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CANADA'S NATIONAL INTEGRATED ENTERIC PATHOGEN SURVEILLANCE SYSTEM

C-ENTERNET SHORT REPORT 2008

Canada

To promote and protect the health of Canadians through leadership, partnership, innovation and action in public health.

— Public Health Agency of Canada

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INTRODUCTION

C-EnterNet is a multi-partner, integrated surveillance initiative facilitated by the Public Health Agency of Canada. C-EnterNet is based on a sentinel surveillance model to collect information on both cases of infectious gastrointestinal illness and sources of exposure within defined communities - an approach that would not be possible on a broader scale. C-EnterNet's innovative approach studies the interface between animals, humans and their ecosystems to provide knowledge that will inform the prevention and control of infectious diseases.

C-EnterNet's pilot sentinel site – the Regional Municipality of Waterloo, Ontario – is a community of approximately 506,000 residents, has a mix of both urban and rural areas and demonstrates innovation in public health and water conservation and treatment. Within this site, active surveillance of enteric pathogens is performed in water, food and on farms, and enhanced human disease surveillance is performed in collaboration with public health partners. Four additional sites are planned to better estimate the burden of enteric disease in Canada in future years.

C-EnterNet's primary objectives are to detect changes in trends in human enteric disease and in levels of pathogen exposure from food, animal and water sources in a defined population; and to strengthen source attribution efforts in Canada. Note that C-EnterNet data need to be considered in the context of the pilot nature of this program. This report provides a summary of data from a pilot sentinel site and three sampling years, thus major conclusions cannot yet be extrapolated nationally.

As in the previous sampling year, C-EnterNet is releasing a short report of preliminary findings. The purpose of this report is to present the main findings from the 2008 surveillance year in Sentinel Site 1 in a timely manner. This report will be followed by a long report, which will include more extensive analyses of temporal trends and subtyping information for an integrated perspective on enteric disease.

For further information about the C-EnterNet program or sampling methodologies, please refer to our website (http://www.phac-aspc.gc.ca/c-enternet/index-eng.php).

HUMAN CASE SUMMARY

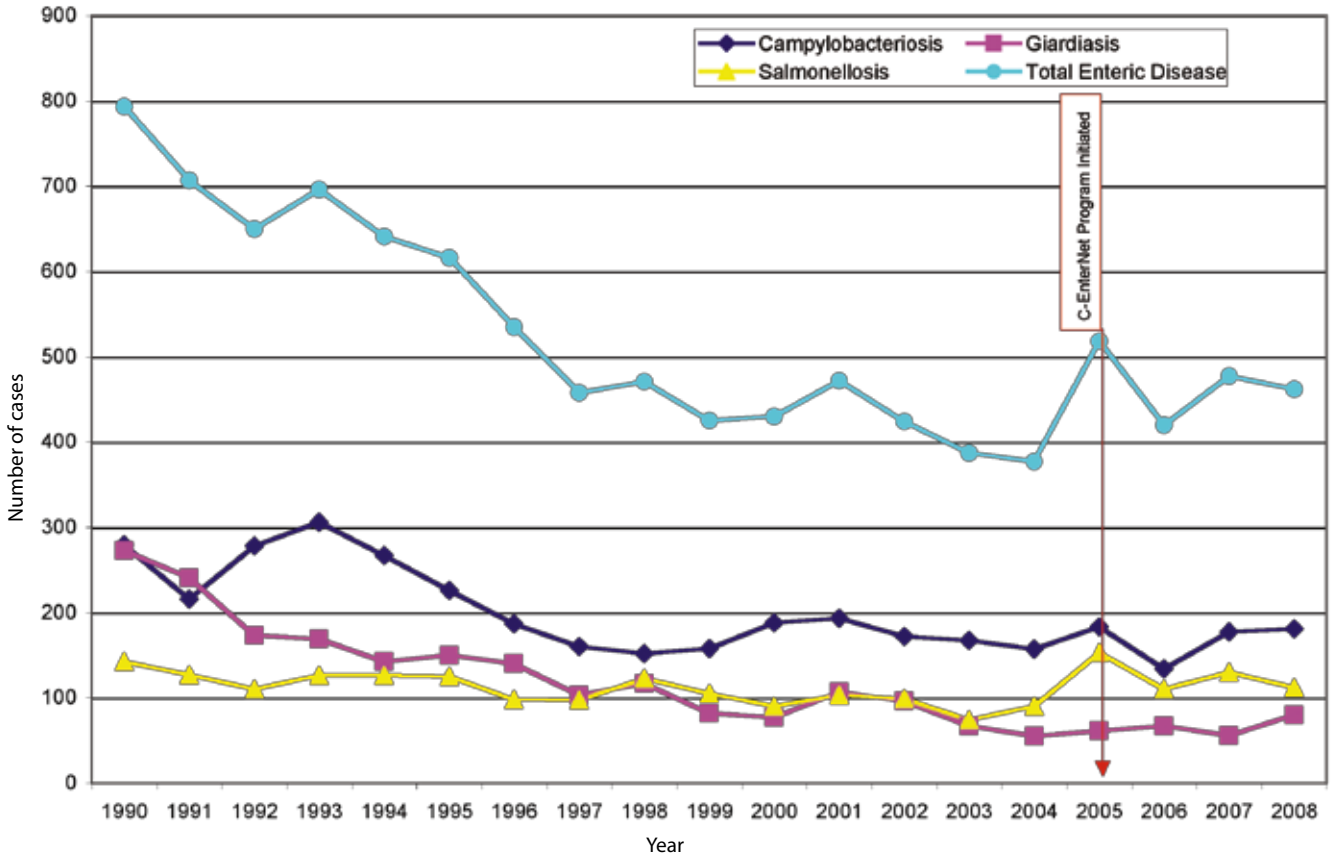
Table 1: Disease-specific annual incidence rates in Sentinel Site 1 in 2008 compared to 2007, 2006 and historical averages

		2008		2007		2006		(1990-2004)*
		# of cases	Incidence Rate *Per 100,000 pers./years*	# of cases	Incidence Rate *Per 100,000 pers./years*	# of cases	Incidence Rate *Per 100,000 pers./years*	Average Incidence Rate *Per 100,000 pers./years*
Total	Endemic	322		331		285		
	Travel	118		142		131		
	Outbreak	33		4		4		
Amoebiasis	Total		5.98		6.44		3.66	5.35
	Endemic	19	3.79	16	3.22	12	2.44	
	Travel	11	2.19	16	3.22	6	1.22	
Campylobacteriosis	Total		36.07		35.62		27.2	49.69
	Endemic	123	24.51	131	26.36	108	21.95	
	Travel	32	6.38	46	9.26	26	5.28	
	Outbreak	26	5.18					
Cryptosporidiosis	Total		3.39		3.82		4.27	2.98
	Endemic	15	2.99	12	2.41	15	3.05	
	Travel	2	0.40	7	1.41	6	1.22	
Cyclosporiasis	Total		0.60		0.60		0.00	0.70
	Endemic	1	0.20	2	0.40	0	0.00	
	Travel	2	0.40	1	0.20	0	0.00	
Giardiasis	Total		15.94		11.27		13.61	31.87
	Endemic	48	9.57	33	6.64	35	7.11	
	Travel	32	6.38	22	4.43	32	6.50	
	Outbreak			1	0.20	0	0.00	
Hepatitis A	Total		0.40		1.41		2.44	2.72
	Endemic	1	0.20	7	1.41	4	0.81	
	Travel	1	0.20	0	0.00	8	1.63	
	Outbreak							
Listeriosis	Total		1.20		0.20		0.00	0.19
	Endemic	3	0.60	1	0.20	0	0.00	
	Travel	0	0.00	0	0.00	0	0.00	
	Outbreak	3	0.60					
Salmonellosis	Total		22.32		26.16		22.36	25.97
	Endemic	82	16.34	96	19.32	60	12.19	
	Travel	28	5.58	33	6.64	48	9.76	
	Outbreak	2	0.40	1	0.20	2	0.41	
Shigellosis	Total		1.20		2.21		1.22	2.83
	Endemic	1	0.20	2	0.40	3	0.61	
	Travel	5	1.00	9	1.81	3	0.61	
Verotoxigenic *E. coli* (VTEC)	Total		2.99		3.82		7.11	5.86
	Endemic	14	2.79	14	2.82	32	6.50	
	Travel	0	0.00	3	0.60	1	0.20	
	Outbreak	1	0.20	2	0.40	2	0.41	
Yersiniosis	Total		1.99		4.43		3.45	3.11
	Endemic	7	1.39	17	3.42	16	3.25	
	Travel	3	0.60	5	1.01	1	0.20	

Cells shaded in yellow represent significant changes from 2006-2007 to 2008 (Fisher's Exact Test P≤ 0.05)

** Keegan et. al. 2009. Epidemiology of enteric disease in C-EnterNet's Pilot Site, Waterloo Region, Ontario, 1990-2004. Canadian Journal of Infectious Diseases and Medical Microbiology. In press.*

HUMAN CASE SUMMARY



Note: Total enteric disease includes endemic, travel and outbrake cases.

Figure 1: Temporal trends of the three most frequent enteric diseases, and total bacterial, viral and parasitic enteric disease from Sentinel Site 1, 1990 to 2008

C-EnterNet's human enteric samples are collected through the existing passive surveillance system in Ontario. This system has been enhanced by C-EnterNet through the collection of epidemiological and microbiological data for the human cases by using an improved standardized questionnaire for sporadic enteric disease cases and by performing advanced subtyping analyses on human stool samples.

The burden of enteric disease continues to be significant in the Region of Waterloo. It must be noted that under-reporting continues to complicate these measures, not only in Sentinel Site 1 but also across Canada. It has been estimated that for every case of acute gastroenteritis that is counted through public health surveillance, there are 313 cases in the community that go unmeasured[1].

In 2008, of the 473 reported cases of 11 bacterial, viral and parasitic enteric diseases in the Region of Waterloo, campylobacteriosis, salmonellosis and giardiasis were most common. Overall, listeriosis increased significantly ($p<0.05$) in 2008 due to an outbreak and higher numbers of endemic cases reported than in recent years. Overall, both Hepatitis A and VTEC infections decreased significantly ($p<0.05$) in 2008 compared to 2007 and 2006. Endemic giardiasis increased significantly ($p<0.05$) in 2008 compared to 2007 and 2006, while endemic yersiniosis decreased significantly ($p<0.05$). The incidence rate of endemic salmonellosis remains consistently high over the past three years, while the endemic rates of campylobacteriosis and cryptosporidiosis have remained stable.

HUMAN CASE SUMMARY
Continued

Travel continues to be a significant factor in the burden of enteric disease. In 2008, 25% of all cases of enteric disease were associated with travel outside of Canada. Travel-acquired campylobacteriosis, giardiasis and salmonellosis showed the highest number of reported cases in 2008. The majority of travel-associated *Campylobacter* cases had reported travelling to Europe (9/31) and the Americas (7/31). The majority of travel-associated *Giardia* cases had reported travelling to Asia (14/32) and Africa (10/32), and the majority of travel-associated *Salmonella* cases had reported travelling to the Americas (15/28). Travel-related cryptosporidiosis decreased slightly since previous years with only 2 cases reported in 2008 with travel to Africa and Asia. There were no travel-associated VTEC infections reported in 2008 compared to previous years, indicating that *E. coli* O157:H7 appears to be a domestically acquired infection.

In 2008, there was an increase in the number of outbreak-associated enteric disease, with a total of 33 reported cases compared to the previous two years where 4 cases each were reported. The majority of outbreak associated cases (26/33) in 2008 were *Campylobacter* cases (all cases linked to one event), whereas in previous years, no *Campylobacter*-associated outbreaks were reported. There were a total of three *Listeria* associated outbreak cases linked to the Canada-wide outbreak. One listeriosis case linked to an outbreak in Québec was associated with unpasteurized cheese.

[1] *Majowicz et al., 2005. Estimating the under-reporting rate for infectious gastrointestinal illness in Ontario. Canadian Journal of Public Health 96 (3):178-81*

RETAIL COMPONENT

Retail meat continues to be an important exposure source for enteric pathogens. Since mid-2005, C-EnterNet has systematically sampled fresh raw pork, chicken and beef from randomly selected grocery stores within the sentinel site on a weekly basis. Retail meat sampling is conducted to understand the risk of pathogen exposure at the consumer level. In 2008, the levels of pathogen contamination on retail raw meat were similar to what was found in 2006 and 2007 combined with the exception of *Yersinia* on pork and *Campylobacter* on chicken. As was the case in 2007, the 2008 prevalence of *Yersinia* spp. decreased significantly ($p<0.05$) in pork.

Raw chicken remains the commodity most frequently contaminated with *Salmonella* and *Campylobacter*. The prevalence of *Campylobacte*r increased ($p<0.05$) in 2008 in chicken compared to 2007 and 2006. However, this increase corresponds to the change in the type of chicken breast sampled from skin-on in 2006-2007 to skin-off in 2008 (Cook and Pollari, personal communication). In 2008, as in 2007, the presence of *Verotoxogenic E. coli* remains low with only two ground beef samples testing positive.

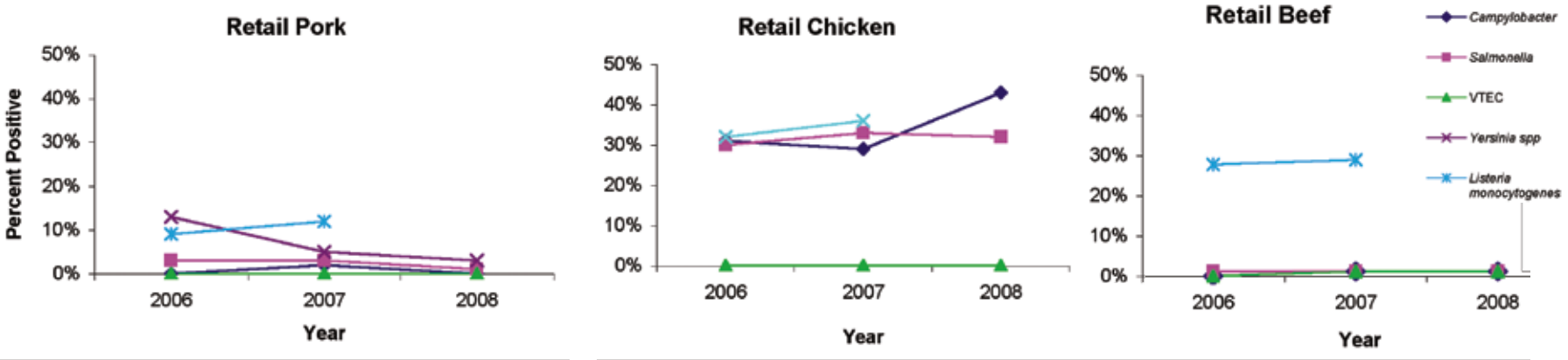
RETAIL COMPONENT

Table 2: Pathogen detection on retail meat in 2006, 2007 and 2008

	2006			2007			2008		
	Pork (n=140)	**Chicken** (n=145)	**Beef** (n= 139)	**Pork** (n=187)	**Chicken** (n=187)	**Beef** (n= 187)	**Pork** (n=178)	**Chicken** (n=185)	**Beef** (n=180)
Campylobacter	0%	31% (45)	0%	2% (3)	29% (55)	1%(1)	0%	43% (80)	1% (2)
Salmonella	3% (4)	30% (43)	1% (1)	3% (6)	33% (61)	1% (1)	1% (1)	32% (60)	1% (1)
VTEC	0%	0%	0%	0%	0%	1% (2)	0%	0%	1% (2)
Yersinia spp	13% (18)	Not tested	Not tested	5% (9)	Not tested	Not tested	3% (6)	Not tested	Not tested
Listeria monocytogenes	9% (12)	32% (46)	24% (33)	12% (22)	36% (68)	25% (46)	Not tested	Not tested	Not tested

Cells shaded in yellow represent significant changes from 2008 to the combined 2006/2007 years (Fisher's Exact Test, $P \leq 0.05$). Note: 2008 results are preliminary

Figure 2: Yearly distribution of pathogen contamination on retail meat, 2006-2008



AGRICULTURE COMPONENT

Table 3: Pathogen detection from manure samples in 2006, 2007 and 2008

	2006		2007				2008			
Sample Prevalence	**Swine** *120 samples*	**Dairy** *179 samples*	**Swine** *120 samples*	**Dairy** *112 samples*	**Beef** *80 samples*	**Broiler Chickens** *36 samples*	**Swine** *111 samples*	**Dairy** *112 samples*	**Beef** *112 samples*	**Broiler Chickens** *100 samples*
Campylobacter	13% (15)	25% (44)	10% (12)	21% (23)	13% (10)	0%	68% (76)[a]	75% (84)[a]	76% (85)[a]	10% (10)
Salmonella	28% (33)	11% (20)	33% (40)	13% (14)	10% (8)	72% (26)	28% (31)	8% (9)	6% (7)	62% (62)
E. coli 0157:H7	0%	9% (16)	0%	5% (6)	9% (7)	0%	1% (1)	4% (4)[b]	13% (14)[b]	0%[c]
Yersinia spp	8% (10)	Not tested	3% (4)	Not tested	Not tested	Not tested	4% (4)	Not tested	Not tested	Not tested
Listeria monocytogenes	1% (1)	8% (15)	Not tested	Not tested	64% (51)	3% (1)	Not tested	Not tested	64% (23)[d]	8% (7)[e]

Cells shaded in yellow represent significant changes from 2008 to the combined 2006/2007 years (Fisher's Exact Test, $P \leq 0.05$)
[a] Significant increase of *Campylobacter* in 2008 is most likely due to the implementation of a more sensitive laboratory method
[b] 8 samples not tested for *E. coli* 0157:H7 (N=104) [c] 4 samples not tested for *E. coli* 0157:H7 (N=96)
[d] N=36 [e] N=88

Note: 2008 results are preliminary

Table 4: Pathogen detection at the farm level in 2006, 2007 and 2008

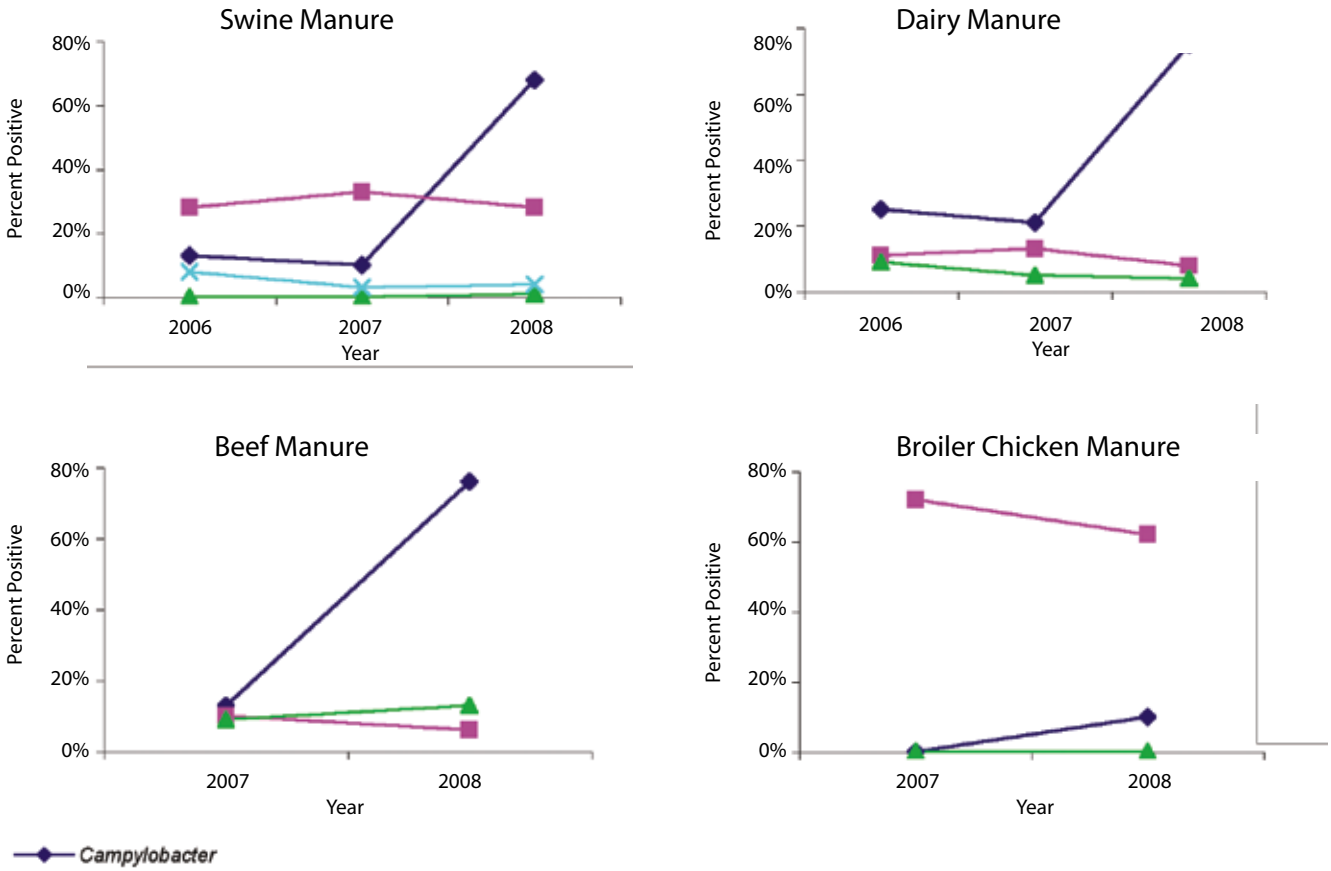
	2006		2007				2008			
Farm Prevalence	**Swine** *30 farms*	**Dairy** *45 farms*	**Swine** *30 farms*	**Dairy** *28 farms*	**Beef** *21 farms*	**Broiler Chickens** *9 farms*	**Swine** *30 farms*	**Dairy** *28 farms*	**Beef** *28 farms*	**Broiler Chickens** *25 farms*
Campylobacter	40% (12)	60% (27)	40% (12)	40% (11)	33% (7)	0%	93% (28)[a]	93% (26)[a]	96% (27)[a]	12% (3)
Salmonella	60% (18)	22% (10)	60% (18)	21% (6)	14% (3)	89% (8)	60% (18)	18% (5)	11% (3)	76% (19)
E. coli O157:H7	0%	29% (13)	0%	21% (6)	24% (5)	0%	3% (1)	12% (3)[b]	31% (8)[b]	0%[c]
Yersinia spp	30% (9)	Not tested	13% (4)	Not tested	Not tested	Not tested	13% (4)	Not tested	Not tested	Not tested
Listeria monocytogenes	3% (1)	33% (12)	Not tested	Not tested	90% (19)	11% (1)	Not tested	Not tested	Not tested	Not tested

Cells shaded in yellow represent significant changes from 2008 to the combined 2006/2007 years (Fisher's Exact Test, $P \leq 0.05$)
[a] Significant increase of *Campylobacter* in 2008 is most likely due to the implementation of a more sensitive laboratory method
[b] 2 farms not tested for *E. coli* 0157:H7 (N=26) [c] 1 farm not tested for *E. coli* 0157:H7 (N=24)

Note: 2008 results are preliminary

AGRICULTURE COMPONENT
Continued

Figure 3: Pathogen detection from manure samples in 2006, 2007 and 2008



Detection of enteric pathogens on farms represents an environmental exposure source. In 2008, all four commodity groups (dairy, beef, swine, and broiler chickens) were sampled. Each month 2-3 farms per commodity are enrolled and visited for a total of approximately 30 farms per commodity per year. The visit involves the administration of a short management survey and sampling of three fresh pooled manure samples from different age groups of animals and one stored manure sample.

Results are presented at the sample level and at the farm level, to account for within-farm similarities. In 2008, the same 30 swine farms were enrolled and sampled as in 2007 and 2006. In contrast, in 2008 13 and 15 of the beef and dairy farms, respectively, had been previously sampled in 2007. Also, the poultry farms sampled in 2008 had not been previously sampled in 2007.

Salmonella was most frequently detected in swine and broiler chickens (at the farm and sample level). *Campylobacter* was frequently detected (at both the farm and sample level) in swine, dairy and beef farms, and was detected on 3 broiler chicken farms (0 were detected in 2007). The prevalence of *Campylobacter* increased significantly ($p<0.05$) in swine, dairy and beef at the farm and sample level in 2008 compared to 2007 and 2006 and is most likely due to the implementation of a more sensitive laboratory methodology at the beginning of 2008, rather than a true prevalence increase. *E. coli* O157:H7 was detected on both dairy and beef at the farm level, and was detected on 1 swine farm which had not been detected in previous sampling years.

WATER COMPONENT

Table 5: Pathogen detection in untreated surface water in Sentinel Site 1, 2006-2008

2008

	All Sites	A	B	C	D	E
Campylobacter	24% (24/100)	24% (5/21)	24% (5/21)	28% (5/18)	41% (9/22)	0% (0/18)
Salmonella	34% (34/100)	62% (13/21)	33% (7/21)	11% (2/18)	18% (4/22)	44% (8/18)
E. coli O157:H7	1% (1/100)	0% (0/21)	5% (1/21)	0% (0/18)	0% (0/22)	0% (0/18)
Yersinia spp	11% (11/100)	10% (2/21)	10% (2/21)	17% (3/18)	14% (3/22)	6% (1/18)
Cryptosporidium [a]	82% (18/22)	100% (2/2)	50% (1/2)	0% (0/1)	87% (13/15)	100% (2/2)
Giardia [a]	95% (21/22)	100% (2/2)	100% (2/2)	100% (1/1)	93% (14/15)	100% (2/2)

2007

	All Sites	A	B	C	D	E
Campylobacter	18% (24/134)	22% (6/27)	12% (3/26)	37% (10/27)	19% (5/27)	0% (0/27)
Salmonella	10% (13/134)	4% (1/27)	7% (2/26)	7% (2/27)	4% (1/27)	26% (7/27)
E. coli O157:H7	2% (3/134)	7% (2/27)	0% (0/26)	0% (0/27)	0% (0/27)	4% (1/27)
Yersinia spp	40% (53/133)	37% (10/26)	37% (10/26)	56% (15/27)	30% (8/27)	41% (11/27)
Cryptosporidium [a]	88% (35/40)	100% (3/3)	100% (3/3)	67% (2/3)	85% (22/26)	100%(5/5)
Giardia [a]	100 % (40/40)	100% (3/3)	100% (3/3)	100% (2/2)	100% (27/27)	100% (5/5)

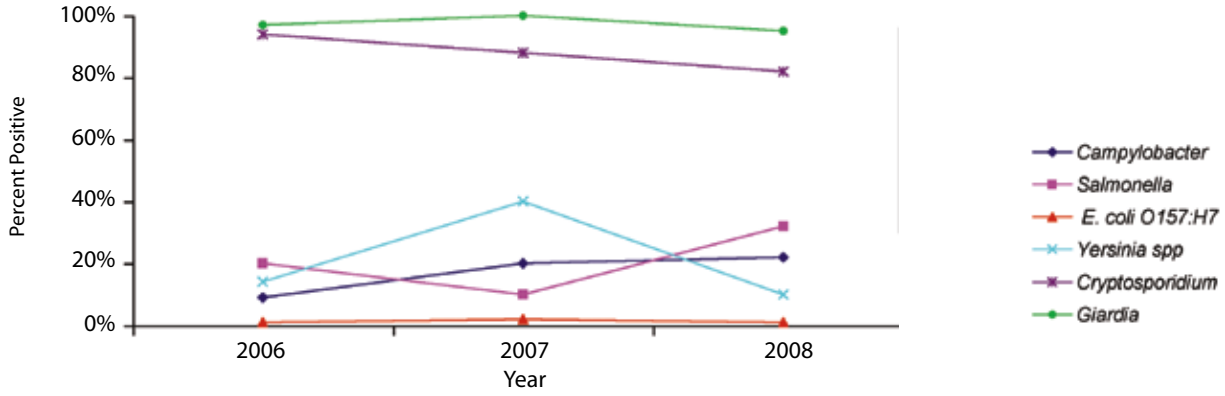
2006

	All Sites	A	B	C	D	E
Campylobacter	9% (13/140)	18% (5/28)	4% (1/28)	14% (4/28)	11% (3/28)	0% (0/28)
Salmonella	20% (28/140)	21% (6/28)	21% (6/28)	18% (5/28)	29% (8/28)	11% (3/28)
E. coli O157:H7	1% (1/124)	0% (0/24)	0% (0/24)	4% (1/24)	0% (0/24)	0% (0/24)
Yersinia spp	14% (15/105)	19% (4/21)	19% (4/21)	14% (3/21)	10% (2/21)	10% (2/21)
Cryptosporidium [a]	94% (33/35)	---	---	100% (3/3)	93% (27/29)	100% (3/3)
Giardia [a]	97% (34/35)	---	---	67% (2/3)	93% (27/29)	100% (3/3)

Note: Cells shaded in yellow represent significant changes from 2008 to 2006 & 2007 combined (Fisher's Exact Test P≤0.05)
[a] By microscopy, not culture method

Sample Site Legend:
A - Canagagigue Creek
B - Conestogo River
C - Upper Grand River
D - Grand River, near drinking water intake
E - Grand River, near one waste water treatment plant effluent

Figure 4: Proportion of positive untreated surface water samples tested by culture method in Sentinel Site 1 between 2006 to 2008 for selected enteric pathogens



Since 2005, five sites along the Grand River have been sampled for exposure surveillance within the C-EnterNet sentinel site, to understand the dynamics of pathogen levels in the environment and the transmission of enteric pathogens from both point and non-point sources within the watershed. After three full years of sampling, we have separated the results based on sample collection point. In 2008, only culture-based methods were used for the detection of pathogens in untreated surface water.

The prevalence of *Salmonella* contamination increased significantly ($p<0.05$) in 2008 compared to 2007 and 2006, and *Campylobacter* prevalence showed a significant increase as well, with the highest levels of contamination at site D (near the drinking water intake) in 2008. The prevalence of *Yersinia* spp. decreased significantly ($p<0.05$) in 2008 compared to 2007 and 2006 and may be due to changes to laboratory methodology used for *Yersinia* detection part way through the sampling year. To-date, pathogenic strains of *Y. enterocolitica* have not been detected in river water. Pathogenic *E. coli* detection in river samples continues to be low with less than 1% of positive samples in 2008. It is still unclear if this is due to low levels or methodology issues (or a combination of both).

Cryptosporidium and *Giardia* are consistently being detected at many of the sample locations along the river and thus continue to be an important consideration for water treatment plant operators in the watershed. The prevalence of *Giardia* contamination in the river has remained fairly stable over the past three years, while the prevalence of *Cryptosporidium* contamination shows a small decline. Nevertheless, the prevalence for both pathogens remains high in the river.

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