2011 SHORT REPORT

C-ENTERNET
CANADA'S NATIONAL INTEGRATED ENTERIC PATHOGEN SURVEILLANCE SYSTEM



Public Health Agency of Canada
Agence de la santé publique du Canada

Canada

TO PROMOTE AND PROTECT THE HEALTH OF CANADIANS THROUGH LEADERSHIP, PARTNERSHIP, INNOVATION AND ACTION IN PUBLIC HEALTH.

— Public Health Agency of Canada

2011 Short Report
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2011 Rapport sommaire

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INTRODUCTION

C-EnterNet is an integrated enteric pathogen surveillance system based on a sentinel site surveillance model that collects information on both cases of infectious gastrointestinal illness and sources of exposure within defined communities. C-EnterNet's primary objectives are to detect changes in trends in human enteric disease and levels of pathogen exposure from food, animal and water sources in a defined population, and to strengthen source attribution efforts in Canada by determining statistically significant risk factors for enteric illness.

C-EnterNet currently has two sentinel sites in operation: the Fraser Health Authority of lower mainland British Columbia since 2010, and the Region of Waterloo Public Health in Ontario since 2005. In each sentinel site, enhanced human disease surveillance is performed in parallel with active surveillance of enteric pathogens in various exposure sources.

The purpose of this report is to present the preliminary findings from the 2011 surveillance year in both sentinel sites. Note that C-EnterNet data need to be considered in the context of two sentinel sites, thus major conclusions cannot yet be extrapolated nationally.[1] This report will be followed by the Long Report, which will include more extensive analyses of temporal trends and subtyping information for an integrated perspective on enteric disease from exposure to illness for 2011.

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).

[1] C-EnterNet is designed to have five sites encompassing about 10% of the Canadian population

HUMAN CASE SUMMARY

The enhanced human disease surveillance component of C-EnterNet has been fully implemented in two sentinel sites: in the Region of Waterloo, Ontario (ON site) and in the Fraser Health Authority, British Columbia (BC site).

In 2011, campylobacteriosis, salmonellosis and giardiasis were the most commonly reported enteric diseases in C-EnterNet's sentinel sites (Table 1). Overall, the total number of endemic, travel- and outbreak-related cases reported in the ON site in 2011 was lower than that reported in 2010, and no outbreaks were observed. The incidence rate of giardiasis significantly decreased in the ON site from 2010 to 2011 ($p<0.05$) (Table 1).

Travel continues to be an important factor in the burden of enteric disease. In 2011, 30% of all cases of enteric disease were associated with travel outside of Canada, in both the ON and BC sites. In both sentinel sites, the travel-related proportion of cases, compared with endemic cases, was highest for cyclosporiasis (50% in the ON site and 100% in the BC site) and shigellosis (67% in the ON site and 72% in the BC site). The proportion travel-related was also high for yersiniosis in the ON site (50%) and for cryptosporidiosis (50%) in the BC site. Compared to 2010, travel-related cryptosporidiosis decreased significantly in the ON site in 2011 ($p<0.05$), and travel-related shigellosis increased significantly ($p<0.05$) in the BC site in 2011 (Table 1).

In 2011, no outbreak-associated cases were reported in the ON site, compared to the previous year when eight outbreak-associated cases were reported. The BC site reported 11 *Salmonella* outbreak-associated enteric disease cases in 2011.

TABLE 1: Disease-specific case counts and annual incidence rates in the ON and BC sites in 2011 compared to 2010, and 2008 National Notifiable Disease incidence rates

		2010				2011				2008
		ON Site		BC Site		ON Site		BC Site		National Totals[b]
		# of Cases	Incidence Rate	# of Cases	Incidence Rate[a]	# of Cases	Incidence Rate	# of Cases	Incidence Rate	Incidence Rate
Total	Endemic[c]	296		223		299		307		
	Travel[d]	132		72		115		123		
	Outbreak[e]	8		8		0		11		
Amoebiasis	Total	26	4.9			25	4.7			--
	Endemic	12	2.3			19	3.6			
	Travel	14	2.7			6	1.1			
Campylobacteriosis	Total	144	27.3	112	33	163	30.7	177	38.5	28.4
	Endemic	112	21.3	89	26.2	126	23.7	132	28.7	
	Travel	32	6.1	23	6.8	37	7	45	9.8	
Cryptosporidiosis	Total	23	4.4	5	1.5	23	4.3	6	1.3	2.4
	Endemic	13	2.5	2	0.6	21	3.9	3	0.7	
	Travel	10	1.9	3	0.9	2	0.4	3	0.7	
Cyclosporiasis	Total	1	0.2	3	0.9	1	0.4	3	0.7	0.5
	Endemic	0	0.0	0	0	1	0.2	0	0	
	Travel	1	0.2	3	0.9	2	0.2	3	0.7	
Giardiasis	Total	78	14.8	45	13.3	58	10.9	61	13.3	12.7
	Endemic	50	9.5	37	10.9	39	7.3	43	9.4	
	Travel	28	5.3	8	2.4	19	3.6	18	3.9	
Listeriosis	Total	1	0.2	2	0.6	0	0	1	0.2	0.38[f]
	Endemic	1	0.2	2	0.6	0	0	1	0.2	
Salmonellosis	Total	129	24.5	96	28.3	111	20.9	137	29.8	18.2
	Endemic	82	15.6	56	16.5	73	13.7	90	19.6	
	Travel	39	7.4	32	9.4	38	7.1	36	7.8	
	Outbreak	8	1.5	8	2.4	0	0	11	2.4	
Shigellosis	Total	6	1.1	6	1.8	6	1.1	18	3.9	2.3
	Endemic	1	0.2	4	1.2	2	0.4	5	1.1	
	Travel	5	1.0	2	0.6	4	0.8	13	2.8	
Verotoxigenic *E. coli* (VTEC)	Total	12	2.2	10	2.9	14	2.6	15	3.3	2.3
	Endemic	12	2.2	9	2.7	13	2.4	13	2.8	
	Travel	0	0.0	1	0.3	1	0.2	2	0.4	
Yersiniosis	Total	8	1.5	24	7.1	8	1.5	23	5.0	--
	Endemic	7	1.3	24	7.1	4	0.8	20	4.4	
	Travel	1	0.2	0	0	4	0.8	3	0.7	

NOTE: Incidence rate is measured as the number of new cases / 100,000 person-years

Cells shaded in yellow represent significant changes from 2010 to 2011 (Fisher's Exact Test, p-value ≤0.05)

[a] 2010 incidence rates have been adjusted to account for partial year of data collection (April - December 2010)

[b] Notifiable Disease Surveillance System, Surveillance and Epidemiology Division, Centre for Communicable Diseases and Infection Control, PHAC (2008)

[c] Endemic cases include reported cases of infection that occur sporadically within the sentinel site. Cases that are lost to follow-up are also included with the endemic cases

[d] Travel-related cases include individuals that have travelled outside of Canada in the relevant time frame before onset of illness

[e] If outbreak is not indicated, there were no outbreaks that occurred

[f] Government of Canada. National Enteric Surveillance Program (NESP) Annual Summary 2011. PHAC (2012)

Since C-EnterNet enhanced human disease surveillance was initiated in April 2010 in the BC site, historical data from 2006-2007 have been included to show changes in disease trends over time (Figure 1). The data include all cases (endemic, travel and outbreak). In the ON site, the incidence rate of campylobacteriosis showed a statistically significant increase by 23% in 2011 compared to the 2006-2007 rates, while yersiniosis significantly decreased by 55% in 2011 (Figure 1). In the BC site, the incidence of salmonellosis showed a statistically significant increase of 50% in 2011, while the incidence was significantly lower for giardiasis and cryptosporidiosis (32% and 62% decrease, respectively) in 2011 compared to the 2006-2007 rates (Figure 1).

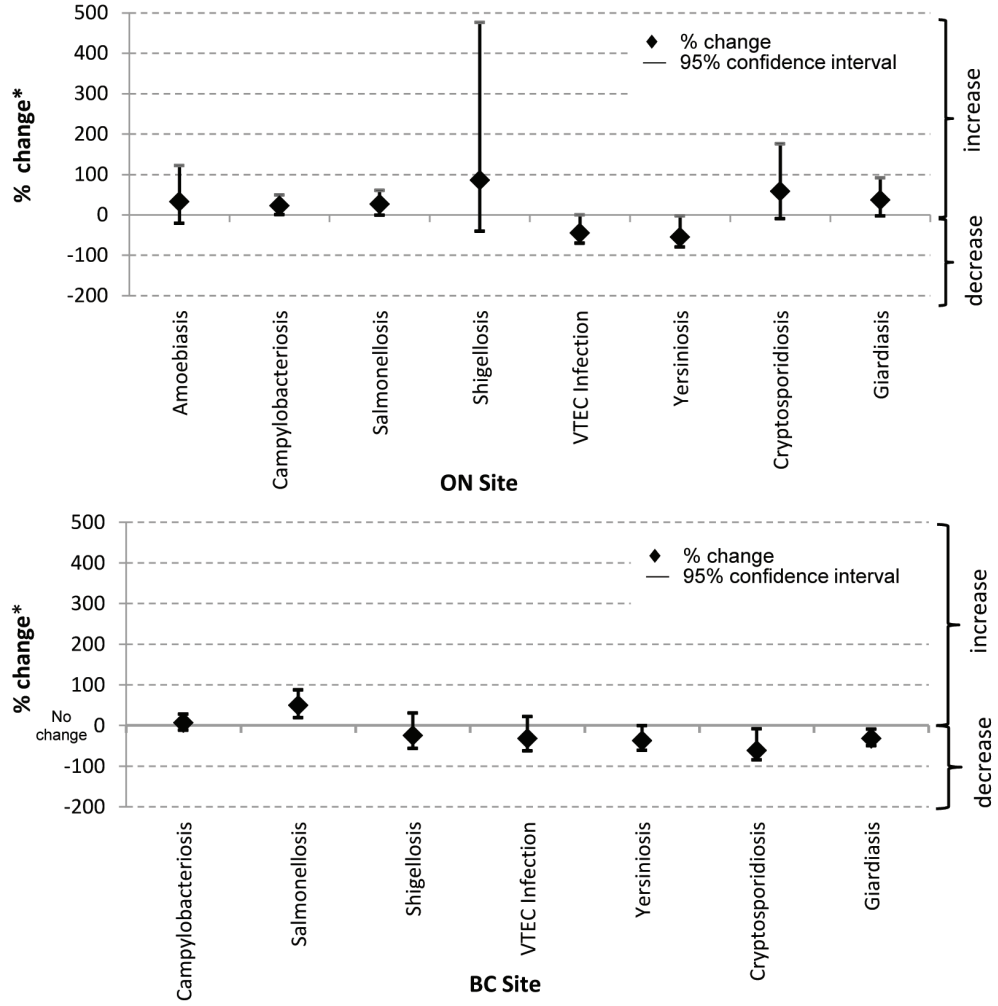

FIGURE 1: Estimated percent change (with 95% confidence interval) in annual incidence rates of all reportable enteric disease cases in the ON and BC sites in 2011, compared to the average annual incidence rate during 2006-2007, by pathogen

* *No significant change* = 95% confidence interval is both above and below the no change line; *significant increase* = entire 95% confidence interval is above the no change line; *significant decrease* = entire 95% confidence interval is below the no change line

RETAIL COMPONENT

Retail food continues to be an important human exposure source for enteric pathogens.

CORE SURVEILLANCE ACTIVITIES

ONTARIO SITE

Since mid-2005, C-EnterNet has systematically sampled fresh raw pork, chicken breasts and ground beef from randomly selected grocery stores within the ON site on a weekly basis. Pork chops were not sampled in 2011 given their historically stable and low pathogen detection rates. For similar reasons, *Campylobacter* and *Salmonella* testing were stopped on ground beef. In 2011, a statistically significant increase in *Listeria monocytogenes* on ground beef was detected. Given that no sampling or laboratory changes occurred from 2010 we will continue to monitor this pathogen in 2012 (Table 2 & Figure 2).

TABLE 2: Pathogen detection on retail meat in the ON site, 2010 and 2011, percent positive (number positive)

Pathogen detection on retail meat	2010			2011	
	Pork (n=197)	Chicken (n=197)	Beef (n=197)	Chicken (n=175)	Beef (n=175)
Campylobacter	2% (3)	36 % (70)	1% (1)	41% (71)	Not tested
Salmonella	2% (3)	29% (57)	1% (1)	26% (46)	Not tested
VTEC	0% (0)	0% (0)	6% (12)	Not tested	6% (10)[a]
Listeria monocytogenes	8% (15)	14% (27)	12% (23)	16% (28)	22% (39)

[a] 173 samples tested for VTEC

Cells shaded in yellow represent significant changes from 2010 to 2011, (Fisher's Exact Test, $p \leq 0.05$)

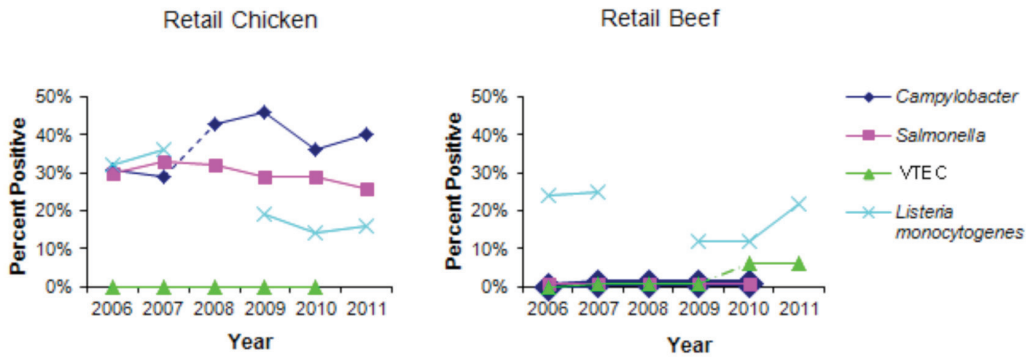

FIGURE 2: Yearly distribution of pathogen contamination on retail meat in the ON site, 2006 to 2011

NOTE: Dashed line indicates a laboratory or sampling method change

BRITISH COLUMBIA SITE

In January 2011, core retail sampling was initiated in the BC site with identical sampling and laboratory procedures as in the ON site (Table 3). These findings will serve as a baseline for results in subsequent years.

TABLE 3: Pathogen detection on retail meat in the BC site, 2011, percent positive (number positive/number tested)

Pathogen detection on retail meat	2011	
	Chicken	Beef
Campylobacter	48% (83/171)	Not tested
Salmonella	36% (63/175)	Not tested
VTEC	Not tested	2% (3/164)
Listeria monocytogenes	46% (81/175)	12% (22/174)

TARGETED RETAIL SURVEILLANCE

POULTRY

In 2011, a targeted retail poultry study was conducted in the ON site (January-December) and the BC site (April-December) (Table 4). At each store visit, in addition to core retail meat sampling, ground chicken, ground turkey and uncooked frozen chicken nugget samples were also collected. The uncooked chicken nuggets and ground chicken had higher rates of *Salmonella* than chicken breasts in both provinces.

TABLE 4: Pathogen detection on ground chicken, ground turkey and frozen chicken nuggets in the ON and BC sites, 2011 percent positive (number positive)

Pathogen detection on retail meat	ON Site			BC Site		
	Ground Chicken (n=158)	Ground Turkey (n=155)	Frozen Chicken Nuggets (n=212)	Ground Chicken (n=96)	Ground Turkey (n=96)	Frozen Chicken Nuggets (n=94)
Campylobacter	13% (21)	16% (25)	1% (3)	68% (65)	44% (42)	0% (0)
Salmonella	52% (82)	23% (35)	43% (91)	76% (73)	26% (25)	47% (44)
Listeria monocytogenes	46% (73)	32% (50)	20% (43)	42% (40)	41% (39)	23% (22)

PRODUCE

In 2011, a study to detect viruses and parasites on fresh soft berries at the retail level was conducted (Table 5). From January to December, a variety of fresh soft berry types were collected throughout the year at retail in both sentinel sites. In the ON site, 69 blackberry, 84 blueberry, 52 raspberry and 95 strawberry samples were collected (N=300), while in the BC site, 65 blackberry, 89 blueberry, 71 raspberry and 74 strawberry samples were collected (N=299). In the ON site, 16 of the samples collected were of domestic origin while 284 were imported. In the BC site, 42 samples were domestic while 257 were imported.

Giardia was the most frequently detected organism in both sentinel sites by PCR and microscopy methods. Although less frequent, *Cyclospora* and *Cryptosporidium* were also detected in both sentinel sites. Since the viability of these organisms was not determined, the potential risk is unknown (Table 5).

The small number of domestic samples collected made meaningful comparisons to imported products difficult. Statistical comparisons did not show a significant difference between domestic versus imported for these pathogens (Table 6).

TABLE 5: Pathogen detection on fresh soft berries in the ON and BC sites, 2011

Pathogen Detection on Fresh Soft Berries	ON Site		BC Site	
	PCR % (# positive/# tested)	Microscopy % (# positive/# tested)	PCR % (# positive/# tested)	Microscopy % (# positive/# tested)
Cryptosporidium	0% (0/300)	2% (6[a]/300)	0.7% (2[b]/299)	2% (6[c]/299)
Giardia	8% (23[d]/300)	3% (8[e]/300)	10% (31[f]/299)	2% (6[g]/299)
Cyclospora	1% (4[h]/300)	1% (3[i]/300)	0.7% (2[j]/299)	0.3% (1[k]/299)
Norovirus	0.3% (1[k]/299)	Not tested	0.7% (2[b]/298)	Not tested
Rotavirus	0.3% (1[l]/299)	Not tested	0% (0/296)	Not tested

[a] 3 Blueberry, 1 Blackberry, 1 Strawberry, 1 Raspberry
[b] 2 Raspberry
[c] 3 Blueberry, 3 Raspberry
[d] 9 Blueberry, 6 Blackberry, 4 Strawberry, 4 Raspberry
[e] 4 Blueberry, 2 Blackberry, 2 Raspberry
[f] 10 Blueberry, 6 Blackberry, 7 Strawberry, 8 Raspberry
[g] 2 Blueberry, 1 Blackberry, 3 Raspberry
[h] 1 Blackberry, 1 Strawberry, 2 Raspberry
[i] 1 Blackberry, 2 Raspberry
[j] 1 Blueberry, 1 Raspberry
[k] 1 Blackberry
[l] 1 Strawberry

TABLE 6: Pathogen detection by PCR on fresh soft berries in the ON and BC sites, 2011; imported versus domestic, percent positive (number positive)

Pathogen Detection on Fresh Soft Berries	Import (n=541)	Domestic (n=58)
Cryptosporidium	0.4% (2)	0% (0)
Giardia	8.6% (47)	12.1% (7)
Cyclospora	0.9% (5)	1.7% (1)
Norovirus	0.6% (3)[a]	0% (0)[a]
Rotavirus	0.2% (1)[b]	0% (0)[a]

n= number of samples tested
[a] One sample not tested
[b] Three samples not tested

AGRICULTURE COMPONENT

Detection of enteric pathogens on farms represents an environmental and food chain exposure source. In 2011 in the ON site, four commodity groups (dairy, beef, swine, and broiler chickens) were sampled. Farms are sampled throughout the year by visiting and enrolling two or three farms per commodity per month for a total of 30 farms per commodity per year. Three fresh pooled manure samples from different age groups of animals and one stored manure sample were collected at each bovine and swine visit. Broiler flocks were sampled within one week of transport for slaughter. No on-farm sampling occurred in the BC site.

Results are presented at the sample level and at the farm level to account for within-farm similarities. Of the farms sampled for each commodity in 2011, 24/30 swine farms, 27/30 dairy farms, 25/30 beef farms and 23/30 broiler chicken farms had also been previously sampled in 2010. In 2011, the prevalence of *E. coli* O157:H7 decreased significantly on beef operations at the sample and farm levels. No other significant changes were noted (Tables 7 & 8, & Figure 3).

In 2011, *Yersinia* testing was performed on the four commodity groups sampled with no positive findings.

TABLE 7: Pathogen detection from individual manure samples in the ON site, 2010 and 2011, percent positive (number positive)

Sample Prevalence	2010				2011			
	Swine (n=120)	Dairy (n=120)	Beef (n=119)	Broiler Chickens (n=120)	Swine (n=120)	Dairy (n=120)	Beef (n=120)	Broiler Chickens (n=120)
Campylobacter	83% (100)	75% (89)	78% (93)	6% (7)	85% (102)	80% (96)	82% (98)	10% (12)
Salmonella	24% (29)	13% (15)	13% (15)	63% (75)	34% (41)	13% (16)	9% (11)	61% (73)
E. coli O157:H7	1% (1)	6% (7)	13% (15)	0% (0)	0% (0)	3% (3)	3% (4)	0% (0)
Yersinia	3% (4)	0% (0)[a]	0% (0)[a]	0% (0)[b]	0% (0)	0% (0)	0% (0)	0% (0)

Cells shaded in yellow represent significant changes from 2010 to 2011 (Fisher's Exact Test, $p \leq 0.05$)

[a] Number samples tested=67

[b] Number samples tested=68

TABLE 8: Pathogen detection at the farm level in the ON site, 2010 and 2011, percent positive (number positive)

Farm Prevalence	2010				2011			
	Swine (30 farms)	Dairy (30 farms)	Beef (30 farms)	Broiler Chickens (30 farms)	Swine (30 farms)	Dairy (30 farms)	Beef (30 farms)	Broiler Chickens (30 farms)
Campylobacter	100% (30)	100% (30)	100% (30)	7% (2)	100% (30)	97% (29)	100% (30)	13% (4)
Salmonella	60% (18)	20% (6)	23% (7)	77% (23)	57% (17)	27% (8)	20% (6)	80% (24)
E. coli O157:H7	3% (1)	20% (6)	30% (9)	0% (0)	0% (0)	10% (3)	7% (2)	0% (0)
Yersinia	13% (4)	0% (0)[a]	0% (0)[a]	0% (0)[a]	0% (0)	0% (0)	0% (0)	0% (0)

[a] 17 farms tested in 2010

Cells shaded in yellow represent significant changes from 2010 to 2011 (Fisher's Exact Test, p-value ≤ 0.05)

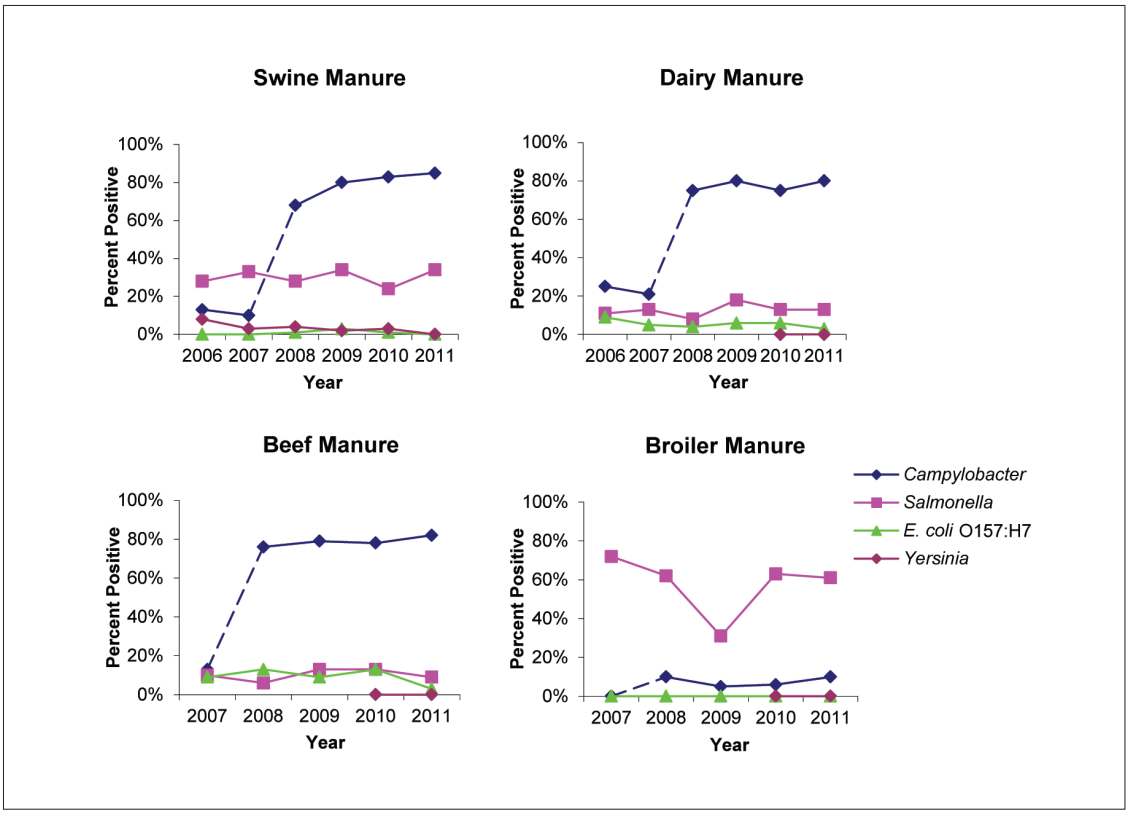

FIGURE 3: Pathogen detection (sample level) from manure samples in the ON site, 2006 to 2011

NOTE: Dashed lines indicate a laboratory or sampling method change

WATER COMPONENT

ONTARIO SITE

During 2011, surveillance in the ON site along the Grand River watershed continued at the same five sampling locations. During the summer months (June-September), sampling was re-directed to three beach locations to assess the load of pathogens at local swimming venues. These data are presented separately from the routine surveillance results from the Grand River.

The 2011 ON site data continue to illustrate consistent trends from year to year at the five sampling locations within the watershed for many of the target pathogens. In 2011, a change in laboratory method again illustrates the importance of method on prevalence estimates. After a short pilot study to determine the enhanced sensitivity of a new method to detect all VTEC (not just *E. coli* O157:H7) in water (the same method C-EnterNet uses to detect VTEC on retail meat), the new method was officially implemented in January of 2011. The method change resulted in enhanced sensitivity, and a notable increase in prevalence at all sampling sites, from 0% for *E. coli* O157:H7 in 2010 to roughly 25% prevalence when a method was used that targeted all Verotoxigenic *E. coli*.

The beach testing in the ON site illustrates that all pathogens were detected at least some of the time, though sample sizes are small. In 2012, the summer beach testing will be repeated to look for trends from year to year.

BRITISH COLUMBIA SITE

The 2011 BC site data represent a sampling initiative that focused on recreational waters in the FHA region, targeting four beach sites between June and September. The 2011 sampling was a pilot project to evaluate methods, sampling logistics and site selection. The beach locations were chosen to reflect freshwater swimming areas in the local area that can be accessed by sentinel site residents. Very few samples were positive for the three target pathogens, and 2012 sampling will further investigate whether these trends will continue from year to year.

TABLE 9: Pathogen detection in untreated surface water in the ON site, 2010 and 2011, and in recreational water in the ON and BC sites, 2011

ON Site 2011						
	All Sites (Core Surveillance)	A	B	C	D	E
Campylobacter	34% (28/82)	31% (5/16)	44% (7/16)	17% (2/12)	39% (9/23)	33% (5/15)
Salmonella	40% (33/83)	13% (2/16)	53% (8/15)	33% (4/12)	29% (7/24)	75% (12/16)
Verotoxigenic *E. coli*[a]	38% (30/78)	33% (5/15)	27% (4/15)	18% (2/11)	32% (7/22)	80% (12/15)
Cryptosporidium	100% (6/6)	---	---	---	100% (6/6)	---
Giardia	100% (6/6)	---	---	---	100% (6/6)	---

ON Site 2010						
	All Sites	A	B	C	D	E
Campylobacter	23% (21/93)	30% (6/20)	33% (7/21)	22% (4/18)	18% (4/22)	0% (0/12)
Salmonella	28% (26/94)	25% (5/20)	19% (4/21)	6% (1/18)	32% (7/22)	69% (9/13)
E. coli O157:H7[a]	3% (3/94)	4% (1/20)	4% (1/21)	0% (0/18)	0% (0/22)	8% (1/13)
Yersinia[b]	76% (32/42)	89% (8/9)	91% (10/11)	71% (5/7)	73% (8/11)	25% (1/4)
Cryptosporidium[c]	100% (12/12)	---	---	---	100% (12/12)	---
Giardia[c]	100% (12/12)	---	---	---	100% (12/12)	---

Targeted Beach Sampling Results 2011								
		ON Site			BC Site			
	All Sites	Elora Gorge	Laurel Creek	Shade Mills	Albert Dyck Lake	Entrance Bay	Harrison Lake Lagoon	Maple Bay
Campylobacter	18% (12/66)	100% (6/6)	17% (1/6)	50% (3/6)	6% (1/12)	0% (0/12)	0% (0/12)	8% (1/12)
Salmonella	8% (2/24)	13% (1/8)	0% (0/8)	13% (1/8)	---	---	---	---
Verotoxigenic *E. coli*	24% (5/21)	29% (2/7)	29% (2/7)	14% (1/7)	---	---	---	---
Cryptosporidium	100% (21/21)	100% (4/4)	100% (4/4)	100% (4/4)	0% (0/2)	0% (0/2)	0% (0/3)	0% (0/2)
Giardia	100% (21/21)	100% (4/4)	100% (4/4)	100% (4/4)	50% (1/2)	0% (0/2)	0% (0/3)	0% (0/2)

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

Cells shaded in yellow represent significant changes from 2010 to 2011 (Fisher's Exact Test p≤0.05), not due to lab method changes
Cells shaded in orange represent significant changes from 2010 to 2011 (Fisher's Exact Test p≤0.05), attributed to a lab method change

[a] The test used to detect *E. coli* O157:H7 in water was changed in January 2011 to detect all VTEC, not just *E. coli* O157:H7

[b] Stopped testing in June, 2010

[c] By microscopy, not culture method

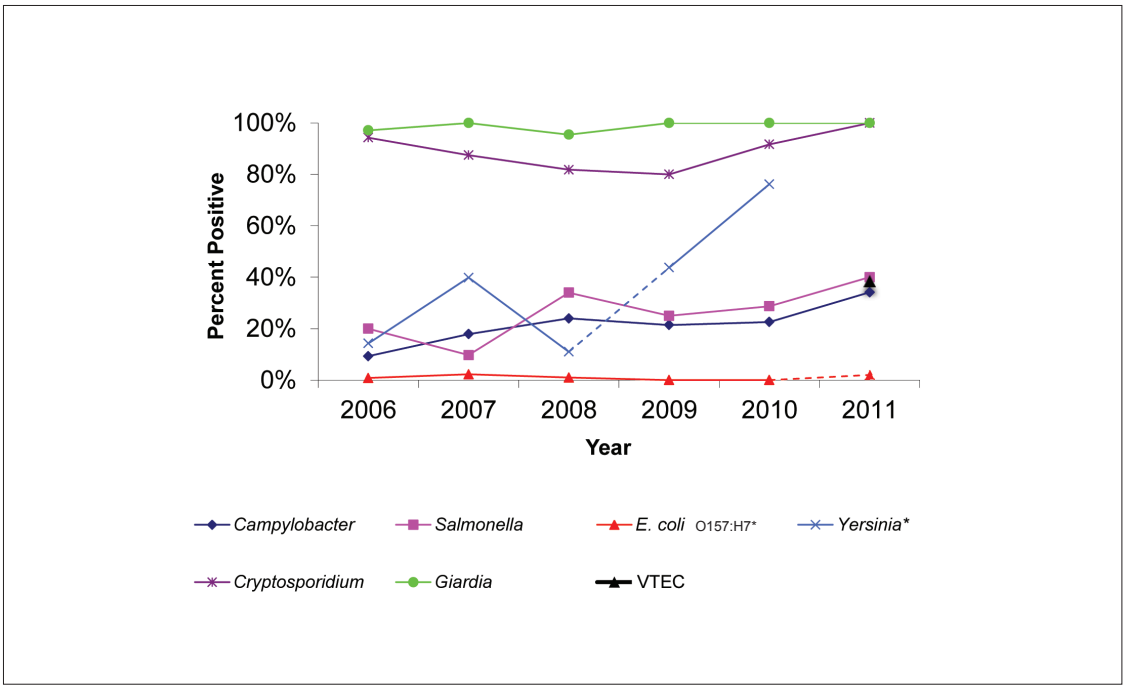

FIGURE 4: Proportion of positive untreated surface water samples tested in the ON site between 2006 and 2011 for selected enteric pathogens

* Dashed line indicates a change in laboratory detection method at some point during surveillance year(s), *Yersinia* not tested after 2010 and *E. coli* O157:H7 method changed to capture all VTEC in 2011

SUMMARY

Following six years of integrated surveillance, some general trends have been observed. At the farm level, it is relatively easy to find enteric human pathogens in food-producing farm animal manure. For example, *Salmonella* and *Campylobacter* have been detected consistently in dairy, beef and swine manure (Figure 3). In contrast, while *Salmonella* has been easy to detect on broiler chicken farms, *Campylobacter* was rarely detected from these samples.

Results also demonstrate that these pathogens are found in the surface waters of the sentinel site community (Figure 4), in both urban and rural sections of the watershed, and at local freshwater beaches. These results demonstrate that contact with the environment is a likely exposure route for human cases. However, this exposure route is still secondary to the foodborne route of transmission.

The retail level surveillance results from C-EnterNet demonstrate that these pathogens are seldom seen on pork chops or ground beef, suggesting that the slaughter and processing steps in these commodities are effective at reducing pathogen loads on the final product. Conversely, both *Salmonella* and *Campylobacter* are frequently found on retail chicken breasts (Figure 2) and more frequently on processed poultry products (Table 4), suggesting potential areas of focus for food safety interventions.

Parasitic and viral pathogens were also detected on fresh soft berries at retail. However the viability/infectivity of these pathogens could not be determined with the testing methods used (PCR and/or microscopy).

In the human component, C-EnterNet reports that both *Salmonella* and *Campylobacter* infections are consistently the top two bacterial pathogens causing human illness and that their rates of infection remained elevated (non-significant increase) again in 2011 (Table 1).

These findings provide current information on trends of exposure and disease for consideration in the development of food safety policies in Canada.

ACKNOWLEDGMENTS

C-EnterNet acknowledges the significant investments made by our partners in both sentinel sites, our provincial and federal government agency colleagues and academic and industry collaborators who help to make this program a continued success.