

Vibrios

Cholera is a Class A Disease and must be reported to the state within 24 hours by calling the phone number listed on the web page.

Non-cholera Vibrio infections are Class C Diseases and must be reported to the state within five business days. All Vibrio cultures should be sent to the State Public Health Laboratory for confirmation.

Epidemiology

All *Vibrio* species infections were added to the list of nationally notifiable diseases in January, 2007. *Vibrios* are Gram-negative, curved, rod-shaped bacteria that are natural inhabitants of the marine environment. In the United States, the transmission of *Vibrio* infection is primarily through the consumption of raw or under-cooked shellfish or by exposure of wounds to warm seawater or seafood drippings.

The most common clinical presentation of *Vibrio* infection is self-limited gastroenteritis. Many cases of *Vibrio*-associated gastroenteritis are under-recognized. This is because most clinical laboratories do not routinely use the selective medium, thiosulfate-citrate-bile-salts-sucrose (TCBS) agar, for processing of stool specimens unless they are specifically requested to do so.

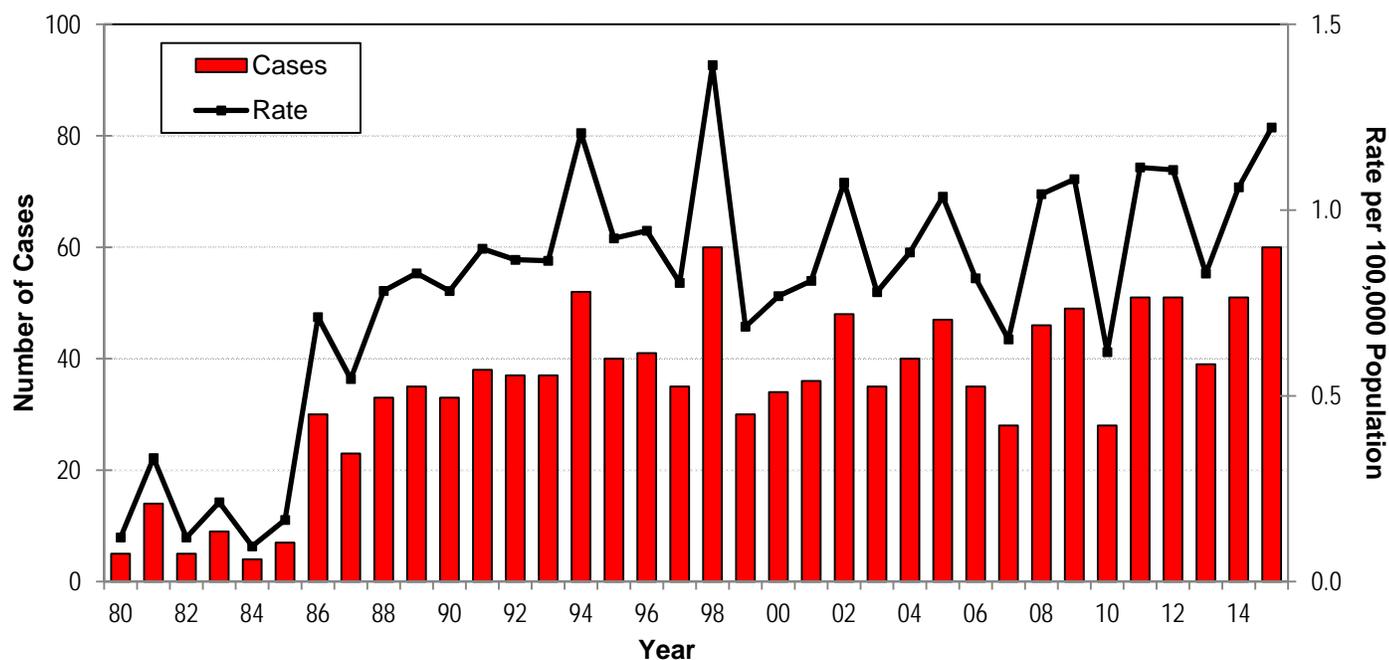
Wound infections and primary septicemia also occur, particularly for *Vibrio vulnificus*. Patients with liver disease and those who are immunocompromised are at a particularly high risk for significant morbidity and mortality associated with these infections. Early detection and initiation of treatment is very important, particularly for cholera and invasive *Vibrio* infections, because these infections may rapidly progress to death.

According to the Centers for Disease Control and Prevention (CDC), there is an average of 215 culture-confirmed *Vibrio parahaemolyticus* cases, 30 hospitalizations, and one to two deaths reported each year nationwide. They estimate the true number of cases a year to be 4500, most not culture-confirmed. Each year there is an average of 50 culture-confirmed *Vibrio vulnificus* cases, 45 hospitalizations, and 16 deaths reported from the Gulf Coast states (Alabama, Florida, Louisiana, Mississippi and Texas). There are as many as 95 cases nationwide (only half are culture-confirmed), 85 hospitalizations and 35 deaths.

Incidence

The number of reported *Vibrio* infections has remained fairly stable over the past 20 years, ranging from 20 to 60 cases per year (Figure 1).

Figure 1: Cases and incidence rates - Louisiana, 1980-2015



The most common *Vibrio* species observed in reported cases in Louisiana is *V. vulnificus* (28%), followed by *V. parahaemolyticus* (23%), *V. cholerae non O1* (18%), and all other *Vibrios*. (All other *Vibrios* include *V. alginolyticus*, *V. damsela*, *V. fluvialis*, *V. hollisae* and *V. mimicus*). *Vibrio cholerae O1* accounts for approximately 2.1% of total *Vibrio* cases (Table 1).

Table 1: *Vibrio* species distribution - Louisiana, 1980-2015

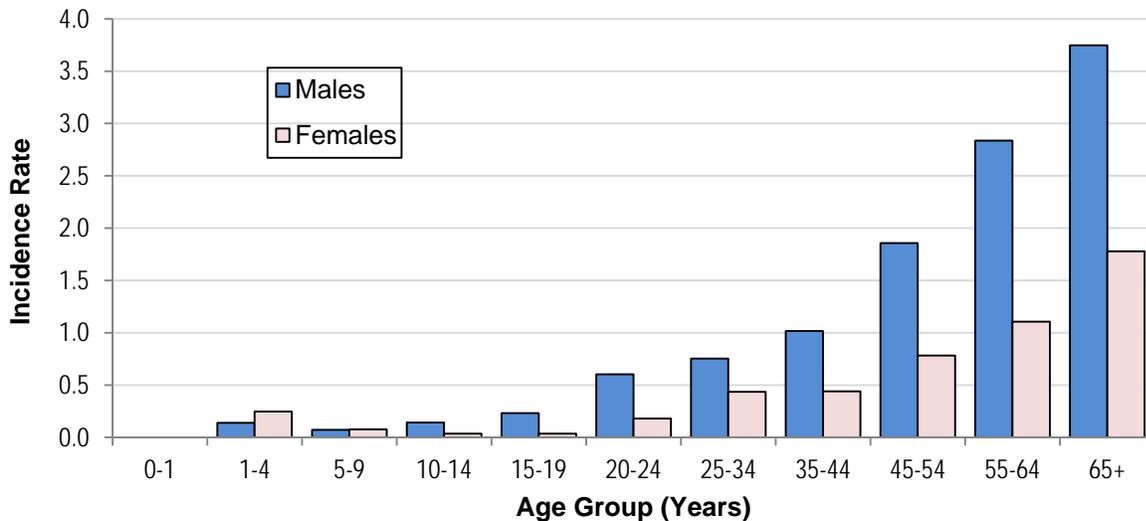
		1980-1989	1990-1999	2000-2009	2010-2015	Total
<i>Vibrio cholerae</i>	<i>Cholerae O1</i>	7	8	10	0	25
	<i>Cholerae O1 no Tox</i>	0	3	5	1	9
	<i>Cholerae O75</i>	0	0	3	3	6
<i>Vibrio parahaemolyticus</i>		33	94	111	57	295
<i>Vibrio vulnificus</i>		54	94	128	76	352
Vibrio other	<i>Cholerae non O1 non O139</i>	41	72	54	62	229
	<i>Alginolyticus</i>	3	18	11	5	37
	<i>Damsela</i>	2	6	1	0	9
	<i>Fluvialis</i>	4	24	24	36	88
	<i>Furnisii</i>	0	0	1	0	1
	<i>Hollisae</i>	2	13	9	7	31
	<i>Mimicus</i>	10	36	39	25	110
	Multiple	4	12	0	8	24
	Species - not identified	15	38	5	5	63
	Subtotal		77	207	144	140
Total		171	407	401	277	1255

Age, Gender, and Race Distribution

Since the distribution is similar for all *Vibrio* cases, the following discussion describes all *Vibrio* species combined.

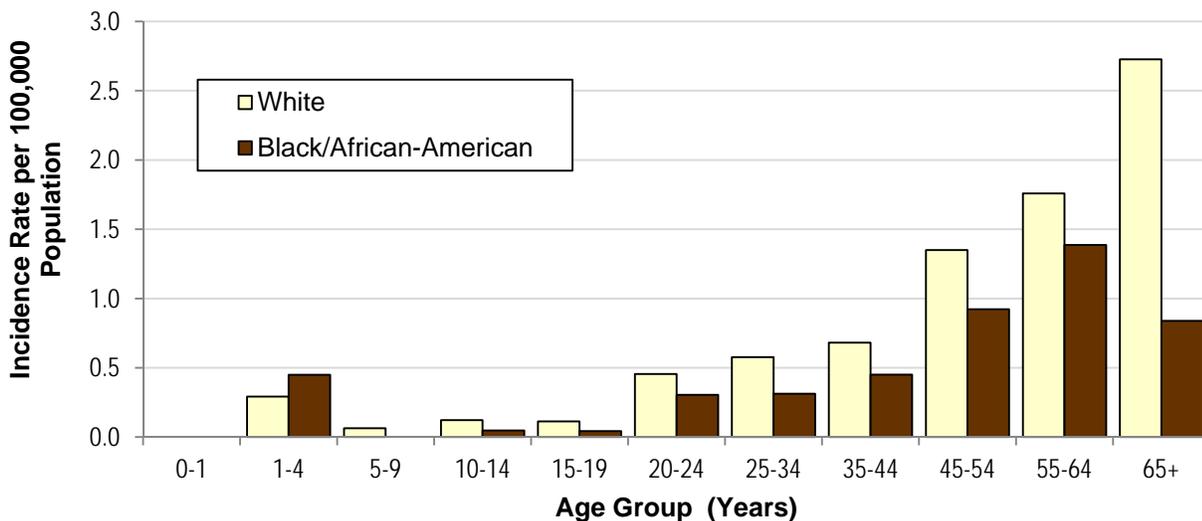
The age group distribution shows an increase in *Vibrio* cases in older age groups. This is an expected finding since adults and older people are more often in contact with seawater, and are the most common consumers of raw seafood (Figure 2).

Figure 2: *Vibrio* annual incidence rates by gender and age - Louisiana, 2000-2015



The race distribution shows a predominance of *Vibrio* infection among Whites in the oldest age group and African-Americans in the one-to-four-year age group (Figure 3).

Figure 3: *Vibrio* annual incidence rates by race and age - Louisiana, 2000-2015



Geographical Distribution

The **geographical distribution** of *Vibrio* cases shows the highest concentrations in southern Louisiana and the large cities. This is possibly due to easy access to fresh seafood, proximity to beaches, and water activity. This distribution reflects the cultural patterns of raw seafood consumption (Table 2).

Table 2: *Vibrio* cases per Region/Parish - Louisiana, 1980-2015

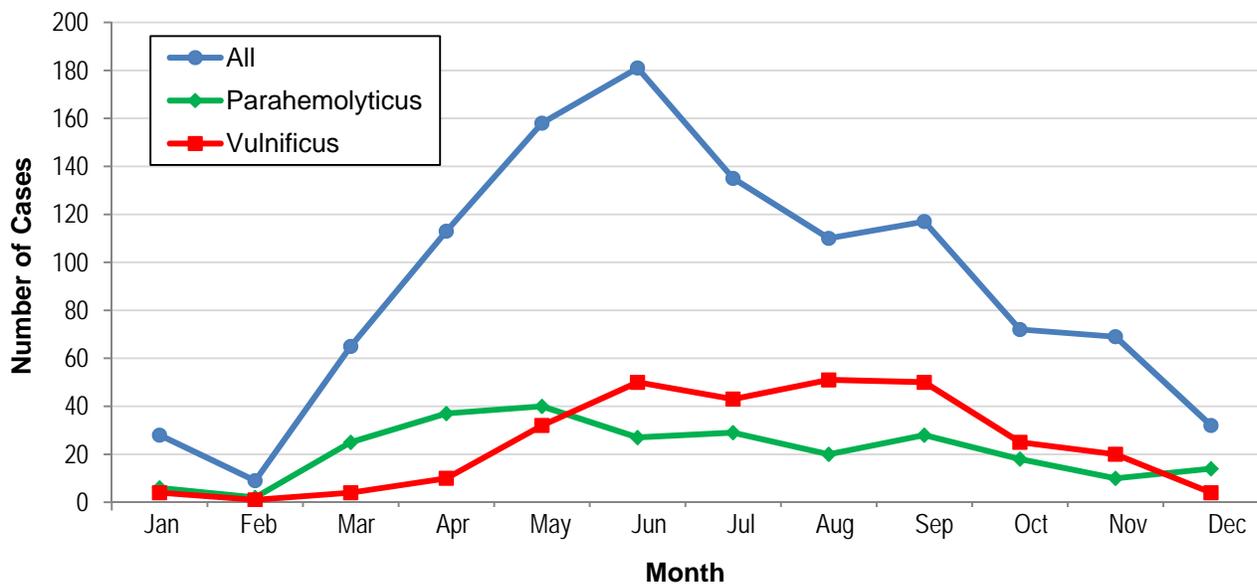
Region	Parish	Cases 1980- 1989	Cases 1990- 1999	Cases 2000- 2009	Cases 2010- 2015	Cases 1980- 2015	Incidence 1980- 2015
1	JEFFERSON	43	94	46	26	209	1.28
	ORLEANS	51	78	63	23	215	1.37
	ST. BERNARD	4	18	17	8	47	2.29
	PLAQUEMINES	7	7	5	5	24	2.72
2	EAST BATON ROUGE	7	17	16	21	61	0.42
	ASCENSION	0	4	4	4	12	0.44
	WEST BATON ROUGE	0	1	3	3	7	0.93
	IBERVILLE	1	1	1	7	10	0.97
	POINTE COUPEE	0	0	0	2	2	0.24
	EAST FELICIANA	0	1	0	1	2	0.28
	WEST FELICIANA	0	2	1	0	3	0.71
3	TERREBONNE	1	46	37	35	115	3.16
	LAFOURCHE	7	14	34	16	71	2.18
	ST. CHARLES	3	4	8	4	19	1.10
	ST. JOHN	0	4	2	3	9	0.57
	ST. JAMES	0	4	6	2	12	1.70
	ST. MARY	1	3	1	1	6	0.32
	ASSUMPTION	0	2	1	2	5	0.61
4	LAFAYETTE	3	9	30	23	65	0.97
	IBERIA	2	10	7	2	21	0.89
	ACADIA	1	3	4	2	10	0.52
	VERMILION	2	6	2	5	15	0.78
	ST. LANDRY	1	4	3	3	11	0.39
	ST. MARTIN	0	6	1	2	9	0.54
	EVANGELINE	0	0	0	0	0	0
5	CALCASIEU	2	9	14	12	37	0.56
	CAMERON	1	1	2	1	5	1.71
	ALLEN	2	1	1	0	4	0.53
	BEAUREGARD	1	0	1	2	4	0.35
	JEFFERSON DAVIS	0	0	1	2	3	0.27
6	RAPIDES	0	2	1	3	6	0.13
	AVOUELLES	3	1	1	1	6	0.44
	VERNON	1	0	0	0	1	0.05
	GRANT	0	0	1	0	1	0.16
	LA SALLE	0	0	0	0	0	0
	CATAHOULA	0	0	0	0	0	0
	CONCORDIA	0	0	0	1	1	0.14
7	CADDO	3	3	4	1	11	0.12
	DESOTO	0	0	0	1	1	0.11
	BIENVILLE	2	0	1	0	3	0.56
	SABINE	0	0	0	0	0	0

	NATCHITOCHEs	0	0	0	0	0	0
	RED RIVER	0	0	0	0	0	0
	BOSSIER	0	0	2	4	6	0.17
	WEBSTER	1	0	2	1	4	0.27
	CLAIBORNE	0	0	0	0	0	0
8	OUACHITA	3	1	3	2	9	0.17
	CALDWELL	0	0	0	1	1	0.29
	EAST CARROLL	0	0	0	0	0	0
	WEST CARROLL	0	0	0	0	0	0
	FRANKLIN	1	0	0	0	1	0.14
	JACKSON	0	1	0	0	1	0.19
	LINCOLN	0	2	0	0	2	0.14
	MADISON	0	0	0	1	1	0.23
	MOREHOUSE	0	0	1	0	1	0.09
	RICHLAND	0	0	0	0	0	0
	TENSAS	0	0	0	0	0	0
	UNION	0	0	0	0	0	0
	WINN	0	0	0	0	0	0
9	ST. TAMMANY	7	34	35	34	110	1.65
	TANGIPAHOA	1	9	9	5	24	0.67
	LIVINGSTON	0	0	9	5	14	0.45
	ST. HELENA	0	0	0	1	1	0.29
	WASHINGTON	2	1	6	3	12	0.75

Seasonal Distribution

Cases reported by month of illness onset show a definite seasonal pattern (Figure 4).

Figure 4: *Vibrio* cases by month of occurrence - Louisiana, 1988-2015



For all *Vibrio* species, there are few cases from December to February; the numbers increase progressively to reach a peak in June. There is a slight difference in seasonality by species. *Vibrio parahaemolyticus* transmission starts earlier than *Vibrio vulnificus* transmission.

Clinical Presentation

The clinical presentation is highly dependent on the *Vibrio* species. Gastroenteritis is the most common clinical presentation, followed by wound infection and septicemia. *Vibrio cholerae* O1 causes almost exclusively gastroenteritis; *Vibrio parahaemolyticus* and the other *Vibrios* cause mostly gastroenteritis, and some wound infections; *Vibrio vulnificus* causes mostly wound infections followed by septicemia and very few gastroenteritis cases (Table 3).

Table 3: Clinical presentation by *Vibrio* group - Louisiana, 1988-2015

Clinical Presentation	Total	<i>V. vulnificus</i>	<i>V. parahaemolyticus</i>	<i>V. cholerae</i> -O1	<i>Vibrio</i> Other
Gastroenteritis	504	14	152	20	318
Wound Infection	212	132	43	0	37
Septicemia	133	91	11	2	29
Undetermined	305	73	69	6	157
Total Cases	1154	310	275	28	541
Death	70	53	5	0	14
Percent	6.1	17.1	2.5	0	2.6

Most *Vibrio* infections have a good prognosis with the exception of *Vibrio vulnificus*.

Exposure

Seafood consumption accounts for 62% of exposure; 38% comes from exposure of the skin to surface waters, particularly seawater. Exposure is dependent on the *Vibrio* species. Most *Vibrio* infections are foodborne with the exception of *Vibrio vulnificus* for which exposure to seawater is a major exposure factor (Table 4).

Table 4: Exposure type by *Vibrio* group - Louisiana, 1988-2015

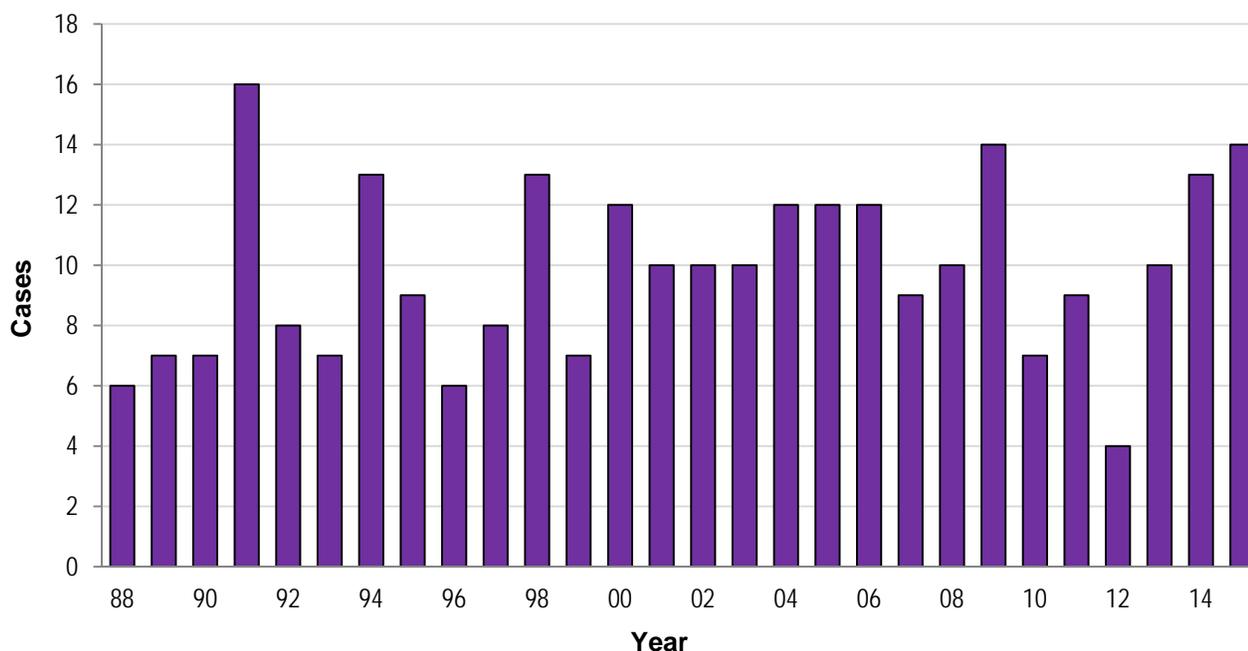
Exposure	Total	Percentage	<i>V. vulnificus</i>	<i>V. parahaemolyticus</i>	<i>V. cholerae</i> -O1	<i>Vibrio</i> other
Skin exposure						
Seawater/Wound	135	22.7	96	27	0	12
Seawater/Unspecified	25	4.2	18	3	2	2
Floodwater/Other surface water	19	3.	15	0	0	4
Dripping/Wound	31	5.2	16	7	1	7
Crab bite	8	1.3	6	1	0	1
Subtotal	218	36.6	151	38	3	26

Exposure	Total	Percentage	<i>V. vulnificus</i>	<i>V. parahaemolyticus</i>	<i>V. cholerae</i> -O1	<i>Vibrio</i> other
Food Consumption						
Oyster/Raw	89	15.0	18	19	3	49
Oyster/Raw/Shellfish	48	8.1	7	7	4	30
Oyster/Shellfish Cooked	5	0.8	0	1	0	4
Shellfish/Cooked	182	30.6	13	52	13	104
Shellfish/Raw	41	6.9	6	18	0	17
Oysters/Cooked	12	2.0	1	6	0	5
Subtotal	377	63.5	45	103	20	209
Grand Total	595		196	141	23	235

Vibrio parahaemolyticus

Vibrio parahaemolyticus represents about 20% of *Vibrio* infections. The number of reported cases of *V. parahaemolyticus* has varied over the last five years (Figure 5).

Figure 5: *Vibrio parahaemolyticus*, annual cases - Louisiana, 1988-2015



Most cases of *Vibrio parahaemolyticus* present as simple gastroenteritis (73%), wound infections (21%), or rarely septicemia (6%), (Table 3). Hospitalizations and deaths are rare. Everyone is susceptible to gastroenteritis due to a *Vibrio parahaemolyticus* infection.

Consumption of crustacean and molluscan shellfish is commonly implicated in the transmission of *V. parahaemolyticus*. Raw oysters are another source of foodborne *V. parahaemolyticus* infection.

- About 25% of patients with *V. parahaemolyticus* gastroenteritis with known food history, reported eating raw oysters alone or with other seafood. Studies indicate that the infectious

dose of *V. parahaemolyticus* is greater than one million viable cells ingested. This dose may be lowered in case of consumption of antacids or food with buffering capacity, at the same time as ingestion of the infectious dose.

- Another 56% reported eating cooked seafood. Of those reporting cooked seafood consumption, the most common items reported were:
 - shrimp
 - crawfish
 - crabs
 - cooked oysters

Note: some cases reported eating more than one cooked seafood item.

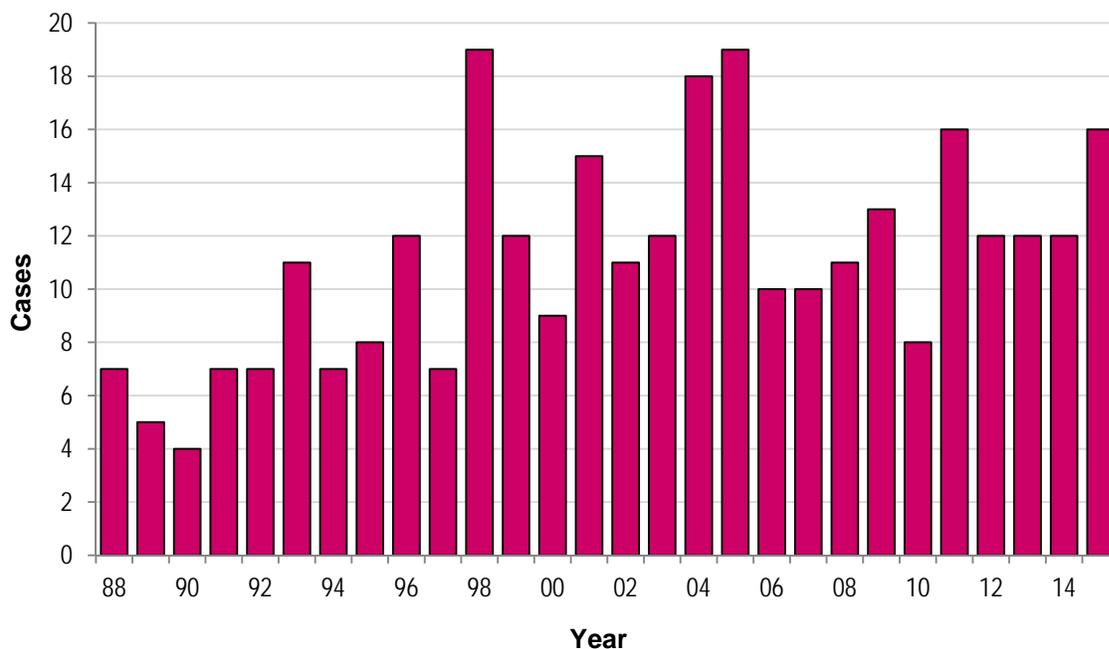
- Finally, 27% of all *Vibrio parahaemolyticus* cases did not consume seafood but had skin exposure to sea or brackish water.

Vibrio vulnificus

V. vulnificus is the most important pathogenic *Vibrio* in the U.S. because of its invasiveness and the high fatality rates associated with infection. It was first identified and described by the CDC in 1976 and has become a cause of seafood-associated deaths in the United States.

Over the last ten years, the number of reported *V. vulnificus* cases has ranged from 8 to 19 cases (Figure 6).

Figure 6: *Vibrio vulnificus*, annual cases - Louisiana, 1988-2015



The most common clinical presentation is a wound infection (56%) followed by septicemia (38%) with the least common being gastroenteritis (6%).

About 91% of patients infected by *Vibrio vulnificus* had one or more medical risk factors. *Vibrio vulnificus* occurs almost exclusively among immunocompromised patients or patients with end-stage liver failure. With increasing survival rates of this susceptible population, it is expected that the number of infections will also continue to increase.

High-risk conditions are: chronic liver disease, hemochromatosis, diabetes, cancers (particularly those on chemo or radio-therapy), leukemia, lymphoma, Hodgkin's, immune suppression (such as HIV), long term steroid use, alcoholism, chronic kidney disease and being elderly. The virulence of *V. vulnificus* in humans is associated with the availability of iron. Patients with increased iron stores, such as is seen in hemochromatosis, alcoholic liver disease, or hemolytic anemia, are susceptible to septicemia (mostly fatal) with *V. vulnificus*. The organism is unable to use transferrin-bound iron for growth; however, in patients with iron overload and transferrin saturation of 75% or higher, free iron is available for use by the organism. Other studies have shown that invasive disease caused by *V. vulnificus* could also be due to resistance to host phagocytic defense mechanisms. Disorders such as diabetes and HIV have been shown to be associated with defects in phagocytosis.

Among individuals with *V. vulnificus* infections, medical risk factors observed were:

- Severe chronic liver disease 21 %
- Diabetes 18 %
- Chronic alcoholism 13 %
- Kidney failure 13 %
- Malignancy 7 %
- Antacid use 5 %
- H2 blocker use 10 %
- Systemic steroid use 5%

The clinical presentation of *Vibrio vulnificus* infection is dependent on the type of exposure to the bacteria (Table 5).

Table 5: Exposure* and clinical presentation for *Vibrio vulnificus*-Louisiana, 1988-2015

Exposure	Wound Infection		Septicemia		Gastroenteritis	
	Number	Percentage	Number	Percentage	Number	Percentage
Contact with sea/surface water	99	54.4	36	19.9	2	8.7
Seafood drippings on skin	48	26.4	31	17.1	2	8.7
Raw/cooked shellfish	24	13.2	59	32.6	10	43.5
Raw oysters alone/with seafood	11	6.0	55	30.4	9	39.1
Total with known exposures	182		181		23	

*Multiple exposures were reported for some cases.

Other Non-Cholerae Vibrios

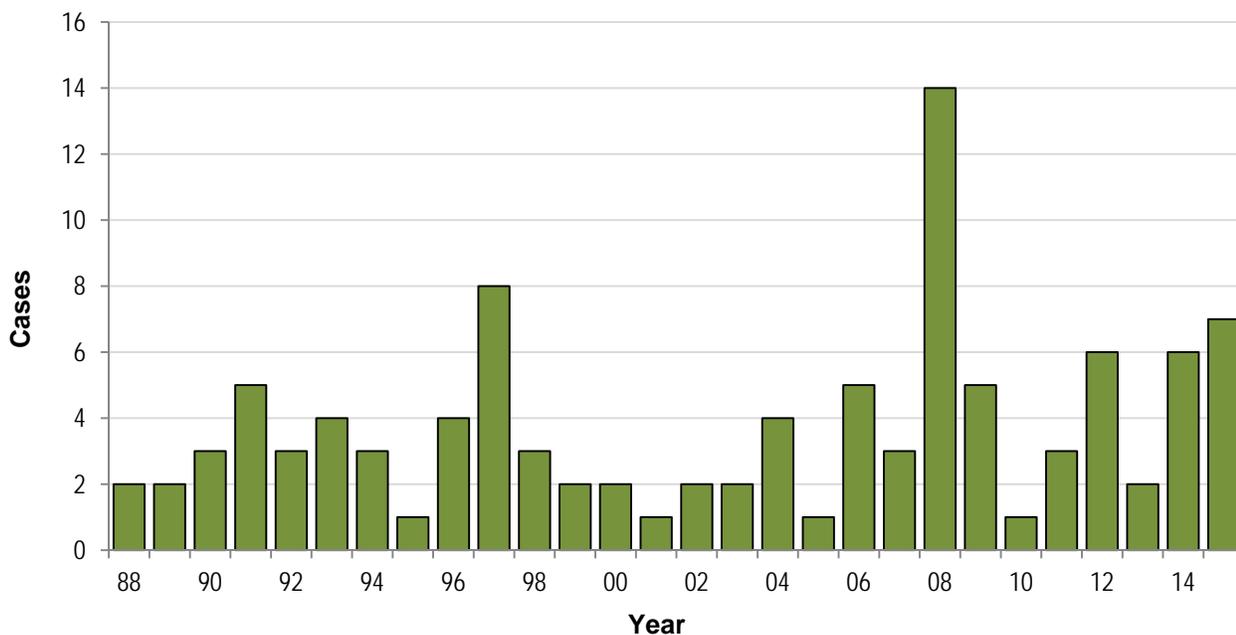
The increase in reported numbers of other non-cholerae *Vibrios* is attributed to increased awareness among medical providers and laboratory testing.

V. alginolyticus is a halophilic *Vibrio*, first recognized as being pathogenic in humans in 1973. Wound

infections account for most of *V. alginolyticus* infections; ear infections are also seen with this organism. Gastroenteritis is thought to be a rare presentation of *V. alginolyticus* infection. Other clinical syndromes reported in association with *V. alginolyticus* infection include chronic diarrhea in a patient with AIDS, conjunctivitis and post-traumatic intracranial infection. Resistance to tetracycline and chloramphenicol has been reported in a few isolates of *V. alginolyticus*, but all strains appear to be sensitive to ciprofloxacin. There is on average, one case reported in Louisiana each year.

V. mimicus is a non-halophilic *Vibrio* named according to its similarity to *V. cholerae*. *V. mimicus*, and as human pathogen, can cause sporadic episodes of acute gastroenteritis and ear infections. It was the most frequently reported *Vibrio* serotype in 2008 with 14 cases (30%), (Figure 7).

Figure 7: *Vibrio mimicus* cases – Louisiana, 1988-2015

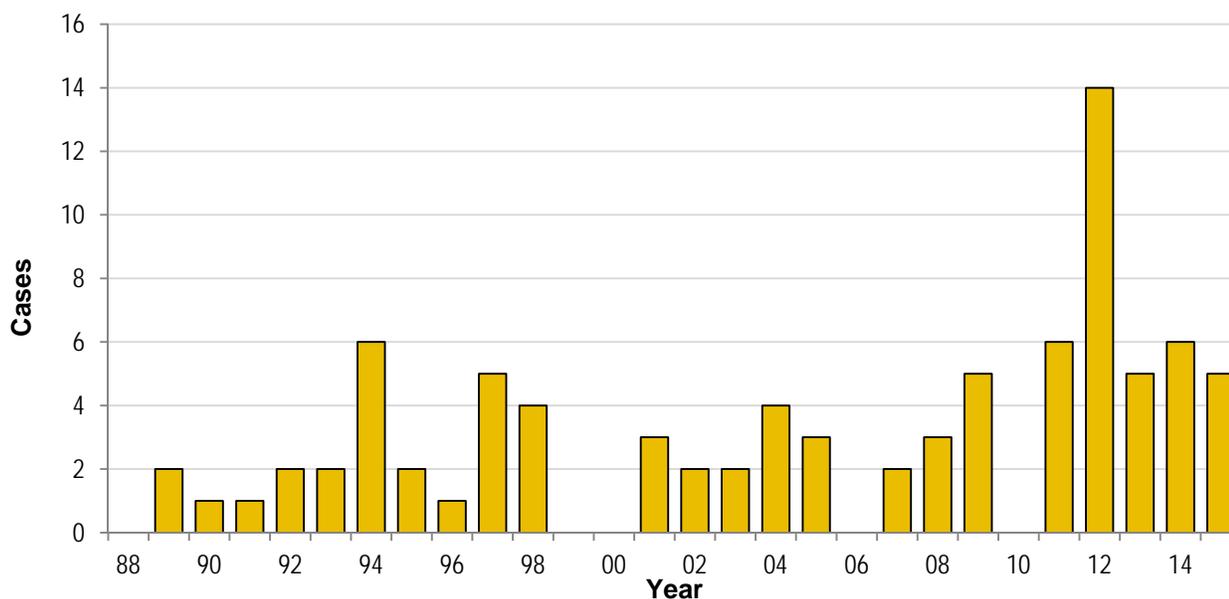


V. mimicus is an etiological agent of sporadic watery diarrhea and food poisoning after the consumption of raw or cooked fish or shellfish. Eighty-five percent of *V. mimicus* cases reported in 2008 were related to the consumption of cooked fish or cooked shellfish.

V. mimicus can produce enterotoxins which are virtually identical to the Cholera toxin (CT), produced by *V. cholerae*. In 2008, 71% (ten) of the isolates were tested at the CDC; six isolates showed the presence of CT using Polymerase chain reaction (PCR). Pulse-field gel electrophoresis (PFGE) was performed on all ten isolates to determine molecular subtype of the bacteria. All ten *V. mimicus* isolates differed in their PFGE pattern. The six patients whose isolates were positive for CT, volunteered to have their blood tested for the presence of antibodies to CT. Serum collected from three of the patients tested positive for the presence of antibodies to the CT toxin. Antibodies to Cholera toxin (CT) do not seem to be sufficient to protect against further infections. The presence of CT has been shown in literature several times, but a patient infected with *V. mimicus* CT-like toxin and developing anti-CT antibodies has not been documented in literature.

V. fluvialis is a halophilic *Vibrio*, first identified in Bahrain in 1975, in a patient with diarrhea. It is biochemically similar to *Aeromonas hydrophila* but can be differentiated from this organism by its ability to grow well on media containing 6% to 7% sodium chloride. The largest series of *V. fluvialis* infections involved 500 patients in Bangladesh, half of whom were young children. In that series, patients presented with diarrhea (100% with 75% bloody diarrhea), vomiting (97%), abdominal pain (75%), dehydration (67%), and fever (35%). *V. fluvialis* rarely causes wound infections or primary septicemia. On average, about two cases of *Vibrio fluvialis* are reported each year in Louisiana. In 2012, 14 cases were reported in Louisiana, 12 of which were confirmed by the State Public Health Lab (Figure 8).

Figure 8: *Vibrio fluvialis* cases – Louisiana, 1988-2015



Of the *V. fluvialis* cases reported in 2012, over half were male (57%). The median age for cases was 60 years of age with a range of six to 84 years. Fifty percent of the cases were from Region 3, the remaining cases were from Regions: 1, 4, 7 and 9. Over half of the cases were hospitalized (57%). Two cases were wound infections; the remaining 12 were gastroenteritis cases. Symptoms reported by gastroenteritis cases were diarrhea (92%), nausea (75%), abdominal cramps (75%), vomiting (58%), bloody stools (33%), and fever (33%). Over half (57%) of cases had at least one more pathogen isolated from the same source as the *V. fluvialis*. Other pathogens isolated were *Plesiomonas shigelloides* (two), *Aeromonas* (two), MRSA, Group B Streptococcus, *Proteus mirabilis*, *Edwardsiella*, *Clostridium difficile* and algae. Exposure information was obtained on nine of the 14 cases. Of the gastroenteritis cases with known exposure, 70% reported consuming raw oysters either alone or with other seafood prior to onset and 30% reported consuming seafood other than oysters.

Photobacterium damsela (formerly *Vibrio damsela*), is a halophilic, Gram-negative bacillus similar to *V. vulnificus*. It strictly causes soft-tissue infections following exposure of wounds to brackish water or injury by saltwater animals. *P. damsela* infections can be fulminant and frequently are fatal even in

immunocompetent hosts. Between 1980 and 2015, 9 cases were reported in Louisiana.

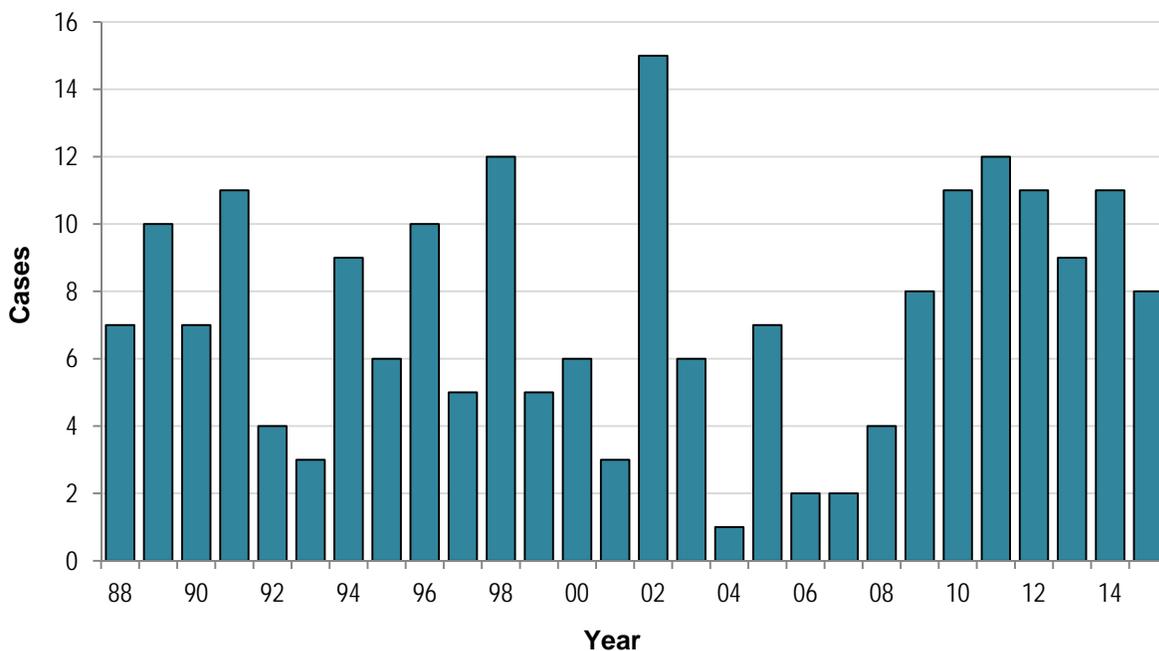
Grimontia hollisae (formerly *V. hollisae*) is a halophilic *Vibrio*, first described in 1982. It most commonly causes gastroenteritis. *G. hollisae* is difficult to isolate, since it grows poorly on selective TCBS media and it needs to be isolated from colonies on a blood agar plate. *G. hollisae* septicemia and wound infections have been reported, but are rare. On average, one case of *G. hollisae* is reported each year in Louisiana.

Vibrio cholerae Non-O1

Vibrio cholerae is classified in groups according to its somatic antigen O.

Non-O1s are found in surface waters (freshwater rivers, ocean) throughout the world. The infection is acquired by ingesting heavily contaminated water or food (raw or poorly cooked seafood, especially oysters, clams, shrimp or crabs). Small outbreaks are sometimes reported (Figure 9).

Figure 9: *Vibrio cholerae* non-O1, annual cases - Louisiana, 1988-2015



These infections usually occur in individuals with increased susceptibility to infections: immunocompromised individuals with gastric disease (low gastric acidity) or liver disease.

V. cholerae non-O1 can produce a wide range of symptoms: asymptomatic infections, simple diarrhea, or severe diarrheal disease. Some isolates are capable of producing a toxin indistinguishable from *V. cholerae* O1. Diarrhea and simple enteritis is the most common clinical picture. Approximately a quarter of infected patients have bloody stools. Illness usually is self-limiting and requires no treatment.

Vibrio cholerae O75

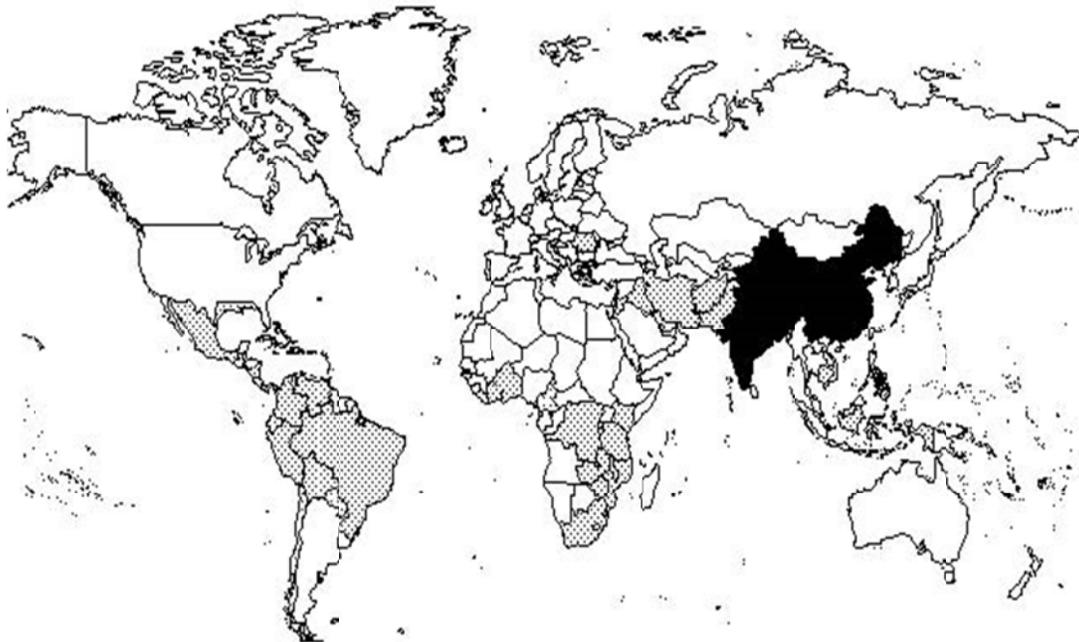
In Louisiana, there have been six reported cases of *Vibrio cholerae* O75 with two cases reported in 2000, one case each year in 2009 and 2010, and two cases in 2011. Two cases of *Vibrio cholerae* O75 toxigenic were reported in Louisiana in 2011. One case was part of a multistate outbreak (LA, GA, IN, TN, AL) associated with consumption of raw or lightly cooked oysters from Apalachicola Bay in Florida. All PFGE patterns of the *V. cholerae* O75 isolates were similar. The main illness was gastroenteritis with no hospitalizations and no deaths.

Vibrio cholerae O1

V. cholerae O1 and *V. cholerae* O139 are the main causes of pandemic cholera. The world now is experiencing a seventh cholera pandemic, with the El Tor variant of *V. cholerae* O1 being the infectious agent. The pandemic started in Indonesia in 1961, spread through the Middle East in the late 1960s and into Africa in the 1970s, where it remains endemic. In 1991, the pandemic reached South America through Peru and spread rapidly.

From 62 cases reported world-wide in 1961, the number reached a peak of 595,000 in 1991. The classical biotype has not disappeared and has caused major epidemics (1982 in Bangladesh). By 1993 the number had decreased somewhat to 300,000. Cholera is now well implanted in Southeast Asia, Africa and South America, with sporadic cases throughout the world (Figure 10).

Figure 10: Seventh cholera pandemic, 1961-1991



The O1 group includes the serotypes Ogawa, Inaba and Hikojima, the classical bio-types and El Tor. El Tor, a variant of the classical cholera, was isolated from a patient in the Sinai Peninsula in 1903. At that time it was considered to be non-pathogenic, but it now has become the agent responsible for the seventh pandemic. El Tor differs from classical *V. cholerae* in its ability to agglutinate chicken

erythrocytes, its sensitivity to polymyxin B and its resistance to cholera phage group 4. Cholera O1 also is classified by toxin production: toxigenic or nontoxigenic.

In 1992, toxigenic *V. cholerae* O139 (the Bengal strain) was recognized as another cause of cholera. *V. cholerae* O139, first discovered on the Indian subcontinent, has been reported in the United States as an imported infection. Although the primary organism that causes cholera globally is *V. cholerae* O1, continued laboratory surveillance of *V. cholerae* O139 is recommended because it has similar epidemic potential.

Vibrio cholerae O1 represents about 3% of all *Vibrio* cases reported in Louisiana over the past 27 years (Figure 11).

Figure 11: *Vibrio cholerae* O1 cases - Louisiana, 1988-2015

