Understanding the human health burden of *Salmonella* from the meat supply

Reciprocal Meat Conference 2006

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Enteric Diseases Epidemiology Branch (proposed name)
Centers for Disease Control and Prevention

CDC's Role

Mission: reduce the human health burden of foodborne diseases

- Independent risk assessment
  - Non-regulatory
- Close collaboration with state health depts
  - National surveillance programs
    - FoodNet, NARMS, PulseNet, OutbreakNet
  - Field investigations
    - At invitation of states

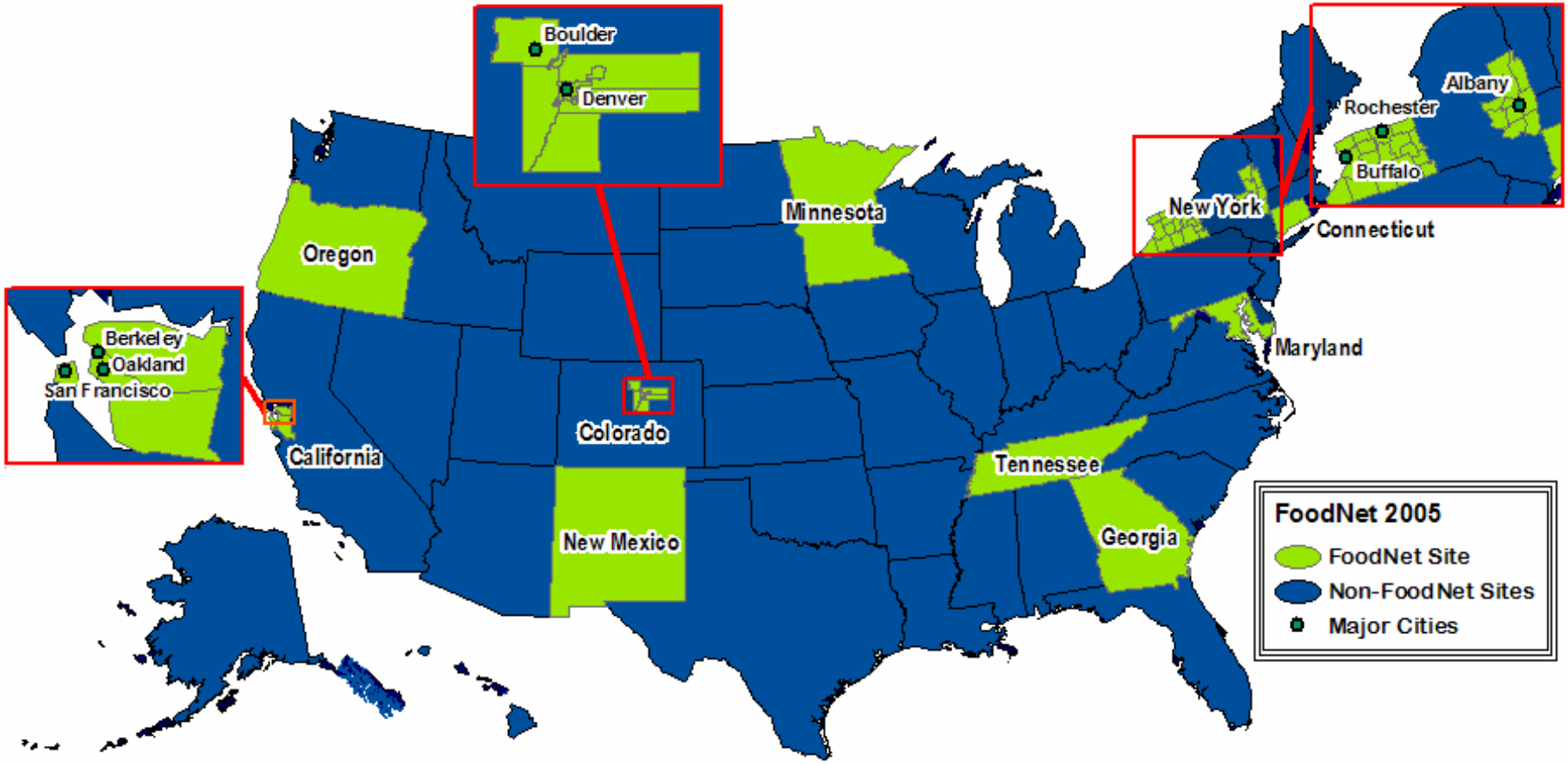
What is FoodNet?

- Foodborne Diseases Active Surveillance Network
  - Established in 1996
- Principal foodborne disease component of Emerging Infections Program
- CDC, USDA-FSIS, FDA, and participating state health departments

FoodNet Surveillance

- Active surveillance for laboratory-confirmed infections
  - *Salmonella, Shigella, Campylobacter,* Shiga-toxin producing *E. coli* (including *E. coli* O157), *Listeria monocytogenes, Yersinia enterocolitica, Vibrio, Cryptosporidium* and *Cyclospora*
- FoodNet personnel ascertain cases from >600 clinical laboratories serving the FoodNet catchment area

FoodNet Sites 2005



44 million (15% of U.S. population)

FoodNet Objectives

1. **Determine the burden** of foodborne illness in the United States
2. **Monitor trends in the burden** of specific foodborne illness over time
3. **Attribute the burden** of foodborne illness to specific foods and settings
4. **Develop and assess interventions** to reduce the burden of foodborne illness

FoodNet provides

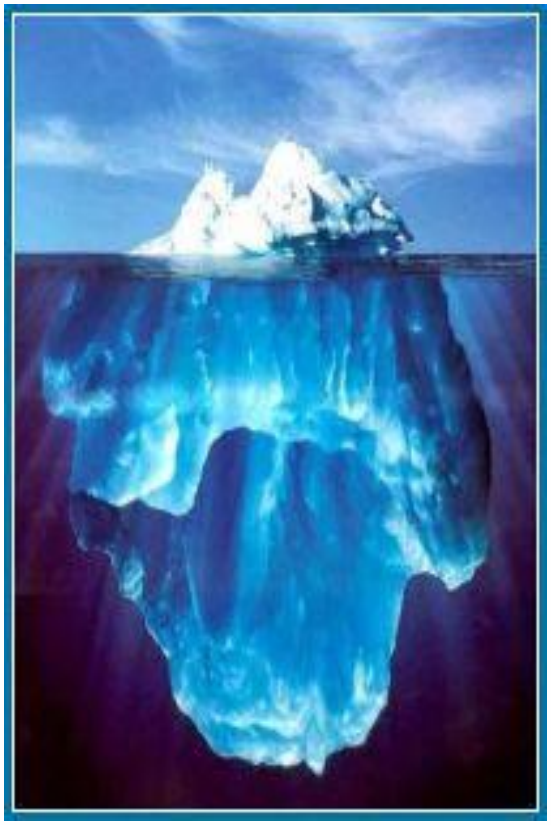
- Stable, comprehensive, consistent surveillance
  - Overall burden of illness estimates
  - Annual trend estimate

    "National Report Card" on the food safety system

    - Monitor progress towards National Health Objectives
  - Source estimate and evaluation of interventions
- Critical data for national food safety policy

Determine burden

- Surveillance: “tip of the iceberg”
- Depends on several factors
  - Medical care seeking behavior
  - Diagnosis, Reporting
- *Salmonella* causes, each year
  - >1 million infections
  - >100,000 doctor visits
  - >30,000 laboratory-confirmed cases
  - >10,000 hospitalizations
  - 500 deaths



Monitor trend

- Published each year in mid-April in CDC's *MMWR* publication
- Measuring change in incidence compared to 1996-1998 baseline
- Use negative binomial regression model to account for:
  - Increase in number of participating sites
  - Site-to-site variation in incidence

FIGURE 1. Relative rates compared with 1996–1998 baseline period of laboratory-diagnosed cases of infection with *Campylobacter*, STEC O157, *Listeria*, *Salmonella* and *Vibrio*, by year

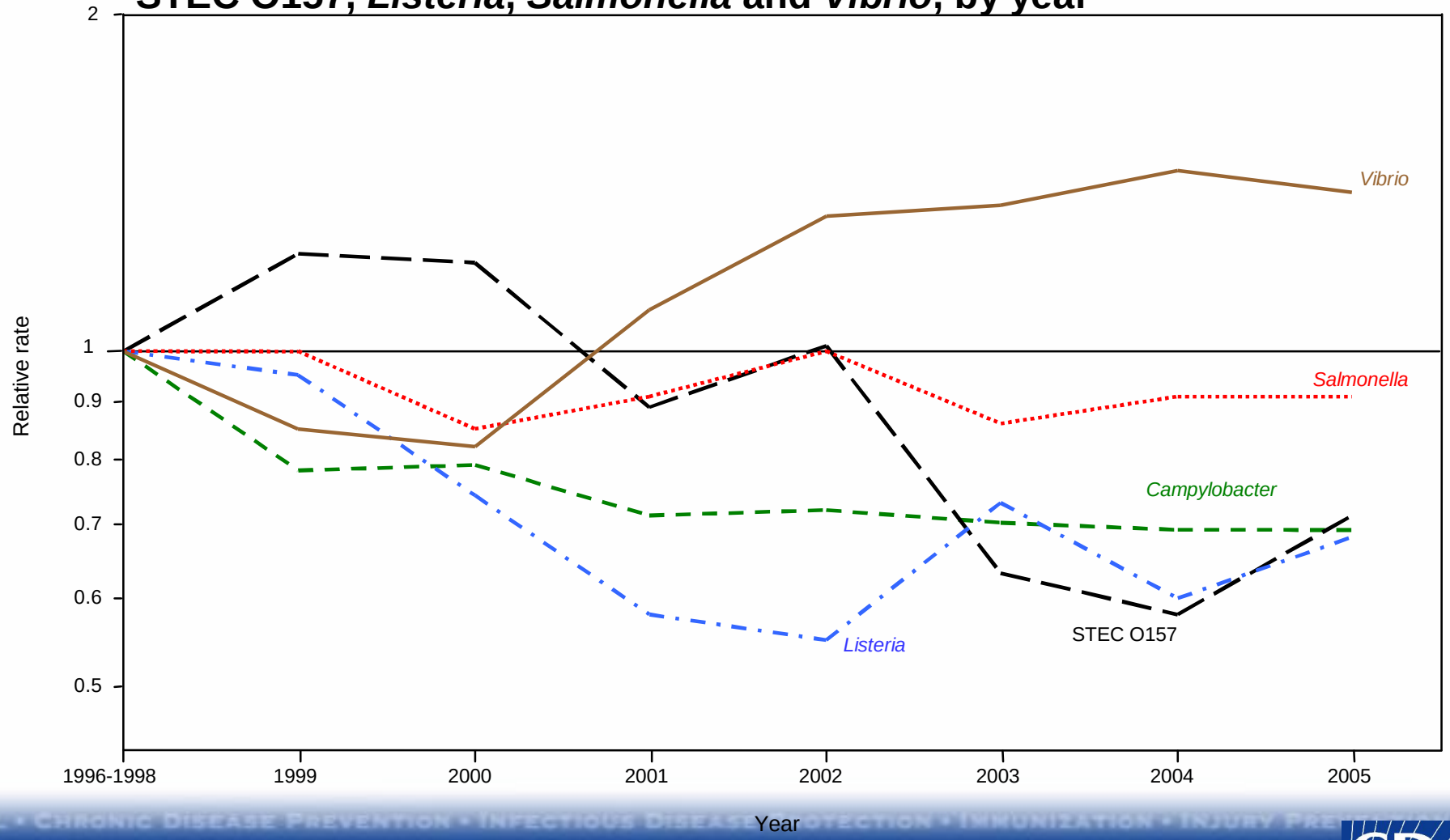
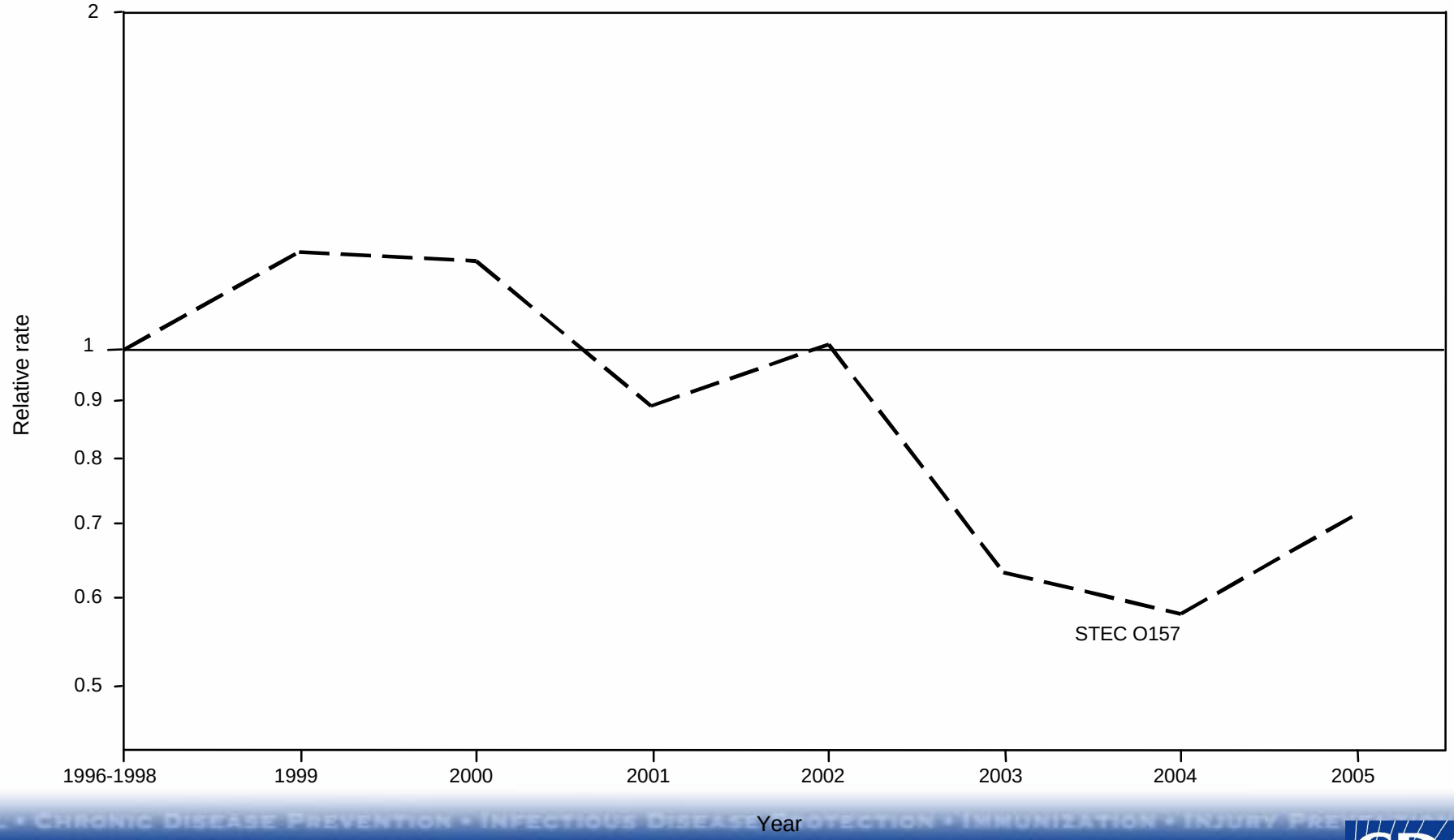


FIGURE 3. Relative rates compared with 1996–1998 baseline period of laboratory-diagnosed cases of infection with STEC O157 by year — Foodborne Diseases Active Surveillance Network, United States, 1996–2005



Trend in *E. coli* O157

- Continued decline in *E. coli* O157 infections not sustained in 2005
  - Compare to 1996-1998 baseline, *E. coli* O157 decreased 29% in 2005
- Consistent with FSIS data on *E. coli* O157 contamination of ground beef

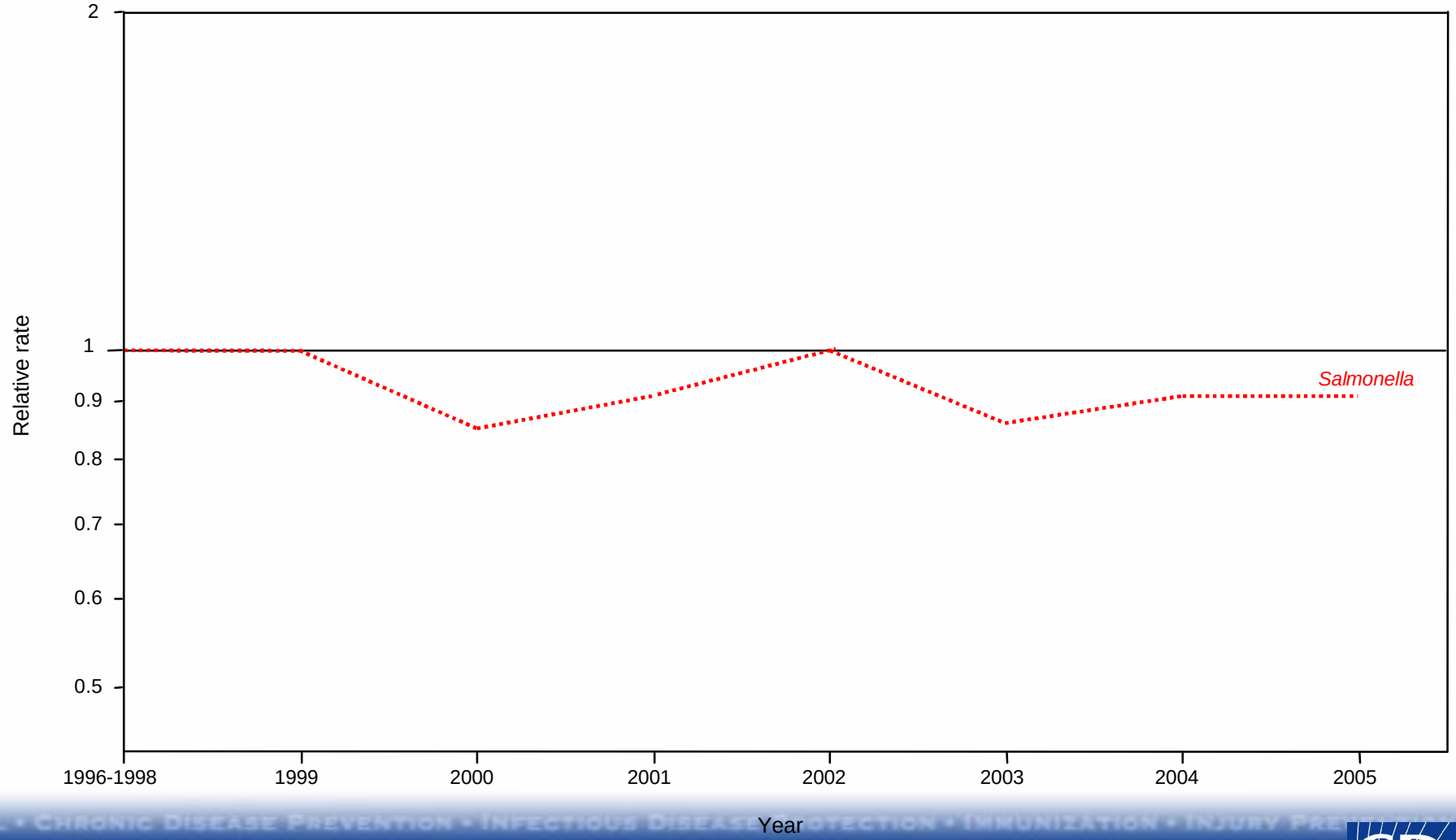
Healthy People 2010 Objectives

	Cases per 100,000		
Pathogen	**2004**	**2005**	**2010 Objective**
STEC O157	0.9	**1.06**	**1.0**

E. coli O157 Success Story

- Coordinated efforts by regulators and industry effective in reducing contamination and illness related to ground beef
- Survey with America Meat Institute to document changes in industry practices
  - What factors contributed to the decline of STEC O157 contamination on ground beef?

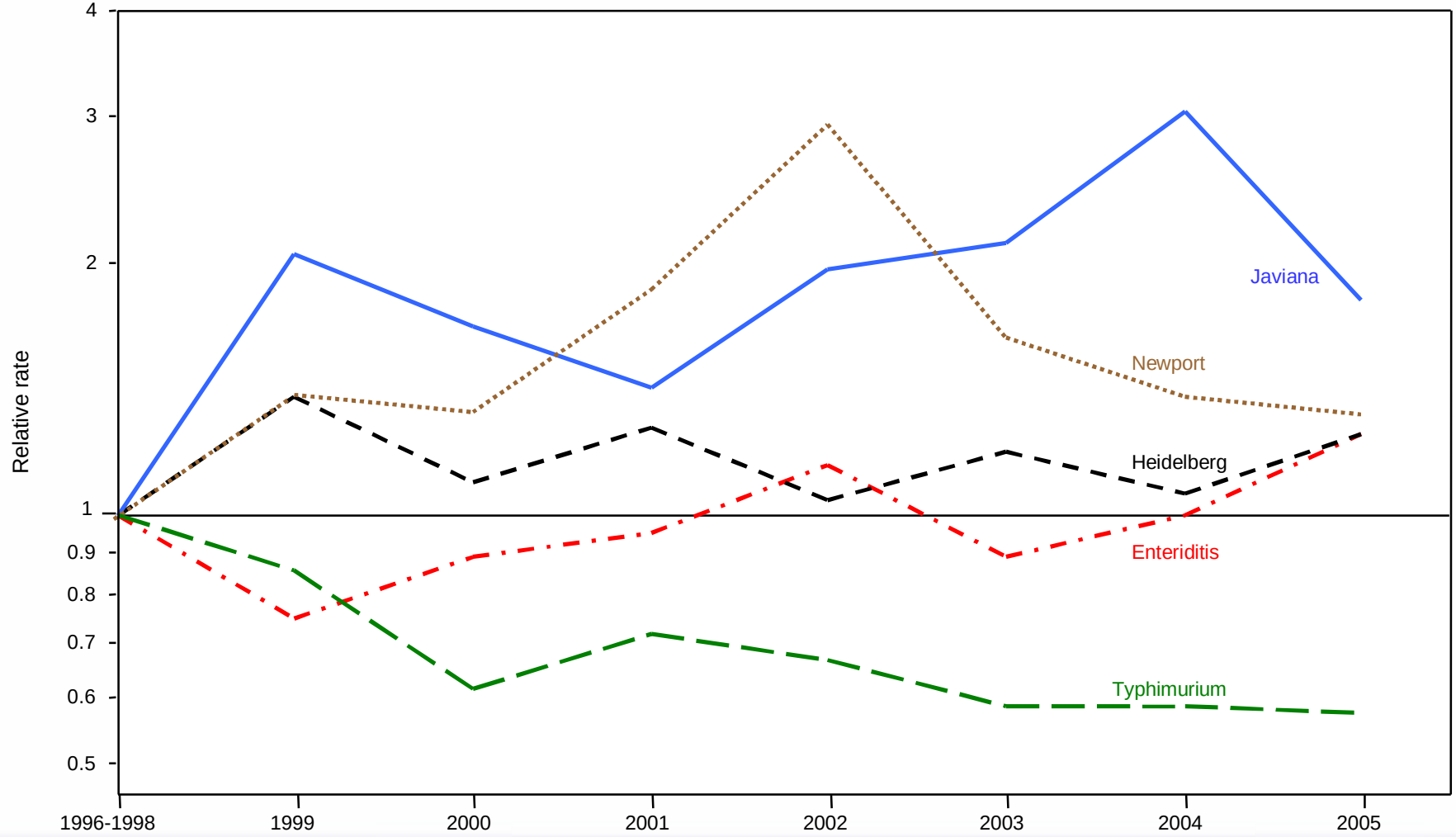
FIGURE 4. Relative rates compared with 1996–1998 baseline period of laboratory-diagnosed cases of infection with *Salmonella* by year — Foodborne Diseases Active Surveillance Network, United States, 1996–2005



Healthy People 2010 Objectives

	Cases per 100,000		
Pathogen	**2004**	**2005**	**2010 Objective**
Salmonella	14.7	**14.55**	**6.8**

FIGURE 2. Relative rates compared with 1996–1998 baseline period of laboratory-diagnosed cases of infection with the five most commonly isolated *Salmonella* serotypes, by year



Trends in *Salmonella*

- Little change
  - Compared to 1996-1998 baseline, *Salmonella* decreased 9% (CI = 2%–15%) in 2005
- Of the five most common *Salmonella* serotypes, only the incidence of *S*. Typhimurium decreased
  - Most change occurred prior to 2000

Steps to reducing *Salmonella?*

v UDSA initiative to reduce the presence of *Salmonella* in raw meat and poultry products

- Need to know source of human infections
  - Animal reservoir species and transmission routes
- Good attribution for *E. coli* O157
- Attribution for *Salmonella* more complex
  - Wide variety of food-animal products
  - Information on attribution differs by serotype

CDC attribution efforts

- Start with human illness data
  - Attribute to different sources
  - “Top down” qualitative risk assessment approach (“Fork-to-farm” approach)
- Can partition illness at various steps throughout the food supply
  - Point of consumption
  - Point of processing
  - Reservoir

‘Point of consumption’ attribution

- Foodborne Disease Outbreaks
  - Major enhancements provided by PulseNet and OutbreakNet
  - Summarize data from all reported outbreaks
  - Complex problem due to food categorization
- FoodNet sporadic case-control studies
  - 18 FoodNet case-control studies completed
    - *Campylobacter, Escherichia coli* O157:H7, *Listeria monocytogenes, Salmonella* Enteritidis, *Salmonella* Newport, *Salmonella* Heidelberg, *Salmonella* Typhimurium

Sporadic case-control studies

- FoodNet case-control studies on different Salmonella serotypes
- Recently completed study on infant cases of *Salmonella* infections
  - New risk factor: Being in shopping cart with raw meat or poultry
- In 2006, FoodNet will launch a 12-month study of *S.* Javiana, *S.* Infantis and S. I 4,[5],12:i:-

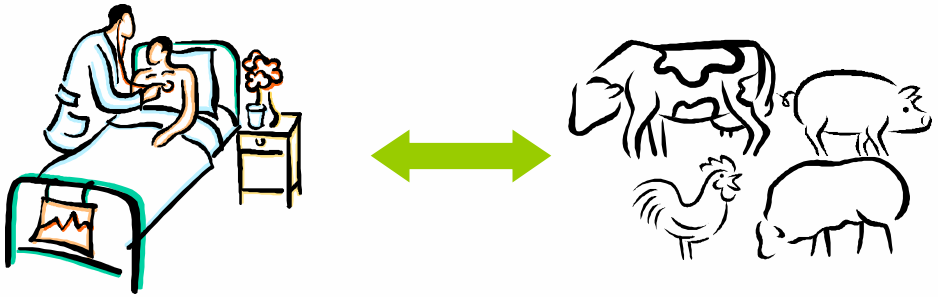
Blending Project

- ***e.g. E. coli* O157:H7**
  - Summary of outbreaks*
    - 20% due to eating hamburgers
    - 4% due to animal contact
  - FoodNet sporadic case-control study
    - 15% due to eating pink hamburgers
    - 8% due to visiting a farm

***Rangel et al. EID 11:603-9, 2005**

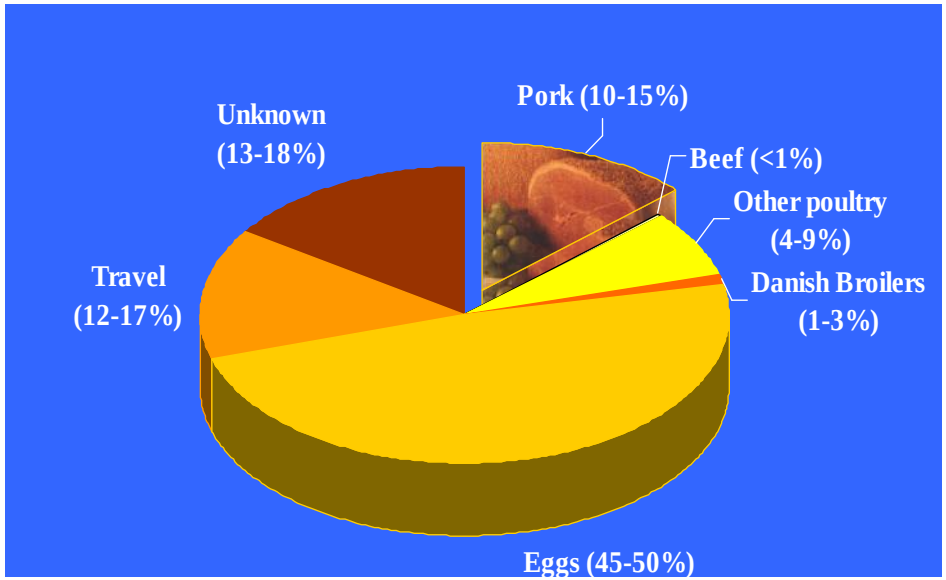
'Point of Processing' Attribution

- Quantify the contribution of meat and poultry as a source of human Salmonellosis
- Data sources
  - Public Health Laboratory Information System
  - USDA, FSIS Hazard Analysis and Critical Control Points (HACCP)

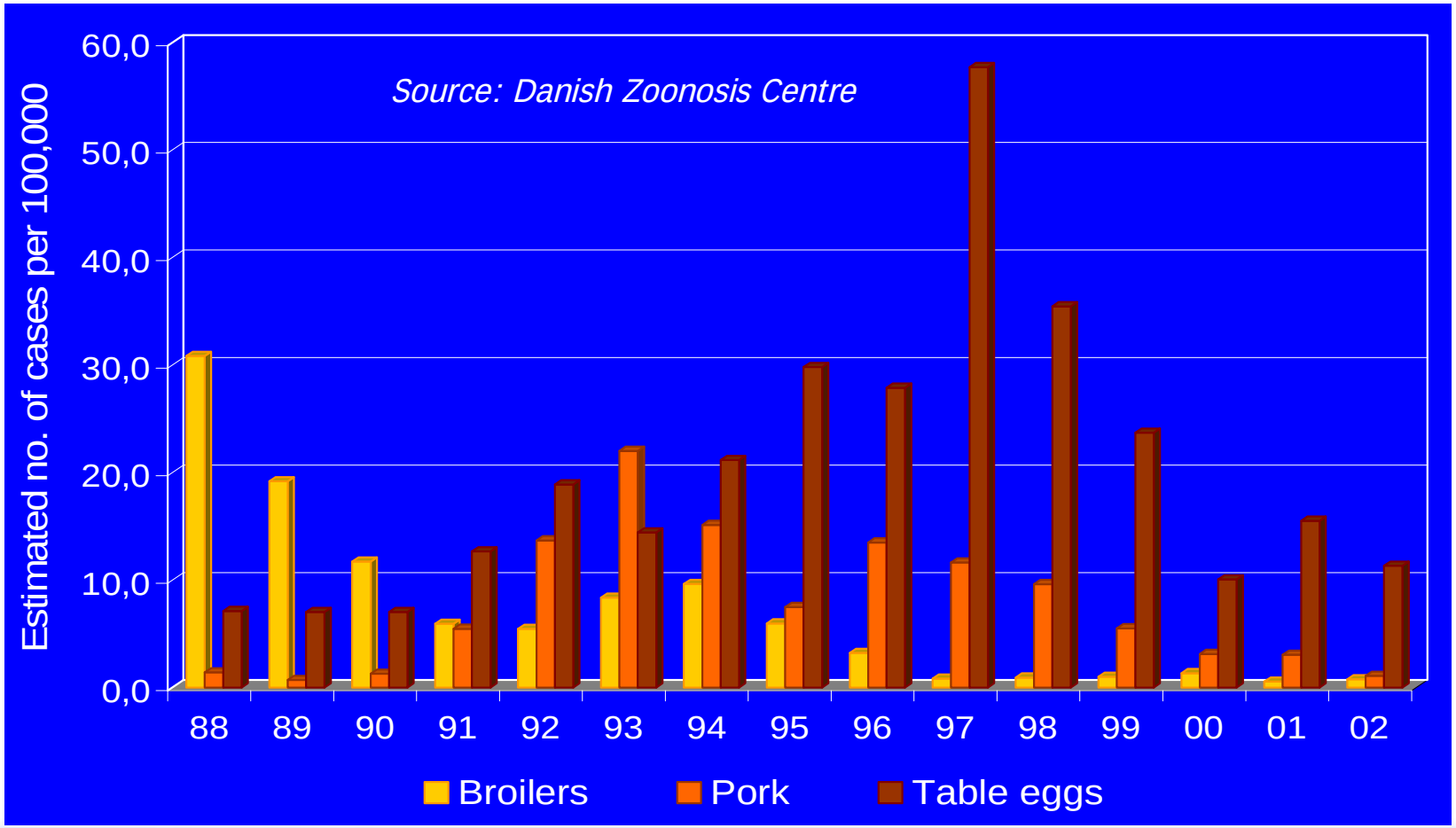


Salmonella Attribution Project

- *Salmonella* attribution project, with USDA-FSIS and University of Minnesota
  - Comparing subtypes from humans and animal-food groups



Trends in sources for human salmonellosis



FoodNet Priorities

1. Attribution
2. Attribution
3. Attribution
4. Multidrug-resistant *Salmonella*

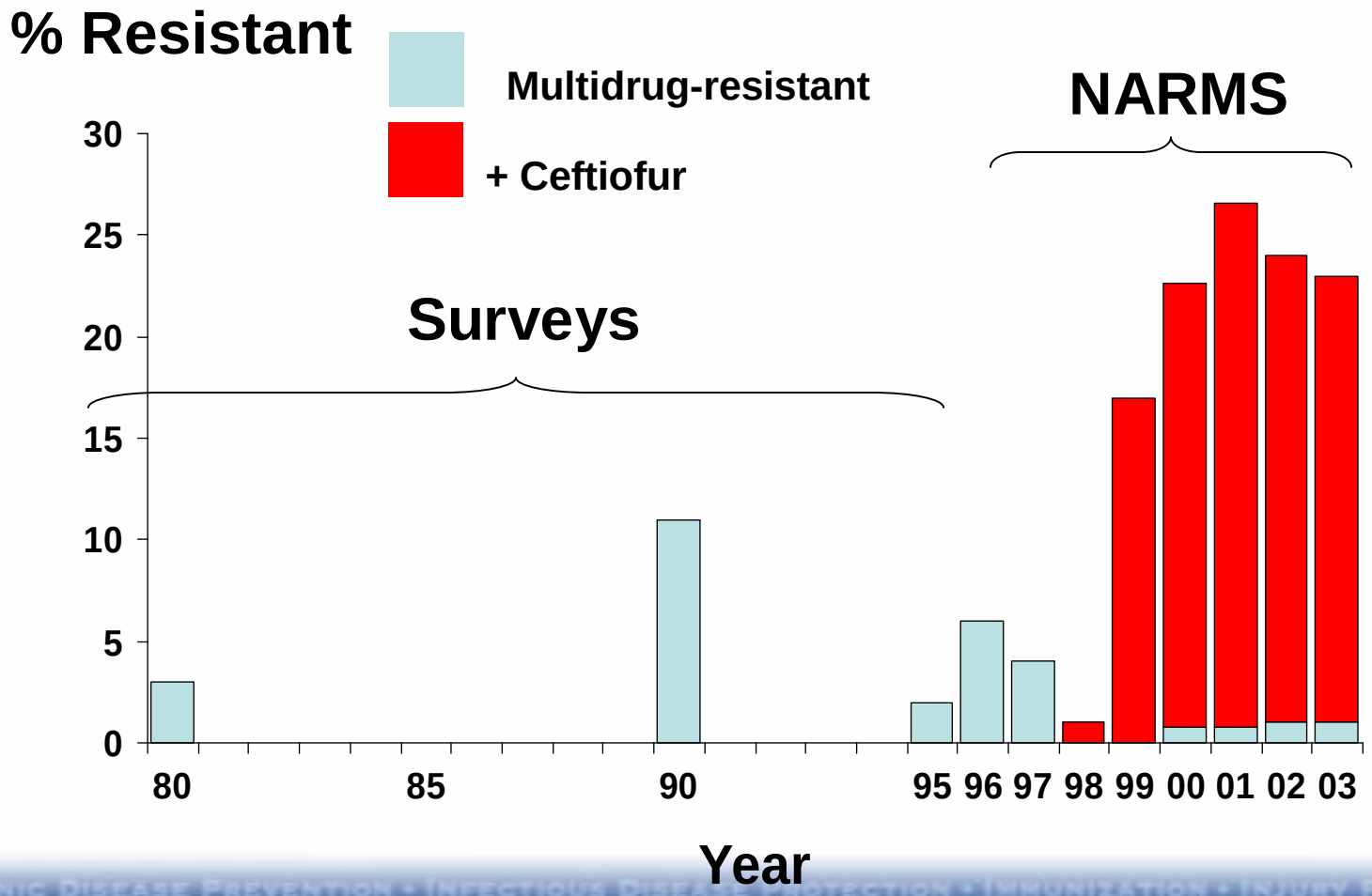
National Antimicrobial Resistance Monitoring System (NARMS)

- In 1996, FDA Joint Advisory Committee recommended the creation of surveillance system to monitor development of antimicrobial resistance among foodborne bacteria
  - Financially supported by FDA-Center for Veterinary Medicine
- Integrated surveillance (*Salmonella, Campylobacter*)
  - CDC: Human surveillance
    - Nationwide
  - FDA-CVM: Retail meat surveillance
    - FoodNet sites
  - USDA: Animal surveillance (On Farm & Slaughter)

Human Health Consequences

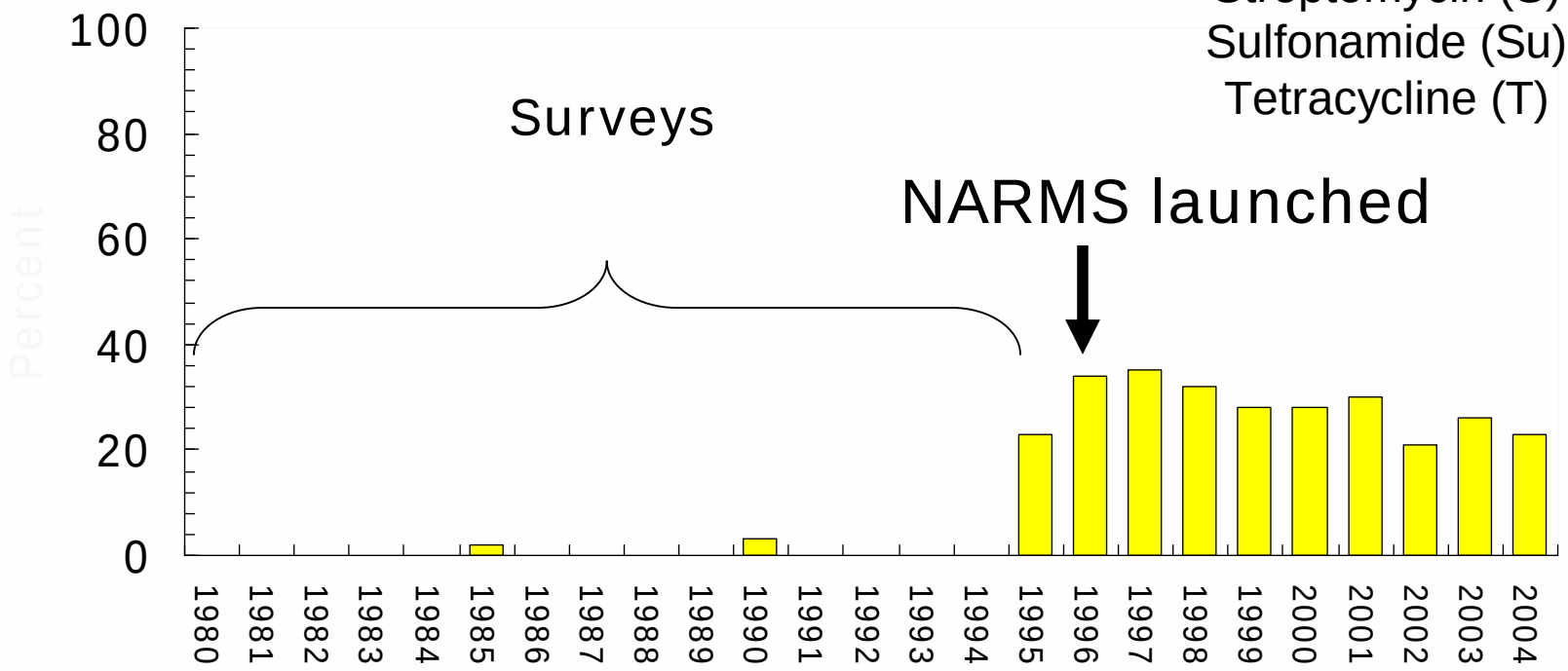
- Accumulating evidence of human health consequence of resistant *Salmonella*
  - Increased severity of illness
  - Increased death
- *Salmonella* treatment failures due to resistance to clinically important antimicrobial agents
  - Third generation cephalosporin
    - Ceftriaxone (humans), ceftiofur (animals)

Proportion of *S*. Newport multidrug-resistant and resistant to ceftiofur

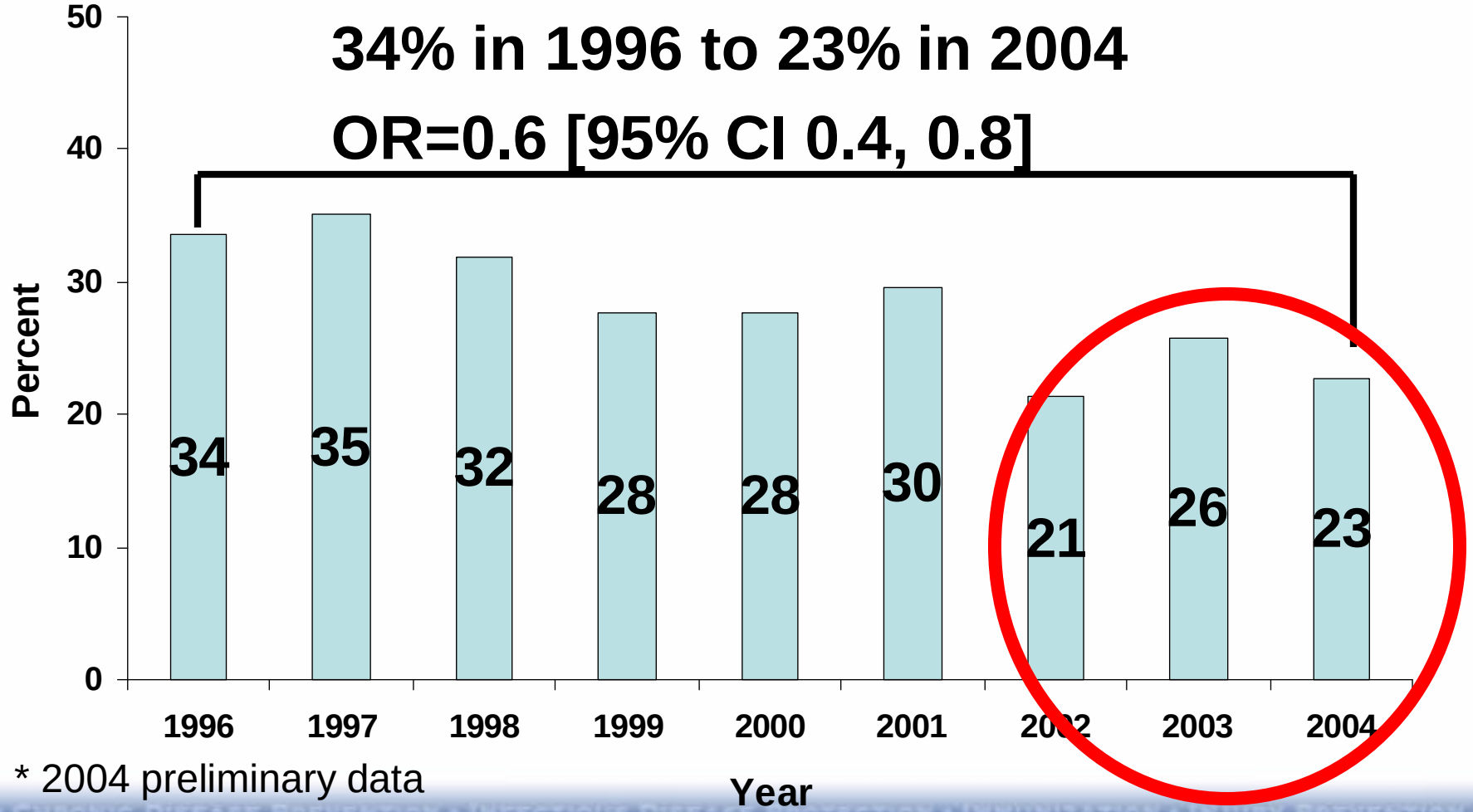


Percent of *Salmonella* Typhimurium isolates with multidrug ACSSuT resistance pattern (1980 – 2004)

ACSSuT
Ampicillin (A)
Chloramphenicol (C)
Streptomycin (S)
Sulfonamide (Su)
Tetracycline (T)



Percentage of *S.* Typhimurium resistant to at least ACSSuT, by year, 1996-2004*



* 2004 preliminary data

Multistate Outbreak of MDR *Salmonella* Typhimurium DT104 in the Northeast, 2003-2004

- Multistate outbreak from contaminated ground beef purchased in grocery stores
  - First documented outbreak of MDR *S.* Typhimurium DT104 from widely distributed food item in the U.S.
- Ground beef originated from one cattle slaughterhouse, suspected source culled dairy cows
- New cases after investigation suggesting continued exposure to contaminated ground beef

Culled Dairy Cows: An Invitation for Resistance and Spread?

- Regular antimicrobial use during life of cow
  - Calves fed medicated milk replacer
  - Waste milk (milk from cows on antimicrobials) given to calves
  - Adult cows given antimicrobials to prevent disease
- Time of slaughter
  - Reason for culling?
  - Asymptomatic carriage of pathogenic bacteria
  - Increased excretion at time of slaughter
- Large production facilities
  - 6000-8000 pounds of beef ground at once
  - Contamination of large lots possible with one infected animal

Collaboration to Address the Problem

- "Salmonella DT104 and Ground Beef - Update and Policy Forum" March 2005
- Objectives
  - Address and discuss the human health, veterinary health, regulatory, industry and consumer concerns associated with the contamination of ground beef by multidrug-resistant *Salmonella* including *Salmonella* Typhimurium DT104
  - Address potential solutions to this emerging concern
    - *Clinical Infectious Diseases 2006*

Resistance predictors for ACSSuT NARMS, 1999-2003*

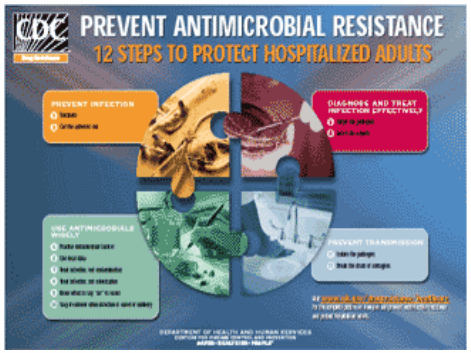
Resistance (Test result)	PPV (95% CI)	NPV (95% CI)
Chloramphenicol	89.9% (87.6, 91.9)	100.0% (100.0, 100.0)
Chloramphenicol + ampicillin	94.1% (92.2, 95.7)	100.0% (100.0, 100.0)

Total 8,164 non-Typhi *Salmonella* isolates tested, of which 719 (8.8%) were ACSSuT

Positive predictive value (PPV) = [test result(+) and ACSSuT(+) / all test result(+)] X 100
Negative predictive value (NPV) = [test result(-) and ACSSuT(-) / all test result(-)] X 100

GET SMART
Know When Antibiotics Work

GET SMART, DFBMD



12 Step Program, DHQP

Reduce the Spread of Antimicrobial Resistance

GET SMART
Know When Antibiotics Work On The Farm

NARMS-EB, DFBMD

Get Smart on the Farm

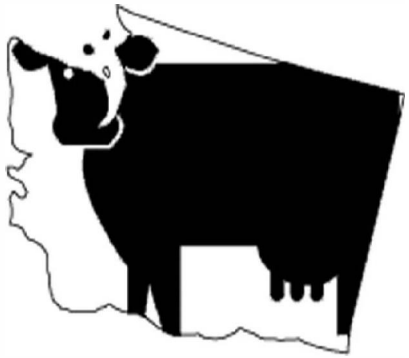
Educational Activities to Promote Appropriate Use of Antimicrobial Agents in Animal Health

- Veterinary Curriculum
- State-based Interventions

Animal Health Practices on Washington Dairy Farms

A Tacoma-Pierce County Health Department

Antibiotic Resistance Task Force Project



Primary Investigator: Monica Raymond, MPH, MS, RN
Project Coordinator: Ron Wohrle, DVM
Advisory Board Chairman: Robert Whitney, DVM

FoodNet Conclusions

- Decline in *E. coli* O157
  - Working with AMI to document changes in industry practices
- Little change in *Salmonella*
  - Need to work on attribution for Salmonella to identify sources of human infections

NARMS Conclusions

- MDR infections cause more severe illness
- Trends in resistance high but stable
- Need to identify ways to reduce prevalence of MDR organisms in beef
- Issues:
  - Culled Dairy Cows
  - Predictors for MDR

Acknowledgements

- Industry partners
  - America Meat Institute
  - National Cattlemen's Beef Association
  - Alliance for Bovine Health
  - Tacoma Pierce County Health Department
  - Washington Dairy Federation
  - American Association of Extension Veterinarians
  - National Pork Board
  - American Association of Bovine Practitioners
- Regulatory partners
  - Food and Drug Administration
  - U.S. Department of Agriculture

http://www.cdc.gov/foodnet

http://www.cdc.gov/narms