



Research Paper

Campylobacter jejuni Outbreak Linked to Raw Oysters in Rhode Island, 2021Genevieve Caron^a, Brendalee Viveiros^{b,*}, Christopher Slaten^b, David Borkman^c, Adam Miller^d, Richard C. Huard^d^a Rhode Island Department of Health, Center for Acute Infectious Disease Epidemiology, 3 Capitol Hill, Providence, RI 02908, USA^b Rhode Island Department of Health, Center for Food Protection, 3 Capitol Hill, Providence, RI 02908, USA^c Rhode Island Department of Environmental Management, Office of Water Resources, 235 Promenade Street, Providence, RI 02908, USA^d Rhode Island Department of Health, Rhode Island State Health Laboratory, 50 Orms Street, Providence, RI 02904, USA

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ABSTRACT

Oysters and other shellfish are not a food that is commonly highlighted as high risk for *Campylobacter* contamination. The Rhode Island Department of Health (RIDOH) conducted a multiagency investigation of a *Campylobacter jejuni* outbreak that was linked to the consumption of raw oysters; the first such outbreak was detected in Rhode Island. The environmental investigation identified birds as the likely source of contamination of the aquacultured oysters. As a result of this outbreak response, several investigative processes and best practice recommendations are offered. 1) RIDOH will be including exposure to raw shellfish as a question on their case report forms to better identify future oyster-related *Campylobacter* clusters. 2) It is important that shellfish aquaculture farms be aware of the risks of using floating gear to hold oyster cages and of the importance of using bird abatement to keep birds off floating aquaculture gear to prevent contamination of oysters from bird feces. 3) It should be recognized that fecal coliform water samples collected near an oyster aquaculture farm may not act as an adequate indicator for the presence of *Campylobacter*. 4) For the first time, Rhode Island has developed guidelines for the closure and reopening of oyster harvest areas due to contamination with *Campylobacter*. It is hoped that increased awareness and mitigation of the described risk factors will help prevent future similar outbreaks of illness.

Campylobacter spp., a bacterial pathogenic genus, is the most frequent bacterial source of diarrheal illness in the U.S., causing up to 1.5 million infections per year (Centers for Diseases Control and Prevention, 2019). *Campylobacter* species associated with human illness include *Campylobacter jejuni*; *Campylobacter coli*, and *Campylobacter lari*, although *Campylobacter jejuni* is associated with over 90% of illnesses (Centers for Disease Control and Prevention, 2021). Individuals with campylobacteriosis will often develop (frequently bloody) diarrhea, fever, abdominal cramping, nausea, and sometimes vomiting (Centers for Diseases Control and Prevention, 2019). On average, it takes 2–5 days for symptoms to develop after exposure to these bacteria, and symptoms typically last about 1 week (Centers for Diseases Control and Prevention, 2019). A small proportion of campylobacteriosis cases may go on to develop Guillain-Barre syndrome, which is often associated with muscle weakness and temporary paralysis, requiring medical attention (Centers for Diseases Control and Prevention, 2019).

Most *Campylobacter* illnesses in the U.S. are found to be sporadic as opposed to part of an identified outbreak. *Campylobacter* illness typically develops from exposure to water or food that has been contaminated with the pathogen or by contact with animals (Centers for Diseases Control and Prevention, 2019). Common foods associated with risk for *Campylobacter* infection include poultry, raw milk, seafood, and produce (Centers for Disease Control and Prevention, 2019). Despite the large burden of campylobacteriosis cases, outbreaks of campylobacteriosis are not as commonly reported as other enteric pathogens (Centers for Disease Control and Prevention, 2019).

From September to November 2021, the Rhode Island Department of Health (RIDOH) detected and responded to an outbreak of eight *Campylobacter* cases linked to Establishment A, a farm-to-table restaurant. This report describes Rhode Island's epidemiological, environmental, and laboratory investigations of a *Campylobacter* outbreak where raw oysters were confirmed as the food vehicle for transmission.

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Materials and methods

Epidemiological Investigation. On 9/2/2021, through routine interviews of two laboratory-confirmed illnesses, RIDOH identified a cluster of two unrelated campylobacteriosis cases who had both eaten at the same farm-to-table restaurant in Rhode Island, Establishment A. One interviewee reported that they had eaten there on 8/16/2021 with a party of nine and that a total of six individuals from the party were ill (Party A). The second interviewee reported eating there on 8/19/2021 with a party of four and stated that only one individual was ill (Party B). RIDOH reached out to the Connecticut Department of Public Health (CT DPH) to make them aware that some individuals from Party A were CT residents, and soon after, the CT DPH identified an additional *Campylobacter* case that had eaten raw oysters at Establishment A on 8/11/2021 (Party C). No other individuals from Party C were ill, and they were not available for an interview. RIDOH looked for additional related illnesses by combing social media sites for illness complaints (Facebook and Yelp), looking for mentions of Establishment A in the RIDOH Foodborne Illness Complaint System, and by asking the restaurant for any reported complaints. Interviews were conducted with all identified cases by telephone. A standard outbreak questionnaire was used to obtain information from cases, including the onset of illness, symptom details, exposure to foods at Establishment A, and contact with other ill individuals. A confirmed case was defined as an individual who tested positive for *Campylobacter* via laboratory culture of a clinical specimen. A probable case was defined as an individual who:

- 1.) Tested positive via a culture-independent diagnostic test (CIDT) from a clinical specimen (without a laboratory culture test); or
- 2.) An individual who was clinically compatible with a campylobacteriosis illness and who was epidemiologically linked to an individual who tested positive for *Campylobacter* either through CIDT or through culture. The case definition for this outbreak included confirmed and probable *Campylobacter* cases who visited Establishment A during August 2021, as all cases identified consumed oysters at Establishment A during this time period.

Environmental Investigation. Investigators from RIDOH performed an onsite environmental investigation at Establishment A. This included an onsite investigation to implement immediate control measures and an environmental assessment to identify the root cause of the outbreak. During the investigation, Environmental Health Food Specialists (EHFSs) collected environmental health data about any food safety hazards through observations and interviewed the staff to ensure there were no ill food workers. A food flow was conducted to review the preparation procedures and shucking process for the raw oysters. Oyster tags and invoices were collected to conduct a traceback of the shellfish that was consumed by the ill individuals. The traceback identified that the raw oysters consumed by the ill individuals were from Harvest Area A, an oyster farm in Rhode Island. On the initial visit to Establishment A on 09/3/2021, six oyster samples were collected by the EHFSs. Following the identification of raw oysters from Harvest Area A as a suspect vehicle, the Rhode Island Department of Environmental Management (RI DEM) performed an environmental assessment of the oyster farm and surrounding areas. This environmental assessment included the following components: a shoreline survey, an investigation of potential agricultural sources, a review of fecal coliform monitoring data, a review of phytoplankton monitoring data, a review of water and air temperatures, a review of recent rainfall, a review of the flushing rates of the harvest area, a review of mooring fields and marinas in the area, a review of wastewater treatment facilities in the area, a review of onsite wastewater treatment systems, a review of other potential pollution sources (including lack of bird mit-

igation), and an analysis of wild harvest shellfish. Historically, this harvest area had been observed to occasionally have birds flocking on the floating gear. Figure 1 shows an image that was taken of Harvest Area A the year prior to the outbreak. During the environmental assessment, an additional 22 shellfish samples that were harvested from Harvest Area A were collected between 09/09/2021 and 09/20/2021 as a collaboration between the Rhode Island Coastal Resources Management Council (CRMC), RI DEM, RIDOH, and the aquaculture lease holder.

Laboratory Investigation. Clinical samples ($n = 4$) were all initially collected and tested via CIDT at clinical laboratories. Once positive for *Campylobacter*, two of the specimens were sent to the Rhode Island State Health Laboratory (RISHL) for culturing of the pathogen, species identification, and further genetic testing via whole genome sequencing (WGS). One specimen was sent to the CT DPH for culturing of the pathogen, species identification, and further genetic testing via WGS. One specimen was only tested via CIDT. Environmental samples (oysters and water samples) were all sent directly to the RISHL upon collection in the field. Forty-eight oyster samples, six quahog samples, and three water samples were sent to the RISHL. Oyster samples and quahog samples were tested for *Campylobacter* and fecal coliform, and water samples were tested for fecal coliform. The FDA Bacteriological Analytical Manual method was used by the RISHL to isolate *Campylobacter* from the oyster samples that were collected (Food and Administration, 2021).

Results

Epidemiological Investigation. Eight *Campylobacter* cases were identified, three confirmed cases and five probable cases (Fig. 2); the confirmed cases were identified as *Campylobacter jejuni*. All eight individuals were interviewed by either RIDOH or the CT DPH (Table 1). All the ill individuals consumed raw oysters from Harvest Area A in Rhode Island. This was the only food exposure in common among all ill individuals. Thirty-eight percent of cases were female (3/8), and the median age was 53 years old (with a range of 23–75 years old). All cases reported diarrhea, and 50% of cases reported bloody diarrhea. Eighty-eight percent of cases reported a fever, 63% reported abdominal cramping, 63% reported nausea, and 38% reported vomiting. The median incubation period of illness onset after exposure to the raw oysters was 50.6 h ($n = 8$) with a range of 41–72 h, which is in alignment with the average incubation period of 2–5 days seen in most *Campylobacter* cases. The median illness duration among recovered cases was 11 days ($n = 5$). One individual developed Guillain-Barre syndrome approximately 2.5 weeks following exposure. This individual was hospitalized, with total duration of illness unknown.

Environmental Investigation. An environmental health investigation at the restaurant found no major deficiencies in food safety. A food flow was performed on the preparation process of raw oysters, and no food safety issues were observed. Through the investigation, it was determined that Party A only consumed one type of raw oysters at Establishment A, and these oysters were grown in Rhode Island. Party B and party C reported ordering an oyster sampler appetizer that also included these Rhode Island-grown oysters. Of the initial six shellfish samples that were collected at the restaurant during the environmental health investigation, one unshucked oyster tested positive for *Campylobacter lari* (Table 2). RIDOH, including the RISHL, and RI DEM put out a joint press release on September 11th, 2021 announcing the closure of Harvest Area A. Of the additional 22 shellfish samples that were collected during the investigation, seven unshucked oysters tested positive for *Campylobacter lari*, and one tested positive for *Campylobacter jejuni*. Two of the oyster samples were also found to have elevated fecal coliform levels (Table 2).



Figure 1. Image of Harvest Area A prior to bird abatement being implemented.

The single prevailing issue identified during the environmental assessment of the oyster farm was the presence of flocks of wild birds on the floating gear. The review of growing area conditions during summer and fall of 2021 found no evidence of widespread elevated fecal coliform in the water based on growing area water sample monitoring results. A shoreline survey update found no large fecal coliform shoreline sources flowing or potentially flowing into the growing area. There were no failed onsite wastewater treatment systems, and there

were no complaints about malfunctioning systems adjacent to the growing area during all of 2021. Investigation of nearby agricultural operations showed no potential farm animal sources of bacterial contamination. Phytoplankton data showed the absence of potentially harmful blooms. Water temperature and air temperatures were similar to those typically observed during prior years. Rainfall during July was approximately 1" above the long-term average, while August 2021 rainfall was slightly below average. Several large rainstorms of approx-

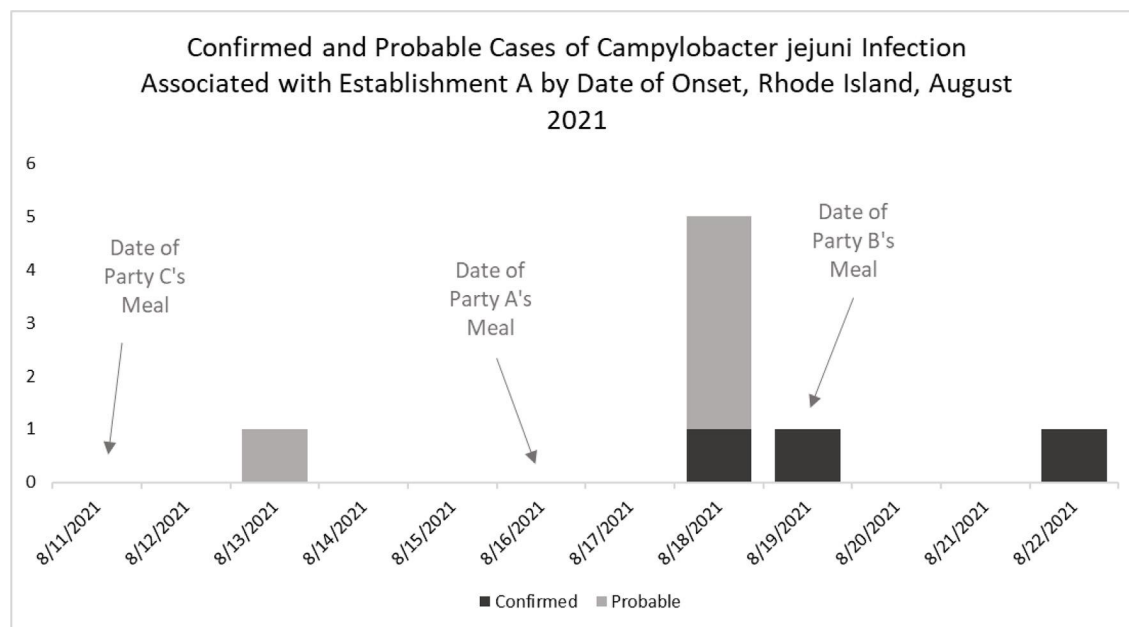


Figure 2. Confirmed and probable cases of *Campylobacter* infection associated with establishment a by date of onset, Rhode Island, August 2021.

Table 1

Demographic and clinical characteristics of confirmed and probable cases of *Campylobacter* Infection ($n = 8$)

Variable	Median	Range	<i>n</i>	%
Age (years)	53	23–75		
Sex				
Male			5	62.5
Female			3	37.5
Medical care				
Inpatient			1	12.5
Outpatient			5	62.5
Unknown			2	25.0
Symptoms				
Diarrhea			8	100
Bloody Diarrhea			4	50.0
Abdominal Cramping			5	62.5
Nausea			5	62.5
Fever			7	87.5
Vomiting			3	37.5
Incubation Period (hours)	50.6	41–72		
Duration (days) ($n = 5$)	11	8–15		

imately 2" or more passed through the area during July through early September 2021. Flocks of birds (cormorants and gulls) have frequently been observed on the lease in Harvest Area A and were found to be an unquantified source of potential shellfish contamination. Contamination of the growing area waters on the lease by flocks of birds roosting on floating gear and defecating in the lease was the presumed mechanism for *Campylobacter* contamination of the oysters. Analysis of wild shellfish (quahogs, *Mercenaria mercenaria*) harvested in the growing area outside the aquaculture lease showed an absence of *Campylobacter* and absence or very low levels of fecal coliform in shellfish tissue.

RIDOH and RI DEM met to discuss the reopening of the harvest area, along with the Rhode Island Coastal Resources Management Council (CRMC). The reopening criteria were as follows:

- 1.) A 2-week natural depuration time;
- 2.) Successful bird abatement;

3.) Three rounds of negative *Campylobacter* samples;

4.) Three rounds of fecal coliform levels below 230 MPN/100 g in the oysters; and

5.) Water samples that met fecal coliform guidelines.

There were no national guidelines available for closing or reopening shellfish harvest areas due to *Campylobacter* contamination by the U. S. Food and Drug Administration (FDA)'s National Shellfish Sanitation Program (NSSP). As such, the reopening criteria were developed in collaboration with the FDA and following some conversations with New York State Department of Health. Wild birds roosting on floating aquaculture gear in shallow aquaculture sites has recently been identified as a source of shellfish contamination in coastal New York (Barnes, 2019). The lease holder worked with CRMC and RI DEM to develop appropriate bird deterrent methods. They opted to remove the floating gear and thus sink oyster cages. After the 2-week natural depuration time, samples of shellfish from the aquaculture lease and wild harvest areas of the growing area were collected. With the help of CRMC, two oyster samples were collected on 10/12/2021, three oyster samples were collected on 10/18/2021, and five oyster samples were collected on 10/25/2021. Water samples were also collected at routine monitoring stations in the growing area to document fecal coliform levels (Table 3). All samples that were collected after bird abatement were implemented tested negative for *Campylobacter* and were found to have low fecal coliform levels. Analysis of aquaculture lease oysters demonstrated that oysters purged microbial contaminants (fecal coliform and *Campylobacter*) approximately 18 days after birds were cleared from the lease. Figure 3 shows an image of Harvest Area A after bird abatement was implemented. On 11/02/2021, the harvest area was reopened to shellfish harvest after a 52-day closure.

Laboratory Investigation. The two clinical samples that were sent to the RISHL for culturing and species identification were confirmed positive for *Campylobacter jejuni*. The specimen that was sent to the CT DPH was also culture-confirmed positive for *Campylobacter jejuni*. The RISHL and CT DPH performed further genetic testing via WGS and determined that two of the three clinical samples were closely related via WGS, and one of the clinical samples was not related.

Table 2

Sample results prior to bird abatement being implemented at Harvest Area A

Date Collected	Sample Type	Test Performed	Results	Accession Number
09/03/2021	RI Oyster	BAM_Campylobacter	Negative	PNUSAC023865
09/03/2021	RI Oyster	BAM_Campylobacter	<i>Campylobacter lari</i>	
09/03/2021	RI Oyster	BAM_Campylobacter	Negative	
09/03/2021	Shucked RI Oyster	BAM_Campylobacter	Negative	
09/03/2021	Shucked RI Oyster	BAM_Campylobacter	Negative	
09/03/2021	Shucked RI Oyster	BAM_Campylobacter	Negative	PNUSAC024022
09/09/2021	RI Oyster	BAM_Campylobacter	Negative	
09/09/2021	RI Oyster	BAM_Campylobacter	Negative	
09/09/2021	RI Oyster	BAM_Campylobacter	Negative	
09/09/2021	RI Oyster	BAM_Campylobacter	Negative	
09/09/2021	RI Oyster	BAM_Campylobacter	Negative	
09/09/2021	RI Oyster	BAM_Campylobacter	Negative	
09/09/2021	RI Oyster	BAM_Campylobacter	Negative	
09/09/2021	RI Oyster	BAM_Campylobacter	Negative	
09/09/2021	RI Oyster	BAM_Campylobacter	Negative	
09/09/2021	RI Oyster	BAM_Campylobacter	Negative	
09/09/2021	RI Oyster	BAM_Campylobacter	<i>Campylobacter lari</i>	
09/09/2021	RI Oyster	BAM_Campylobacter	<i>Campylobacter lari</i>	
09/09/2021	RI Oyster	BAM_Campylobacter	<i>Campylobacter lari</i>	
09/09/2021	RI Oyster	BAM_Campylobacter	<i>Campylobacter jejuni</i>	
09/09/2021	RI Oyster	BAM_Campylobacter	<i>Campylobacter lari</i>	
09/13/2021	RI Oyster	BAM_Campylobacter	<i>Campylobacter lari</i>	PNUSAC024027
09/13/2021	RI Oyster	BAM_Campylobacter	Negative	
09/13/2021	RI Oyster	BAM_Campylobacter	Negative	
09/13/2021	RI Oyster	BAM_Campylobacter	<i>Campylobacter lari</i>	
09/13/2021	RI Oyster	BAM_Campylobacter	Negative	
09/13/2021	RI Oyster	BAM_Campylobacter	Negative	PNUSAC024028
09/13/2021	RI Oyster	BAM_Campylobacter	<i>Campylobacter lari</i>	
09/13/2021	RI Oyster	BAM_Campylobacter	Negative	
09/13/2021	RI Oyster	BAM_Campylobacter	Negative	
09/13/2021	RI Oyster	BAM_Campylobacter	Negative	
09/20/2021	RI Oyster	BAM_Campylobacter	<i>Campylobacter lari</i>	PNUSAC0335cce98
09/20/2021	RI Oyster	BAM_Campylobacter	Negative	
09/20/2021	RI Oyster	Fecal Coliform	1700 MPN/100 g	
09/20/2021	RI Oyster	Fecal Coliform	3500 MPN/100 g	

Table 3

Sample Results After Bird Abatement was Implemented at Harvest Area A

Date Collected	Sample Type	Test Performed	Results
10/12/2021	RI Quahog	Fecal Coliform	< 20 MPN/100 g
10/12/2021	RI Oyster	Fecal Coliform	20 MPN/100 g
10/12/2021	RI Oyster	Fecal Coliform	78 MPN/100 g
10/12/2021	RI Quahog	BAM_Campylobacter	Negative
10/12/2021	RI Oyster	BAM_Campylobacter	Negative
10/12/2021	RI Oyster	BAM_Campylobacter	Negative
10/18/2021	RI Oyster	BAM_Campylobacter	Negative
10/18/2021	RI Oyster	BAM_Campylobacter	Negative
10/18/2021	RI Oyster	BAM_Campylobacter	Negative
10/18/2021	RI Quahog	BAM_Campylobacter	Negative
10/18/2021	RI Quahog	BAM_Campylobacter	Negative
10/18/2021	RI Oyster	Fecal Coliform	230 MPN/100 g
10/18/2021	RI Oyster	Fecal Coliform	110 MPN/100 g
10/18/2021	RI Oyster	Fecal Coliform	68 MPN/100 g
10/18/2021	RI Quahog	Fecal Coliform	78 MPN/100 g
10/18/2021	RI Quahog	Fecal Coliform	68 MPN/100 g
10/25/2021	RI Oyster	BAM_Campylobacter	Negative
10/25/2021	RI Oyster	BAM_Campylobacter	Negative
10/25/2021	RI Oyster	BAM_Campylobacter	Negative
10/25/2021	RI Oyster	BAM_Campylobacter	Negative
10/25/2021	RI Oyster	Fecal Coliform	< 20 MPN/100 g
10/25/2021	RI Oyster	Fecal Coliform	< 20 MPN/100 g
10/25/2021	RI Oyster	Fecal Coliform	20 MPN/100 g
10/25/2021	RI Oyster	Fecal Coliform	20 MPN/100 g
10/25/2021	RI Oyster	Fecal Coliform	20 MPN/100 g

The two clinical samples that were closely related were both from Party A (Fig. 4). Prior to bird abatement being implemented, twenty-eight samples were collected and tested at the RISHL (Table 2). Twenty-six samples were tested for *Campylobacter*, and two samples were tested for fecal coliform. Eight of those samples were culture-confirmed positive for *Campylobacter*. One of those samples was identified as *Campylobacter jejuni*, and the other seven samples were identified as *Campylobacter lari*. The other seventeen samples tested for *Campylobacter* were negative. The two samples tested for fecal col-

iform had levels above 230 MPN/100 g. The sample that tested positive for *Campylobacter jejuni* was an oyster sample, and it was determined via WGS that it was not related to any of the clinical samples (Fig. 4). Table 2 provides the results for the positive samples that were collected before bird abatement was implemented and includes accession numbers for positive samples. After bird abatement was implemented, 26 samples were collected and tested at the RISHL. All samples were negative for *Campylobacter*, and fecal coliform levels were below 230 MPN/100 g. Table 3 provides the sample results that were collected after bird abatement was implemented.

Discussion

Based on the epidemiological, laboratory, and environmental evidence, *Campylobacter jejuni* was identified as the etiology for this outbreak, and raw oysters were identified as the confirmed food vehicle. The laboratory investigation was able to identify *Campylobacter* in four individuals, while the incubation period (50.6 h), symptoms, and duration of illness identified for all cases during the epidemiological investigation were consistent with *Campylobacter* illness. The epidemiological investigation was able to identify that all cases consumed raw oysters, and environmental staff confirmed at the establishment that all oysters consumed by the cases were grown in Harvest Area A. Environmental and laboratory staff collected and tested oysters from Harvest Area A, and *Campylobacter jejuni* and *Campylobacter lari* were identified in these oysters via culture confirmation.

This is the first *Campylobacter* outbreak linked to oysters that was detected in Rhode Island. According to the CDC's National Outbreak Reporting System, since the 1970s, there have been 996 outbreaks detected in the U.S. that were due to *Campylobacter* (Centers for Disease Control and Prevention, n.d.). Of these, only twelve (1.2%) were confirmed or suspected of having shellfish as a source of the outbreak (Centers for Disease Control and Prevention, n.d.). Oysters and other shellfish are not a food that is commonly highlighted as high risk for *Campylobacter* contamination. As such, exposure to this food item might not commonly be included as a question on the case report



Figure 3. Image of Harvest Area A after bird abatement was implemented.

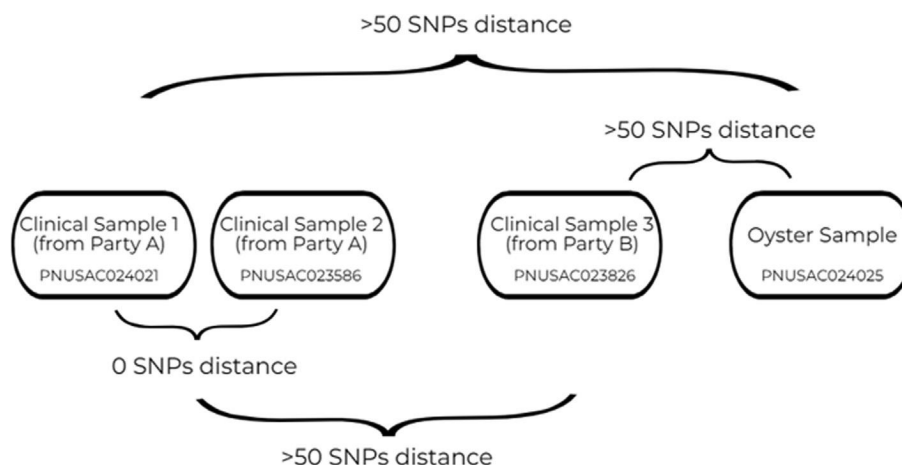


Figure 4. Genetic variation of genetically sequenced clinical and environmental samples related to the investigation shown by distance between single nucleotide polymorphisms (SNPs).

forms/interview forms that state and local health departments use when interviewing laboratory-identified *Campylobacter* cases. Following the response to this outbreak, RIDOH will be including exposure to raw shellfish as a question on their case report forms to better identify future oyster-related *Campylobacter* clusters. It is recommended that other state and local health department consider doing this as well, if not already included.

The environmental investigation identified birds as the likely source of contamination of the oysters. There were no other sources of contamination identified, and once the source of bird feces contamination had been removed from the oyster beds and 2 weeks of depuration had been completed, *Campylobacter* and elevated fecal coliform levels were no longer identified in the oyster meats through laboratory testing. *Campylobacter* is a bacterium that is known to reside in the gastrointestinal tracts of birds, chickens, ducks, and gulls, as well as other types of wild, farm, and domestic animals (Facciola et al., 2017; Hughes et al., 2009). *Campylobacter jejuni* is more commonly associated with human illness than *Campylobacter lari*, possibly due to pathogenicity (Facciola et al., 2017). It is also suspected that *Campylobacter lari* is more likely to survive in the environment, which possibly explains why the majority of the positive shellfish samples tested positive for *Campylobacter lari* (Facciola et al., 2017; Hughes et al., 2009; Rosef et al., 2001). Limited information is known about the genetic diversity of *Campylobacter jejuni* (Llarena et al., 2017). It is

hypothesized that the *Campylobacter jejuni* clinical isolates from separate exposure events and the environmental isolate were not related via WGS due to the genetic variability within the species and the likelihood that the isolates originated from different individual birds. Indeed, the strong epidemiologic and environmental evidence suggests oysters were the food vehicle and that bird feces were the source of contamination.

Wild bird feces are a vehicle that can easily transmit these bacteria into the environment from the birds' intestinal tracts (Facciola et al., 2017). For example, one study in New Zealand tested wild bird feces collected in children's playgrounds and found *Campylobacter jejuni* in 12.5% of samples (French et al., 2009). A previous outbreak of *Campylobacter jejuni* in Washington State in 1991 also found that fecal matter from wild birds was a suspected source of contamination (Abeyta et al., 1993). As such, it is important that shellfish aquaculture farms are aware of the risks of fecal contamination from wild birds, and as was identified in this outbreak, of the risks of using floating gear to hold oyster cages. If using floating gear, it is important to keep bird abatement on the floatation devices under control to prevent contamination of oysters through bird feces. The risk of contamination and the ability for *Campylobacter* to survive given the characteristics of the water (e.g., salinity, temperature, etc.) in a particular aquaculture harvest location may need to be considered. This is an area that could merit further research.

It should also be considered that fecal coliform water samples collected near the oyster aquaculture farm did not act as an adequate indicator to the *Campylobacter* that had contaminated the oyster meats. Some studies have shown that fecal coliform often has not been found to be an adequate indicator of *Campylobacter* contamination (Rosef et al., 2001; Wilson and Moore, 1996). Surveillance testing conducted as part of this outbreak's environmental investigation did, however, find that there were elevated fecal coliform found in the oyster meats prior to our control measure (i.e., sinking the oyster cages), and that these levels decreased to acceptable levels after 2 weeks of depuration. Use of fecal coliform levels in shellfish meats as a possible indicator of *Campylobacter* contamination is an area that could merit further research.

For the first time, Rhode Island has developed guidelines for the closure and reopening of oyster harvest areas due to the contamination of *Campylobacter*. Since there were no national criteria available for use, this report serves as an example for other states to use and provides a recommendation to national regulatory bodies to develop guidelines that can assist states with the response of *Campylobacter* outbreaks linked to shellfish growing area.

This report describes a confirmed outbreak of *Campylobacter jejuni* where raw oysters were confirmed as the food vehicle. This provides additional evidence that shellfish consumption should be considered when assessing the source of *Campylobacter* illness, and that wild bird fecal contamination can present a health risk through the contamination of raw oysters.

Credit authorship contribution statement

Genevieve Caron: Writing – original draft. **Brendalee Viveiros:** . **Christopher Slaten:** . **David Borkman:** . **Adam Miller:** . **Richard C. Huard:** .

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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