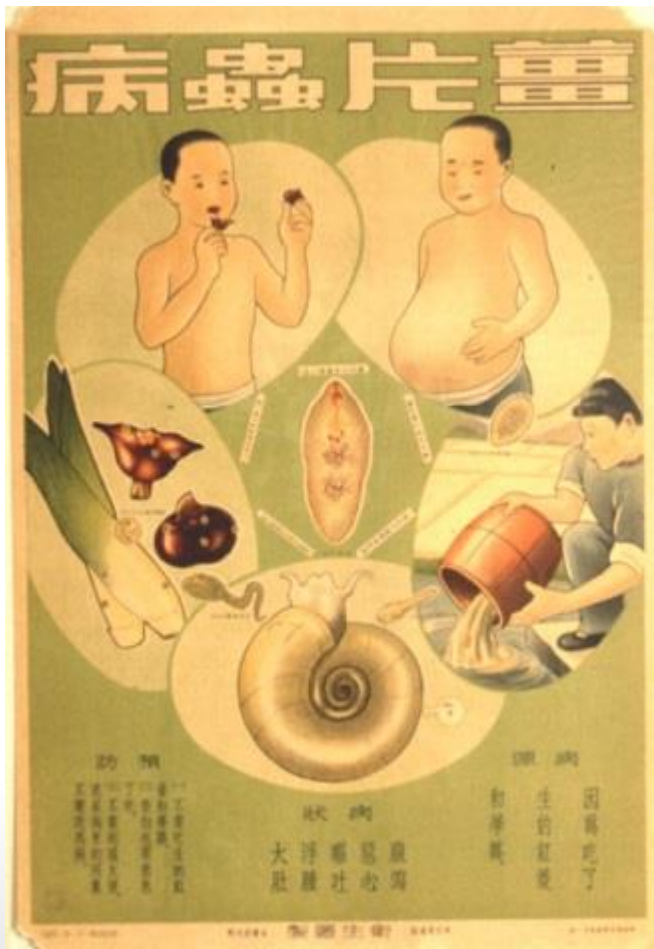
Norman Stoll

# Risk Communication

- Public Health Education
  - University--all healthcare fields
  - School children
  - Families
  - Doctors and patients

# Risk Communication

- Messages for Individuals



Public

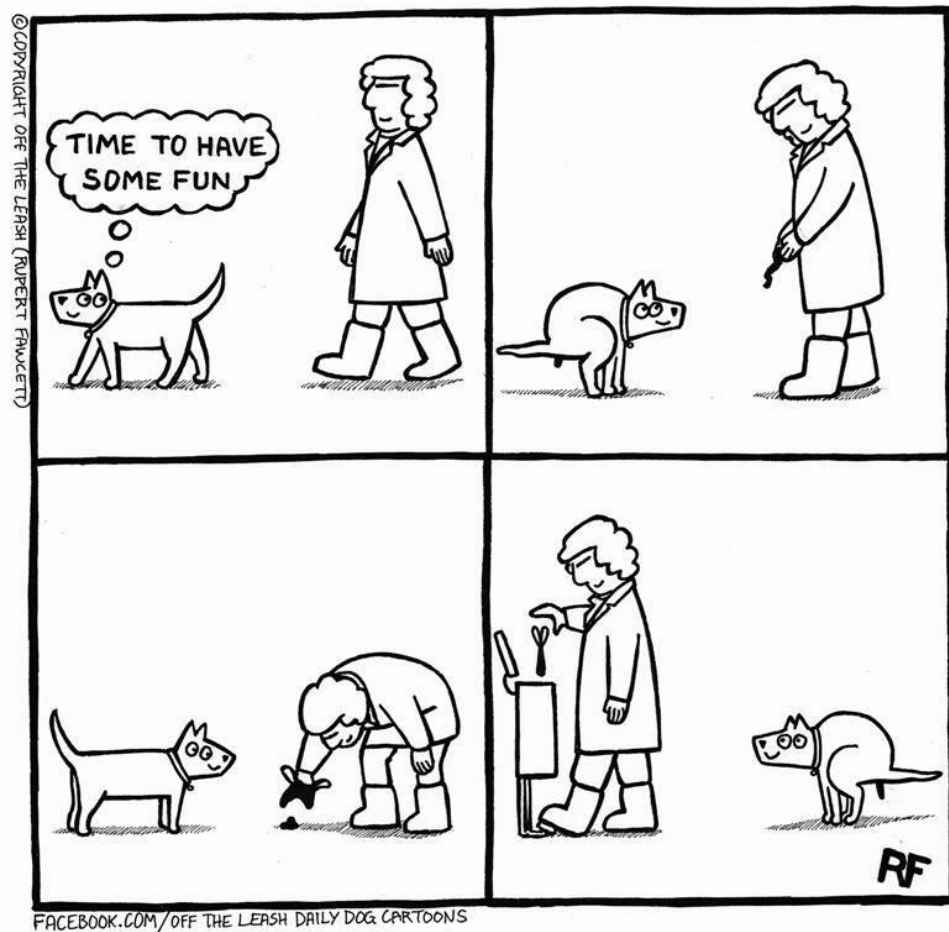
Courtesy of Clendening Library, 2015.

# Risk Communication

- Messages for Individuals



Dog owners



# Risk Communication

- Messages for Communities



## The scoop on cleaning up dog poop is ... it matters to your health

By Deb Glaum | Community Health Intern and veterinarian

**Oct. 25, 2013** — Lawrence is a wonderful community for dogs and dog lovers. There are so many places that owners and their canine companions can enjoy in and around the city. Besides spending time at the off-leash dog parks, many people like to take their pet wherever they go in public, and in many places, the dogs are welcome. However, it's inevitable – if you're going to have dogs

# Risk Communication

- Messages Globally



# The Solution— A Multidisciplinary Approach

“Ours is the age of the specialist, and long gone is the day of the educated amateur, the person of letters who could paint, write, and serve in elected office, who could lead in battle and yet publish in science and compose sonnets. The vapid dating line, ‘What’s your sign?’ has given way to the even more insulting, because it is so limiting, ‘What’s your major?’”

Steve Perkins

( 80 )

# Closing Thoughts

**Be:**

- **Sensible**
- **Safe**
- **Aware**

**Questions???**



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