

A TEMPORAL STUDY OF *SALMONELLA* SEROVARS IN BREEDER FLOCKS & HATCHERIES IN ONTARIO BETWEEN 1998 AND 2008



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Foodborne Salmonellosis

- *Salmonella* is the 2nd major cause of food borne illness
- Reported rate of human salmonellosis was 18.0 cases/100,000 in Canada in 2006 (PHAC, 2007)
- Ontario – 5th highest rate of salmonellosis in 2006 (21.3 cases/100,000 persons)
- Major food sources attributed to *Salmonella* outbreaks: fresh produce, meat, eggs, and cheese (PHAC, 2007; Ravel *et al.*, 2009)



Previous Temporal Studies on *Salmonella*

- Few temporal studies on *Salmonella* serovars in breeder flocks (Guerin *et al.*, 2005; Zhang *et al.*, 2005)
- Major limitation: denominator or population data were not always available to determine prevalence at population level



Ontario Hatchery and Supply Flock Policy (OHSFP)

- Provincial government monitoring program
- Ensures that Ontario breeder flocks are free from *S. Pullorum* and *Gallinarum*
- Routine collection of **environmental samples** from Ontario **breeder flocks** and **fluff samples** from **hatcheries** (broilers, layers, turkeys and other poultry types) to determine the status of *Salmonella* and *Mycoplasma* --- **all *Salmonella* serovars captured**



Objectives

1. To describe the **long term trends** and **seasonal patterns** in the prevalence of *Salmonella* from breeder flocks and hatcheries in Ontario
2. To determine the prevalence and temporal patterns of **major serovars** for each poultry breeder type, including serovars of public health significance
3. To identify **temporal clusters** of major serovars for each poultry breeder type



MATERIALS AND METHODS



Materials and Methods

Period of study: Jan 1998 – Dec 2008

1. Environmental swabs from waterers, nest boxes, litter, fresh feces

- Collected once from **breeder flocks** between the age of 16 and 24 weeks
- 1 swab / 1,000 birds **or** a minimum of 3 swabs / flock

2. Fluff samples - 5 g of fluff collected from every hatcher at 6-week intervals

- *Salmonella* cultured at AHL
- Serotyping – Laboratory for Foodborne Zoonosis, PHAC



Materials and Methods

1. Descriptive statistics

- Prevalence estimates - Submission level, Sample level

2. Multi-level logistic regression

- Association between *Salmonella* status and year, season, and poultry breeder type

3. Cluster detection test (SaTScan version 8.0)

Case = an isolate of a specific serovar

Non-case = All the serovars except the serovar of interest and all the negatives, during the same time.



RESULTS-BREEDER FLOCK ENVIRONMENT



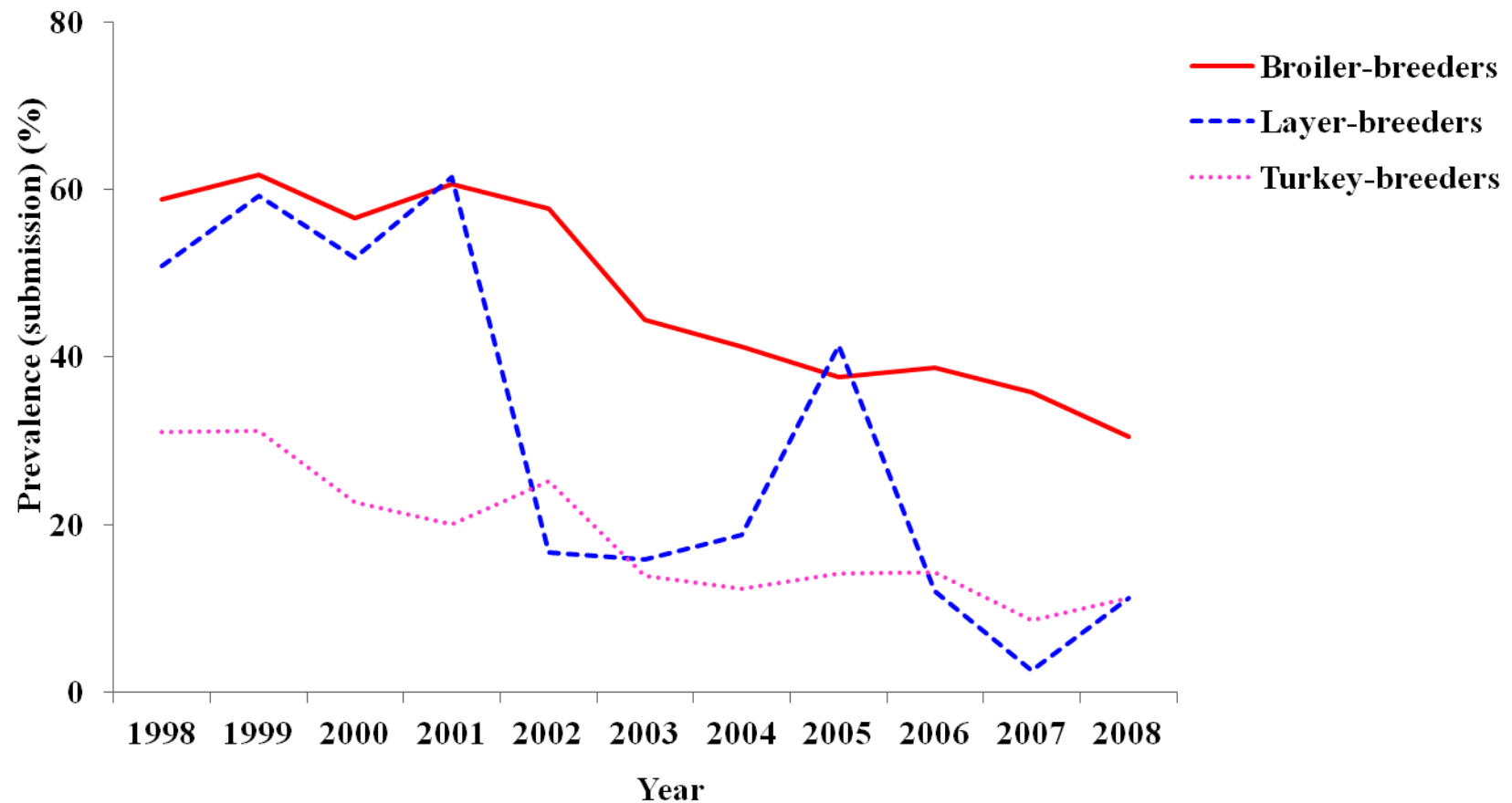
Salmonella-positive isolates from different poultry breeder types from environmental samples

Poultry type	Number of submissions	Number of <i>Salmonella</i> isolates	Prevalence (submission) (%)
Broiler-breeders	3,658	1,733	47.4
Layer-breeders	751	193	25.7
Turkey-breeders	2,272	445	19.6
Overall	6,681	2,371	35.5

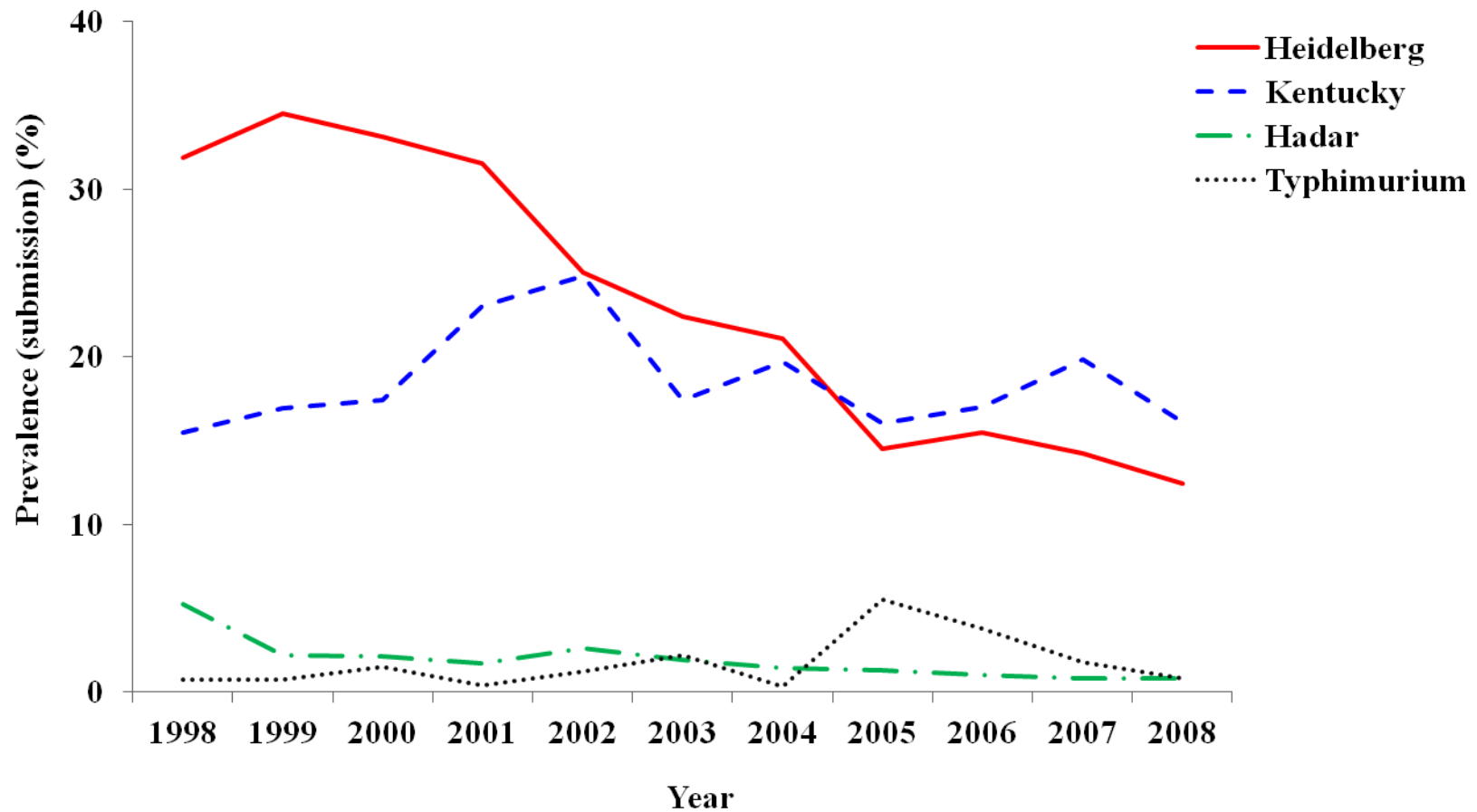
Percentage of major serovars from *Salmonella*-positive **environmental samples**

Serovar	Broiler-breeders	Layer-breeders	Turkey-breeders
Heidelberg	40.8	31.0	52.9
Kentucky	32.4	5.1	0.1
Hadar	3.3	0.7	2.7
Typhimurium	2.9	7.6	0.0
Thompson	1.6	8.3	0.1
Enteritidis	0.9	1.8	0.5
Brandenburg	0.0	9.8	6.0
Senftenberg	1.4	3.2	3.4
Saintpaul	0.0	0.0	7.6
Total	2,626	274	576

Trends in the prevalence (submission) of *Salmonella* from environmental samples in different poultry breeder types



Trends in the most common *Salmonella* serovars isolated from **environmental samples** from **broiler-breeders**



RESULTS-HATCHERY FLUFF



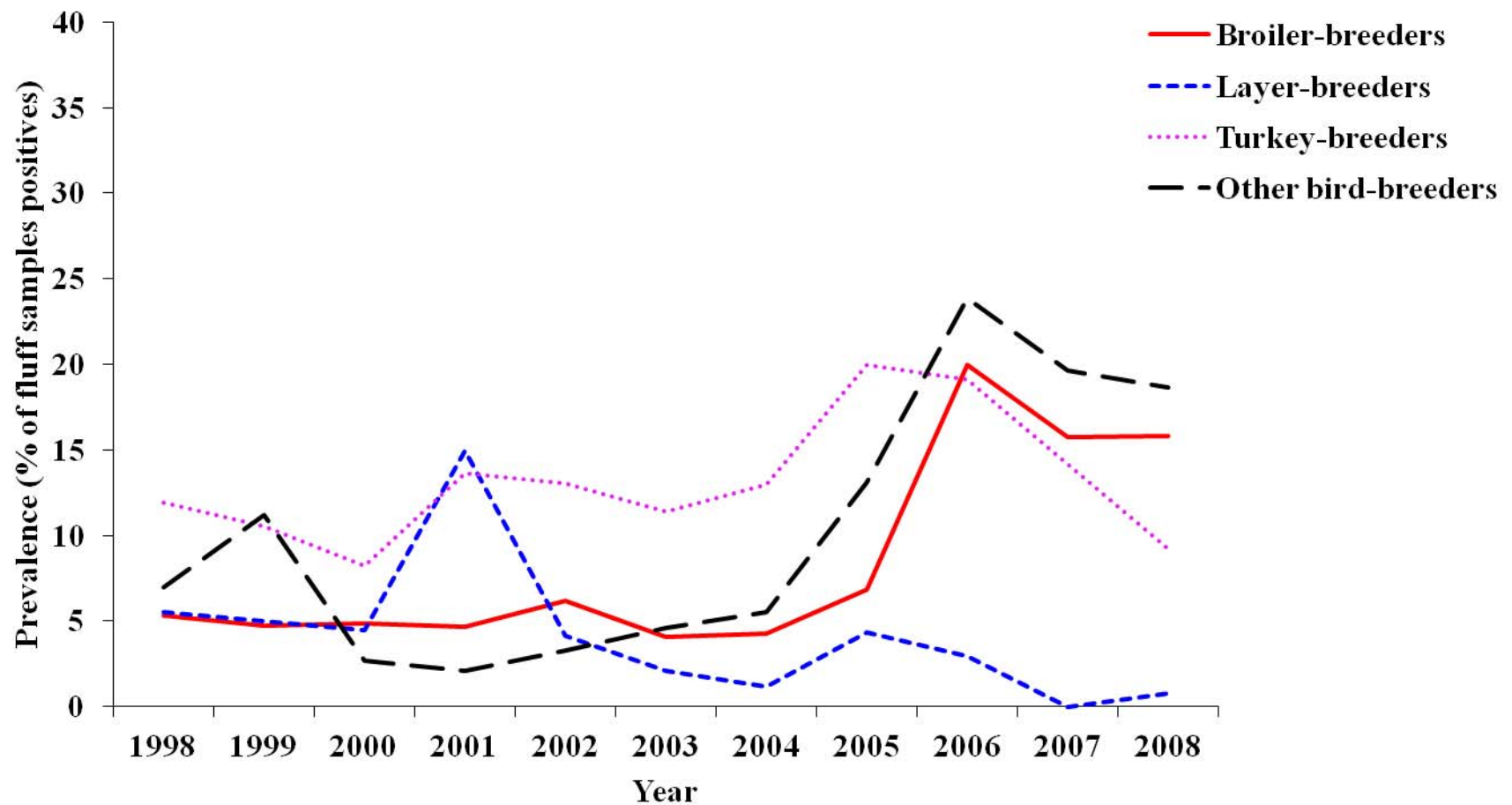
Salmonella-positive isolates from different poultry breeder types from **hatchery fluff samples**

Poultry type	Number of hatcheries	Number of samples submitted (%)	Number of <i>Salmonella</i> isolates	Poultry-type specific sample prevalence (%)
Broiler-breeders	14	17,886 (63)	1564	8.7
Layer-breeders	10	5,750 (20)	181	3.1
Turkey-breeders	4	3,082 (11)	406	13.2
Other-breeder birds	23	1,551 (6)	185	11.9
Total	51	28,269	2,336	8.3

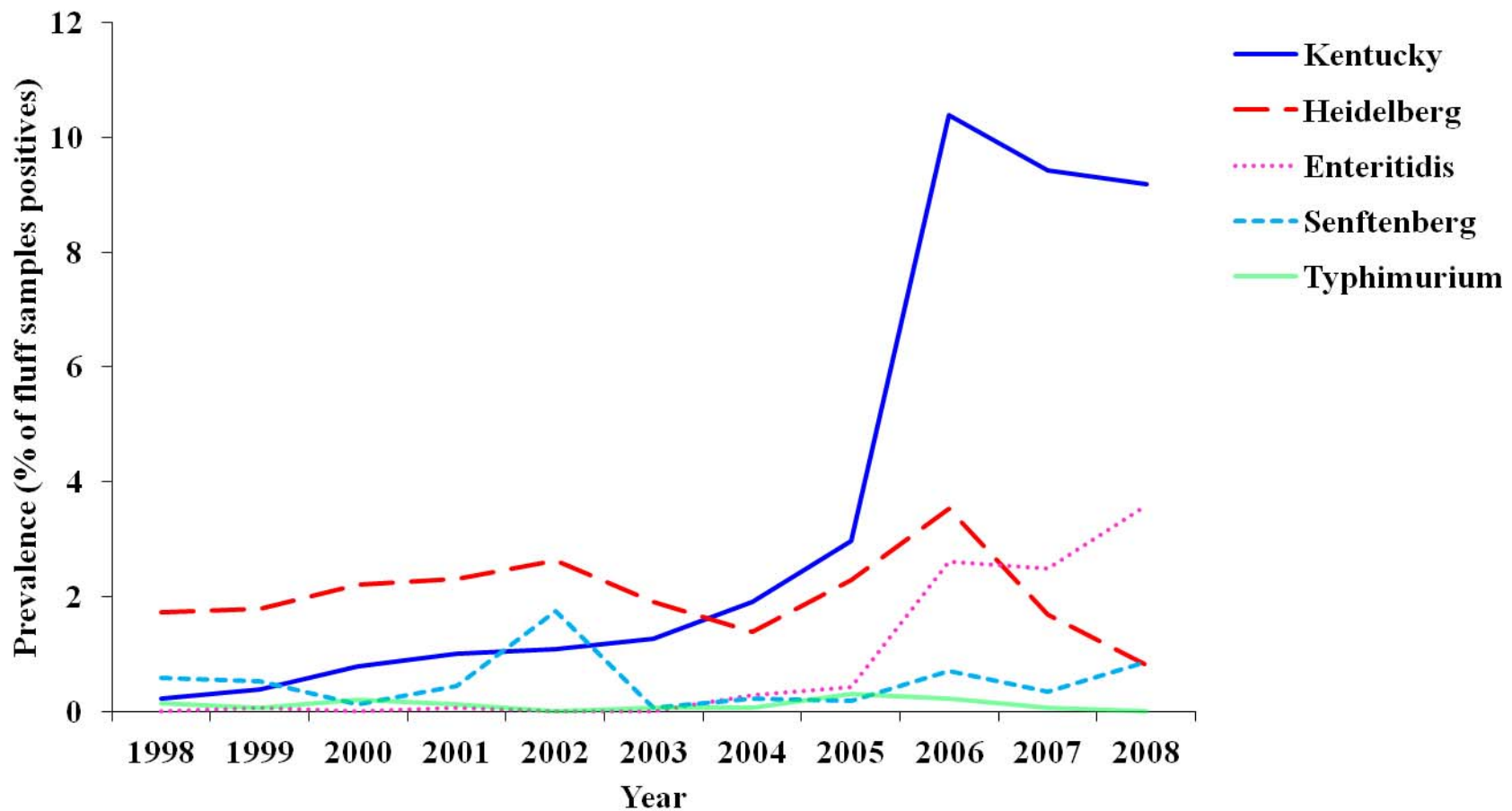
Percentage of major serovars from *Salmonella*-positive **hatchery fluff samples**

Serovar	Broiler-breeders	Layer-breeders	Turkey-breeders	Other-breeder birds
Kentucky	43.3	0.6	0.4	0.0
Heidelberg	22.9	35.9	33.7	8.6
Enteritidis	11.1	0.0	0.0	30.3
Senftenberg	6.0	32.0	38.6	4.3
Thompson	2.1	2.7	0.0	12.9
Hadar	1.9	0.6	2.2	5.9
Typhimurium	1.3	4.9	0.0	10.3
Saintpaul	0.3	0.0	6.4	0.0
Braenderup	0.2	5.5	0.0	3.7

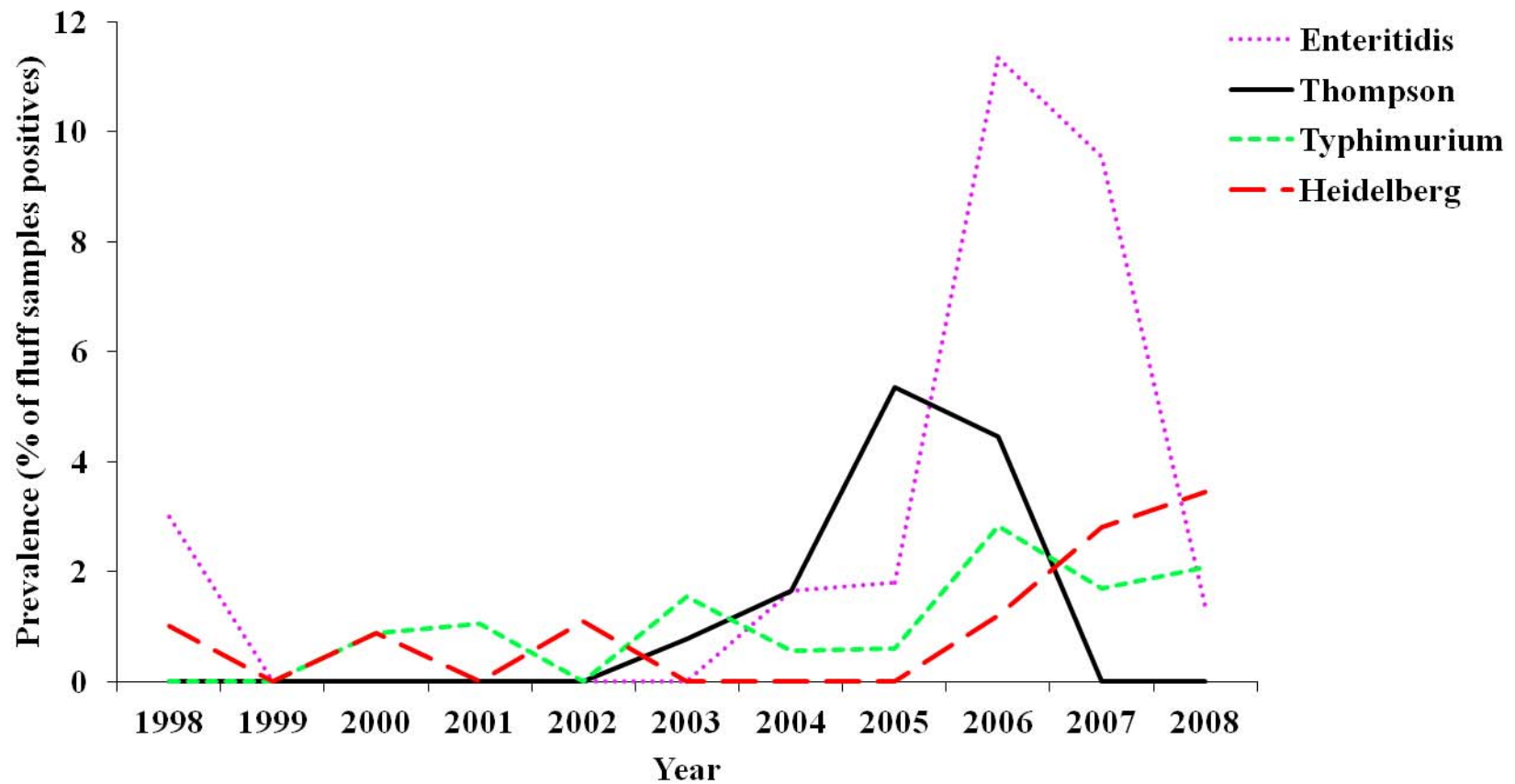
Trends in the prevalence of *Salmonella* from hatchery fluff samples in different poultry breeder types



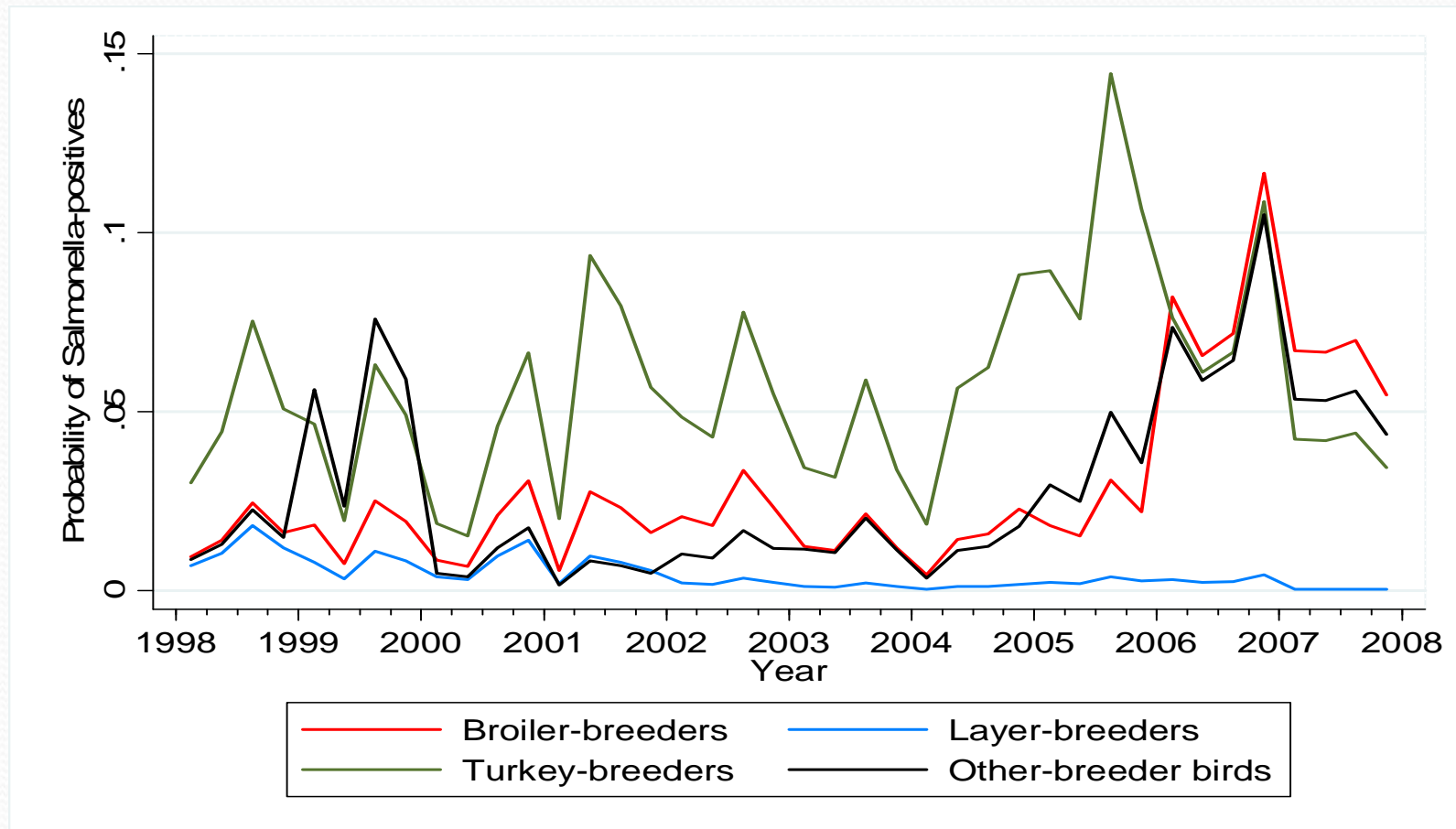
Trends in selected *Salmonella* serovars isolated from hatchery fluff samples from broiler-breeders



Trends in the most common *Salmonella* serovars isolated from hatchery fluff samples from other-breeder birds



Predicted probability of *Salmonella*-positives in different poultry types from hatchery fluff samples



Cluster Identification

Poultry type	Serovar	Sample type	First cluster	Second cluster	Third cluster
Broiler-breeders	Heidelberg (1074)	Environment	1998/05-2002/08 (613)	2002/09-2004/09 (194)	
	Heidelberg (359)	Fluff	2005/12-2006/08 (63)	2005/04-2005/04 (19)	1999/08-2003/10 (156)
	Typhimurium (77)	Environment	2005/03-2006/10 (35)		
	Typhimurium (20)	Fluff	2005/09-2005/10 (4)		
	Hadar (89)	Environment	1998/01-1998/11 (23)		
	Hadar (29)	Fluff	1998/03-1999/08 (12)	2006/02-2006/10 (8)	

Cluster Identification

Poultry type	Serovar	Sample type	First cluster	Second cluster	Third cluster
Layer - breeders	Heidelberg (85)	Environment	1998/01-2002/12 (61)	2003/01-2005/12 (24)	
	Heidelberg (65)	Fluff	1998/01-2002/01 (61)	2008/04-2008/04 (3)	
Turkey-breeders	Heidelberg (305)	Environment	1998/01-2003/05 (268)	2003/09-2004/10 (17)	2006/10-2006/12 (6)
	Heidelberg (137)	Fluff	2000/06-2002/12 (74)	2006/10-2007/03 (22)	1999/08-2003/10 (156)

Cluster Identification

Poultry type	Serovar	Sample type	First cluster	Second cluster
Broiler-breeders	Enteritidis (173)	Fluff	2005/07-2008/12 (166)	2004/04-2004/06 (5)

- **Long-duration clusters:** likely indicate a continuous common source
- **Short-duration clusters:** likely indicate a point source

SUMMARY / DISCUSSION



Summary - General

- Long-term trends in the prevalence of *Salmonella* in breeder flocks and hatcheries were often driven by trends in specific serovars
- There was a seasonal pattern in the prevalence of *Salmonella* in the hatcheries, with peaks in the summer and fall



Summary – *Salmonella* Enteritidis (SE)

- The prevalence of SE from environmental samples from broiler breeder flocks was low, suggesting domestic-origin might not be an important source to broiler hatcheries
- Long-duration cluster of SE suggests that U.S.-origin hatching broiler eggs contaminated with SE is a more likely source (Agnes Agunos, Keith Harron, 2010, personal communication), as imports from the U.S. increased between 2004 and 2007 (Bob Guy, 2010, personal communication)
- Small cluster of SE isolates from broiler fluff suggest a different source e.g. contamination of hatchers via humans, egg or egg trays



Summary – *Salmonella* Enteritidis (SE)

The prevalence of SE might be reduced by implementing:

- 1) surveillance activities detecting *Salmonella* Enteritidis in imported hatching broiler eggs
- 2) control measures reducing *Salmonella* Enteritidis in U.S. broiler breeder flocks supplying hatching eggs to Canada
- 3) prompt investigation and implementation of control measures at the hatcheries



Summary – Temporal links

- Clusters of several serovars (e.g. Heidelberg, Typhimurium, Hadar) from breeder flocks were **temporally linked** to clusters in the respective hatcheries
- **Interventions at breeder flock level** might help to reduce the transmission of *Salmonella* from breeder flock to hatcheries, and to lower levels of the production chain



Acknowledgements

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