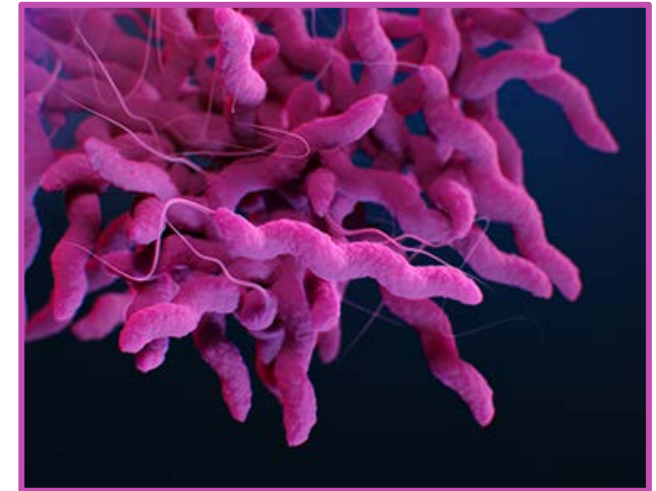
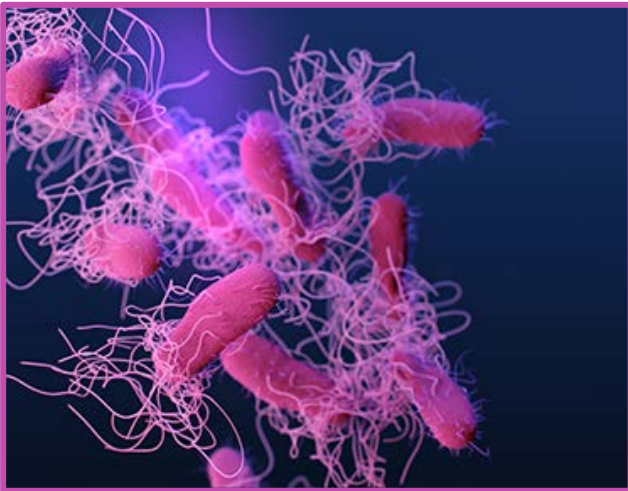


## Consumption of poultry is a major way people get *Salmonella* infections



Patricia M. Griffin, MD | Chief, Enteric Diseases Epidemiology Branch

Meeting of AFDO Healthy People 2030 Foodborne Illness Reduction Committee--*Salmonella* | May 14, 2021

# Topics

## ■ *Salmonella*

- Most important bacterial foodborne pathogen
- Three short stories about serotypes
  - Typhimurium decreasing
  - Enteritidis increasing
  - Infantis increasing due to a new, resistant strain

## ■ **Chicken**

- The major U.S. source of animal protein
- A major source of *Salmonella* illness
- A major reason for *Salmonella* serotype decreases and increases

## ■ **Summary and conclusion**

*Salmonella* is the biggest bacterial foodborne illness challenge in the United States

-----CDC annual estimates-----

Pathogen	Foodborne illnesses	Foodborne hospitalizations	Foodborne deaths
<i>Salmonella</i>	1,000,000	19,000	380
<i>Campylobacter</i>	845,000	8,500	80
<i>E. coli</i> O157	63,000	2,100	20
<i>Listeria</i>	1,600	1,500	260

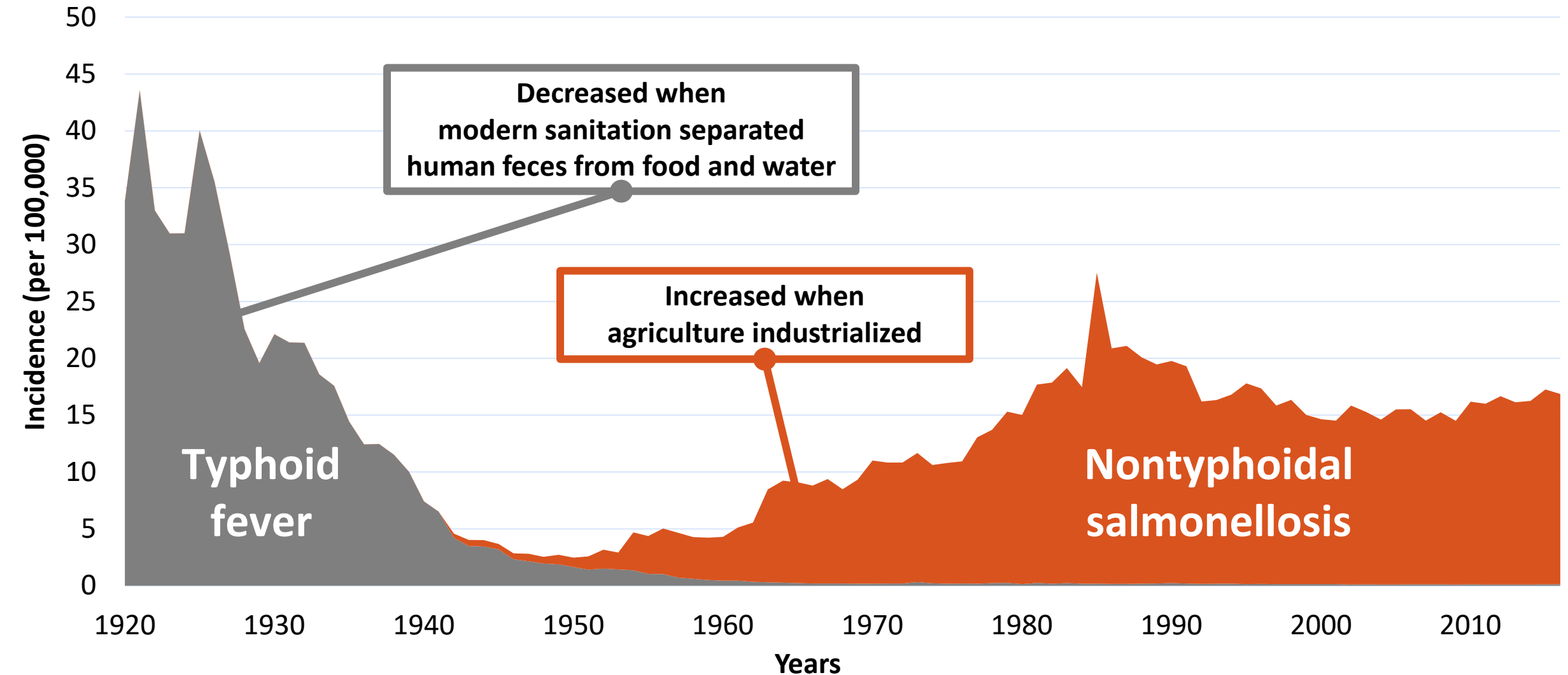
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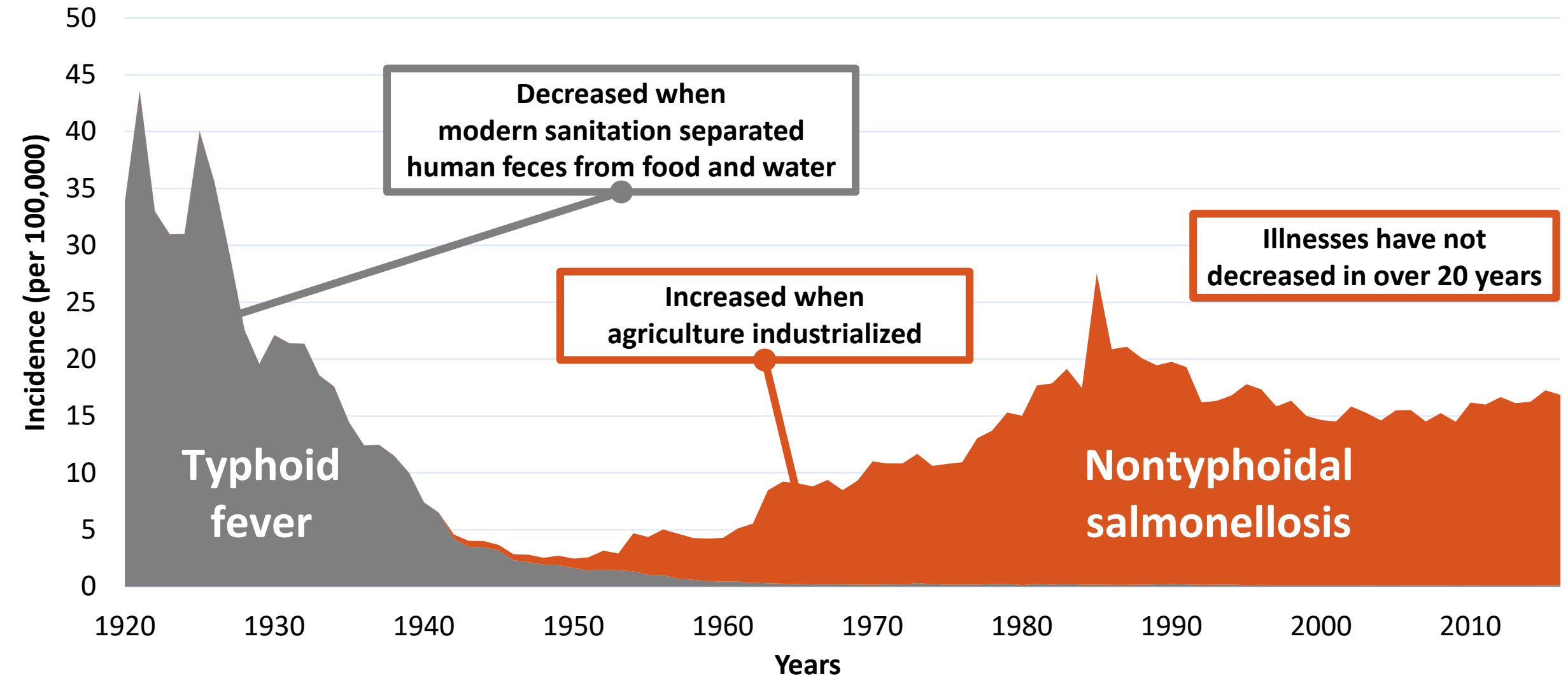
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Healthy People 2030 Goal for USA: 25% reduction in *Salmonella* infections from 2015–2017

By the mid-20<sup>th</sup> century typhoid fever (caused by *S. Typhi*) had declined, but **nontyphoidal salmonellosis was rising**. It is now **our major foodborne disease problem**.



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Highly resistant *Salmonella* strains continue to emerge in many food animals. People are “incidental hosts.”



**Chickens**



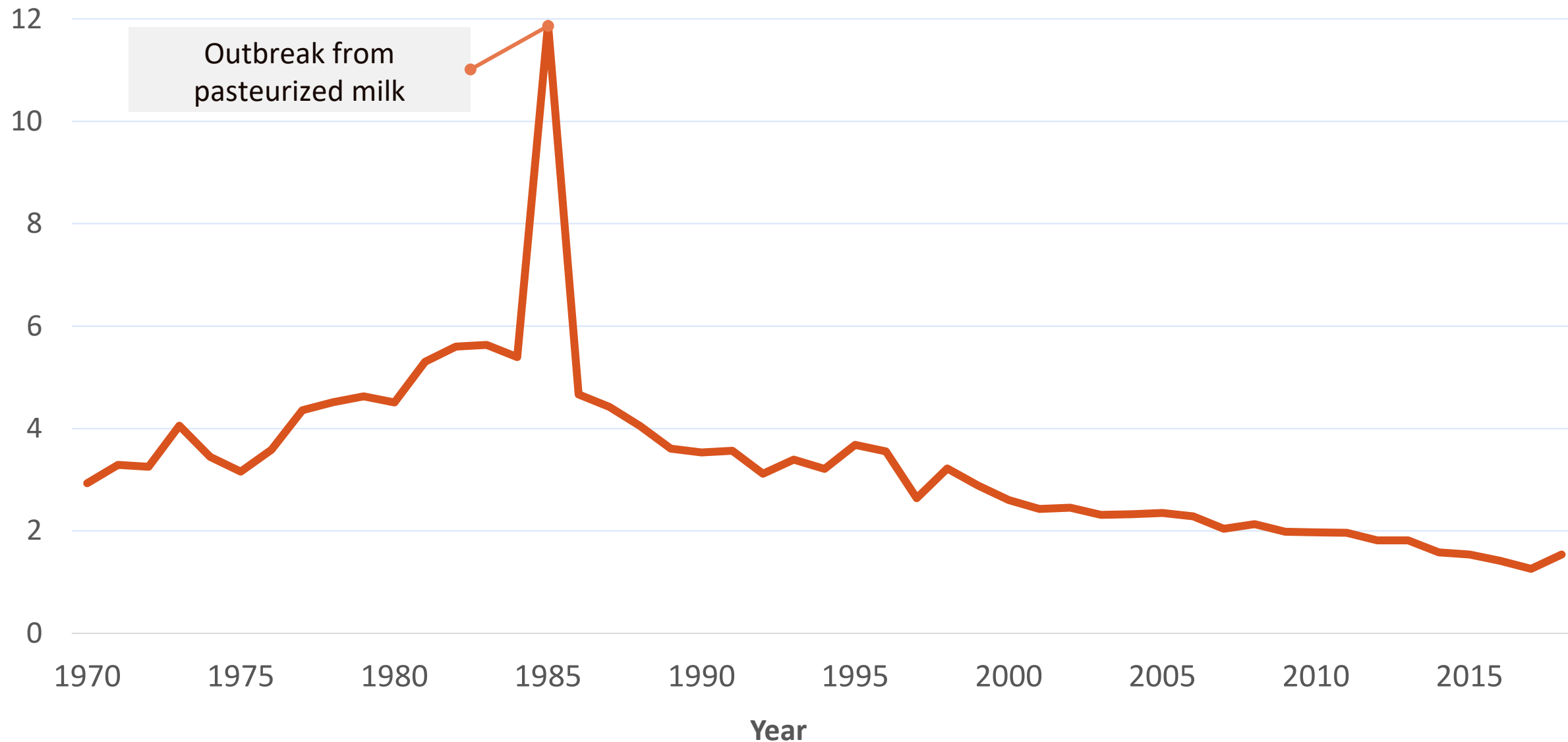
**Cattle**



**Pigs**

# Incidence of serotype Typhimurium infections has been declining

Incidence (per 100,000)





# Both *Salmonella* Typhimurium and Heidelberg infections have declined

Typhimurium

#1 until 2008



Now #2

Heidelberg

#4 in 2003



Now #15

Why? Possible reason:



Both targeted by same poultry vaccine, used on many broiler farms



Chicken is a major source of these infections

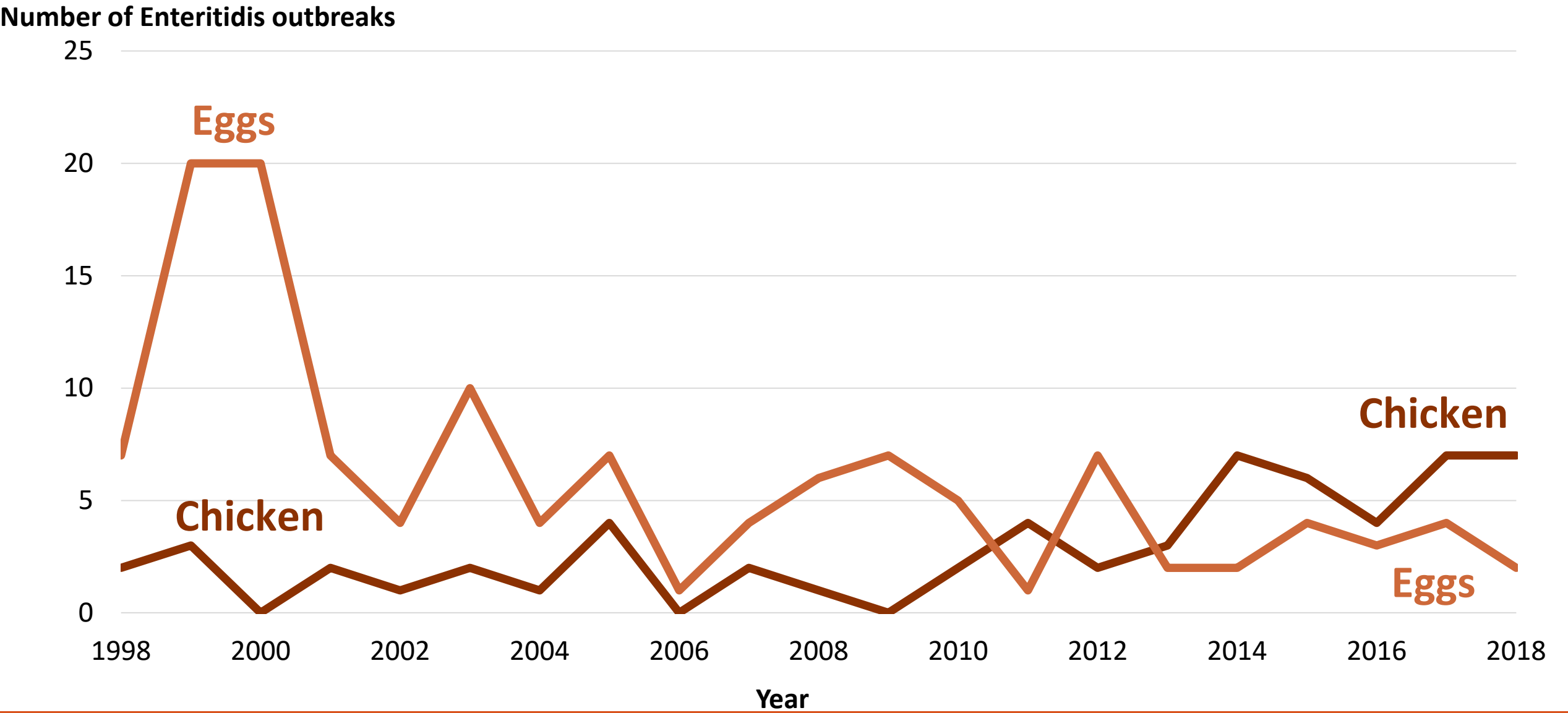


In 2008, **Enteritidis** surpassed **Typhimurium**  
as the most common *Salmonella* serotype  
causing human illness

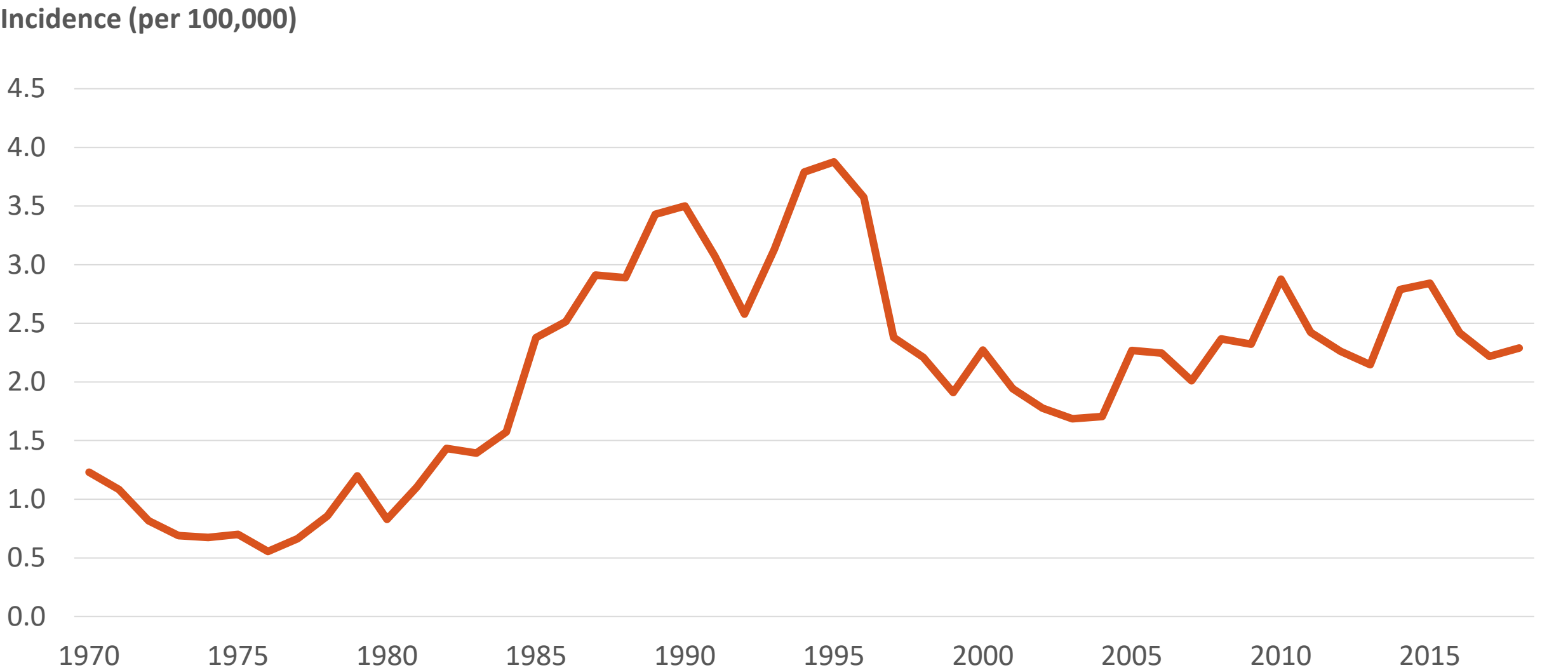
# Annual incidence of infection with *Salmonella* / by serotype, USA

	Serotype	Incidence lab-confirmed infections (per 100,000 pop. per year)	% of total	% with international travel
1	Enteritidis	3.0	19	22
2	Typhimurium	1.7	11	6
3	Newport	1.6	10	5
4	Javiana	1.4	9	3
5	I 4,[5],12:i:-	0.9	6	10
	Top 5	—	56	—
	All	16.9	100	11

# Enteritidis used to cause many egg outbreaks, now it causes more chicken than egg outbreaks



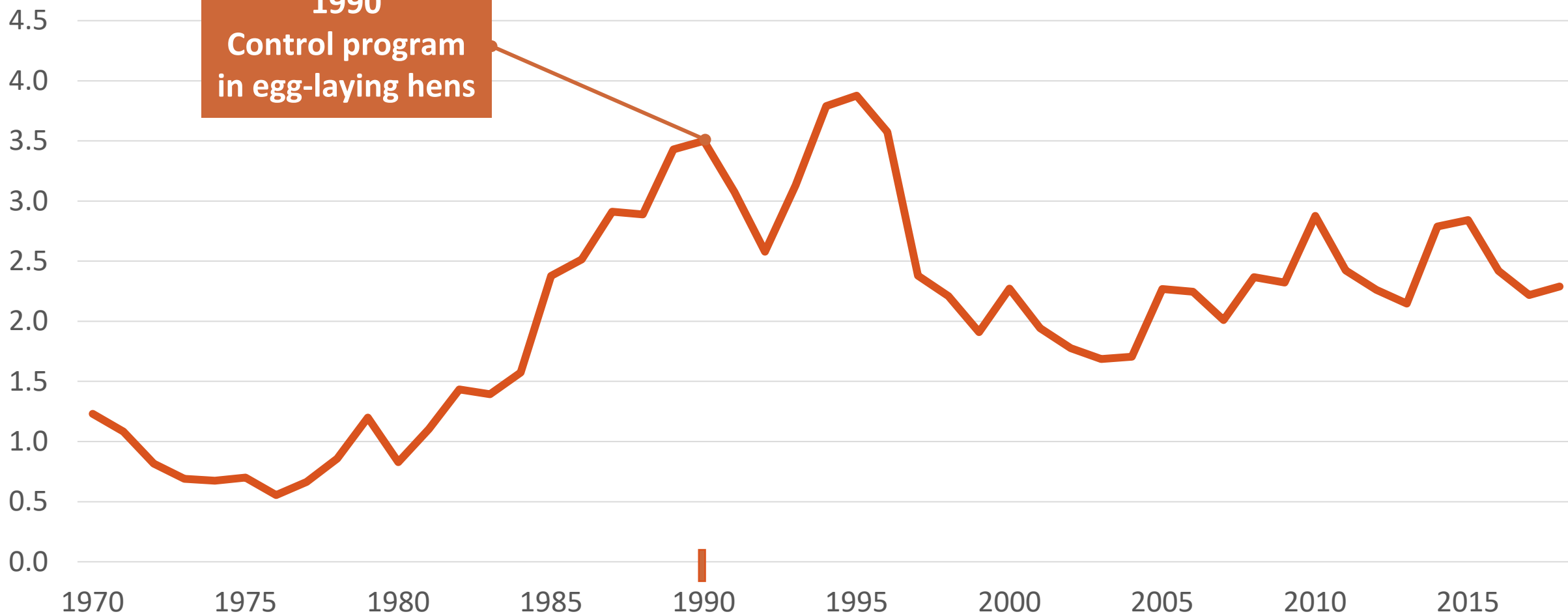
# Incidence of Enteritidis infections has varied with its sources



# 1980s through early 2000s were the egg years for Enteritidis

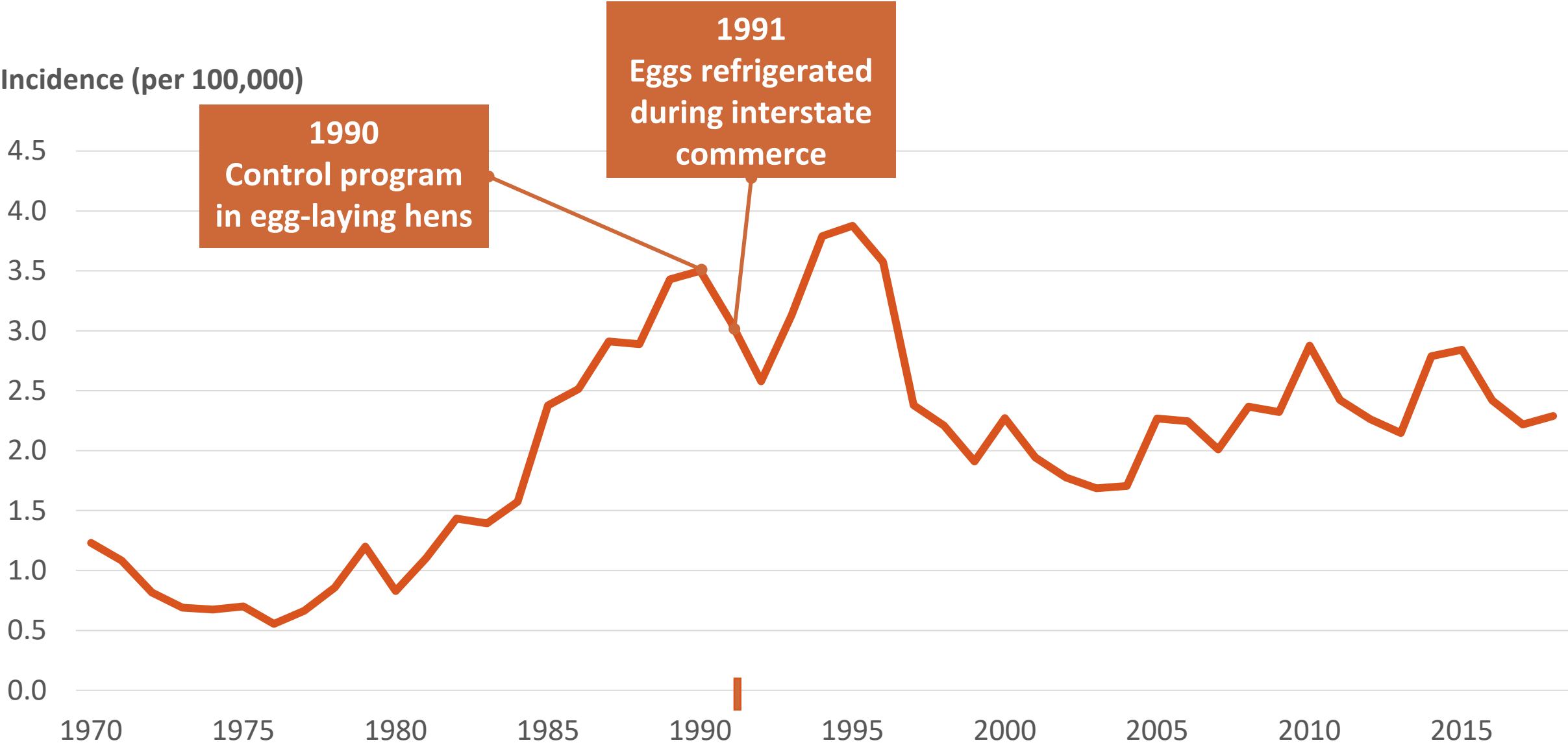
Incidence (per 100,000)

1990  
Control program  
in egg-laying hens

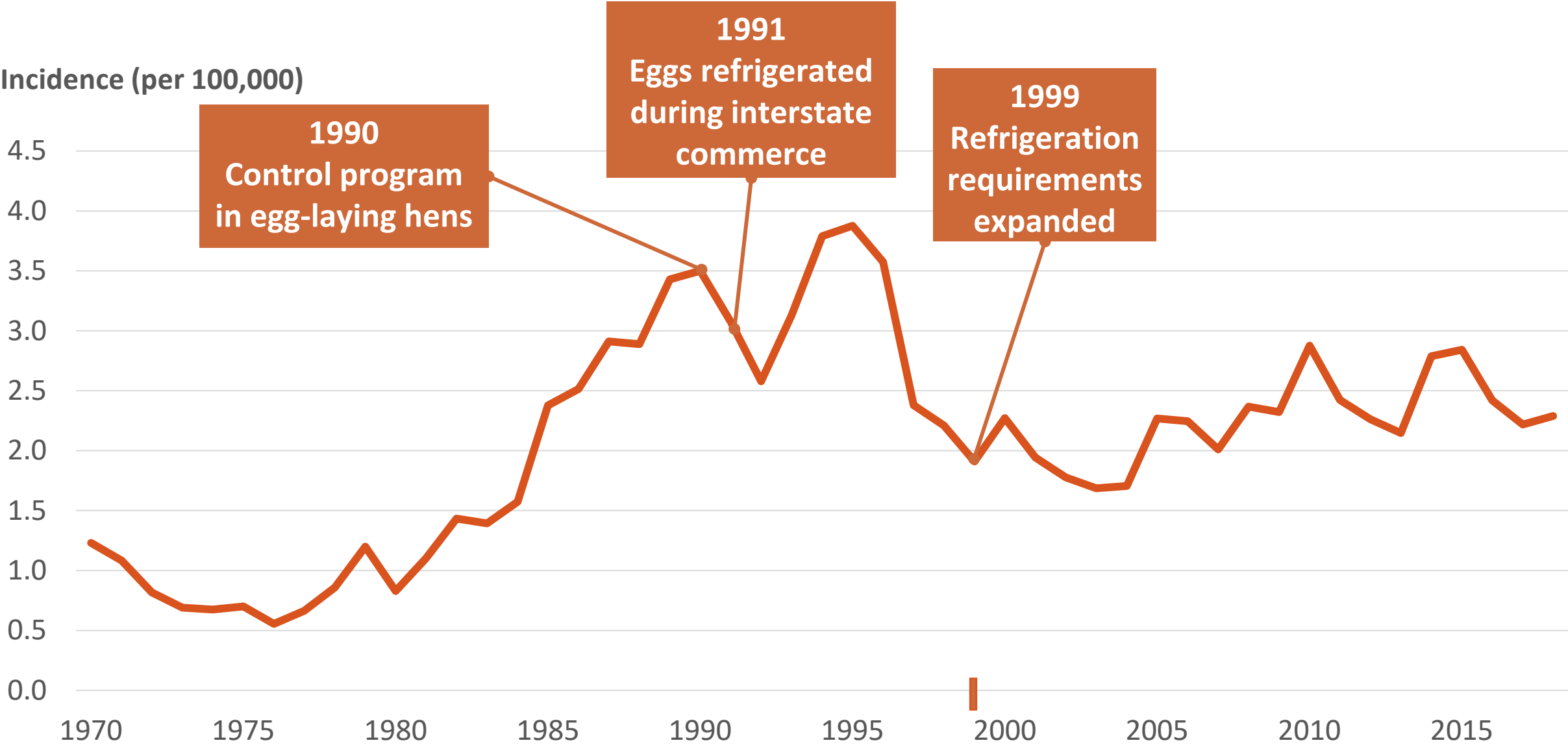




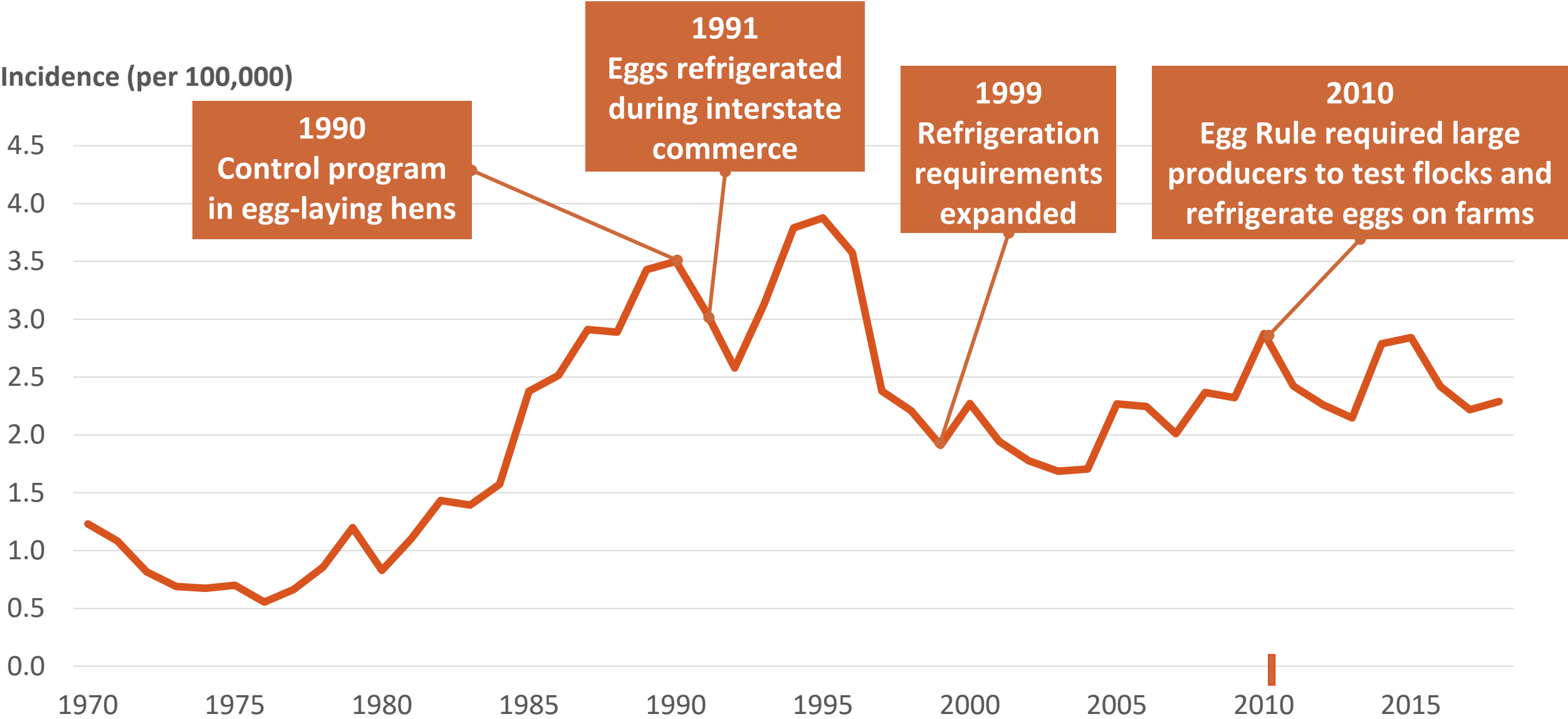
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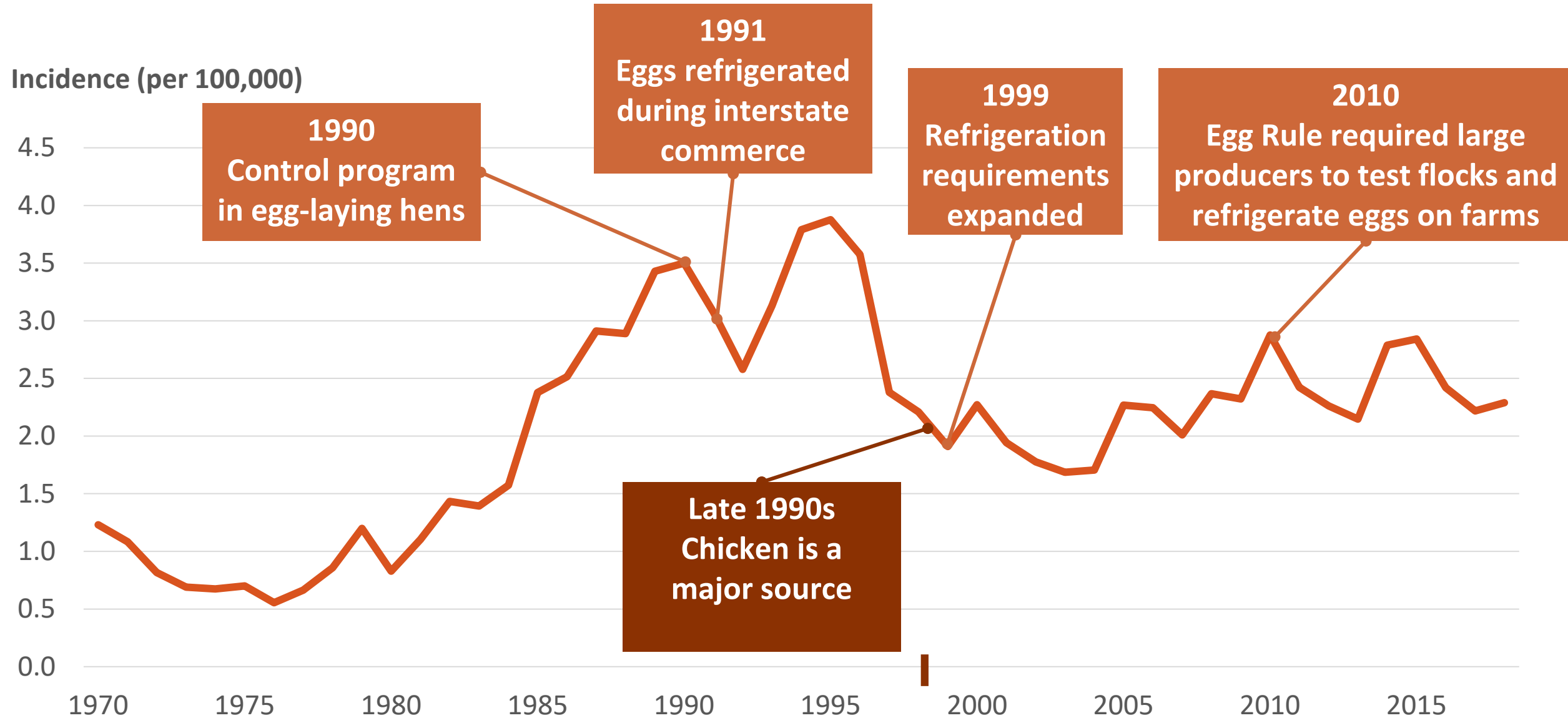
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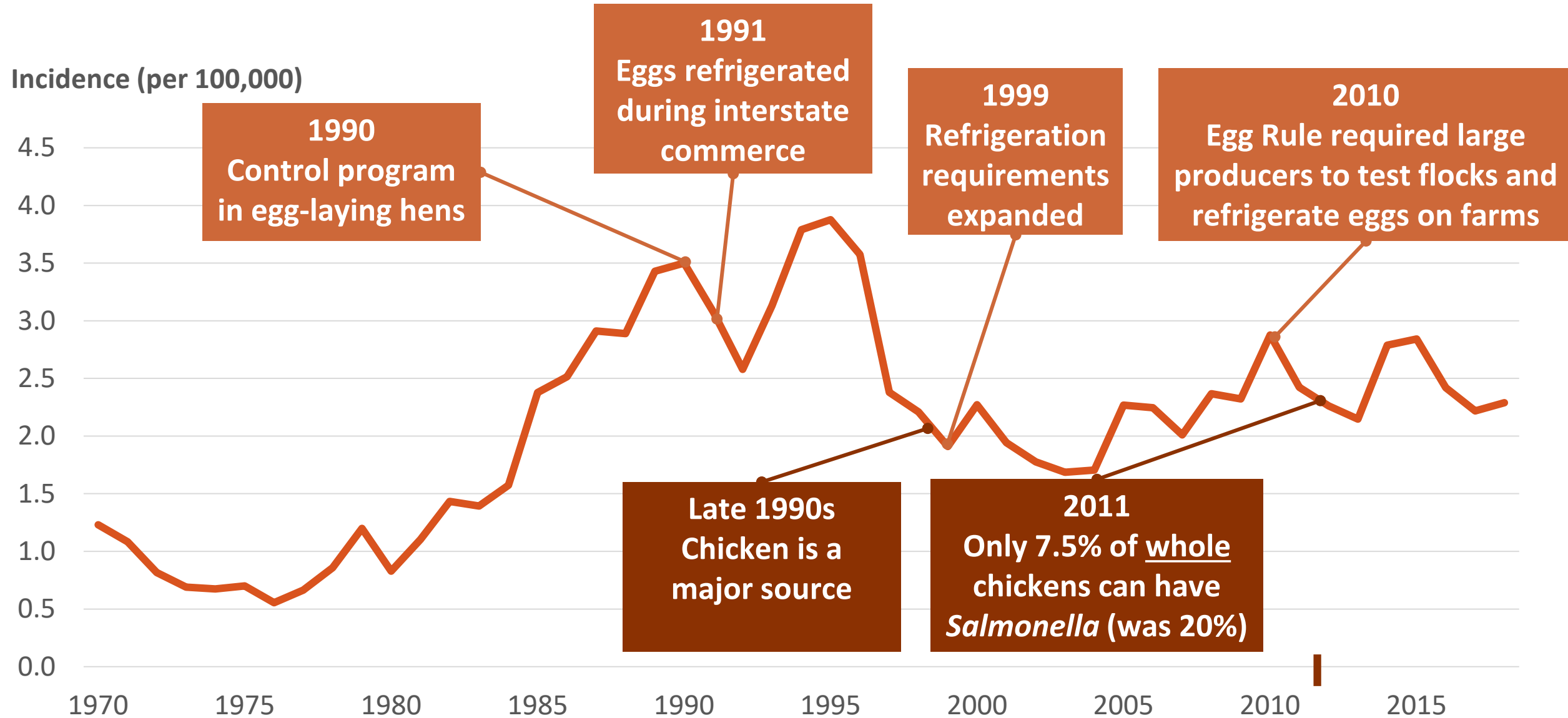
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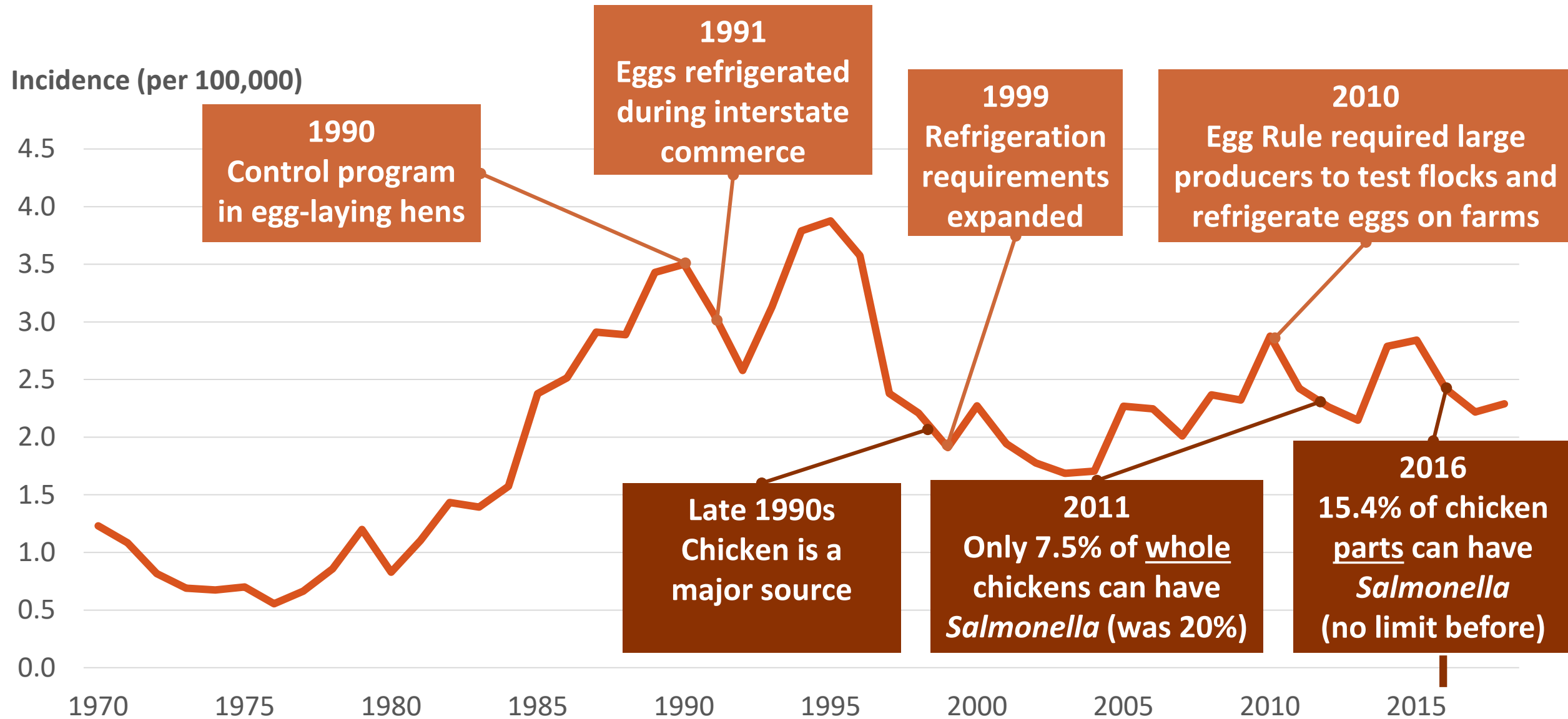
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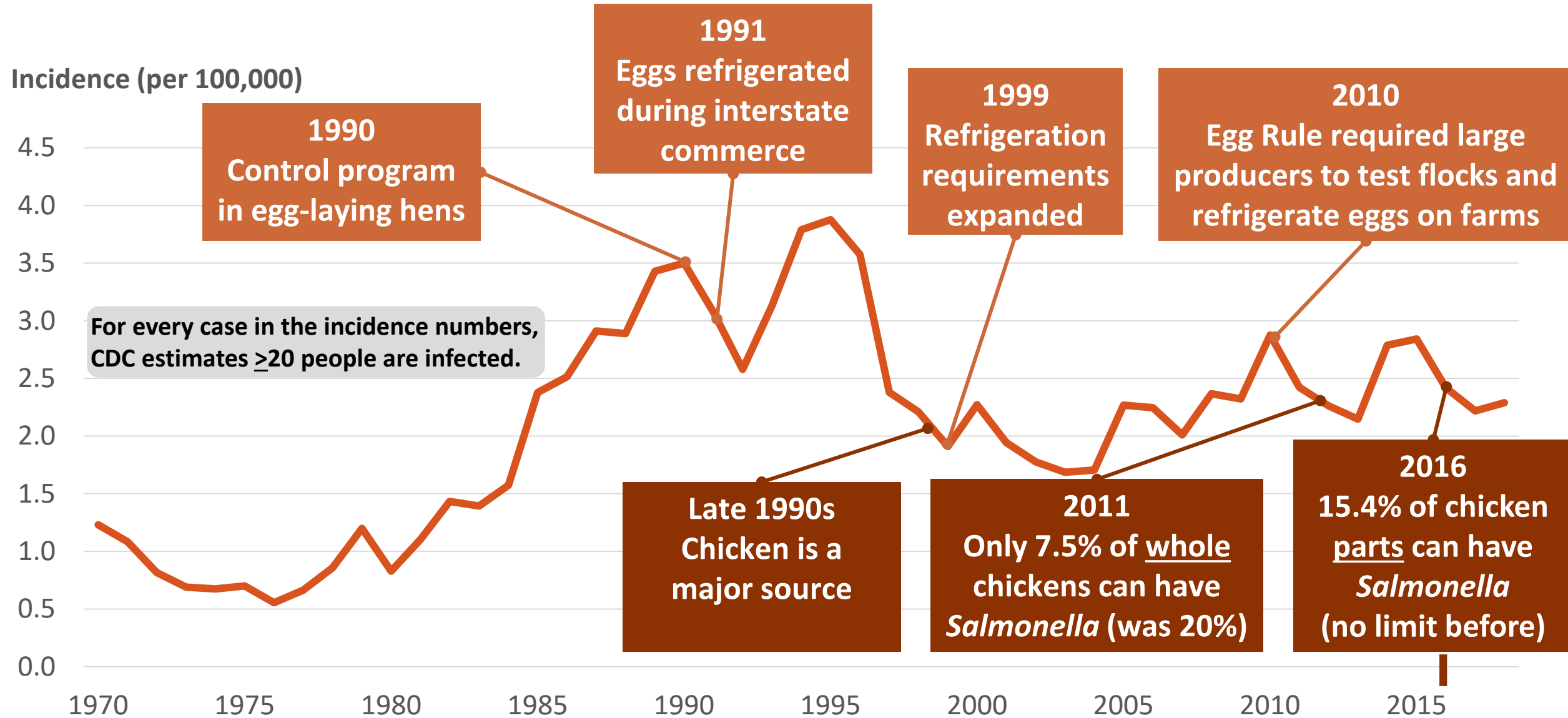


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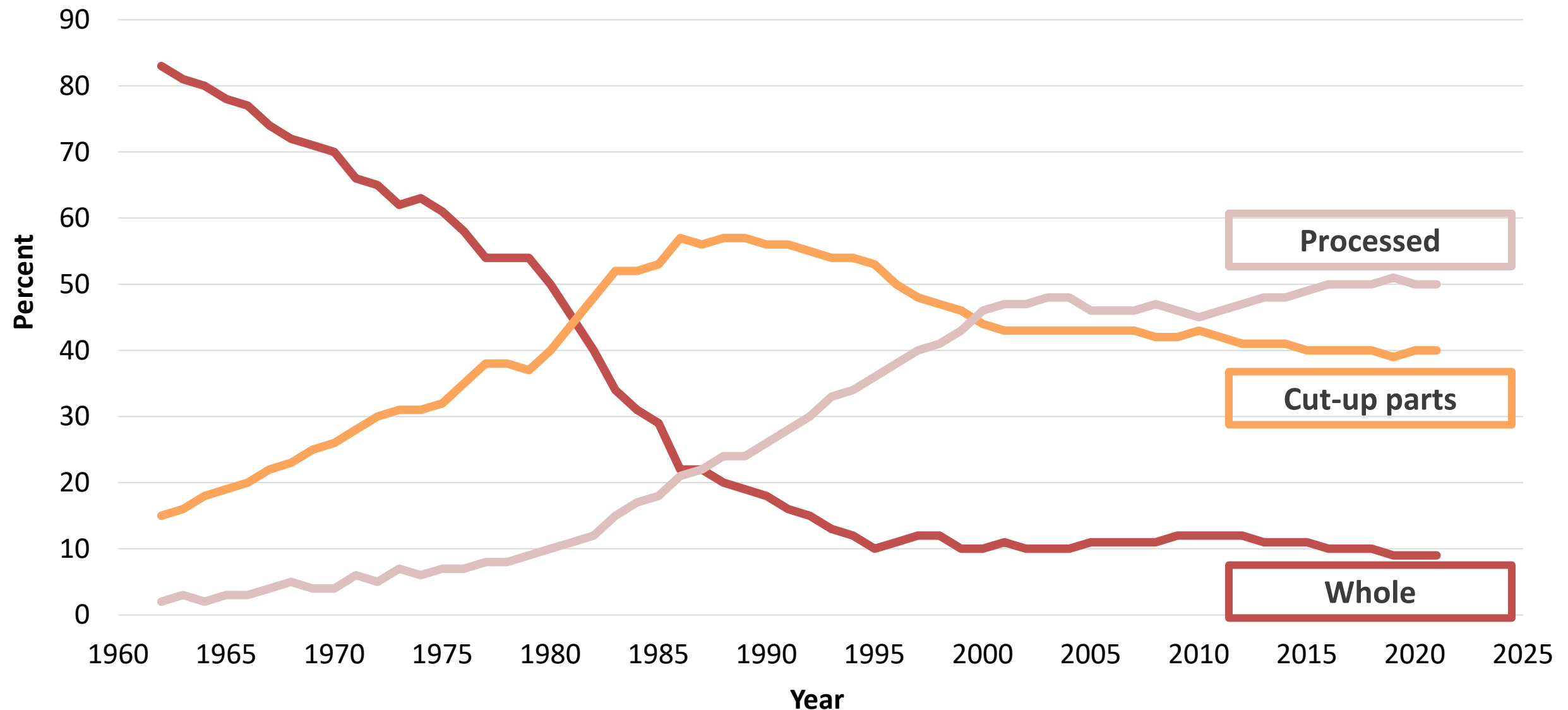




# By late 1990s, chicken was recognized as a major source of Enteritidis

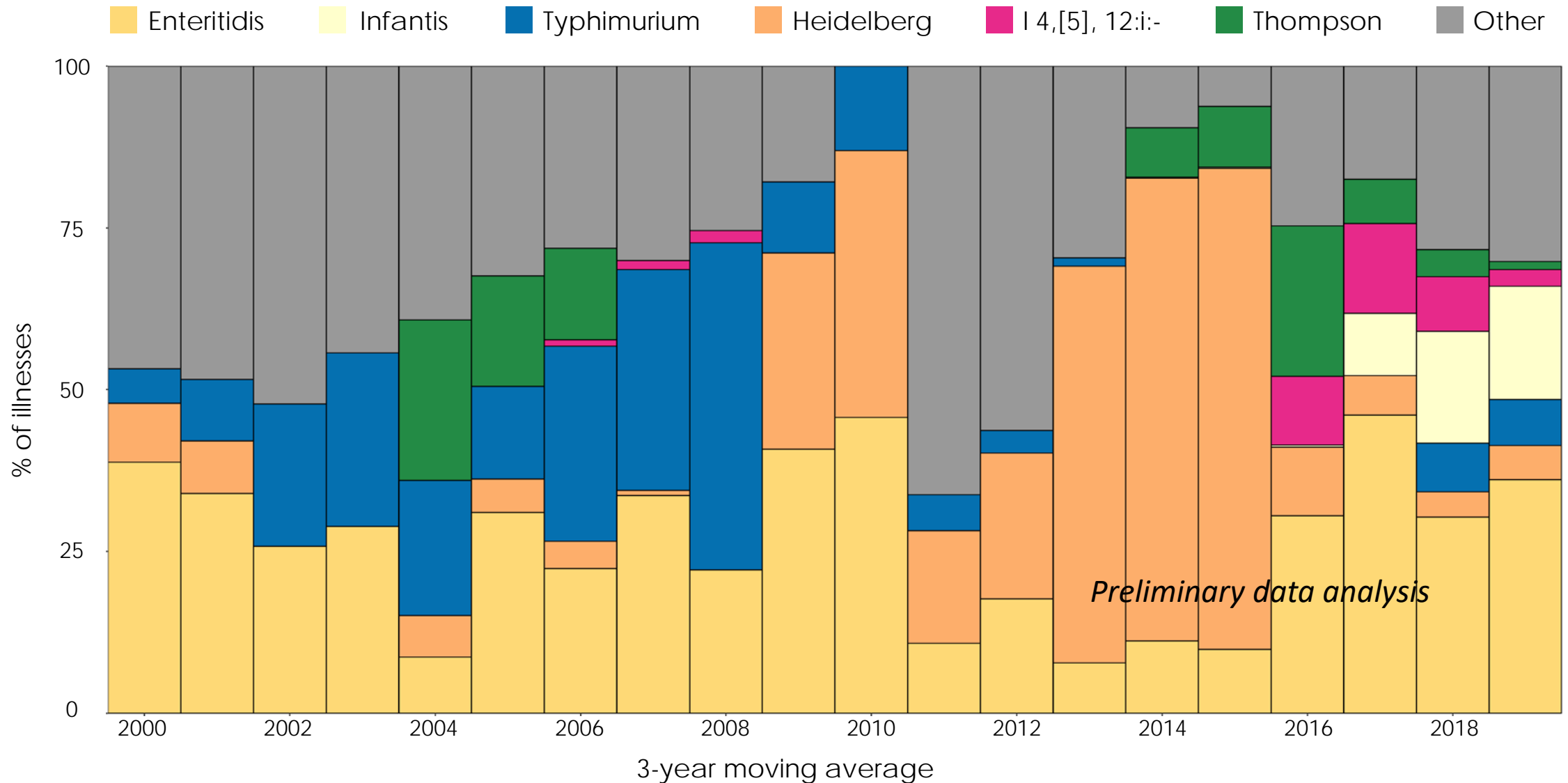


We used to buy mostly whole chickens, but  
by early 1980s were mostly buying cut-up parts or processed



Source: National Chicken Council, 1962–2015

# % of outbreak-associated illnesses caused by major *Salmonella* serotypes in outbreaks due to chicken, 2000–2019



*Preliminary data analysis*

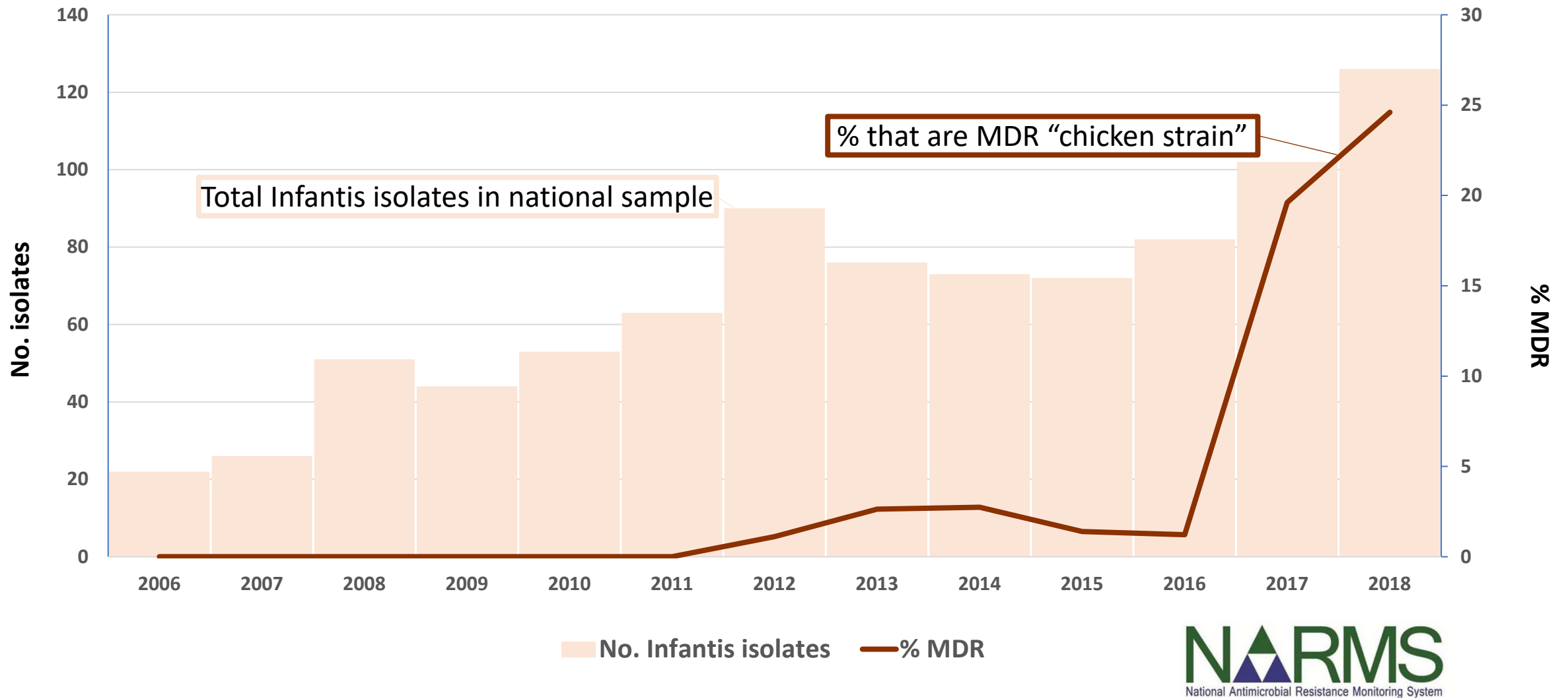
# Emergence of multidrug-resistant (MDR) *Salmonella* Infantis from chicken

- **2014**
  - FDA isolated MDR Infantis from retail chicken
  - CDC identified a few cases of MDR Infantis in humans who had not traveled
  - Distinctive, similar PFGE subtype patterns
- **Later investigations**
  - Found MDR Infantis in many poultry flocks
  - Isolates from chickens and humans very similar by whole-genome sequence
  - Human illness is most often linked to consumption of chicken

# Annual incidence of infection with *Salmonella* / by serotype, USA

	Serotype	Incidence lab-confirmed infections (per 100,000 pop. per year)	% of total	% with international travel
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	<b>Top 6</b>	—	<b>59</b>	—
	All	16.9	100	11

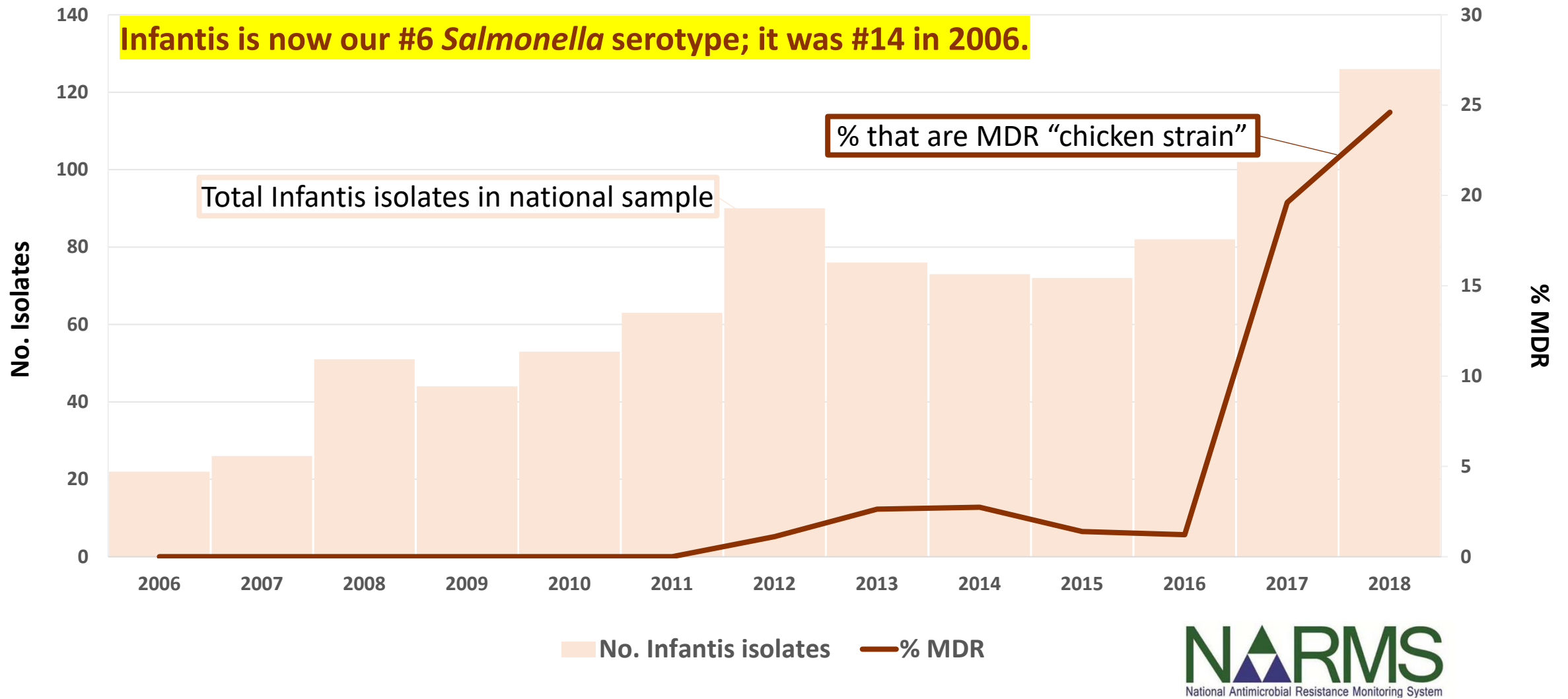
# Multidrug resistant (MDR) *Salmonella* Infantis infections spiked in 2017



MDR chicken isolates have typical pulsed-field gel electrophoresis (PFGE) or whole genome sequence (WGS) pattern;  
Data are preliminary, from the National Antimicrobial Resistance Monitoring System (NARMS) and PulseNet



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## **Antibiotics to which the MDR *Salmonella* Infantis strain is resistant**

- **Ampicillin**
- **Ceftriaxone**
- **Chloramphenicol**
- **Ciprofloxacin**
- **Gentamicin**
- **Nalidixic acid**
- **Streptomycin**
- **Sulfisoxazole**
- **Tetracycline**
- **Trimethoprim-sulfamethoxazole**

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Antibiotics in orange are used to treat *Salmonella* infections in humans

# Topics

## ■ *Salmonella*

- Most important bacterial foodborne pathogen
- Three short stories about serotypes
  - Typhimurium decreasing
  - Enteritidis increasing
  - Infantis increasing due to a new, resistant strain

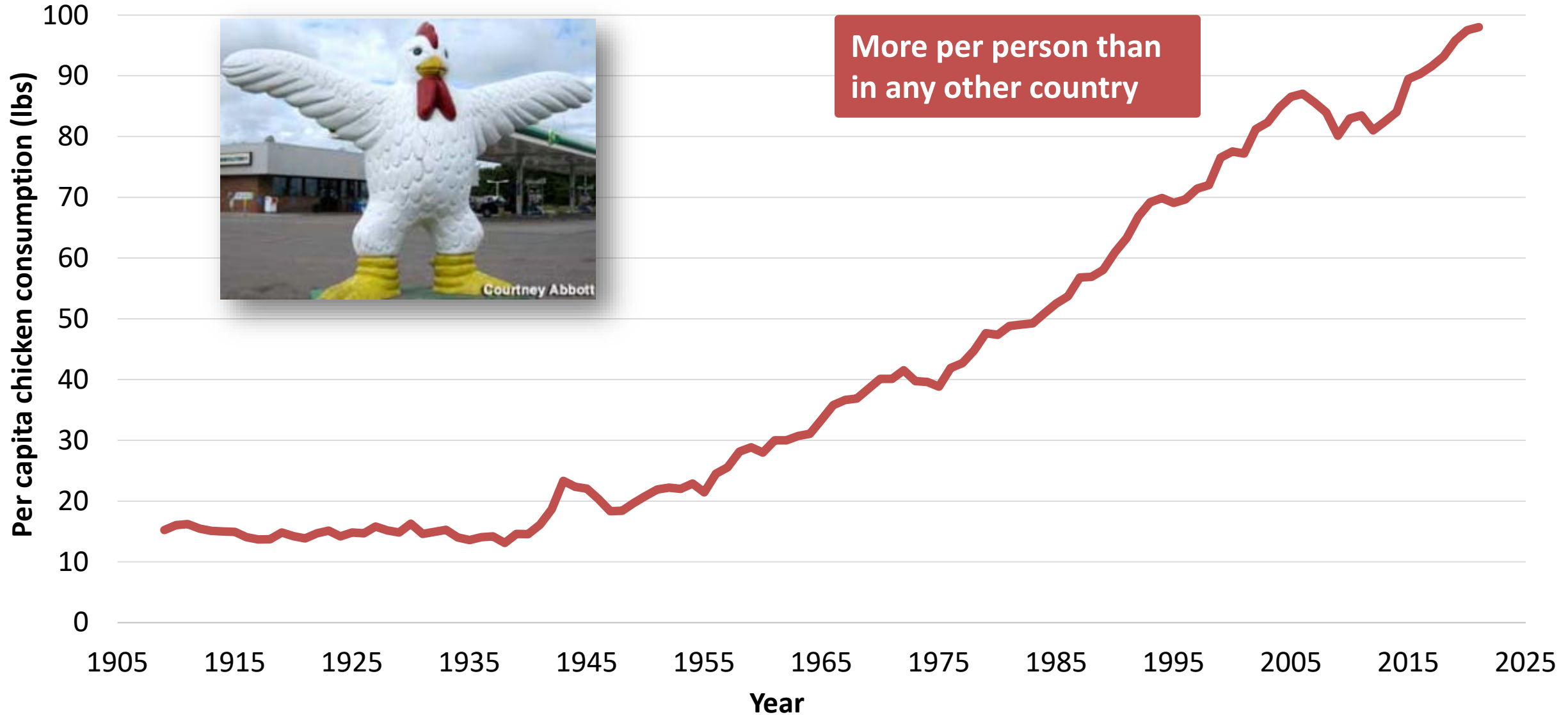
## ■ **Chicken**

- The major U.S. source of animal protein
- A major source of *Salmonella* illness
- A major reason for *Salmonella* serotype decreases and increases

## ■ **Summary and conclusion**

# Chicken consumption has increased markedly since early 1900s

## Now the #1 animal protein consumed in USA



IFSAC estimated that in 2018  
chicken was one of the top 2 sources  
of all *Salmonella* illnesses,  
responsible for 14.3% of foodborne *Salmonella* illnesses





# Crude estimate of annual chicken-associated illnesses caused by *Salmonella*

14.3% of 1,000,000 = 143,000 illnesses

Pathogen	Foodborne illnesses	Foodborne hospitalizations	Foodborne deaths
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# A central problem:

## Lack of surveillance, investigation, and mandated foodborne illness control measures on farms

- **No routine surveillance on farms for pathogens that cause foodborne illness**
- **By the time CDC determines that many people are getting sick, a pathogen has often spread widely on farms**
  - Investigations of human illness usually stop outside the farm, so we don't figure out the root of the problem
- **Farmers have few incentives for decreasing carriage of human pathogens by food animals**
  - Animals often arrive at the slaughterhouse carrying a large burden of *Salmonella*



# Summary

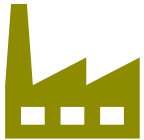
- ***Salmonella* is our most important foodborne bacterial cause of illness and death**
  - Typhimurium infections have been declining (now #2 serotype)
    - likely related to vaccination of chickens
  - Enteritidis infections increased (now #1 serotype)
    - when it increased in broiler flocks
  - Infantis infections markedly increased very recently (#14 → #6 serotype)
    - due to emergence of a highly resistant strain in broiler flocks
- **Chicken is #1 protein consumed in United States**
- **The burden of chicken-associated illnesses is large**
- **Current measures to prevent illness from chicken are insufficient**

# We could markedly decrease *Salmonella* illnesses from chicken with a multi-pronged approach



## On farms

e.g., vaccination, hygiene, audits



## At slaughterhouses

e.g., performance standards, which animals accepted



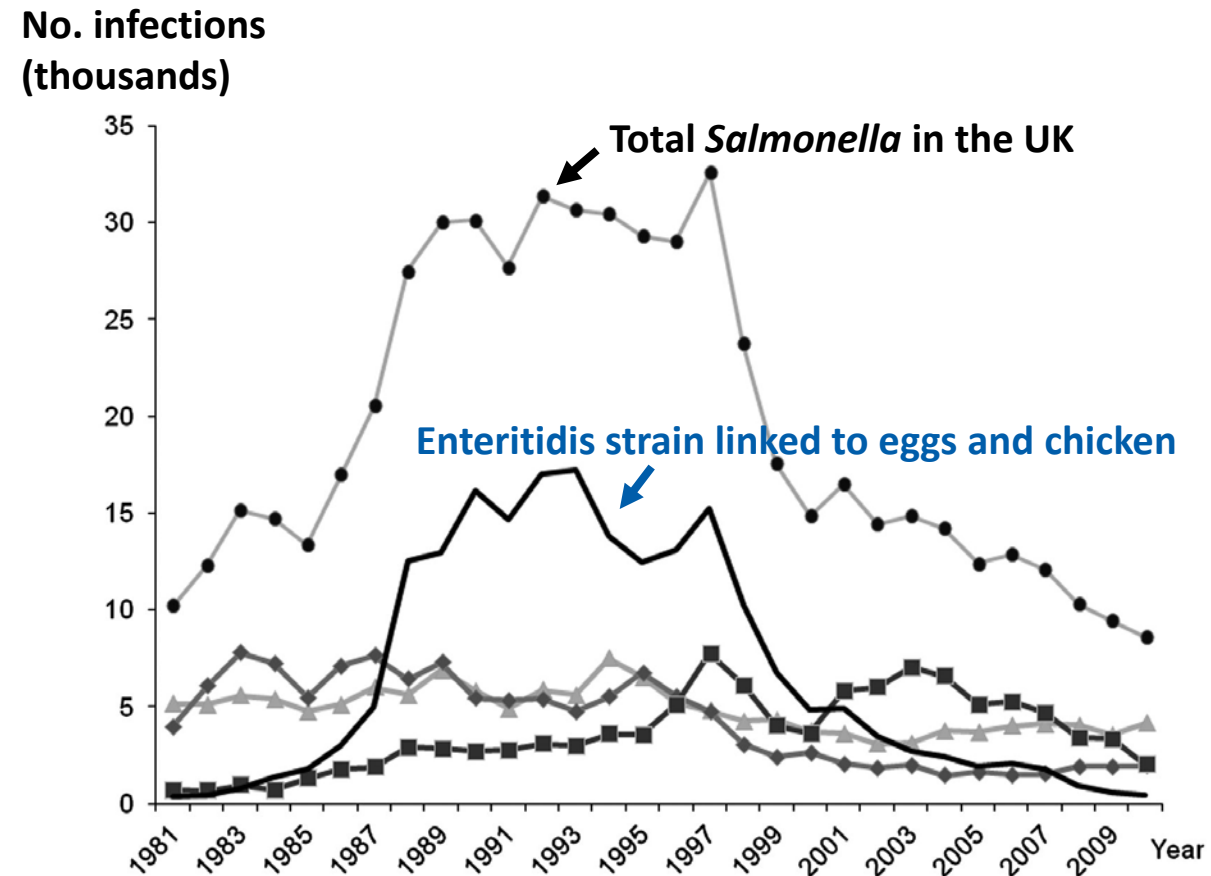
## At retail

e.g., buying agreements, industry standards

# Reasons for optimism

- Vaccination can be effective
- Poultry industry has eradicated from flocks some *Salmonella* serotypes that make poultry sick
- The UK & France have markedly decreased *Salmonella* infections using vaccination, targeting of particular serotypes, hygiene measures on farms, legislation, and investigation

**What we learn could help us decrease chicken-associated illnesses caused by *Campylobacter* and *Clostridium perfringens***



# Current and former members of these groups contributed to this work

- State and local public health departments
- CDC's enteric diseases epidemiology, outbreak, and laboratory branches
- Food Safety and Inspection Service, U.S. Department of Agriculture
- U.S. Food and Drug Administration



Enteric Diseases Epidemiology Branch

For more information, contact CDC  
1-800-CDC-INFO (232-4636)  
TTY: 1-888-232-6348 [www.cdc.gov](http://www.cdc.gov)

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

