

# Environmental Contamination with *Salmonella enterica* in Homes with Pet Reptiles, Minnesota 2003-2018

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State Public Health Veterinarian  
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# Sources of *Salmonella*

**Foodborne sources are most common**

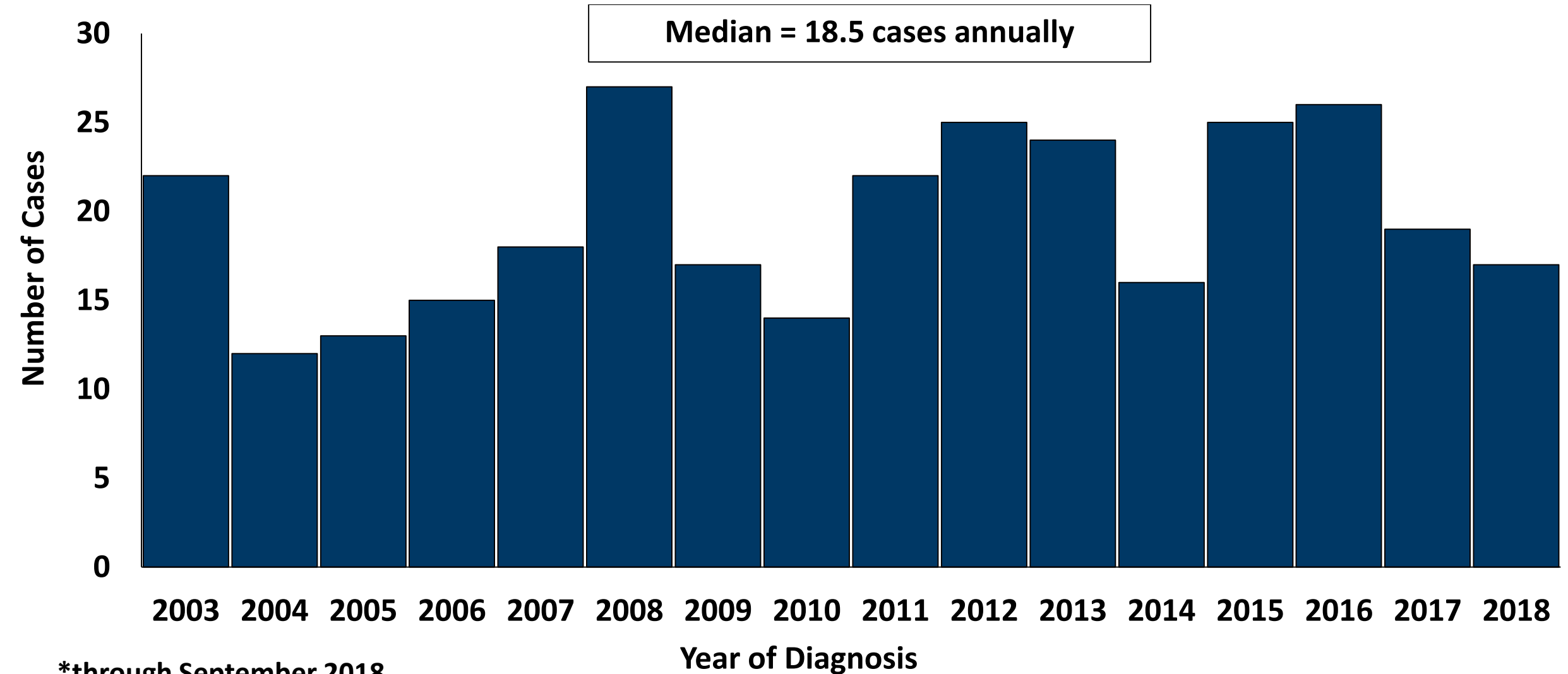
- Retail meat
- Raw milk or dairy products
- Contaminated vegetables or drinking water

**Zoonotic transmission well-known**

- Poultry
- Cattle
- Swine
- Pet reptiles



# Reptile-Associated Salmonellosis Cases, Minnesota, 2003–2018\*, n = 312



# Reptile-Associated Salmonellosis (RAS) in MN, 1996-2011

- Approximately 3.5% of *Salmonella* cases in Minnesota can be attributed to reptiles
  - 47% of cases reported contact with lizards; 20% snakes; 19% turtles; 14% with multiple types of reptiles
- 31% of RAS cases were under the age of 5
- 17% of Minnesota RAS cases occurred in infants (< 1 year of age)
  - Most reported no direct contact with the reptile

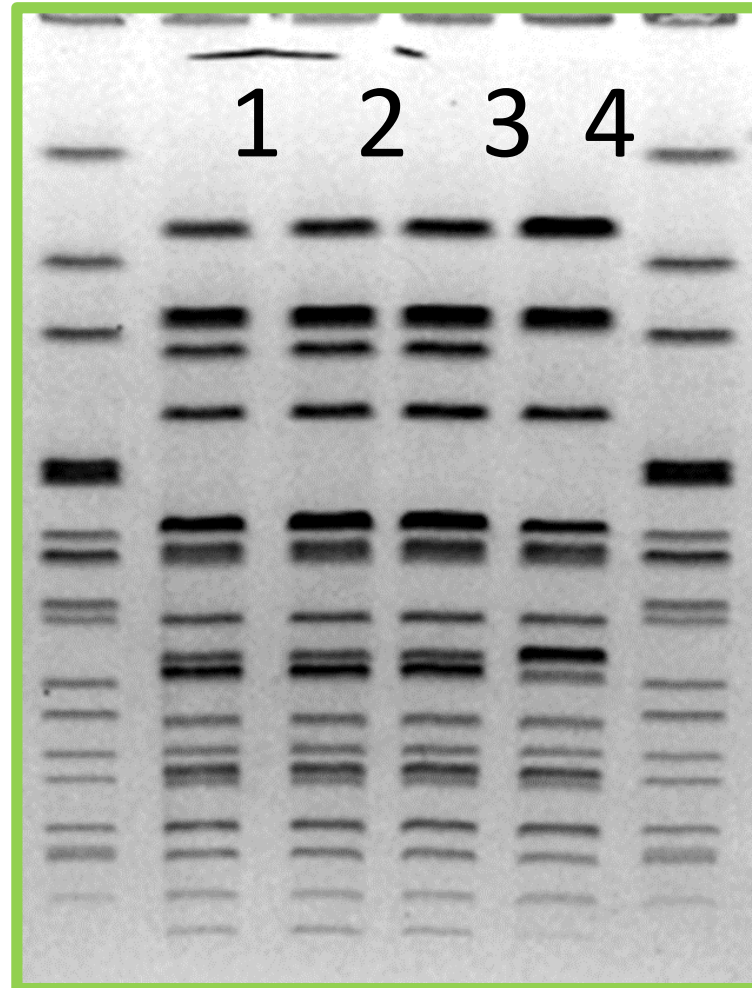
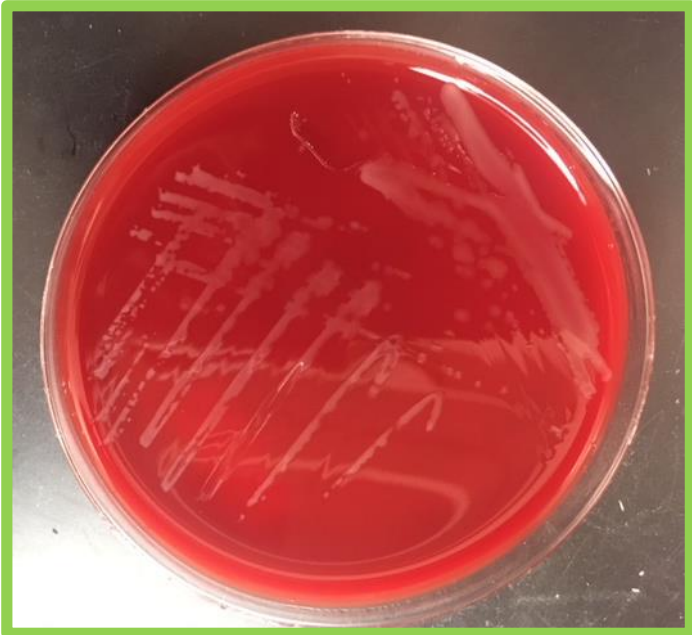
Whitten, ZPH 2014

# Enteric Disease Surveillance in Minnesota

- Human cases are reportable to MDH by HCPs and bacterial isolates must be sent by clinical labs to MDH-PHL
- MDH-PHL confirms the isolate and performs serotyping and molecular subtyping
  - Pulsed-field gel electrophoresis subtyping (PFGE)
  - Whole genome sequencing (WGS)



# *Salmonella* Isolation and PFGE matches



- Pulsed-Field Gel Electrophoresis (PFGE)
- Lyse DNA with enzymes
- DNA fragments are separated in a gel based on mass and charge
- Pattern of fragments is DNA fingerprint

# Enteric Disease Surveillance in Minnesota

- **Concurrently, MDH staff interview the case with a standard questionnaire**
  - **Illness history, travel history, food history, water exposure, and animal contact for the 7 days before illness onset**

8. Did you have contact with household pets, either in the home or elsewhere?

☐ Y ☐ N

Pet	Contact	Describe contact	Was the animal ill with GI illness?
Dog	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> U		<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> U
Cat	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> U		<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> U
Bird (not live poultry)	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> U		<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> U
Reptiles/Amphibians	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> U		<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> U
Other: _____	<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> U		<input type="checkbox"/> Y <input type="checkbox"/> N <input type="checkbox"/> U

9. During the week prior to your illness, did you live on, work on, or visit a farm?

☐ Y ☐ N

**If yes**, name, location, and dates at farm (other than home farm):

☐ Live on farm

☐ Work on farm: \_\_\_\_\_ When? \_\_\_\_\_

☐ Visit farm: \_\_\_\_\_ When? \_\_\_\_\_

10. Did you visit a petting zoo, educational exhibit, fair, or other venue with animals in the week before your illness?

☐ Y ☐ N

**If yes**, name/location: \_\_\_\_\_ When? \_\_\_\_\_



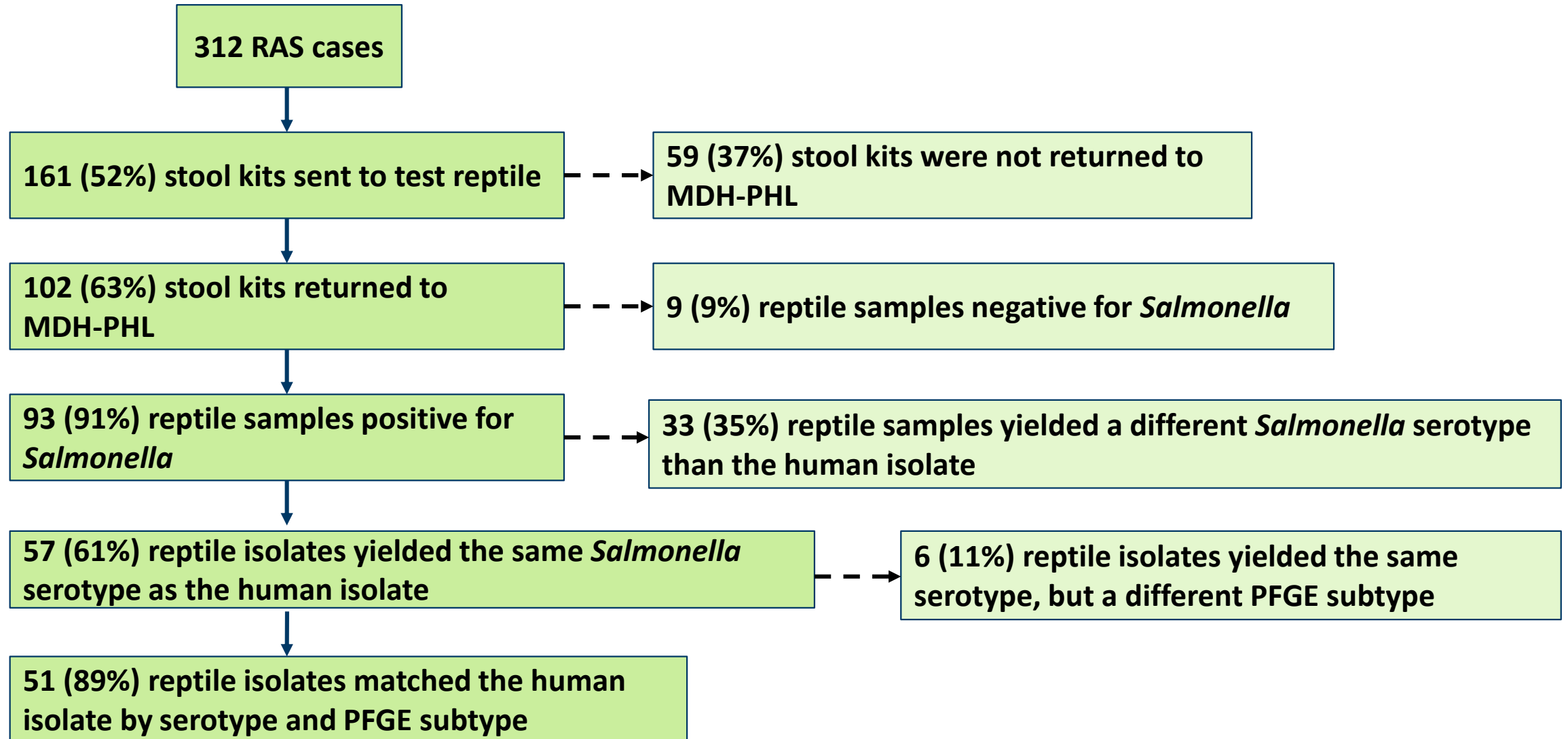
# Supplemental Reptile Questionnaire

- Type of reptile (s)
- Setting of exposure
- Housing and feeding
- Who handles the reptile
- Where habitat is cleaned
- Do you want your reptile(s) tested for *Salmonella*?

Questionnaire About You and Your Pet (Please fill this out if you own a Hedgehog, Lizard, Snake, and/or Turtle)				
<b>DEMOGRAPHICS</b> (about yourself)		Spec # _____	Disease _____	Subtype _____
Name _____ (Last) (First)				
Where are you exposed to reptiles? (check all that apply)				
<input type="checkbox"/> 1. Household				
<input type="checkbox"/> 2. Work (Describe occupation _____)				
<input type="checkbox"/> 3. Daycare or School				
<input type="checkbox"/> 4. Friend or relative				
<input type="checkbox"/> 5. Other _____				
If the answer is 2-5 then ask for name of owner and permission to contact?				
Owners name _____ (Last) (First)		Phone ( ) _____		
<b>ABOUT YOUR ANIMAL</b>				
How many exotic animals do you own? _____				
List each animal and their age, sex, length, and weight.				
Type of Animal (i.e. snake, lizard etc.)	Sex	Age (yrs)	Length (in.)	Weight (lbs)
1. _____	M / F / Unk	_____	_____	_____
2. _____	M / F / Unk	_____	_____	_____
3. _____	M / F / Unk	_____	_____	_____
How often do you handle your pet(s)? (number of times per day) _____				
How long have you owned your reptile? _____ (yrs./mos./wks.)				
<b>INFORMATION ON ANIMAL #1</b> _____				
<b>HOUSING</b>		<b>FEEDING</b>		
Type of housing		What foods are fed? (check all that apply)		
1. <input type="checkbox"/> Aquarium		1. <input type="checkbox"/> Commercial diet (ie. Trout chow, dog food, cat food)		
2. <input type="checkbox"/> Terrarium (closed)		2. <input type="checkbox"/> Rodents		
3. <input type="checkbox"/> Cage		2.1 <input type="checkbox"/> live		
4. <input type="checkbox"/> Other _____		2.2 <input type="checkbox"/> frozen		
Dimensions (approx. square inches) _____		2.3 <input type="checkbox"/> cooked		
Number of animals(s) per cage _____		3. <input type="checkbox"/> Produce (Fruits and vegetables)		
Is your animal allowed to roam free throughout the house? Y N		3.1 <input type="checkbox"/> raw		
Type of bedding (check all that apply)		3.2 <input type="checkbox"/> cooked		
1. <input type="checkbox"/> Carpeting		3.3 <input type="checkbox"/> describe _____		
2. <input type="checkbox"/> Woodshaving/bark		4. <input type="checkbox"/> Insects or worms		
3. <input type="checkbox"/> Gravel/sand		5. <input type="checkbox"/> Cooked meat or poultry		
4. <input type="checkbox"/> Paper		6. <input type="checkbox"/> Table scraps		
5. <input type="checkbox"/> Other _____		Do you provide any dietary supplements? Y N		
		If yes, describe _____		



# RAS Cases with Associated Reptile Stool Sampling, MN 2003–2018\* (n = 312)



# Reptile Environmental Sampling Project

- When the same *Salmonella* serotype was isolated from the reptile as the case-isolate, and if the 2 isolates were indistinguishable by PFGE:
  - Case offered environmental sampling of home
  - Convenience sample:
    - Case specimen collection date < 2 months prior to home visit
    - Within 1 hour drive from MDH
- Reptile sampling is ongoing: home sampling occurred from 2003-2015

# Reptile Environmental Sampling Project: Objectives

- Document the home environment as a potential source of *Salmonella* infection for RAS cases
  - Particularly for those cases who reported no direct contact with the pet reptile in the 7 days prior to illness onset







# Reptile Environmental Sampling Project: Results

- Households sampled = 15
- Median time to sampling = 24 days (range, 12-78 days)
- In 15 of 15 households, *Salmonella* isolates were identified that were PFGE matches to the case-isolate
- In 11 (73%) of 15 households, other *Salmonella* species were also identified

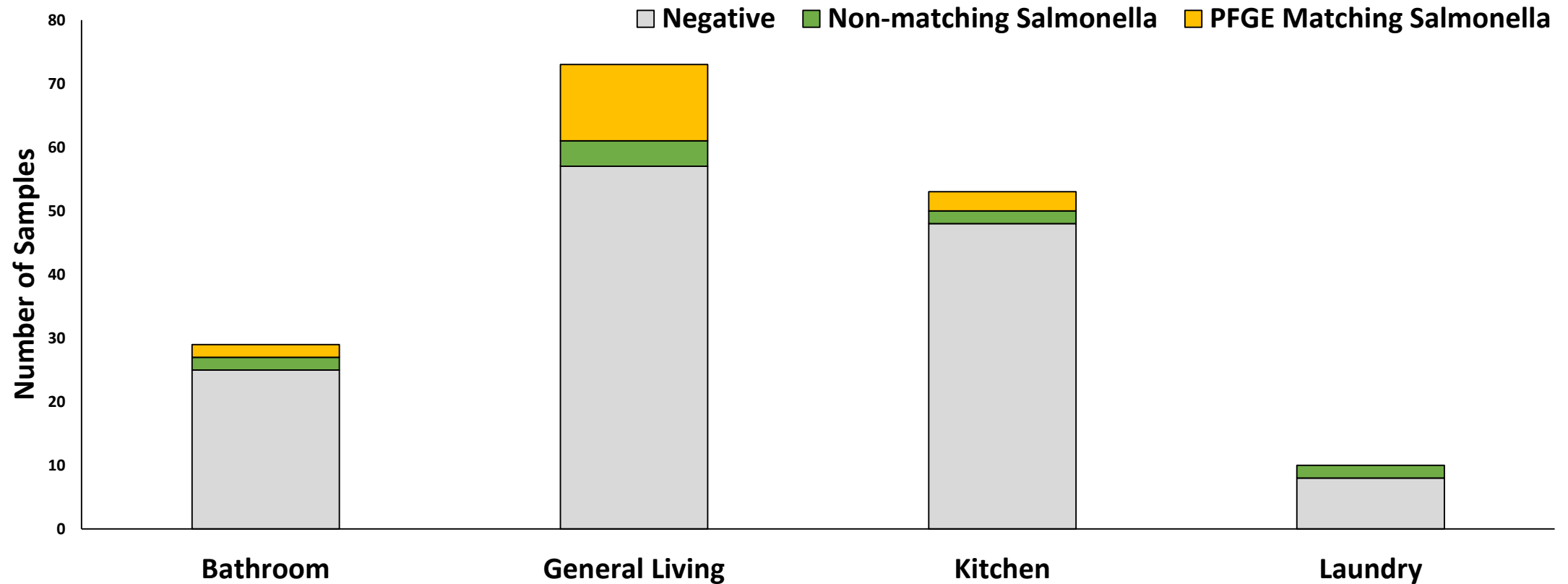
# Reptile Environmental Sampling Project: Results

- 94 (35%) of 271 total samples were positive for any *Salmonella*
- 46 (49%) of the 94 *Salmonella* isolates were PFGE-matches to the case-isolate
  - Median of 5 *Salmonella*-positive samples per household (range 2 to 22 samples)
  - Median of 3 *Salmonella*-positive PFGE-matching samples per household (range, 1 to 7 samples)

# Reptile Environmental Sampling Project: Results

- 19 (12%) of 153 household surfaces were positive for any *Salmonella*
  - 10 (53%) of the 19 household surfaces were a *Salmonella* serotype and PFGE subtype match to the case and reptile isolates
    - A median of 1 household surface per household (range, 0-2) had a *Salmonella* serotype and PFGE subtype match to the case and reptile isolates

# *Salmonella* Contamination by Location



# Reptile Environmental Sampling Project: Results

- 12 of 15 households had a vacuum cleaner
- 8 (67%) of 12 vacuum contents positive for any *Salmonella*
- 7 of 8 households had case/reptile/vacuum contents *Salmonella* PFGE matches
- 1 household: different serotype isolated
- 1 household: PFGE match and different serotype isolated

# What's in your vacuum cleaner?

## BRIEF REPORTS

### Infant Salmonellosis and Vacuum Cleaners

by R. L. Haddock, DVM, MPH, and F. A. Nocon, BS  
Office of Epidemiology and Research, Department of Public Health and Social Services, PO Box 2816, Agaña, Guam 96910, USA.

#### Summary

Microbiological examination of the contents of vacuum cleaner bags from homes demonstrated a statistically significant association between *Salmonella* contamination of the bags and some cases of infant salmonellosis may result from contact with the bags and that steps taken to protect infants from potentially contaminated bags may reduce the risk of contracting this infection.

#### Introduction

The Journal of The Royal Society for the Promotion of Health; March 2003, 123 (1), pp. 39-45

### The survival and recovery of bacteria in vacuum cleaner dust

I W Haysom, K Sharp

Iain W Haysom, School of Science and the Environment, Bath Spa University College, Newton Park, Newton St Loe, Bath BA2 9BN, England

Kay Sharp, PhD, Senior Lecturer, School of Life and Sport Sciences, University of Surrey Roehampton, Whitelands College, West Hill, London SW14 3SN, England Tel: +44 (0)20 8392 3677 Email: K.Sharp@roehampton.ac.uk

Corresponding author: Kay Sharp

Received 14 January 2002, revised and accepted 28 January 2003

#### Key words

Environmental contamination; microbial survival; salmonella; vacuum cleaners

#### Abstract

The possibility exists that environmental dust could be a source of gastro-intestinal infection in the domestic environment and

#### Introduction

Although the total number of people suffering from laboratory confirmed gastro-intestinal illness has dropped slightly in recent

## DISPATCHES

### Household Contamination with *Salmonella enterica*<sup>1</sup>

Daniel H. Rice,\* Dale D. Hancock,\* Paivi M. Roozen,\* Maryanne H. Szymanski,\* Beth C. Scheenstra,\* Kirsten M. Cady,\* Thomas E. Besser,\* and Paul A. Chudek†

Household contamination with *Salmonella enterica* increases when occupational exposure exists (cattle farms with known salmonellosis in cattle, a salmonella research laboratory, or a veterinary clinic experiencing an outbreak of salmonellosis). Fifteen of 55 (27.2%) vacuum cleaner bags from households with occupational exposure to *S. enterica* were positive versus 1 of 24 (4.2%) without known exposure. Use of a carpet cleaner and several cleaners/disinfectants reduced, but failed to eliminate, *S. enterica* from artificially contaminated carpet.

(BPW, Remel Inc., Lenexa, KS), and incubated overnight at 37°C. Preenriched samples were mixed, and 1 mL of BPW was transferred to 9 mL of tetrathionate broth (Tet, Remel Inc.), incubated overnight at 37°C, and then 100 µL of Tet was transferred to 10 mL Rappaport-Vassilladis broth (R10, Difco, Detroit, MI). The Tet tubes were incubated an additional 24 h with the R10 tubes at 37°C, and then plated onto brilliant green agar containing sulfadiazine (BGS, Difco, Detroit, MI). BGS plates were incubated for 48 h at 37°C, examined at 24 h and 48 h, and suspect colonies were biochemically screened. All *S. enterica* isolates were serotyped by the National Veterinary Services Laboratory, Ames, Iowa.

*Salmonella* organisms from all groups were found in household vacuum cleaner bags, except those from homes in which occupants had no contact with livestock or exposure to *S. enterica* (Table 1) in the workplace. *S. enterica* serovar Dublin was found in 1 of 12 (8.3%) vacuum bags collected from households with direct contact with livestock having no known recent cases of salmonellosis. Eight of 26 (30.8%) vacuum bags from households with occupants who had contact with *Salmonella*-infected cattle were positive. One of the positive vacuum bag samples came from a home in which an infant developed salmonellosis concurrent with an outbreak on the



# What's in your vacuum cleaner?

- Haddock 1994: Association between infant salmonellosis cases and *Salmonella* contamination of vacuum dust (OR 3.13 (CI = 1.32-7.5). Some infant salmonellosis cases may result from home environment
- Haysom 2003: 4% of “normal” household vacuums positive for *Salmonella*. Bacteria survive up to 2 months in vacuum dust – useful indicator of environmental contamination in the home
- Rice 2003: Prevalence of *Salmonella* in vacuum bags. 27% when occupational exposure (farm) and 4% when no known exposure

# Who are the people?

- 1 index cases associated with each household:
  - 64% female
  - Median age 8 years (range, 1 month to 40 years)
  - 50% hospitalized for a median of 3 days (range 2-13 days)
  - Cases associated with 9 (60%) households reported no direct contact with the pet reptile
    - 4 of these cases were infants <1 year of age

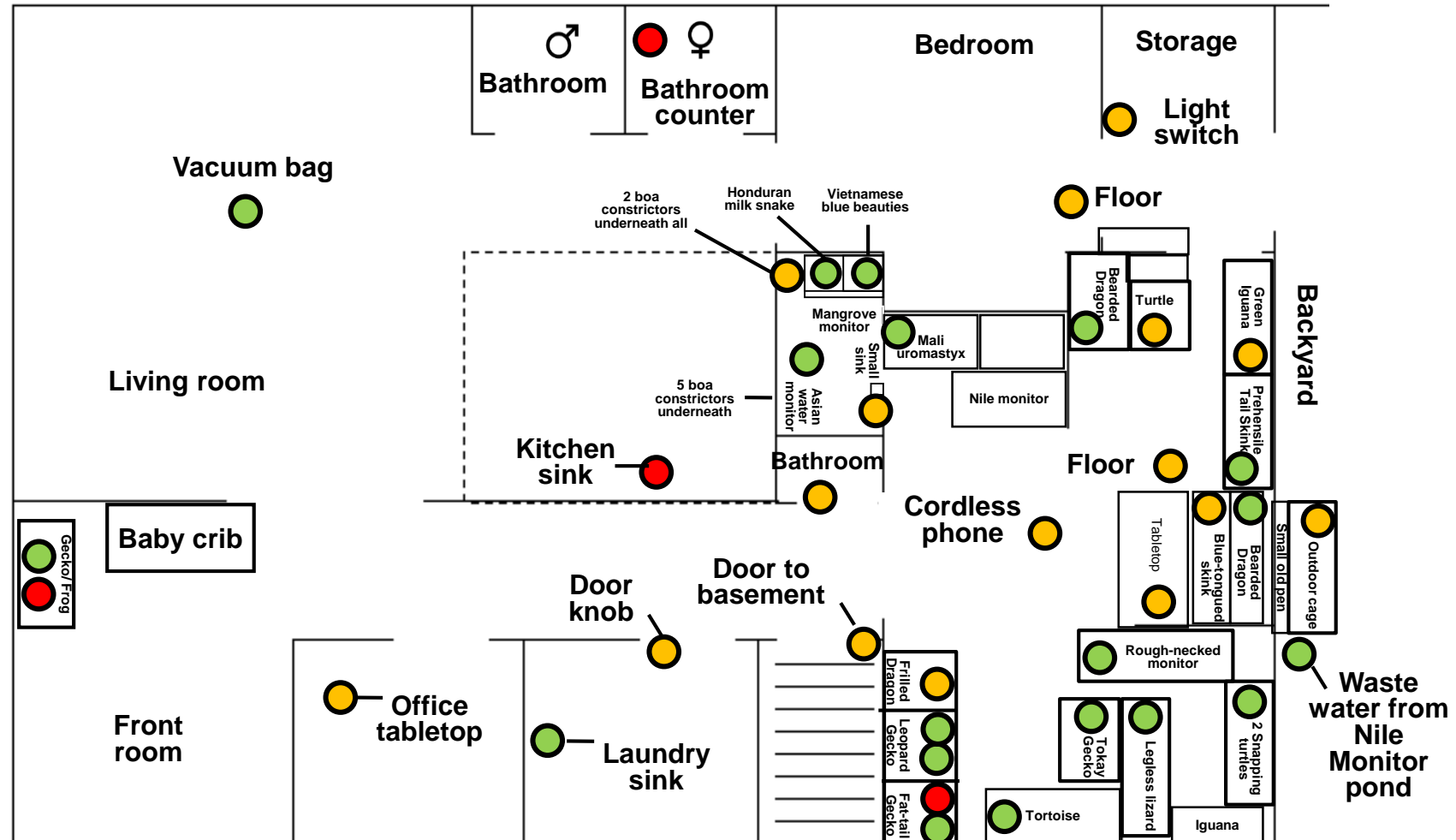
# What are the stories?

- 3-month-old baby with *Salmonella* Ealing
- Staying with mom at grandma's house
- Grandma is a herpetologist and does reptile rehabilitation out of her home
- >50 reptiles in the home
- 2 friends also acquired *Salmonella* infections
- Initiated our reptile-home project



# Household # 1, 2003: Reptile Rehabilitator

- S. Ealing
- S. spp Other
- Negative Sample



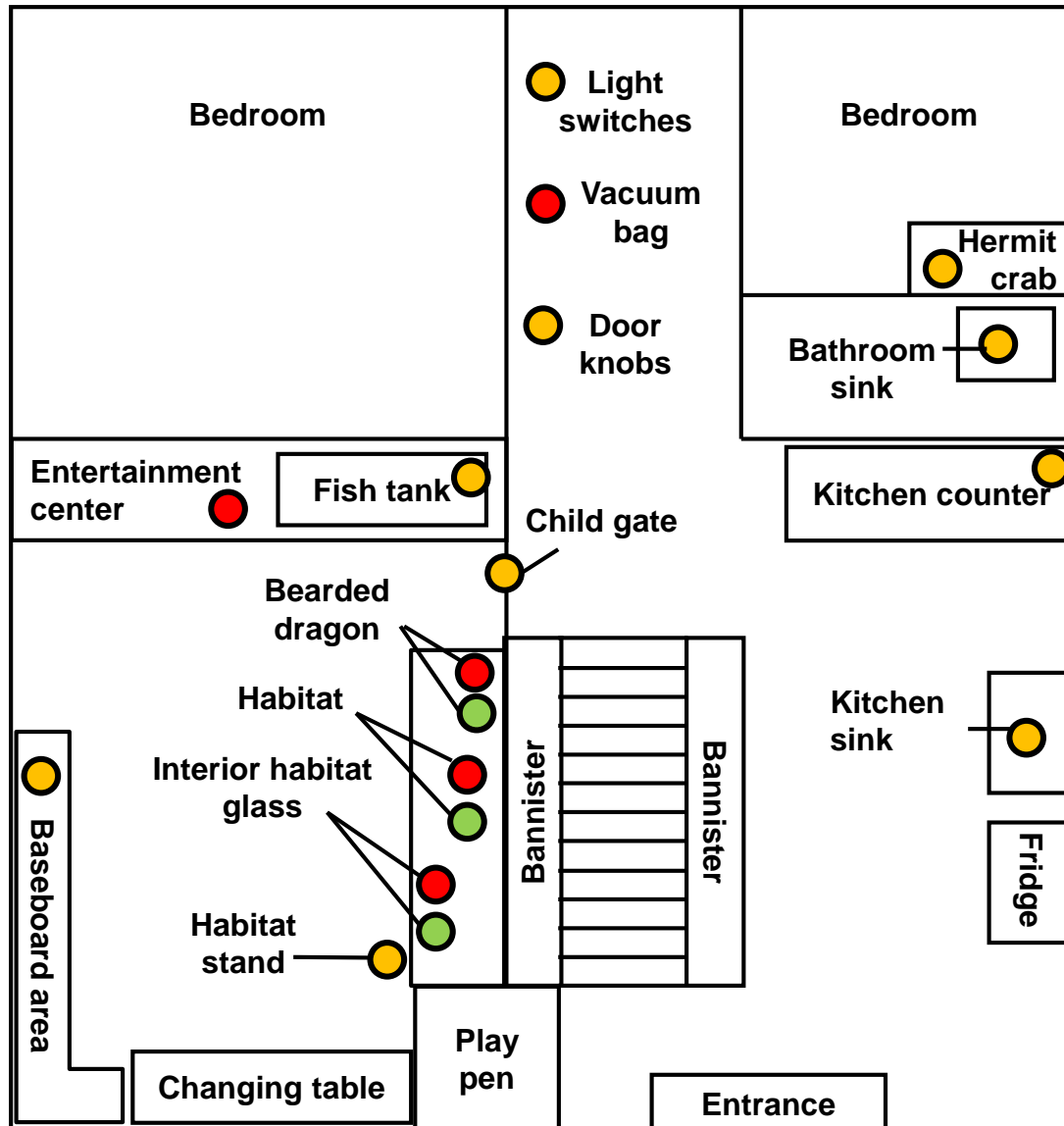
\* 9 different *Salmonella* serotypes found

# What are the stories?



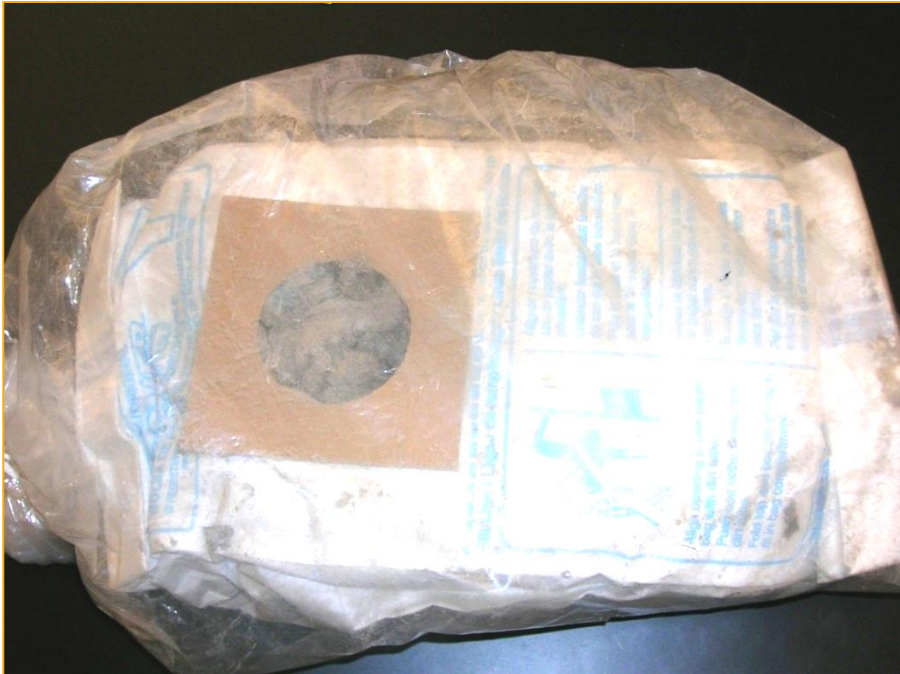
- 3-month-old baby with *Salmonella* ssp IV
- Visited aunt who runs an in-home daycare, 5 days prior to illness onset
- Aunt's daycare had 2 bearded dragons, hermit crabs, and fish
- Daycare had been granted a waiver to allow reptiles

## Household # 8, 2012: Daycare





# What are the stories?

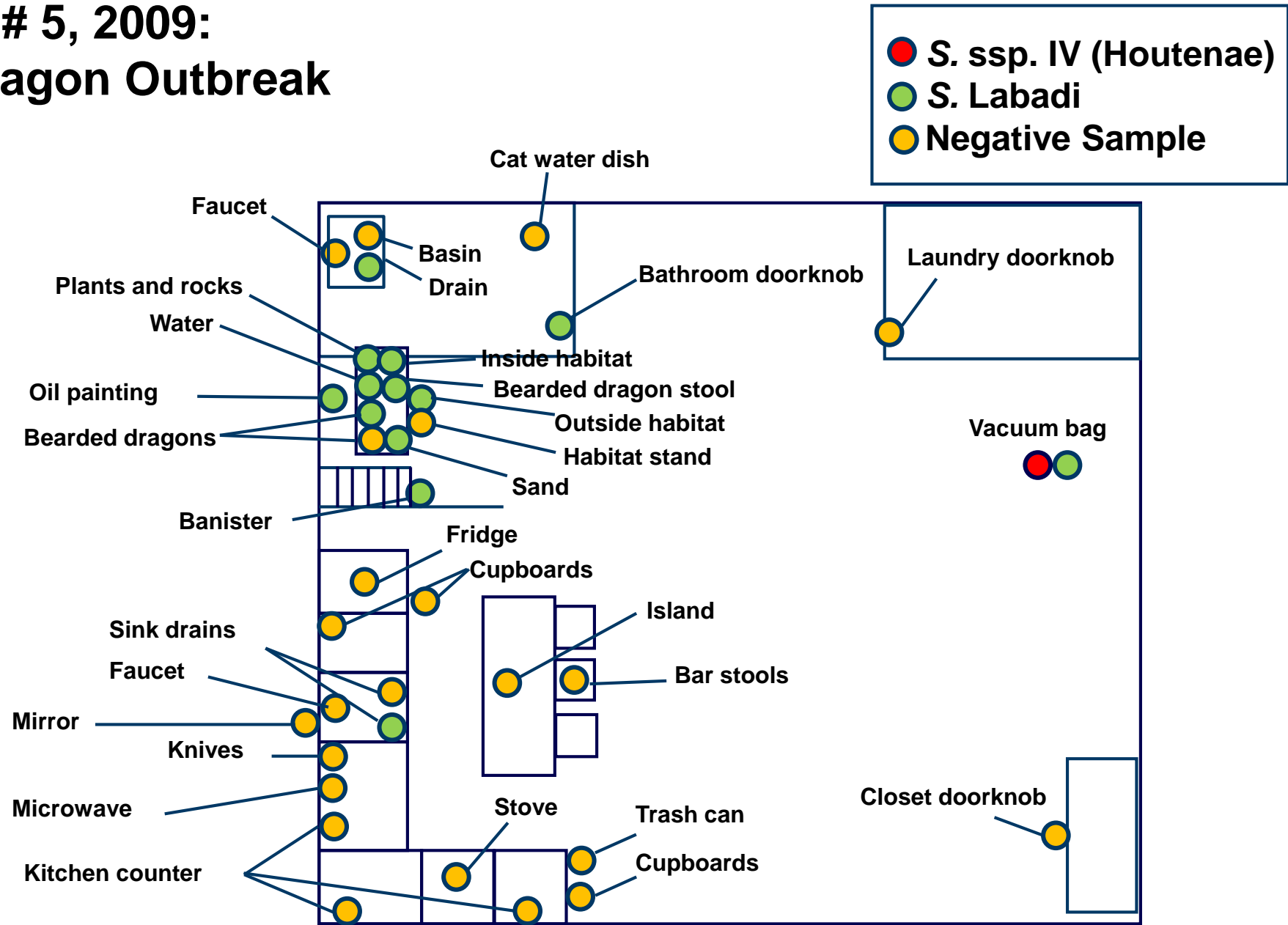


Vacuum cleaner bag from  
Household 5: *Salmonella* IV,  
and *Salmonella* Labadi

- 17 people with *Salmonella* ssp IV infections following church pot-luck dinner
- Eating gravy was associated with illness
- Asymptomatic gravy- preparer owned two bearded dragons
- Foodborne outbreak resulted from environmental contamination of home

Lowther, ZPH 2011

# Household # 5, 2009: Bearded Dragon Outbreak



# Discussion for Herp Lovers

- **Keep reptiles in an area separate from general living spaces and use infection control precautions to move between the reptile area and your home**
  - **Boots and outerwear that stay in the reptile area**
  - **Disposable gloves to clean habitats and handle reptiles**
  - **Sinks for feeding and cleaning habitats in the reptile area, ideal**
  - **Separate handwashing sink with paper towels in the reptile area, ideal**
- **Risk to infants and young children is real -- take precautions to protect them**

# Conclusions for Public Health

- Children most affected
- Environmental component important
  - Indirect transmission common
- Educational materials at point of sale should emphasize the importance of environmental contamination and indirect contact
- CDC recommendation is well founded: reptiles should not be kept in homes with children under 5 years of age

# Preventing Pet Associated Zoonoses: Zoonoses Education Coalition

CDC's Healthy Pets, Healthy People Website [www.cdc.gov/healthypets](http://www.cdc.gov/healthypets)

### Stay safe and healthy while feeding reptiles and amphibians!



Live and frozen feeder rodents (such as mice and rats) and the reptiles and amphibians that eat them (snakes, lizards, turtles, and frogs) can sometimes carry germs that can make people sick. These germs can cause illnesses ranging from diarrhea to birth defects.

- Feeder rodents and reptiles can carry germs even if they look healthy and clean.
- Germs are shed in rodent and reptile droppings and can easily contaminate their bodies and anything in areas where they live.
- These germs can contaminate areas where rodents are housed or handled, or where frozen rodents are prepared, thawed, and stored. The germs can spread to people after they touch rodents, reptiles, or any areas that come in contact with these animals.
- Reptiles that live in tanks or cages can contaminate their habitats, including their water bowls.

### PROTECT YOURSELF AND YOUR FAMILY FROM GERMS

#### FEED YOUR REPTILE SAFELY.

Handling frozen or live rodents is not recommended for children under 5 years old, adults over 65, or people with weakened immune systems because they are at a greater risk for serious illness from germs that animals can carry.

- Use frozen rodents when possible to reduce the risk of injury to you or your pet.
- Don't handle reptiles after handling rodents to reduce your risk of bites.
- Feed reptiles with tongs when using feeder rodents.
- Never feed your reptile wild rodents.

#### WASH YOUR HANDS.

- Always wash hands thoroughly with soap and water right after handling rodents or reptiles, or after touching anything that was in contact with these animals.
- Adults should supervise hand washing for young children.
- If soap and water are not readily available, use hand sanitizer until you are able to wash your hands thoroughly with soap and water.

#### KEEP IT CLEAN.

Clean and disinfect all surfaces and supplies that come in contact with rodents.

- Keep rodents, reptiles, and their supplies out of kitchens or other areas where food is prepared, served, stored, or consumed.
- Don't store frozen rodents in the microwave or in food preparation areas.
- Clean supplies outside the house when possible. If you clean supplies indoors, use a laundry sink or bathtub and thoroughly clean and disinfect the area right after.

FOR MORE INFORMATION VISIT: [WWW.CDC.GOV/HEALTHYPETS](http://WWW.CDC.GOV/HEALTHYPETS)

 Centers for Disease Control and Prevention  
National Center for Emerging and Zoonotic Infectious Diseases  
11/2017/10-16

### Stay healthy around pet reptiles and amphibians!



Reptiles (such as snakes, lizards, and turtles) and amphibians (such as frogs and toads) can sometimes carry germs that can make people sick. These germs can cause illnesses ranging from fever to serious diarrhea.

- Amphibians and reptiles can carry germs even if they look healthy and clean.
- Germs are shed in their droppings and can easily contaminate their bodies and anything in areas where they live and roam, such as their habitat or aquarium tank water.
- These germs can spread to people after they touch these animals or anything in their habitats.

**But there's good news! You can take steps to stay healthy while enjoying your pets.**

### PROTECT YOURSELF AND YOUR FAMILY FROM GERMS

#### PICK THE RIGHT PET FOR YOUR FAMILY.

Reptiles and amphibians are not recommended for children under 5 years old, adults over 65, or people with weakened immune systems because they are at a greater risk for serious illness from germs that pets can carry.

- Small turtles (shell length under 4 inches) are illegal to sell and own in the US because they are likely to cause salmonella infection, especially in children.

#### WASH YOUR HANDS.

- Always wash hands thoroughly with soap and water right after touching, feeding, or caring for your pets or cleaning their habitats.
- Adults should supervise hand washing for young children.
- If soap and water are not readily available, use hand sanitizer until you are able to wash your hands thoroughly with soap and water.

#### KEEP IT CLEAN.

Keep amphibians and reptiles out of kitchens and other areas where food is prepared, served, stored, or consumed.

- Clean habitats and supplies outside the house when possible.
- If you clean supplies indoors, use a laundry sink or bathtub and thoroughly clean and disinfect the area right after.

#### PLAY SAFELY.

- Don't kiss, snuggle, or hold reptiles and amphibians close to your face.
- Don't let them roam free in your home.
- Don't touch your mouth after handling reptiles and amphibians.
- Don't eat or drink around animals.

FOR MORE INFORMATION VISIT: [WWW.CDC.GOV/HEALTHYPETS](http://WWW.CDC.GOV/HEALTHYPETS)

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### Stay healthy around small pets!



Pet rodents (such as mice, rats, hamsters, gerbils, and guinea pigs) and other small pets (such as hedgehogs, sugar gliders, chinchillas, and ferrets) can sometimes carry germs that can make people sick. These germs can cause illnesses ranging from serious diarrhea to birth defects.

- Small pets can carry germs even if they look healthy and clean.
- Germs are shed in their droppings and can easily contaminate their bodies, habitats, toys, bedding, and anything in areas where they live.
- These germs can spread to people after they touch these animals or anything in their habitats.

**But there's good news! You can take steps to stay healthy while enjoying your pets.**

### PROTECT YOURSELF AND YOUR FAMILY FROM GERMS

#### PICK THE RIGHT PET FOR YOUR FAMILY.

Rodents and other small pets are not recommended for children under 5 years old, adults over 65, or people with weakened immune systems because they are at a greater risk for serious illness from germs that pets can carry.

#### WASH YOUR HANDS.

- Always wash hands thoroughly with soap and water right after touching, feeding, or caring for your pets or cleaning their habitats.
- Adults should supervise hand washing for young children.
- If soap and water are not readily available, use hand sanitizer until you are able to wash your hands thoroughly with soap and water.

#### KEEP IT CLEAN.

Keep small pets and their supplies out of kitchens and other areas where food is prepared, served, stored, or consumed.

- Clean habitats, toys, and supplies outside the house when possible.
- If you clean supplies indoors, use a laundry sink or bathtub and thoroughly clean and disinfect the area right after.

#### PLAY SAFELY.

- Don't kiss, snuggle, or hold small pets close to your face.
- Don't let them roam free in your home.
- Don't touch your mouth after handling small pets.
- Don't eat or drink around animals.

FOR MORE INFORMATION VISIT: [WWW.CDC.GOV/HEALTHYPETS](http://WWW.CDC.GOV/HEALTHYPETS)

 Centers for Disease Control and Prevention  
National Center for Emerging and Zoonotic Infectious Diseases  
11/2017/10-16



ORIGINAL ARTICLE

## Reptile-Associated Salmonellosis in Minnesota, 1996–2011

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### Impacts

- *Salmonella* serotypes not traditionally considered to be reptile-associated (e.g. subspecies I serotypes such as Typhimurium and Enteritidis) were the most common serotypes identified in people with reptile-associated salmonellosis and in reptiles.
- Seventeen per cent of cases occurred in infants (children  $\leq 1$  year of age), suggesting *Salmonella* can readily be transmitted without direct contact with a reptile.
- Thirty-one per cent of reptile-associated salmonellosis cases in Minnesota occurred in children under the age of 5 years, underscoring the public health recommendation that reptiles not be kept in homes or school/day care settings with children under the age of 5 years.



Tory Whitten, MPH



Thank you!

Contact us anytime at [ZDU@state.mn.us](mailto:ZDU@state.mn.us)