

## **Cryptosporidium Outbreak After Action Report – Utah, 2007**

Prepared by the Utah Department of Health, Bureau of Epidemiology  
in conjunction with Salt Lake Valley Health Department, Utah County Health Department, and  
Davis County Health Department

### **I. Background and Introduction**

Cryptosporidiosis is a gastrointestinal illness caused by *Cryptosporidium parvum*, a spore-forming coccidian protozoan. The most common manifestation of cryptosporidiosis is frequent, nonbloody, watery diarrhea, and less frequent symptoms include abdominal cramps, fatigue, nausea, vomiting, anorexia, and weight loss; symptoms often wax and wane but remit in less than 30 days in most immunologically healthy persons.(Heymann, 2004) Treatment for diarrhea caused by *Cryptosporidium* is available. FDA licensed nitazoxanide (Alinia®, Romark Laboratories, Tampa, FL, USA) for treatment of cryptosporidiosis in children aged 1-11 years in November 2002. In June 2004, nitazoxanide was also licensed for older children and adults.

Persons infected with this protozoan excrete oocysts, the infectious form, in feces. It has been reported that  $10^8$ - $10^9$  oocysts can be shed in a single bowel movement and that oocysts can be excreted for up to 50 days after cessation of diarrhea, however, in most people, the shedding of oocysts stops within 2 weeks.(Yoder and Beach, 2007) Transmission is via the fecal-oral route, which can include person-to-person, animal-to-person, waterborne, and foodborne transmission. The infectious dose is low, and as few as 10-30 oocysts can cause infection in healthy persons.(Yoder and Beach, 2007)

Oocysts are highly resistant to chemical disinfectants used to purify drinking water as well as the normal chlorination schedules and filtration of swimming pools. Waterborne outbreaks have been associated with contaminated municipal water and exposure to contaminated recreational water venues. Incidence is greatest in the summer and early fall, corresponding to the outdoor swimming season.(American Academy of Pediatrics, 2003)

In 1994, the Council of State and Territorial Epidemiologists agreed to reporting of cryptosporidiosis as a nationally notifiable disease; the first full year of reporting began in

1995.(Yoder and Beach, 2007) The baseline rate in Utah is approximately 15 cases per year. In 2001, Salt Lake Valley Health Department in Utah had reports of 41 cases, most of which occurred in August-October (median age: 4 years; range: 1 month-73 years; 51% male). Incidence of cryptosporidiosis and cryptosporidiosis outbreaks have increased throughout the United States since 2004, particularly in treated recreational water venues.(CDC, unpublished data) In 2007, Utah experienced a cryptosporidiosis outbreak associated with multiple recreational water venues, with person-to-person transmission also implicated.

This report describes the epidemiology of the outbreak and the environmental issues that were relevant because transmission was associated with exposure to recreational water venues. Lessons learned and recommendations for prevention of future outbreaks are presented.

## **II. Methods**

### **A. Case definition**

The Cryptosporidiosis case definition was revised by the Center's for Disease Control and Prevention(CDC) and the Council of State and Territorial Epidemiologists (CSTE) in 1998. Laboratory-confirmed cryptosporidiosis is defined as the detection—in symptomatic or asymptomatic persons—of *Cryptosporidium* oocysts in stool by microscopic examination; or, in intestinal fluid or small-bowel biopsy specimens; or oocyst or sporozoite antigens by immunodiagnostic methods, e.g., ELISA; or by PCR techniques when routinely available, or demonstration of reproductive stages in tissue preparations. The case classifications are as follows:

- *Confirmed, symptomatic*: a laboratory-confirmed case associated with one of the symptoms described above
- *Confirmed, asymptomatic*: a laboratory-confirmed case associated with none of the above symptoms

National reporting for cryptosporidiosis began in 1995. The 1995 case definition included a case classification for “probable” cases. A probable case was defined as a “clinically compatible case that is epidemiologically linked to a confirmed case.” In addition to the 1998 case definition, the 1995 probable case definition was used to classify cases associated with the outbreak.

## **B. Data Collection, Entry, and Analysis**

The UDOH Surveillance Program received cryptosporidiosis case reports via fax, email, mail, and telephone. The majority of cases were reported by laboratories (75%) and local health departments (20%), and hospitals, physicians, and other state health departments reported the remaining 5% of cases. The reports were entered into Utah's NETSS (National Electronic Telecommunication System for Surveillance) database and transmitted to local health departments, if necessary, within one business day. Local health departments interviewed cases using a variety of investigation forms throughout the outbreak, and the NETSS database was updated accordingly. An additional database was created with Microsoft Access and used for entry of variables not captured by the NETSS database. The UDOH Surveillance Program uses a temporal scan statistic tool ("G-surveillance methods") for aberration detection activities, which is particularly useful for sparse data. Cryptosporidiosis outbreak data, as of December 31, 2007, were analyzed using SAS 9.1 and Microsoft Excel software. Statewide and district-specific rates were calculated based on 2007 data from the Utah Population Estimates Committee (available at: <http://jobs.utah.gov/jsp/wi/utalmis/gotoPopulation.do> (accessed 1/8/2008)). Age group-specific rates were calculated based on U.S. Census data for Utah in 2000, the most recent year for which data by age group were available. All rates were calculated as:

$$(\text{number of cases} / (\text{population} * \text{time}(\text{years}))) * 100,000.$$

## **III. Detection of Outbreak and Timeline**

On July 12, 2007, the Utah County Health Department (UCHD) notified the Utah Department of Health (UDOH) enteric epidemiologist of an increase in cryptosporidiosis cases in Utah County (1 confirmed case reported in June with public pool exposure; 4 suspect cases reported in July were being investigated). As of July 12, UDOH had received reports for only 2 cases (1 case from UCHD with onset date of June 8, and 1 case from Tooele County Health Department with onset date of July 4), which did not cause a surveillance alert. On July 26, 2007, UDOH detected an unusual temporal cluster of 8 confirmed cryptosporidiosis cases. During the previous five years (2002-2006), a mean of 14.4 cases (Range: 6-20) were reported annually. The UDOH surveillance epidemiologist notified the UDOH enteric epidemiologist of a cryptosporidium alert based on reports received at UDOH. A line listing of cases with onset dates early in the outbreak is presented in appendix 2.

## **Outbreak Timeline**

### July 12

- UCHD detected an increased number of case reports and notified UDOH

### July 19

- UCHD notified Utah County Environmental Health; standard pool inspection procedures followed
- UDOH was in contact with Jonathan Yoder from the Parasitic Diseases Branch at the CDC

### July 26

- UDOH detected an increased number of case reports

### July 31

- SLVHD investigated GI illness cluster (no lab testing; 39/45 pool party attendees were ill)
- SLVHD investigated a case with childcare exposure; Facility director notified SLVHD of increased cases in Utah County
- SLVHD required hyperchlorination of named pools from this date on

### August 1

- DCHD reported an increase in cases to SLVHD

### August 2

- UDOH sent email to notify all local health district communicable disease contacts and laboratories of the increase in cases
- Seven Peaks and 2 Utah County pools were hyperchlorinated
- UCHD issued press release
- UCHD sent letter to all public pools requesting postage of signs
- Non-significant increase in GI illness detected by RODS surveillance system; Kaysville water samples tested positive for coliform bacteria (after flushing system twice, no more positive tests)
- DCHD sent letter to medical community about need for appropriate testing
- SLVHD issued list-serve message to health care providers

### August 7

- SLVHD sent message to Salt Lake County Public Works

### August 8

- UCHD issued a second press release

### August 9

- UCHD faxed & emailed message to all physicians
- DCHD sent letter to medical community
- SLVHD sent messages to urgent care facilities, health providers, hospitals, emergency departments, infection control practitioners, an organization and two large water venues known to be having large swimming events
- UDOH organized conference call; decided on coordinated effort with consistent messaging

### August 10

- UDOH issued a press release, "Avoid Swimming When Sick"
- Several newspaper articles printed
- Interviews were conducted on television and radio
- UDOH posted information on UDOH website
- SLVHD sent messages to YMCA, Hotel/Motel Association, summer camps

### August 13-14

- Newspaper articles printed
- SLVHD met with SL County Parks and Recreation; provided signs to pools

### August 15

- SLVHD sent messages to Utah High School Athletic Associations, swim teams, Home Owner Associations, facility management companies, pool maintenance, chemical suppliers, aquatic directors

#### August 16

- SLVHD sent messages to CCR&R directors
- DCHD sent letters to pool operators regarding hyperchlorination procedures

#### August 17

- UDOH organized conference call; discussed using shorter investigation form (“Crypto Mini” form was implemented), issues related to childcare facilities, sending a list-serve message to physicians, and back to school issues
- UDOH issued press release, “Health Alert: Diarrhea Outbreak on the Increase”
- SLVHD sent messages to Utah Poison Control Center, 2-1-1 Info Bank, SL County Aging Services, nursing home/assisted living facilities

#### August 18

- SLVHD sent messages to LDS Church

#### August 21

- DCHD sampled major pools

#### August 22

- SLVHD sent message to Boy Scouts

#### August 24

- UDOH organized conference call

#### August 27

- SLVHD sent message to childcare facilities
- Newspaper articles printed
- UCHD instated pre-recorded message on Public Information Line

#### August 28

- UDOH organized conference call
- **Children less than 5 years of age and any persons requiring diapers were restricted from swimming in public pools. This was implemented in 10 health districts: Bear River, Central Utah, Davis County, Salt Lake Valley, Southwest Utah, Summit County, Tooele County, Utah County, Wasatch County, and Weber-Morgan. Southwest Utah supported but did not mandate the restrictions.**
- **Pool Recommendations: weekly hyperchlorination, maintain an increased minimum level of chlorine at all times, and post informational materials**
- **Childcare centers were asked to avoid all recreational water activities; Informational materials were sent to all childcare facilities**
- UDOH issued press release, “Health Officials Ask Kids Under Age Five to Avoid Pools”
- Newspaper articles printed; Television and Radio reports aired
- SLVHD issued press release
- DCHD had a meeting with pool operators
- DCHD sent information to healthcare providers regarding treatment guidelines

#### August 29

- UCHD sent messages to childcare facilities

#### August 30

- SLVHD sent message to school nurses, First Alert
- UCHD faxed and emailed message to physicians, clinics, infection control practitioners, emergency departments, laboratories; sent letter to residential and charter schools

#### August 31

- DCHD sent information to healthcare providers regarding treatment guidelines
- DCHD sent messages to childcare facilities

#### September 5

- ARUP began reporting test results to UDOH on a nearly daily basis
- Southwest HD detected an increase in cases
- SLVHD implemented one-page investigation form

September 10

- SLVHD issued press release

September 11

- UDOH organized conference call; swimming restrictions and use of increased chlorination schedules were extended until further notice
- UDOH issued press release, "Swimming Restrictions Extended for Kids Under Age Five"

September 25

- Swimming restrictions for children less than 5 years of age not requiring diapers were lifted; diapered persons of all ages were still restricted
- UDOH issued press release, "Swimming Restrictions Modified for Kids Who Don't Wear Diapers"

October 11

- Increased chlorination schedules were no longer recommended; standard (pre-outbreak) chlorination schedules were applied
- UDOH issued press release, "Utahns Encouraged to Take Active Role in Preventing Pool Problems"

November 14

- Swimming restrictions for persons requiring diapers were lifted
- UDOH issued press release, "Back to Business as Usual at Utah Pools"

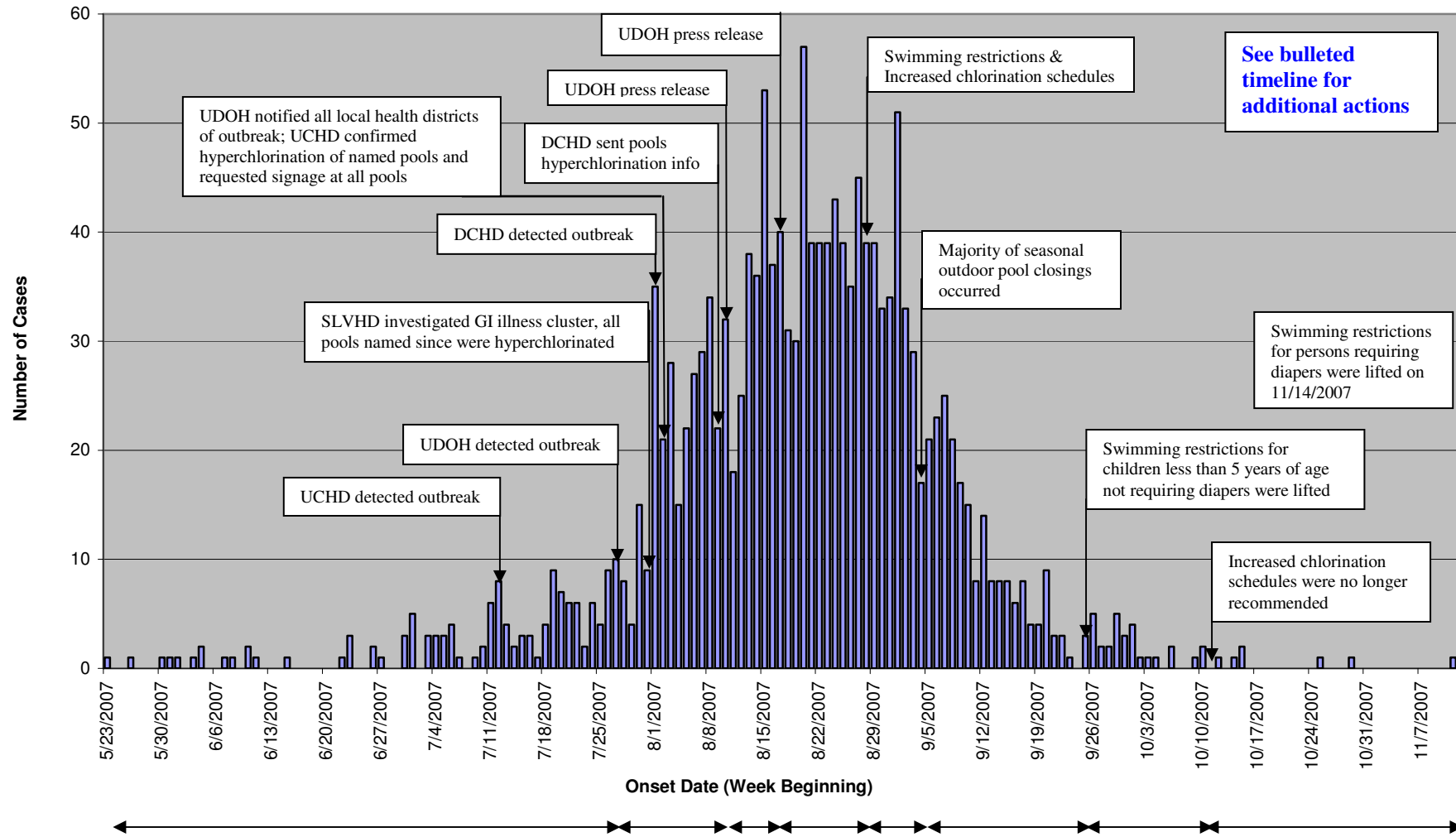
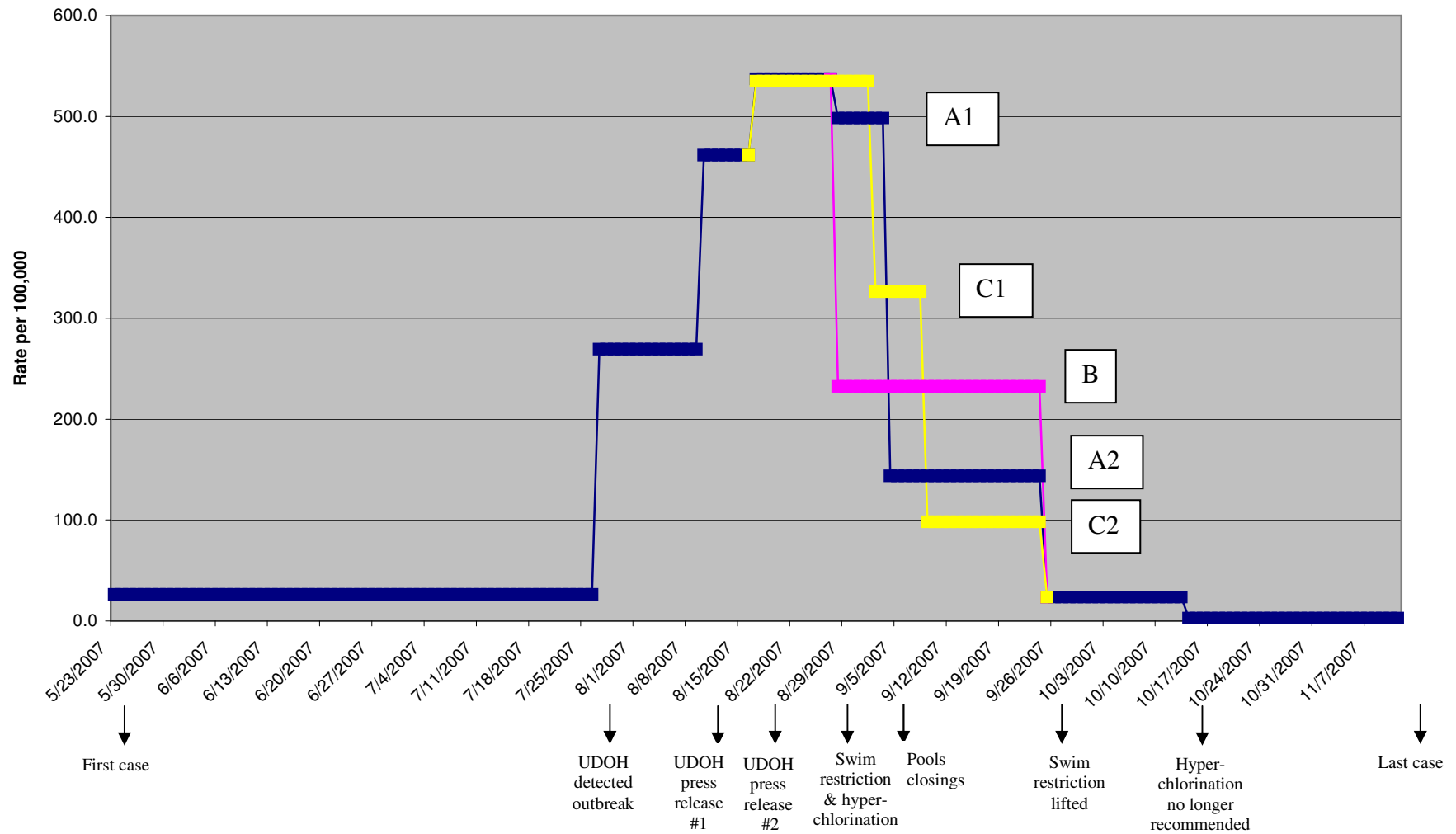


Figure 1. Epidemic curve for cases with known onset date, May 23-November 11, 2007



**Figure 2. Incidence rates during select periods of the outbreak, May 23-November 11, 2007**

Rate periods in blue (A1 and A2) indicate the rates during select periods as indicated in the figure.

Rate period in pink (B) combines rates for A1 and A2.

Rate periods in yellow (C1 and C2) indicate the rates for the periods as indicated in A1 and A2 but shifted 5 days to take the mean incubation period into account.

#### **IV. Summary**

A total of 1,902 confirmed cases and 53 probable cases (1,955 cases total) were reported to UDOH during May 23-December 16, 2007 (table 1 and figure 3). Onset dates are known for 1,601 confirmed cases. The first and last confirmed cases considered to be associated with this outbreak had onset dates of May 23 and November 11, respectively, which represents an outbreak period of 173 days. Confirmed cases were reported to UDOH during June 17-December 16. The peak of the outbreak was during the week of August 19, when the incidence rate was 557.6/100,000. The peak week of reporting of cases occurred during the week of September 2. This discrepancy will be examined later in this report.

Cases were reported from all 12 local health districts (table 2 and figures 4 and 5), but 93% were reported from five of these health districts (Bear River, Davis County, Salt Lake Valley, Utah County, and Weber-Morgan). Early in the outbreak, the majority of cases were reported from Utah County, but, overall, Salt Lake Valley reported the largest number of cases (718, 38%), followed by Utah County (518, 27%), Davis County (293, 15%), Bear River (125, 7%), and Weber-Morgan (116, 6%).

Case patients were about equally divided by sex (953/1,878=50% with reported sex were female). Of 696 with reported race, 657 (94%) were white. Of 650 with reported ethnicity, 55 (8%) were Hispanic. A large percentage of case patients were less than 5 years of age (633 (33%); figure 6). This is a large percentage compared with the age distribution of all Utah residents, 9% of whom are less than 5 years of age. Age-specific epidemic curves are shown in figure 7. The median age of case patients increased during the outbreak (figure 8). The incidence rates (per 100,000 population) for the outbreak period of May 23-November 11 by age group were: 637.8 for 0-4 years, 385.8 for 5-9 years, 152.3 for 10-19 years, 133.0 for 20-44 years, 33.3 for 45-64 years, and 26.6 for 65+ years (data not presented).

Data on duration of illness was available for 177 case patients. These patients had onset dates from May 23-October 9 and represented six health districts (Salt Lake Valley 59%, Utah County 28%, Davis County 6%, Weber-Morgan 4%, Central Utah 2%, and Bear River 1%). Of these 177 case patients, 99 (56%) reported that their illness was resolved at the time of the interview and 78 (44%) were still having symptoms. Median duration of illness was 18 days.

No patients were known to have died, but 97 of 1,144 with data available (8%) were hospitalized. Only 27 cases had data on number of days hospitalized (mean  $\pm$  standard deviation:  $2.6 \pm 2.7$  days (range <1-12 days)). Seven patients were reported as being immunocompromised. Treatment was received for 72% (n = 936) of 1,309 case patients without missing information on treatment. Of 874 with treatment type reported, 777 (89%) had taken the antiparasitic nitazoxanide (Alinia®). The other two most frequently taken drugs were the antibiotic azithromycin (25 (3%)) and the antiparasitic metronidazole (45 (5%)). The percent of cases reporting treatment decreased over the course of the outbreak (figure 9). This might have been because of anecdotal evidence of an insufficient supply of nitazoxanide.

Importantly, 1,225 of 1,523 with available data (80%) had water exposure at a recreational water venue (treated or untreated) during the incubation period 14 days prior to onset date. Case patients who reported water exposures at recreational water venues named a mean  $\pm$  standard deviation of  $1.4 \pm 0.8$  (median: 1, range: 1-6) exposure locations. Over 800 case patients (839(69%)) named only one location, and 268 (22%) named two locations (figure 10). The mean number of locations named decreased slightly over the course of the outbreak:  $1.8 \pm 1.2$  for May 23-July 26,  $1.4 \pm 0.7$  for July 27-August 27, and  $1.2 \pm 0.6$  after August 27. Anecdotal evidence from local health departments suggested this trend, as it was noted that it was more difficult to determine the likely infectious exposure early in the outbreak because more cases had multiple exposures.

Many different recreational water venues were named. Estimates include over 472 unique venues: 373 treated venues (85 community, city, and county pools, country club and fitness club pools, and waterparks; 95 apartment or condominium pools; 41 hotel pools; 152 private pools); 99 untreated venues (92 lakes, ponds, rivers, creeks, and oceans; 7 fountains). Note that this includes venues within and outside of Utah. Attempts were made to include only unique venues named, but these numbers may be overestimated for private pools and possibly apartment or condominium pools because the locations of many of these were not specified. Treated venues were named by more case patients (n = 1,175, with city/county/club pools and waterparks named most frequently) than untreated venues (n = 468, with lakes and irrigation water named most frequently); 71 patients reported water exposures outside of Utah (table 3). During the peak

weeks of the outbreak, consistently more than 90% of patients with water exposure had exposure at a treated water venue; exposure at untreated water venues decreased during these peak weeks (figure 11).

The most frequently named pools are presented in Figures 12-16 by week of outbreak. Utah County pools were the first to be named during the outbreak and had the earliest peak frequencies of being named as exposures, during the week of August 5 (figure 12). Pools in other health districts had peaks during the week of August 12 through the week of August 26 (Davis County followed by Bear River, Salt Lake Valley, and Weber-Morgan).

Swimming while ill was reported by 155 of 560 (28%) case patients with data available. Use caution when interpreting this number because there was a large amount of missing data for water exposures while ill (it was not included on most of the investigation forms used). Also, in general, water exposure information was collected for those exposures that had occurred during the incubation period only and the exact illness and infectious periods were not known. The age distribution of patients who had reported water exposures while ill was: 37% 0-4 years, 30% 5-9 years, 23% 10-19 years, and 10% 20-45 years. The number of water exposure venues named was greater for patients who had reported water exposures while ill compared with those who reported water exposure but not while ill (table 4). Twenty-nine percent (29%) of patients who did not report water exposures while ill named more than one venue, while 59% of patients who did report water exposures while ill named more than one venue. Of those with water exposures while ill, most (70%) named one venue that they were exposed to while ill. Fifty-six patients (36%) reported exposure to new venues that they were not exposed to during the incubation period – 44 (28%) named one new venue, 9 (6%) named two new venues, and 3 (2%) named three new venues. The percent of patients per week who reported recreational water exposure while ill decreased during the outbreak (figure 18).

Recreational water exposures decreased during the outbreak, while exposure to contacts ill with similar symptoms and unknown exposures (neither recreational water nor ill contacts) increased (figure 19). Contacts ill with similar symptoms were named by 1,045 of 1,430 (73%) case patients with data available. Of 827 of these case patients with number of ill contacts reported, 2,340 ill contacts were named. Restricting to ill contacts with symptom onset prior to that of the

case patient, 789 of 1,430 (55%) case patients with data available had ill contacts. A total of 189 case patients named 333 ill contacts with symptoms prior to their onset of symptoms. These 189 case patients named a mean  $\pm$  standard deviation  $1.8 \pm 1.4$  ill contacts (median:1, range: 1-10). Although the level of contact the case patient had with their ill contact was not specified, the majority of ill contacts named were family members of case patients (approximately 90% of those with data available, including contacts with immediate family, extended family, fiancé, girlfriend, boyfriend, roommate, and nanny). Other contacts named included friend, neighbor, coworker, and contact at daycare.

Because of much missing data on number of ill contacts, it was assumed that those with missing data had the same distribution of the number of ill contacts as those with data available. With this assumption, it was calculated that all confirmed cases ( $n = 1,902$ ) had a total of 3,795 ill contacts. Note that this may be an overestimation if the same ill contact was named by more than one case (e.g., where multiple family members were ill). Anecdotally, when multiple family members were ill, it seemed that frequently only one member would be tested for cryptosporidiosis (i.e., there would only be one confirmed case per family), and this family member who was tested was often one of the youngest children.

Cases with high risk of transmission included 28 food handlers (28/1,517, 2%), 101 daycare attendees/employees (101/1,450, 7%), 7 nursing home residents/employees (7/1,517, 0.5%) and 19 patient care providers (19/1,480, 1%). No cases were known to be attributed to ill food handlers or ill patient care providers.

Of 1,385 cases with data on both water exposure and ill contacts, 170 (12%) had named ill contacts but no water exposure. Because there is no evidence of other (e.g., food) exposures attributed to illness, these cases were likely due to person-to-person transmission. This is a conservative estimate, including only patients without any water exposure. Some investigation forms included a question, “Does infection appear to be secondary?” Of 703 cases with data, 172 (24%) “yes” responses were recorded by the interviewer.

Other potential exposures were named less often: travel (15/1,147, 0.1% outside the United States and 216/1,154, 19% within the United States), contact with animals (104/230, 45% but

68/73, 93% who reported contact with an animal also reported that the animal was not ill), and drinking untreated water (35/289, 12%). The four patients who reported contact with an ill animal had onset dates of July 4, July 31, August 1, and September 22.

**Table 1. Number of confirmed cryptosporidiosis cases by week reported to UDOH and week of onset date, respective cumulative numbers, and weekly rates per 100,000 population, May 23-December 16, 2007**

| <b>Week of</b> | <b>Reported</b> | <b>Reported (cumul.)</b> | <b>Onset</b> | <b>Onset (cumul.)</b> | <b>Rate per 100,000 population*</b> |
|----------------|-----------------|--------------------------|--------------|-----------------------|-------------------------------------|
| May 20         | 0               | 0                        | 2            | 2                     | 3.9                                 |
| May 27         | 0               | 0                        | 3            | 5                     | 5.8                                 |
| June 3         | 0               | 0                        | 5            | 10                    | 9.7                                 |
| June 10        | 0               | 0                        | 4            | 14                    | 7.8                                 |
| June 17        | 1               | 1                        | 4            | 18                    | 7.8                                 |
| June 24        | 0               | 1                        | 6            | 24                    | 11.7                                |
| July 1         | 0               | 1                        | 19           | 43                    | 37.0                                |
| July 8         | 1               | 2                        | 23           | 66                    | 44.9                                |
| July 15        | 1               | 3                        | 33           | 99                    | 64.4                                |
| July 22        | 7               | 10                       | 45           | 144                   | 87.8                                |
| July 29        | 20              | 30                       | 127          | 271                   | 247.7                               |
| August 5       | 37              | 67                       | 184          | 455                   | 358.8                               |
| August 12      | 70              | 137                      | 260          | 715                   | 507.0                               |
| August 19      | 264             | 401                      | 286          | 1001                  | 557.6                               |
| August 26      | 323             | 724                      | 276          | 1277                  | 538.1                               |
| September 2    | 451             | 1175                     | 169          | 1446                  | 329.5                               |
| September 9    | 326             | 1501                     | 78           | 1524                  | 152.1                               |
| September 16   | 162             | 1663                     | 37           | 1561                  | 72.1                                |
| September 23   | 94              | 1757                     | 18           | 1579                  | 35.1                                |
| September 30   | 54              | 1811                     | 12           | 1591                  | 23.4                                |
| October 7      | 35              | 1846                     | 4            | 1595                  | 7.8                                 |
| October 14     | 25              | 1871                     | 3            | 1598                  | 5.8                                 |
| October 21     | 10              | 1881                     | 1            | 1599                  | 1.9                                 |
| October 28     | 7               | 1888                     | 1            | 1600                  | 1.9                                 |
| November 4     | 4               | 1892                     | 0            | 1600                  | 0.0                                 |
| November 11    | 1               | 1893                     | 1            | 1601                  | 1.9                                 |
| November 18    | 1               | 1894                     | 0            | 1601                  | 0.0                                 |
| November 25    | 2               | 1896                     | 0            | 1601                  | 0.0                                 |
| December 2     | 1               | 1897                     | 0            | 1601                  | 0.0                                 |
| December 9     | 1               | 1898                     | 0            | 1601                  | 0.0                                 |
| December 16    | 4               | 1902                     | 0            | 1601                  | 0.0                                 |

\*Rate based on onset

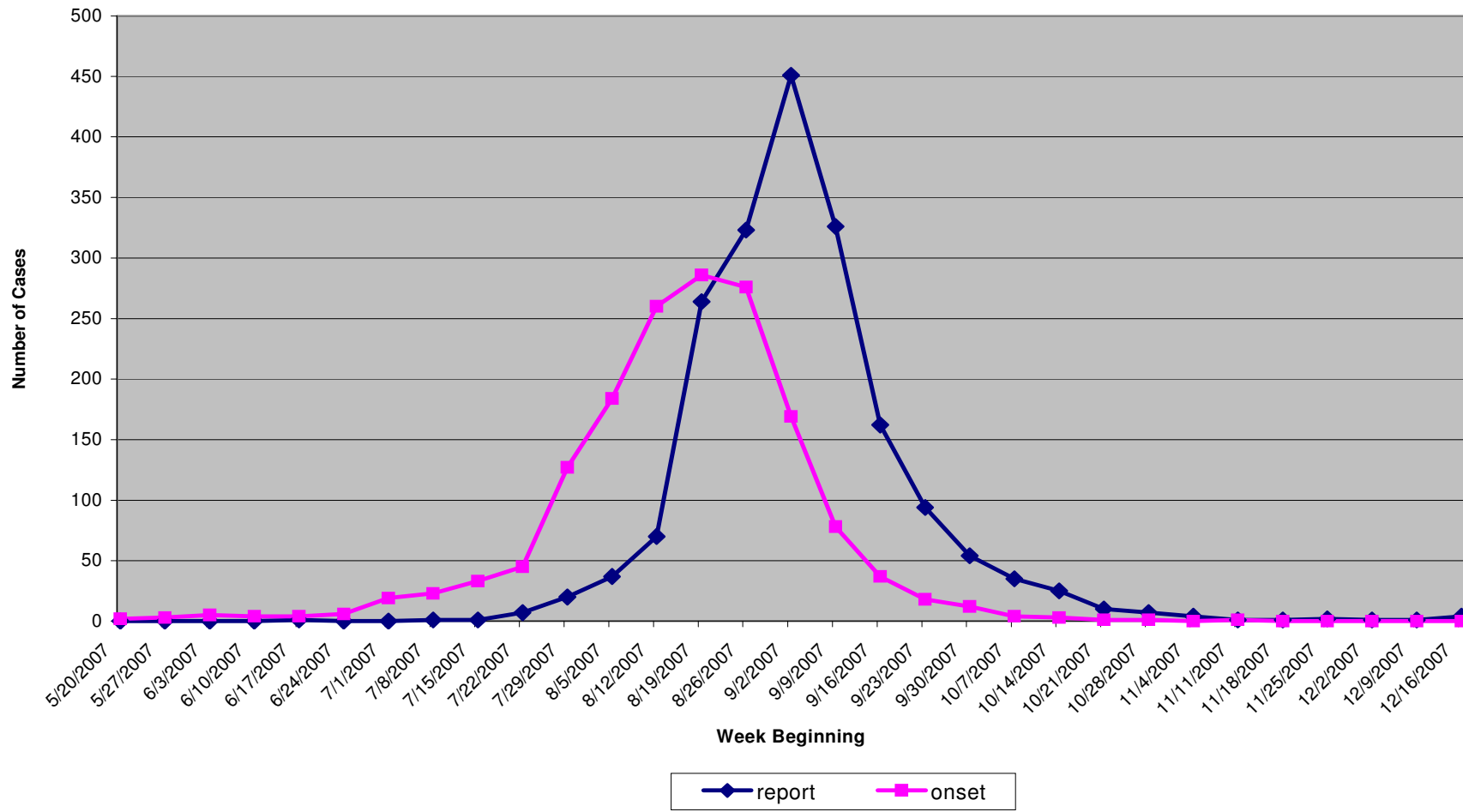


Figure 3. Epidemic curves indicating number of confirmed cases by week of onset date and week reported to UDOH, May 23-December 16, 2007

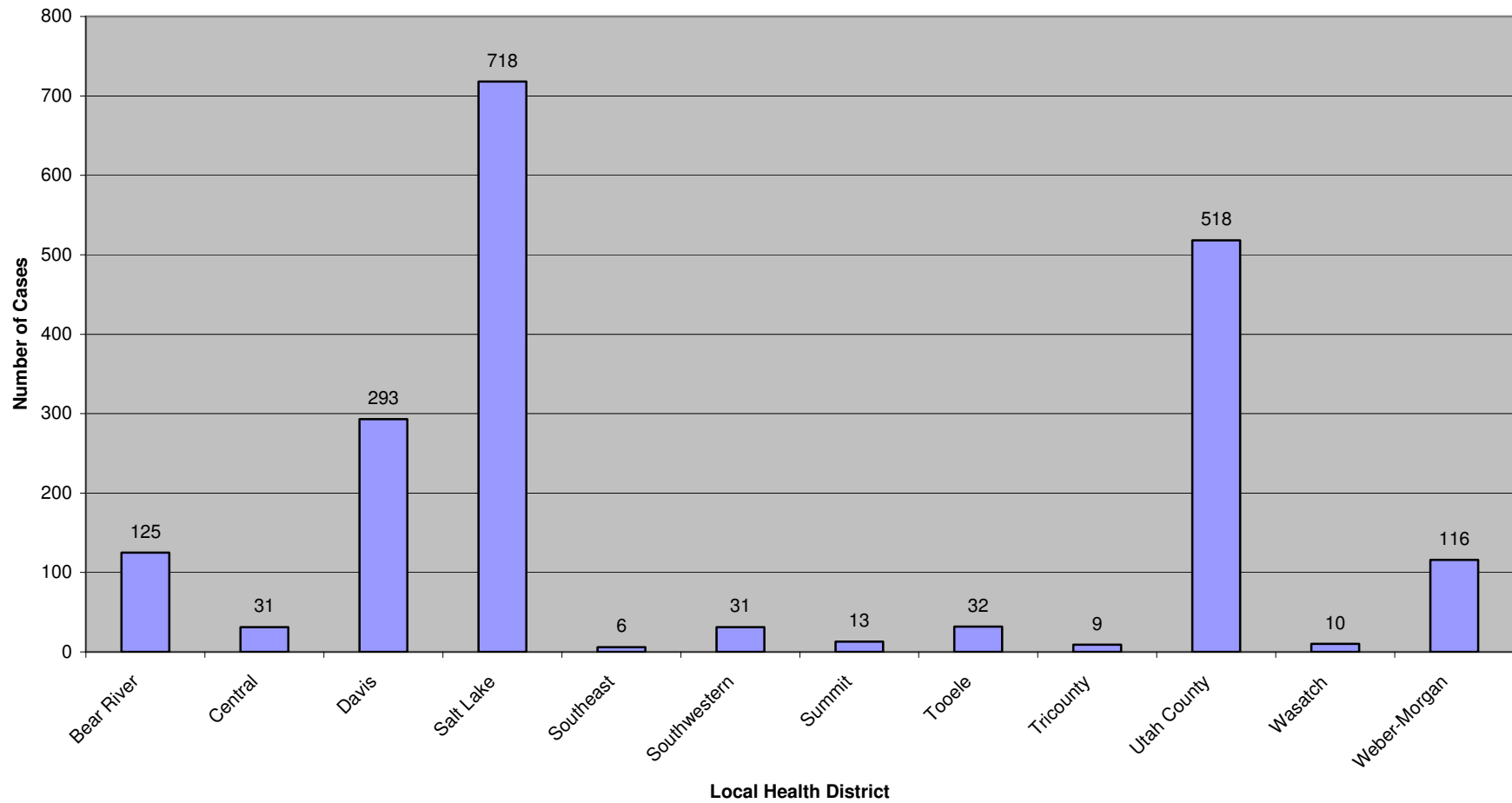
**Table 2. Number of confirmed cryptosporidiosis cases by date reported to UDOH and onset date, respective cumulative numbers, and period rates per 100,000 population by local health district, May 23-December 16, 2007**

| <b>Dates of Outbreak*</b>     | <b>Reported</b> | <b>Reported<br/>(cumul.)</b> | <b>Onset</b> | <b>Onset<br/>(cumul.)</b> | <b>Rate per 100,000<br/>population**</b> |
|-------------------------------|-----------------|------------------------------|--------------|---------------------------|--|
| <b>May 20-July 26</b>         | <b>8</b>        | <b>8</b>                     | <b>126</b>   | <b>126</b>                | <b>26.2</b>                              |
| Bear River                    | 0               | 0                            | 1            | 1                         | 3.5                                      |
| Central                       | 0               | 0                            | 1            | 1                         | 7.6                                      |
| Davis                         | 1               | 1                            | 18           | 18                        | 34.1                                     |
| Salt Lake                     | 0               | 0                            | 24           | 24                        | 13.2                                     |
| Southwest                     | 0               | 0                            | 2            | 2                         | 5.5                                      |
| Summit                        | 0               | 0                            | 1            | 1                         | 14.6                                     |
| Tooele                        | 1               | 1                            | 1            | 1                         | 9.9                                      |
| Utah County                   | 6               | 6                            | 78           | 78                        | 87.3                                     |
| <b>July 27-August 9</b>       | <b>58</b>       | <b>66</b>                    | <b>279</b>   | <b>405</b>                | <b>269.4</b>                             |
| Bear River                    | 0               | 0                            | 17           | 18                        | 279.3                                    |
| Central                       | 1               | 1                            | 4            | 5                         | 140.9                                    |
| Davis                         | 8               | 9                            | 40           | 58                        | 352.3                                    |
| Salt Lake                     | 15              | 15                           | 94           | 118                       | 240.5                                    |
| Southwest                     | 0               | 0                            | 3            | 5                         | 38.4                                     |
| Summit                        | 0               | 0                            | 1            | 2                         | 67.9                                     |
| Tooele                        | 0               | 1                            | 1            | 2                         | 46.1                                     |
| Tricounty                     | 0               | 0                            | 2            | 2                         | 113.5                                    |
| Utah County                   | 34              | 40                           | 93           | 171                       | 483.5                                    |
| Wasatch                       | 0               | 0                            | 1            | 1                         | 118.8                                    |
| Weber-Morgan                  | 0               | 0                            | 23           | 23                        | 260.7                                    |
| <b>August 10-August 27</b>    | <b>336</b>      | <b>402</b>                   | <b>676</b>   | <b>1081</b>               | <b>507.8</b>                             |
| Bear River                    | 13              | 13                           | 34           | 52                        | 434.5                                    |
| Central                       | 6               | 7                            | 10           | 15                        | 274.0                                    |
| Davis                         | 48              | 57                           | 133          | 191                       | 911.0                                    |
| Salt Lake                     | 108             | 123                          | 249          | 367                       | 495.5                                    |
| Southeastern                  | 0               | 0                            | 1            | 1                         | 37.5                                     |
| Southwest                     | 2               | 2                            | 9            | 14                        | 89.7                                     |
| Summit                        | 0               | 0                            | 5            | 7                         | 264.0                                    |
| Tooele                        | 1               | 2                            | 8            | 10                        | 286.9                                    |
| Tricounty                     | 0               | 0                            | 4            | 6                         | 176.6                                    |
| Utah County                   | 139             | 179                          | 165          | 336                       | 667.2                                    |
| Wasatch                       | 2               | 2                            | 6            | 7                         | 554.3                                    |
| Weber-Morgan                  | 17              | 17                           | 52           | 75                        | 458.4                                    |
| <b>August 28-September 24</b> | <b>1285</b>     | <b>1687</b>                  | <b>481</b>   | <b>1562</b>               | <b>232.3</b>                             |
| Bear River                    | 79              | 92                           | 39           | 91                        | 320.4                                    |
| Central                       | 22              | 29                           | 6            | 21                        | 105.7                                    |
| Davis                         | 205             | 262                          | 75           | 266                       | 330.3                                    |
| Salt Lake                     | 508             | 631                          | 232          | 599                       | 296.8                                    |
| Southeastern                  | 6               | 6                            | 0            | 1                         | 0.0                                      |
| Southwest                     | 24              | 26                           | 14           | 28                        | 89.7                                     |
| Summit                        | 12              | 12                           | 4            | 11                        | 135.7                                    |
| Tooele                        | 20              | 22                           | 10           | 20                        | 230.6                                    |
| Tricounty                     | 7               | 7                            | 0            | 6                         | 0.0                                      |
| Utah County                   | 312             | 491                          | 70           | 406                       | 182.0                                    |
| Wasatch                       | 6               | 8                            | 0            | 7                         | 0.0                                      |
| Weber-Morgan                  | 84              | 101                          | 31           | 106                       | 175.7                                    |

| <b>September 25-December 31</b> | <b>215</b> | <b>1902</b> | <b>39</b> | <b>1601</b> | <b>11.0</b> |
|---------------------------------|------------|-------------|-----------|-------------|-------------|
| Bear River                      | 33         | 125         | 5         | 96          | 24.0        |
| Central                         | 2          | 31          | 1         | 22          | 10.3        |
| Davis                           | 31         | 293         | 4         | 270         | 10.3        |
| Salt Lake                       | 87         | 718         | 13        | 612         | 9.7         |
| Southeastern                    | 0          | 6           | 0         | 1           | 0.0         |
| Southwest                       | 5          | 31          | 2         | 30          | 7.5         |
| Summit                          | 1          | 13          | 0         | 11          | 0.0         |
| Tooele                          | 10         | 32          | 2         | 22          | 26.9        |
| Tricounty                       | 2          | 9           | 1         | 7           | 16.6        |
| Utah County                     | 27         | 518         | 5         | 411         | 7.6         |
| Wasatch                         | 2          | 10          | 1         | 8           | 34.6        |
| Weber-Morgan                    | 15         | 116         | 5         | 111         | 16.5        |

\*Date ranges were chosen based on occurrence of major public health actions: July 26 – UDOH detected outbreak, August 10 – First press release by UDOH, August 28 – Swimming restrictions and increased chlorination schedules instituted, September 25 – Swimming restrictions for children less than 5 years of age not requiring diapers lifted

\*\*Rate based on number of confirmed cases with onset date within given period



**Figure 4. Number of confirmed cases reported (n = 1,902) by local health district, May 23-December 16, 2007**

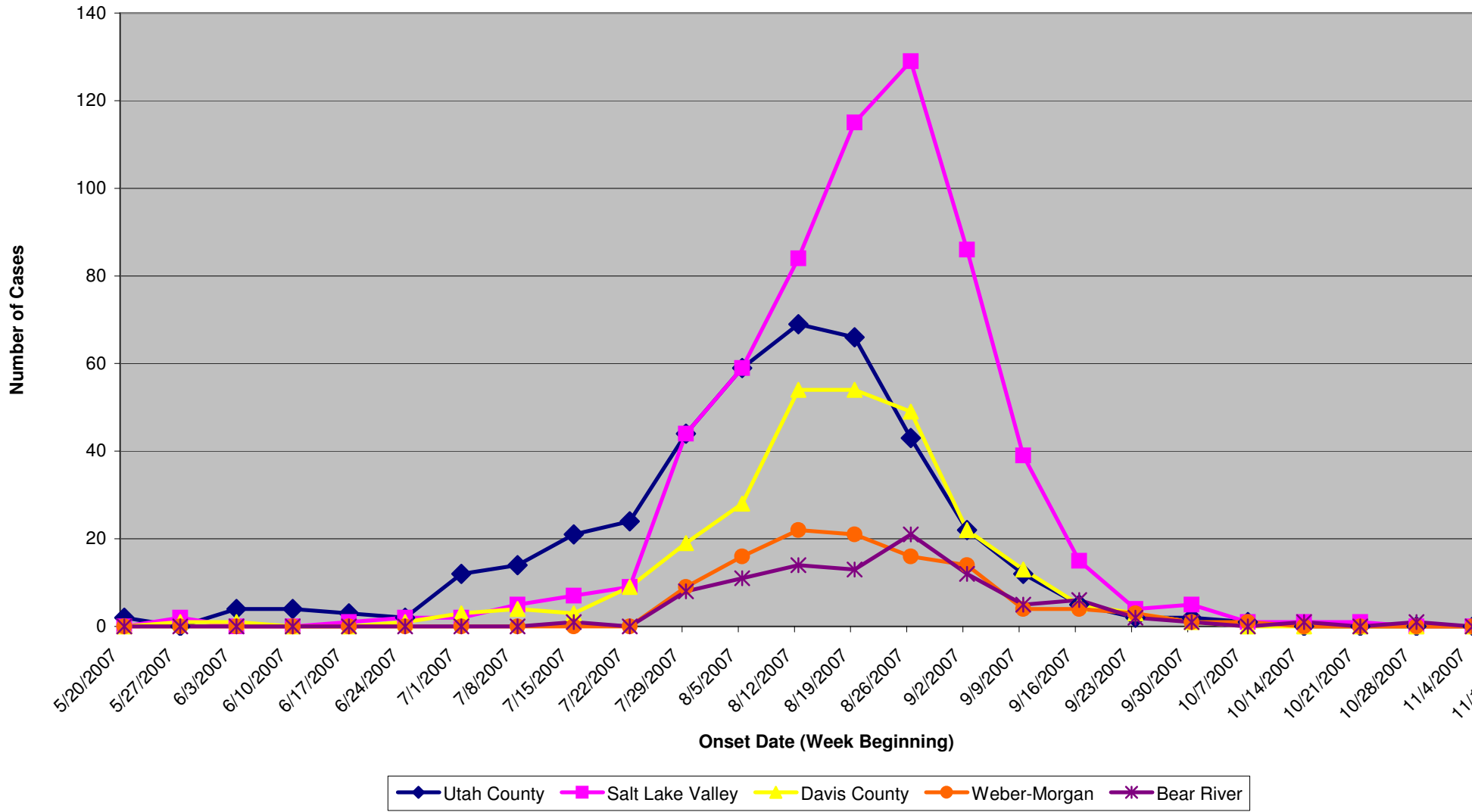


Figure 5. Epidemic curves indicating number of confirmed cases with known onset date by local health district, May 23-November 11, 2007

Note: 1,902 confirmed cases were reported statewide (1,601 had known onset date); 1,770 confirmed cases were reported from these five health districts (1,500 with known onset date).

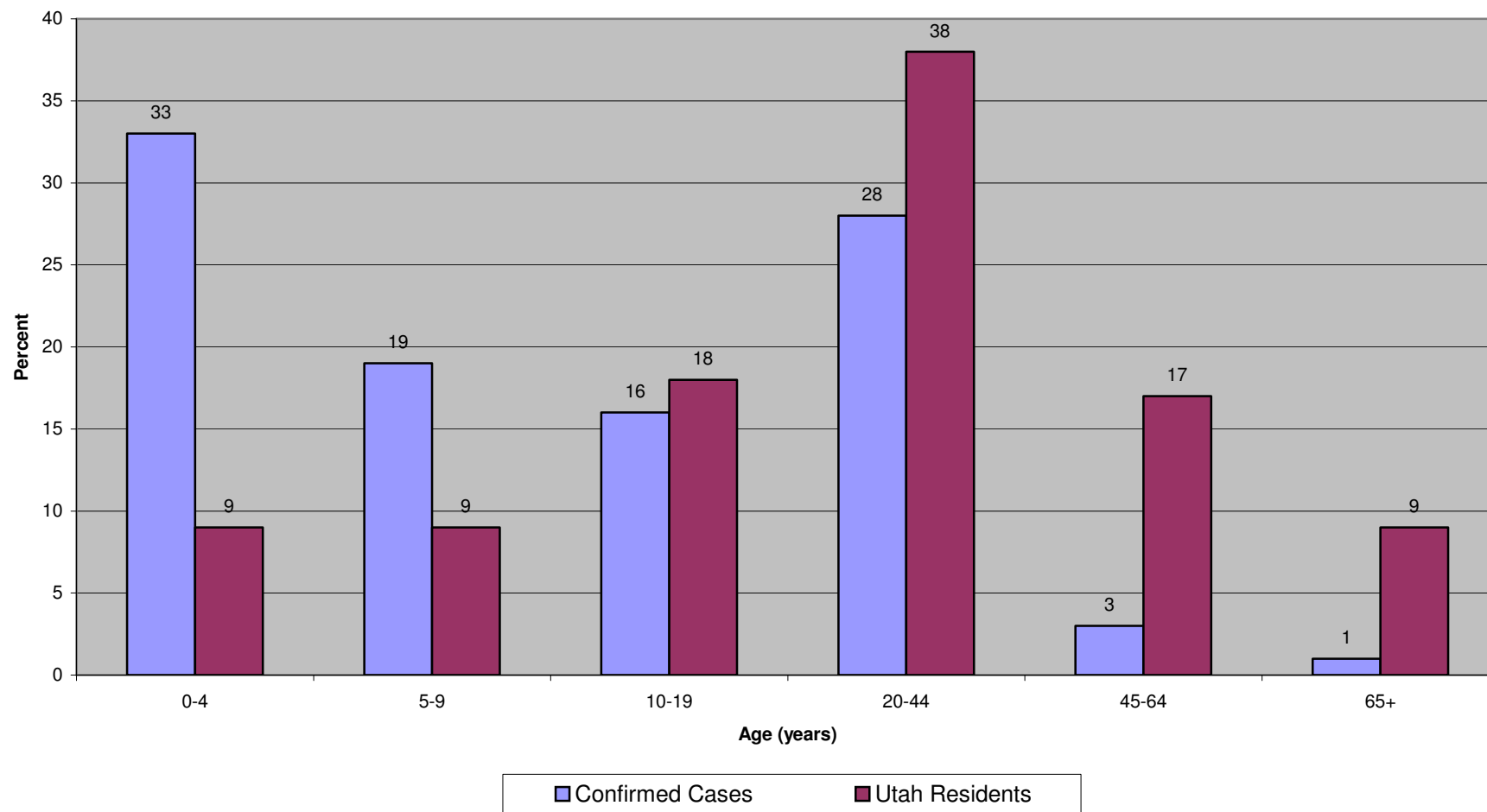
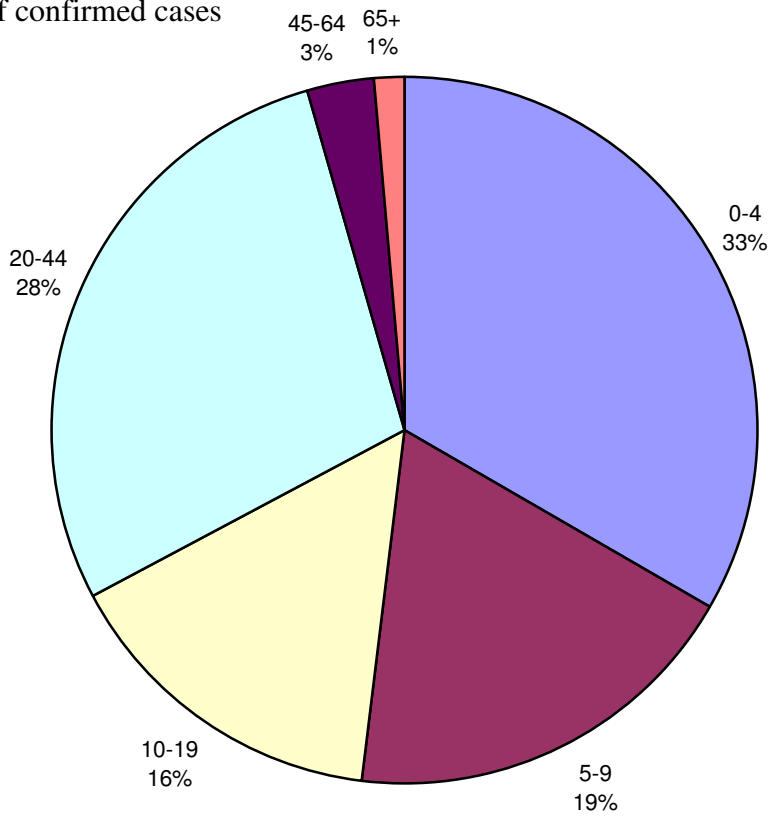
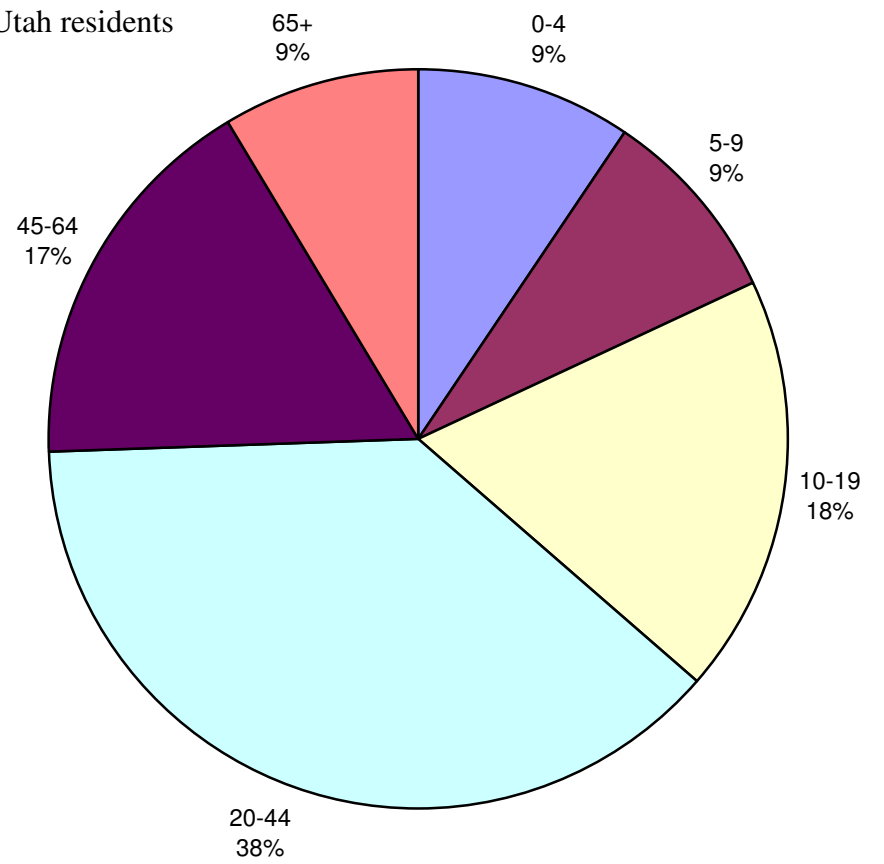


Figure 6. Age of confirmed cases (n = 1,902) compared with age of all Utah residents

Age of confirmed cases



Age of Utah residents



TO BE DELETED (?)  
I think the bar chart is a  
better representation of  
this comparison

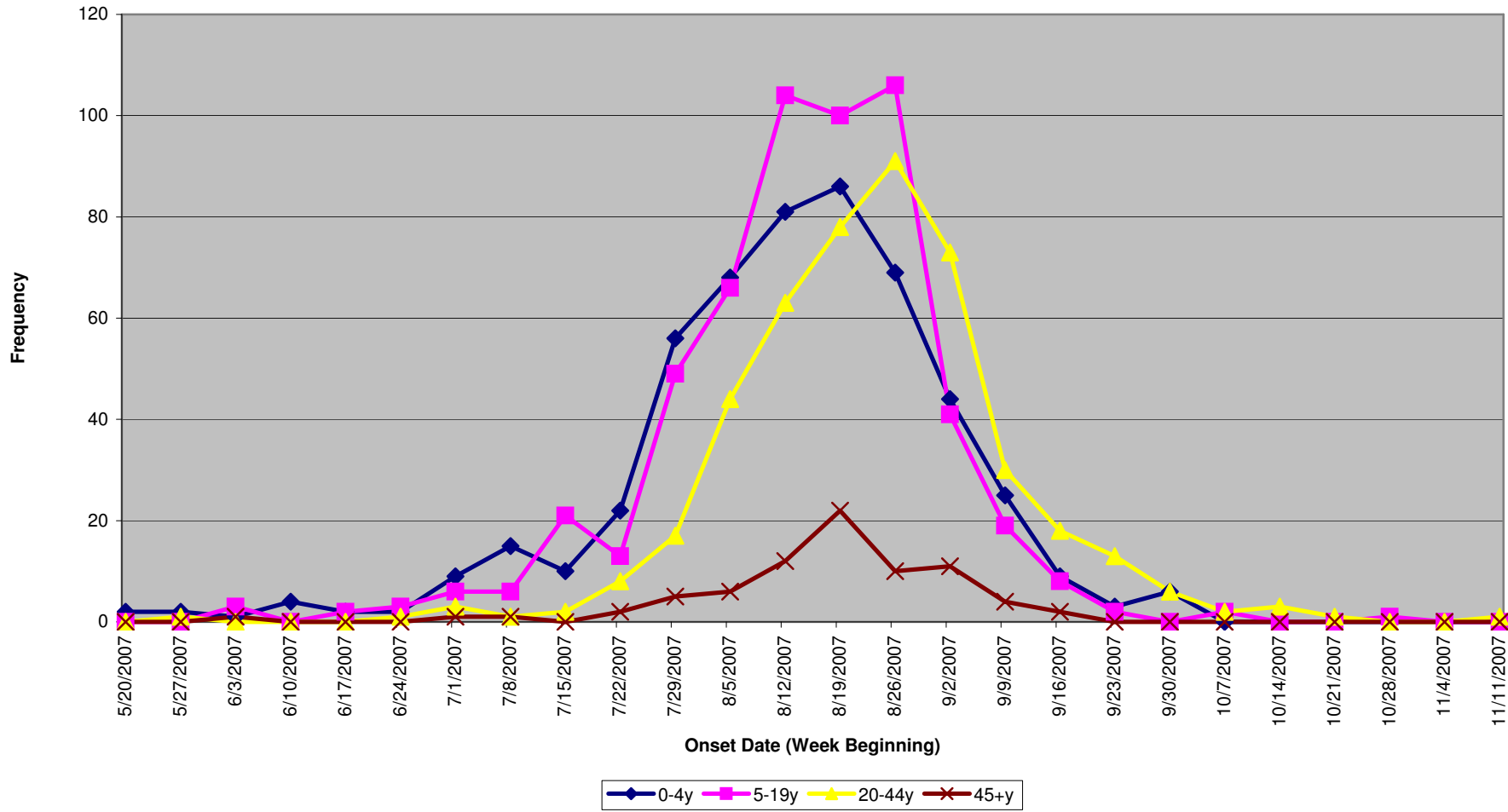
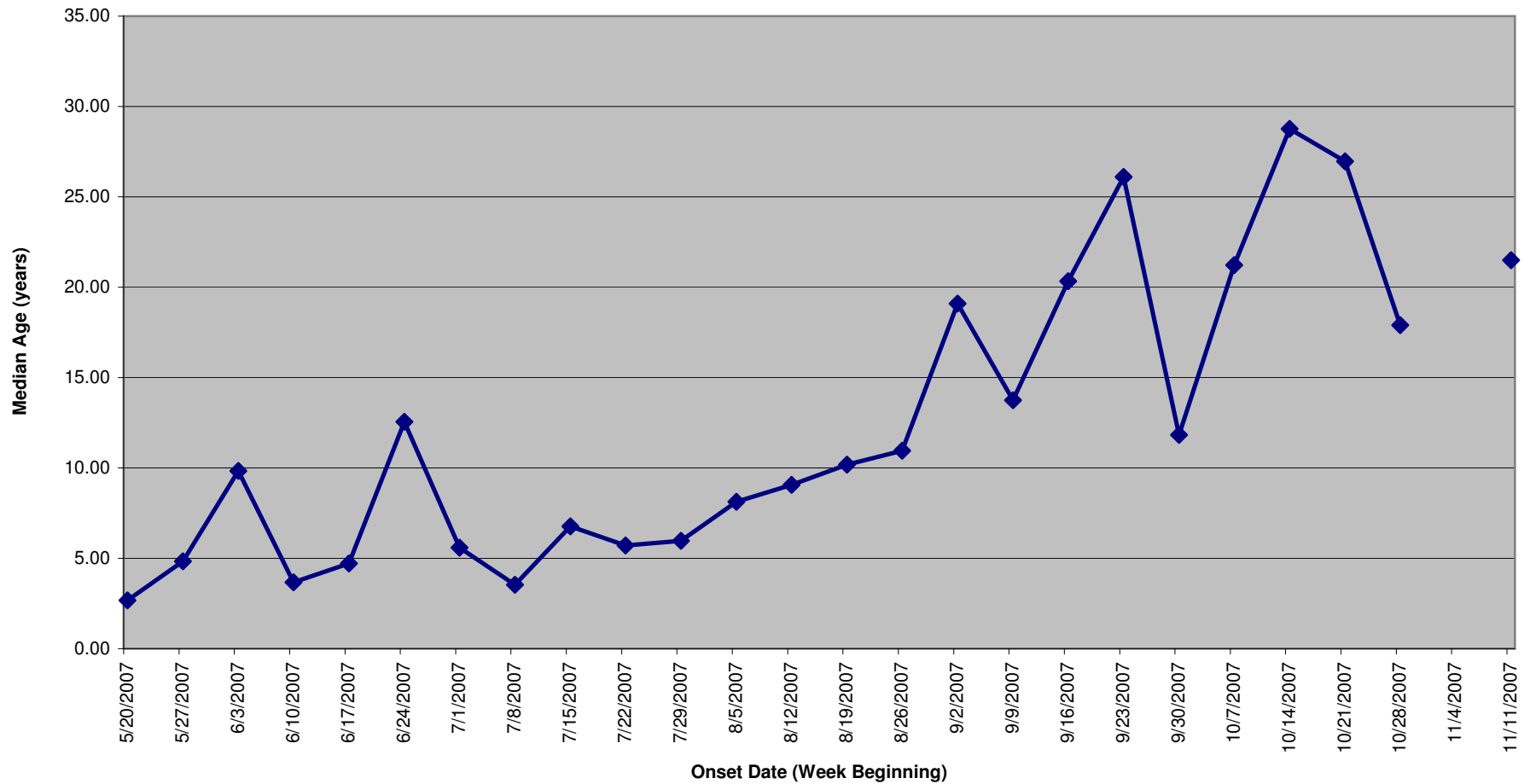


Figure 7. Age-specific epidemic curves indicating number of confirmed cases with known onset date (n = 1,602), May 23-November 11, 2007



**Figure 8. Median age of confirmed cases with known onset date (n= 1,601), May 23-November 11, 2007**

Note: There were no cases with onset date during the week of 11/4/2007 or after the week of 11/11/2007.



**Figure 9. Percent of confirmed cases reporting treatment with antibiotics or antiparasitics and percent of confirmed cases reporting treatment with nitazoxanide, July 1-October 6, 2007**

Note: Because of small numbers at the beginning and end of the outbreak, only the week beginning July 1 through the week beginning September 30, which had  $n > 10$  cases, were included.

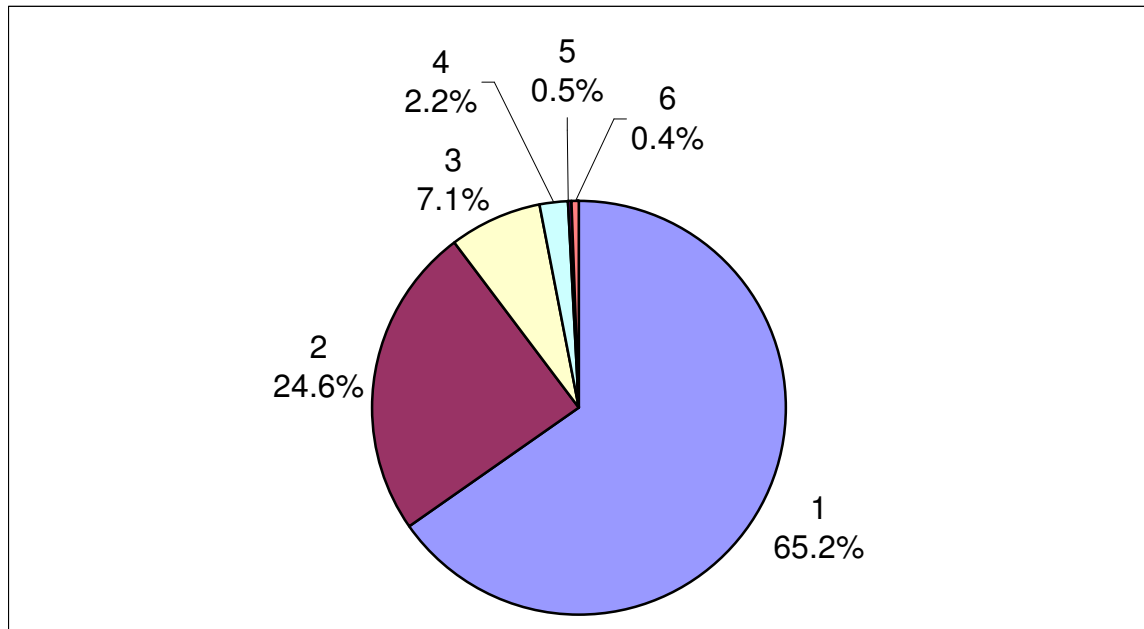
**Table 3. Number of case patients reporting recreational water exposure by type of venue**

| <b>Location</b>                 | <b>N</b> |
|---------------------------------|----------|
| <b>Treated</b>                  | 1,089    |
| City/County/Club                | 685      |
| Waterpark*                      | 275      |
| Private Pool                    | 152      |
| Apartment or Condo Pool         | 95       |
| Hotel or Resort Pool            | 62       |
| School/University Pool          | 11       |
| <b>Untreated</b>                | 401      |
| Lake                            | 191      |
| River                           | 83       |
| Ocean                           | 8        |
| Pond                            | 7        |
| Canal                           | 2        |
| Irrigation**                    | 152      |
| Fountain                        | 24       |
| Sprinkler                       | 17       |
| <b>Location outside of Utah</b> | 65       |

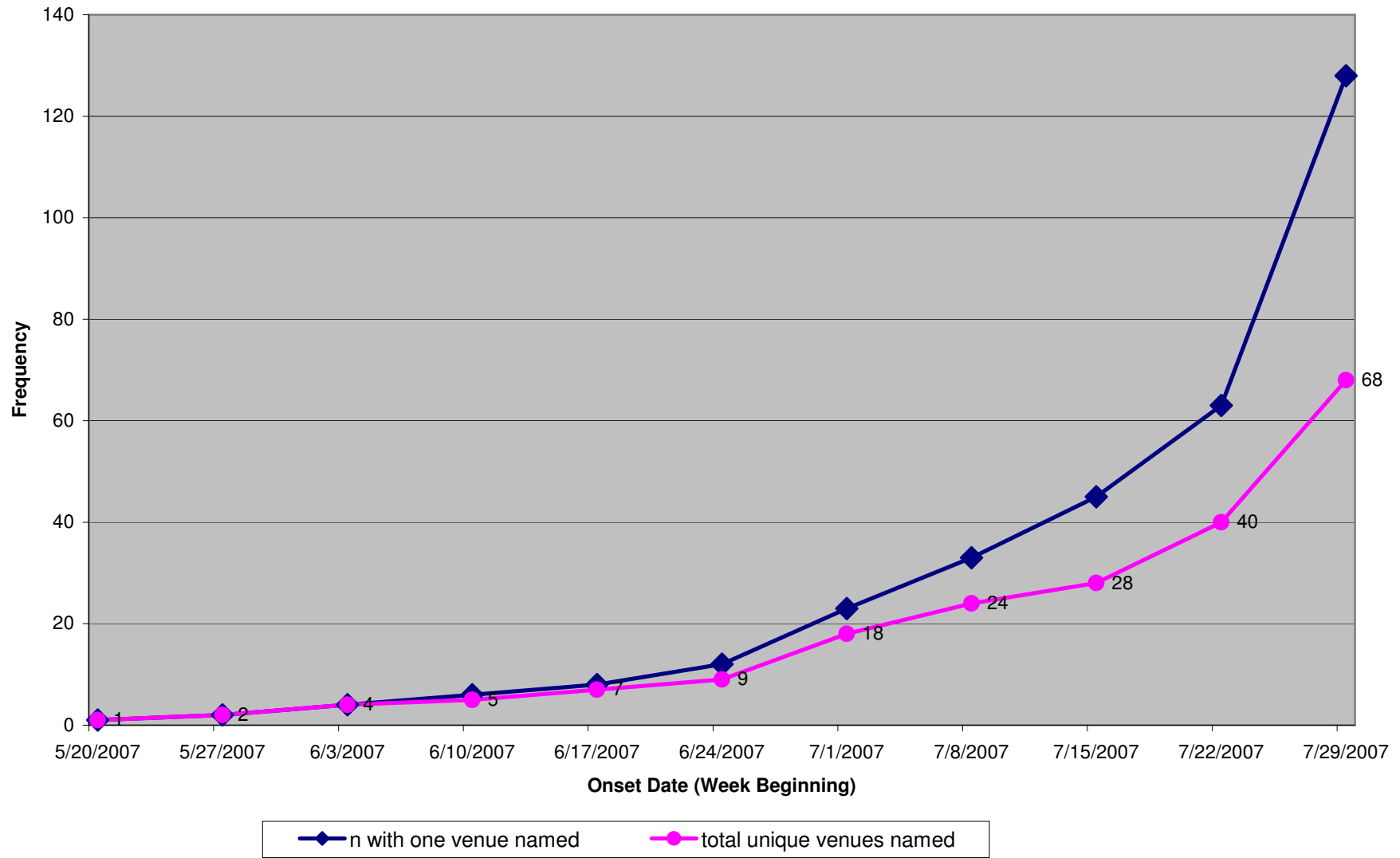
Note: data are approximations and categories do not sum to equal the total numbers because categories are neither comprehensive nor mutually exclusive.

\*Includes Seven Peaks, Cherry Hill, Raging Waters, and Lagoon (Laguna Beach)

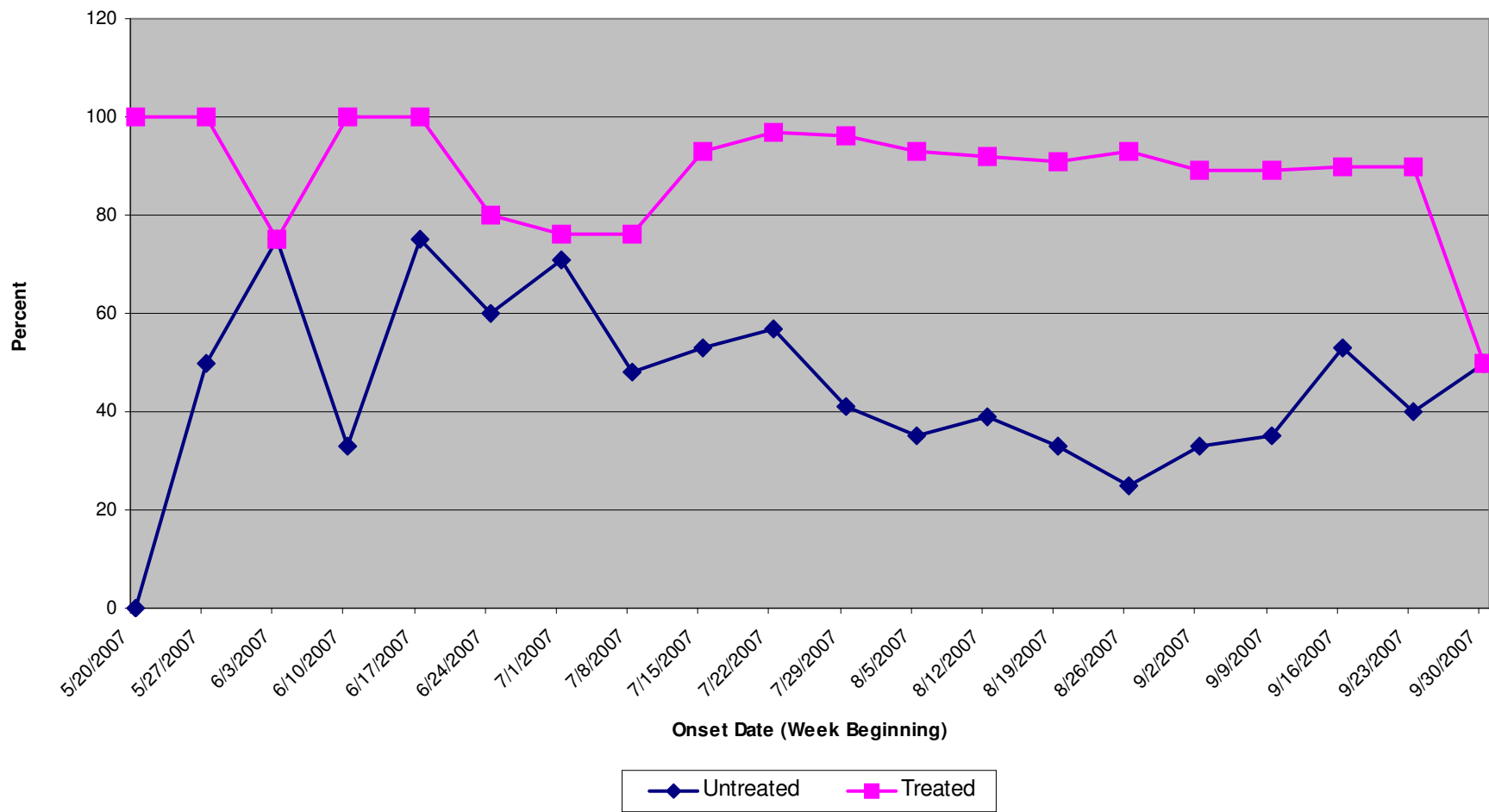
\*\*Includes fountains, sprinklers, collapsible pools or “kiddie pools,” water activities at a childcare center, slip and slide, and a dunk tank.



**Figure 10. Number of different venues named per case patient with water exposure at recreational water venues (n = ### with data available)**



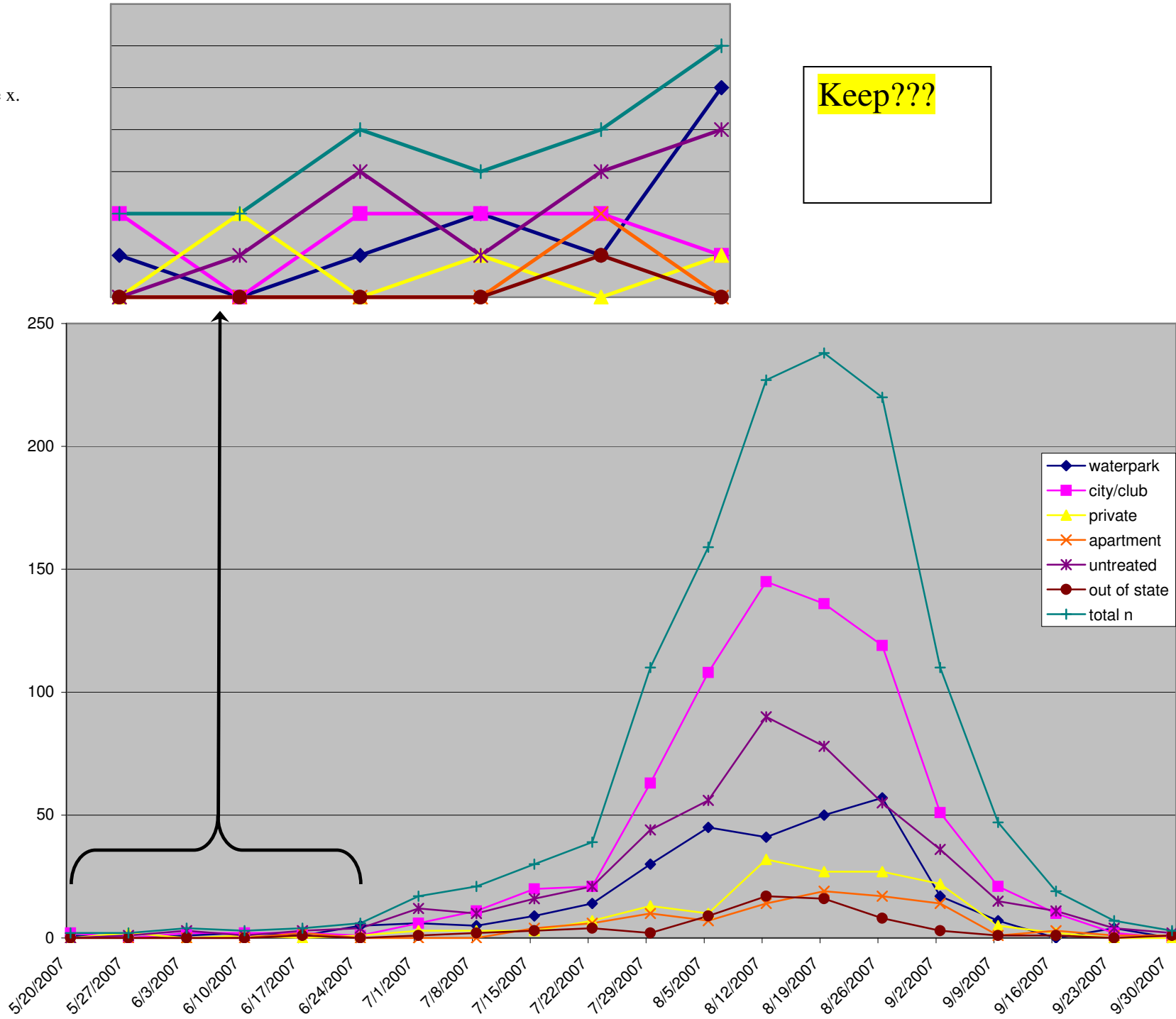
**Figure 11. Cumulative number of case patients with one recreational water venue named and cumulative number of unique venues named by these patients by week of onset date, May 23-August 4, 2007**



**Figure 12. Percent of case patients with known onset date and recreational water exposure by venue type (treated or untreated), May 23-October 6, 2007**

Note: Values do not add to 100% because categories are not mutually exclusive. Some case patients named multiple venues.

Figure x.



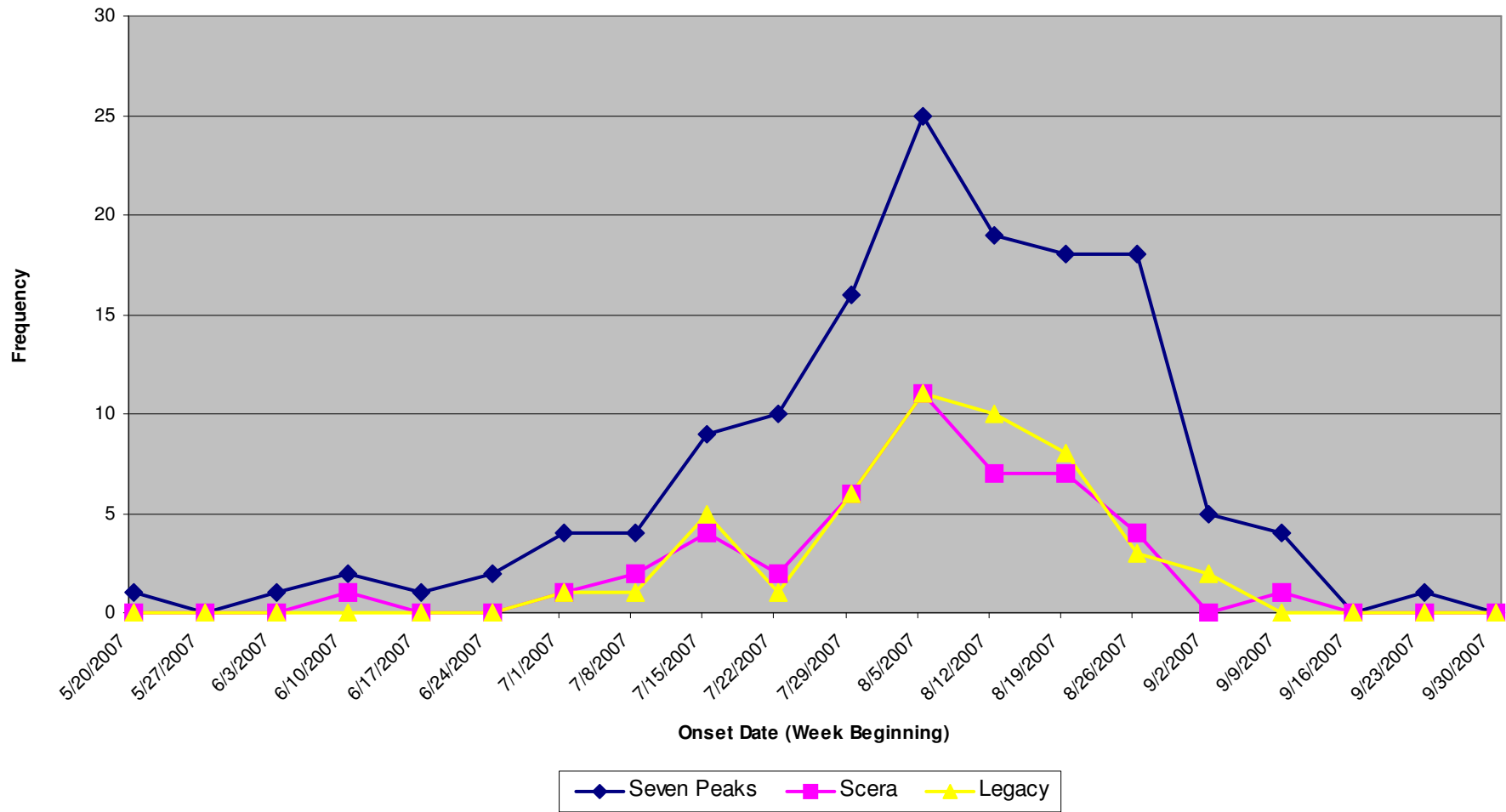


Figure 13. Number of confirmed case patients naming select Utah County pools by week of onset date, May 23-October 6, 2007

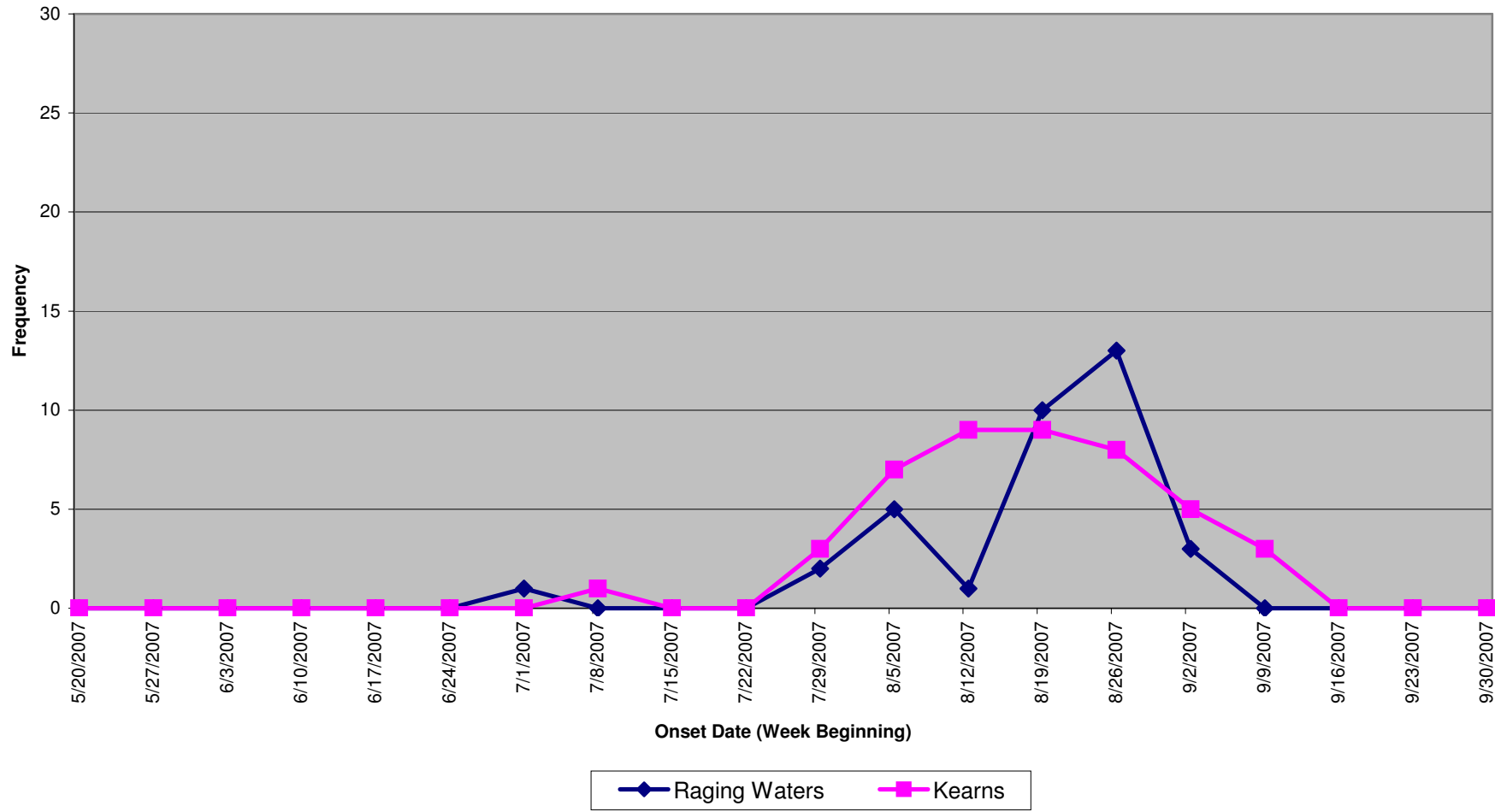


Figure 14. Number of confirmed case patients naming select Salt Lake Valley pools by week of onset date, May 23-October 6, 2007

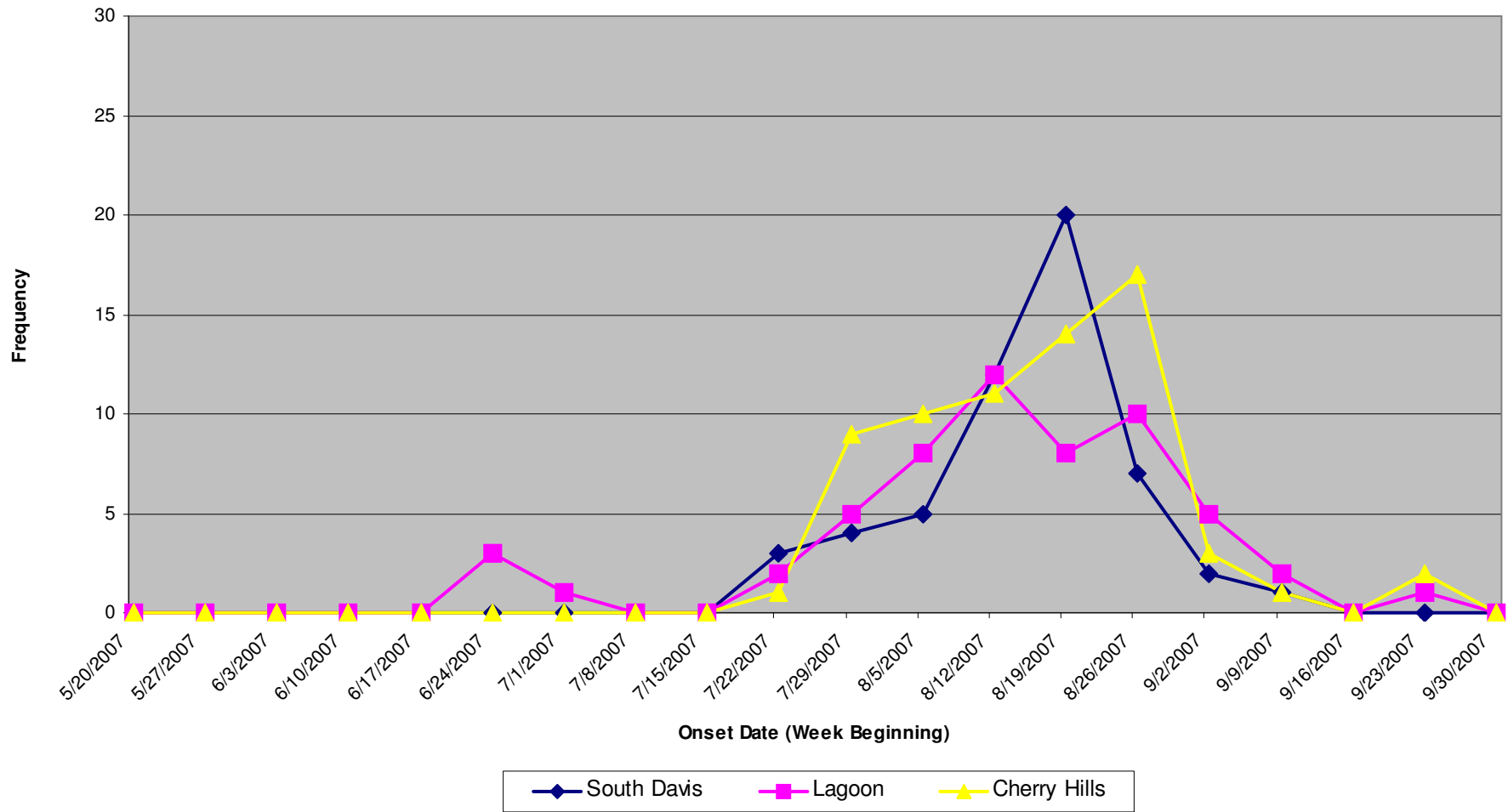
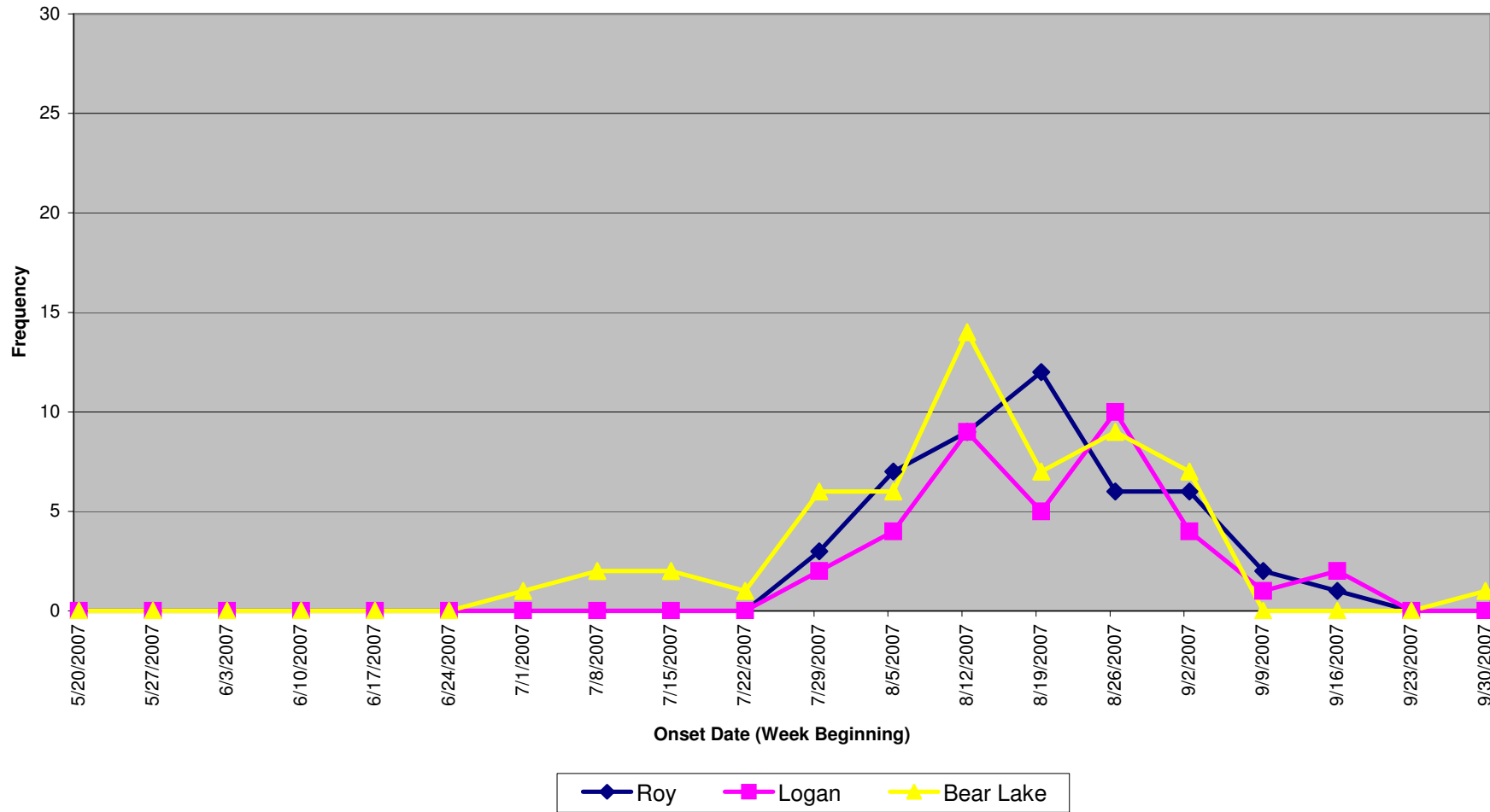
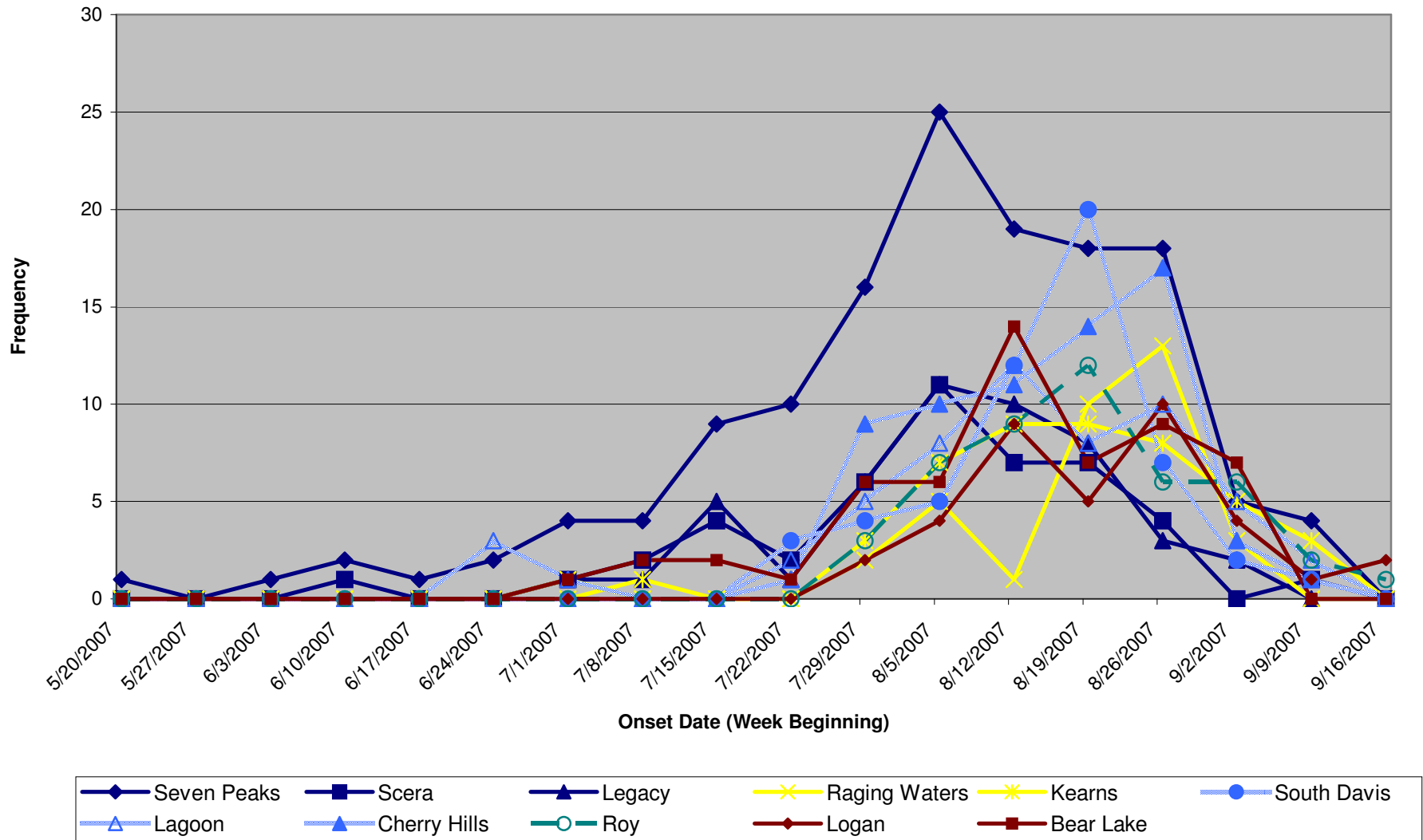


Figure 15. Number of confirmed case patients naming select Davis County pools by week of onset date, May 23-October 6, 2007



**Figure 16. Number of confirmed case patients naming select Weber-Morgan and Bear River pools by week of onset date, May 23-October 6, 2007**

Note: Roy is in Weber-Morgan district and Logan and Bear Lake are in Bear River district.



**Figure 17. Most frequently named recreational water venues named during the outbreak, May 23-September 22, 2007**

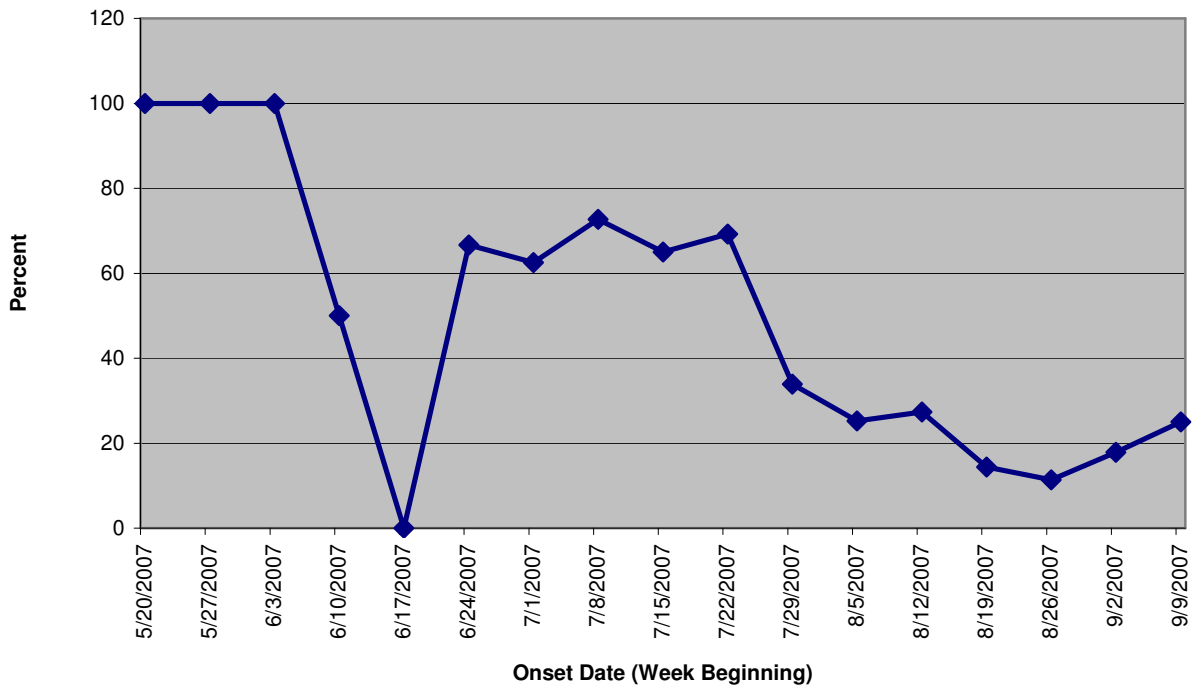
Note: Utah County (blue): Seven Peaks, Scera, Legacy; Salt Lake Valley (yellow): Raging Waters, Kearns; Davis County (pink): South Davis, Lagoon, Cherry Hills; Weber-Morgan (green): Roy; Bear River (brown): Logan, Bear Lake

**Table 4. Number of recreational water venues named by whether or not the case patient reported exposure(s) while ill**

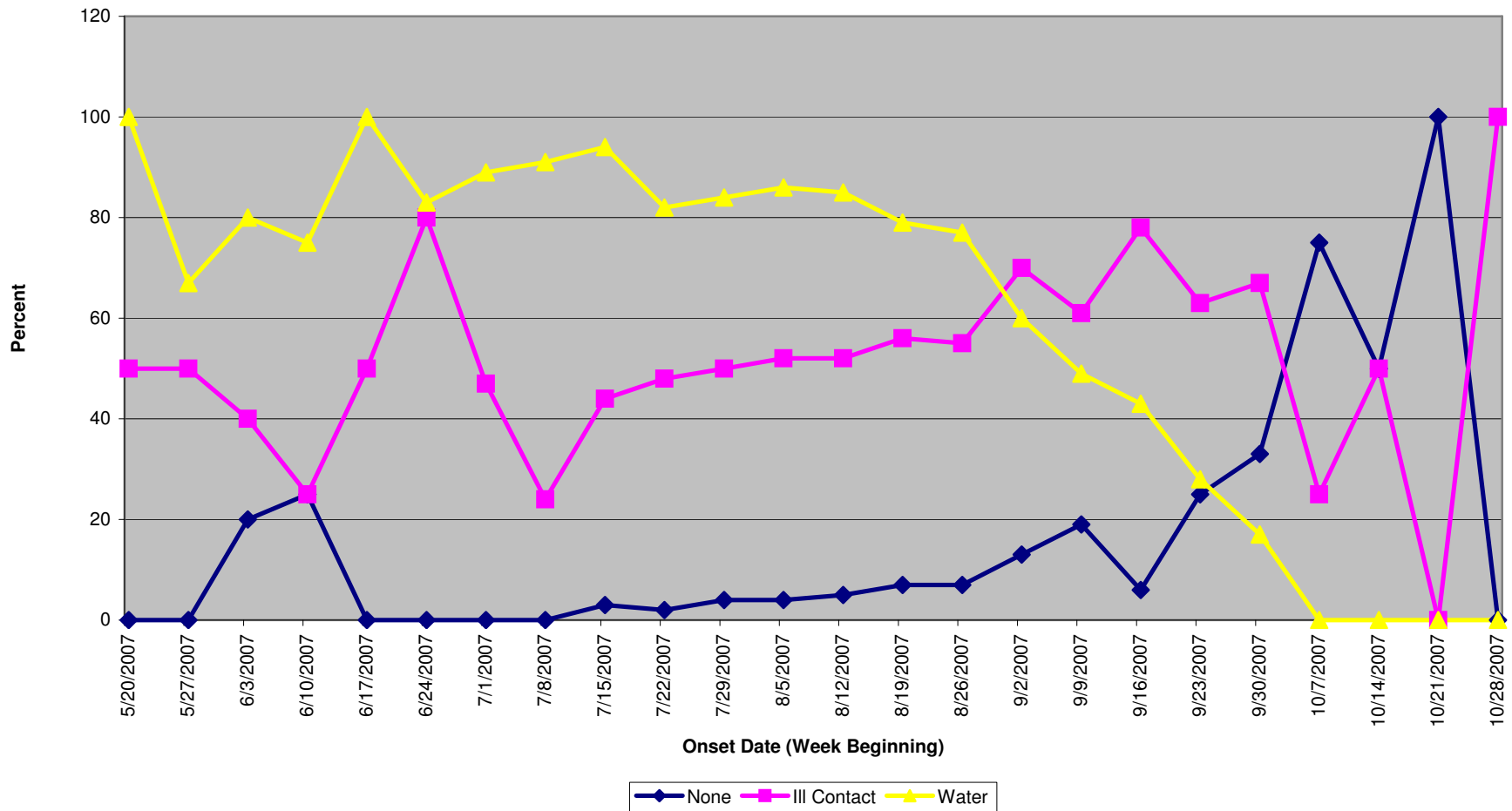
| Venues | No Water Exposure While Ill | Water Exposure While Ill |                     |
|--------|-----------------------------|--------------------------|---------------------|
|        | During Incubation Period    | During Incubation Period | After Disease Onset |
|        | %                           | %                        | %                   |
| 1      | 71                          | 41                       | 70 (28)*            |
| 2      | 22                          | 38                       | 19 (6)              |
| 3      | 6                           | 13                       | 5 (2)               |
| 4      | <1                          | 4                        | 5 (0)               |
| 5      | <1                          | 1                        | 0 (0)               |
| 6      | <1                          | 3                        | 0 (0)               |

Percentages may not add to 100 because of rounding

\*Percentages given in parentheses indicate the percentage of case patients who reported recreational water exposure while ill who swam in a venue that he or she did not have exposure to during the incubation period. (38% of those with recreational water exposure while ill reported a new venue; 62% had exposure only at one or more of the same venues as during the incubation period)



**Figure 18. Percent of patients who reported recreational water exposure while ill, May 23-September 15, 2007**



**Figure 19. Percent of case patients with known onset date who reported recreational water exposure (treated or untreated), contacts ill with similar symptoms, or neither exposure, May 23-November 3, 2007**

Note: Values do not add to 100% because categories are not mutually exclusive. Some case patients named both exposures.

## **V. Delay in Detection (and/or Response)**

On July 26, UDOH detected an increase based on 8 reported cases. In retrospect, 126 reported cases had onset dates during May 23-July 26. A lag between onset date and date of report to UDOH delayed detection of the outbreak. The lag between onset date, date of laboratory test, and dates of report to local health department and UDOH were assessed. Of 125 cases that were reported to the local health department more than one day prior to UDOH receiving the report (11% of 1,153 cases with dates available), the median lag between report to local health department and report to UDOH was 4 days (mean  $\pm$  standard deviation:  $7.0 \pm 7.2$  days, range: 2-45 days). The onset dates for these 155 cases were June 4-November 11, but these included only 4 cases with onset dates prior to July 26 (the date the outbreak was detected by UDOH). Therefore, the lag between report to local health department and report to UDOH was not a significant factor in delaying detection of the outbreak.

The median lag between onset date and lab test date was 23 days (mean  $\pm$  standard deviation:  $29.9 \pm 23.8$  days, range: 2-125 days) for the cases with onset dates during May 23-July 26. Longer lags occurred during the earliest weeks of the outbreak (table 5 and figure 20). During the first 4 weeks of the outbreak, patients did not have a laboratory test until approximately 2-3 months after onset of symptoms. This was a major factor impeding the detection of the outbreak. In general, this lag decreased successively over the remaining weeks of the outbreak.

In general, the median lag between laboratory test and report to UDOH was at least one week from the beginning of the outbreak through August. UCHD determined that one hospital laboratory was not aware that cryptosporidiosis was a reportable disease until late July. Reporting lag between laboratory test date and date of report to UDOH decreased during the outbreak, albeit less consistently and less dramatically than the lag from onset to laboratory test (table 5 and figure 20). This decrease was at least partly due to ARUP Laboratories increasing the frequency of reporting to UDOH as of September 5. Additionally, other possible explanations include that the general public might have been more likely to visit a health care provider and get tested sooner because of increased awareness of cryptosporidiosis as the outbreak continued. Similarly, physicians may have been more likely to request a laboratory test sooner (and also specifically a test for cryptosporidiosis as opposed to another illness with similar symptoms).

An accurate evaluation of the effectiveness of the interventions was complicated by both lags between onset and reporting and the disease's incubation period (range: 1-14 days, mean: 7 days). When UDOH evaluated the timeliness of reporting on September 4, the median number of days from onset date was 9 for laboratory test date, 15 for date of report to local health district, and 16 for date of report to UDOH for confirmed cases from all health districts with known onset dates. The median number of days from lab test date to date of report to UDOH was 6 days. ARUP Laboratories, from which 60% of all initial reports had originated, had been transmitting the positive *Cryptosporidium* laboratory results once weekly. UDOH requested that ARUP transmit the reports more frequently, and, on September 5, ARUP began transmitting test results on a nearly daily basis. For the period of September 12-October 6, timeliness of reporting from all diagnostic laboratories to UDOH was re-evaluated. The reporting time decreased from a median of 6 days to 4 days. Still, there was approximately a 3-week period between infectious exposure of a patient and report of disease to UDOH. Evaluation of the effectiveness of interventions was, therefore, not timely, as it was considered that 3 weeks would have to pass before any changes in incidence would occur (in the data) based on the intervention. Decreasing all lags within the reporting chain could improve both detection and response to an outbreak and evaluation of the effectiveness of interventions.

**Table 5. Lag (days) between onset, laboratory test, and report to UDOH, May 23-November 11, 2007**

| <b>Week of</b> | <b>n</b> | <b>Onset to Lab Test median (range)</b> | <b>Onset to Report to UDOH median (range)</b> | <b>Lab Test to Report to UDOH median (range)</b> |
|----------------|----------|---|---|--|
| May 20         | 2        | 54 (52-55)                              | 70 (68-71)                                    | 16 (16-16)                                       |
| May 27         | 3        | 91 (59-91)                              | 93 (82-98)                                    | 7 (2-23)   |
| June 3         | 5        | 68 (5-125)                              | 75 (12-133)                                   | 7 (6-14)   |
| June 10        | 4        | 62 (47-79)                              | 71 (50-82)                                    | 6 (3-9)  |
| June 17        | 4        | 13 (4-25)                               | 42 (34-44)                                    | 30 (9-40)  |
| June 24        | 6        | 36 (6-64)                               | 47 (26-70)                                    | 7 (5-35)   |
| July 1         | 19       | 24 (2-100)                              | 34 (6-103)                                    | 9 (1-28)   |
| July 8         | 23       | 21 (5-67)                               | 27 (12-69)                                    | 6 (1-17)   |
| July 15        | 33       | 20 (3-57)                               | 28 (8-61)                                     | 7 (0-16)   |
| July 22        | 45       | 18 (1-46)                               | 26 (10-59)                                    | 8 (0-23)   |
| July 29        | 127      | 13 (0-60)                               | 23 (3-74)                                     | 8 (0-38)   |
| August 5       | 184      | 9 (1-46)                                | 17 (7-52)                                     | 8 (2-26)   |
| August 12      | 260      | 10 (0-44)                               | 17 (3-50)                                     | 7 (0-23)   |
| August 19      | 286      | 7 (0-29)                                | 14 (3-70)                                     | 6 (0-45)   |
| August 26      | 276      | 6 (0-23)                                | 11 (2-36)                                     | 5 (0-17)   |
| September 2    | 169      | 5 (0-29)                                | 11 (0-33)                                     | 4 (0-21)   |
| September 9    | 78       | 6 (0-26)                                | 12 (3-48)                                     | 5 (1-45)   |
| September 16   | 37       | 6 (0-19)                                | 10 (1-30)                                     | 5 (2-26)   |
| September 23   | 18       | 6 (1-66)                                | 14 (4-70)                                     | 4 (2-15)   |
| September 30   | 12       | 4 (0-11)                                | 9 (4-18)                                      | 5 (2-8)  |
| October 7      | 4        | 3 (1-7)                                 | 9 (6-14)                                      | 5 (2-13)   |
| October 14     | 3        | 4 (2-12)                                | 8 (4-22)                                      | 4 (2-10)   |
| October 21     | 1        | 4 (4-4)                                 | 8 (8-8)                                       | 4 (4-4)  |
| October 28     | 1        | 8 (8-8)                                 | 28 (28-28)                                    | 20 (20-20)                                       |
| November 4     | 0        | ---                                     | ---   | ---  |
| November 11    | 1        | 3 (3-3)                                 | 8 (8-8)                                       | 5 (5-5)  |



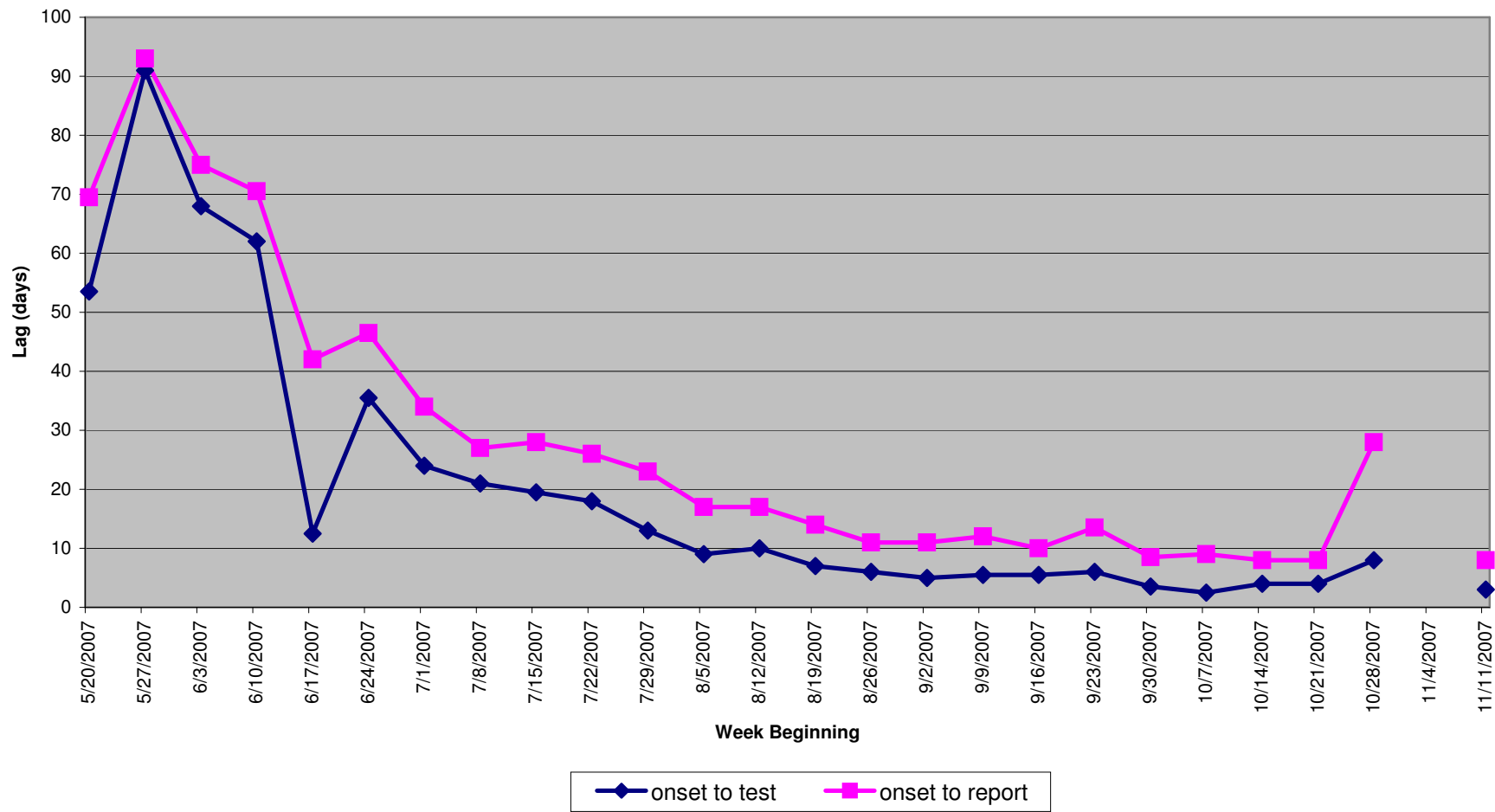


Figure 20. Lag between onset date and laboratory test date and date of report to UDOH (cases with known onset date, n = 1,602), May 23-November 11, 2007

## **VI. Investigation Forms**

Due to some local health districts having become overwhelmed with the large number of cases being reported daily/weekly, the standard investigation form, “Enteric,” was modified and shortened to allow for quicker interviewing that was cryptosporidiosis outbreak-specific. This new form, “Crypto Mini,” was officially implemented on August 17. SLVHD then implemented a 1-page “Morbidity Report” with few, brief exposure questions on September 5. Additionally, SLVHD and other health districts submitted unofficial investigation reports that were also very brief, and these were grouped together as “Morbidity Report” forms in this analysis. Use of these forms during the outbreak is shown in Figure 21. The dark black line represents the number of cases reported each week during the outbreak. As the number of reported cases increased, use of the shortened investigation form (“Crypto Mini”) increased initially, and then began to decrease. Use of “Morbidity Report” forms continually increased during the outbreak. While use of shorter investigation forms helped overwhelmed local health departments’ ability to interview more cases in a timelier manner, pertinent data was not being collected on these new forms. This included, potentially, locations where patients swam during the incubation period, whether the patient swam while ill and where, and information on contacts ill with similar symptoms.

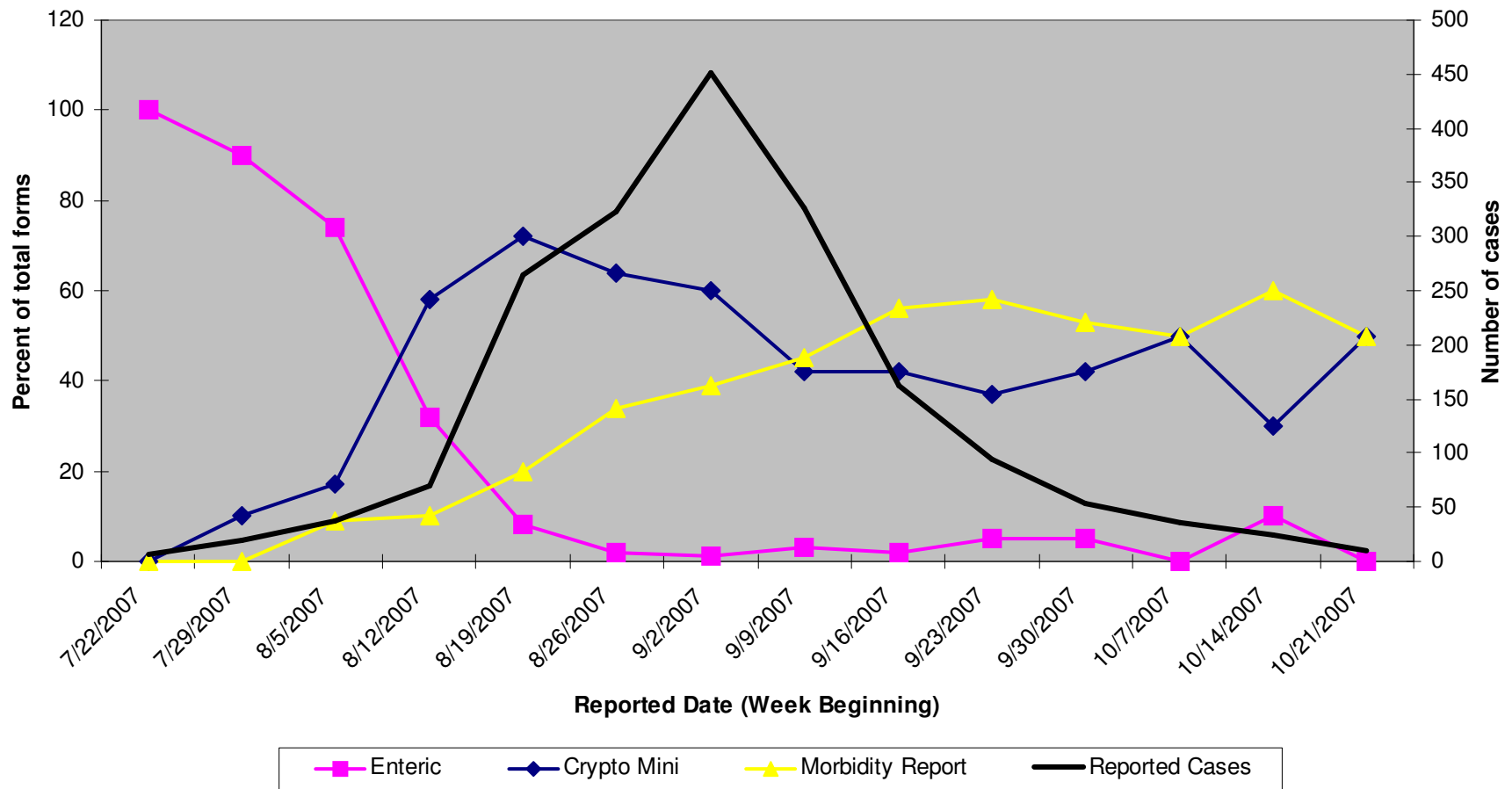


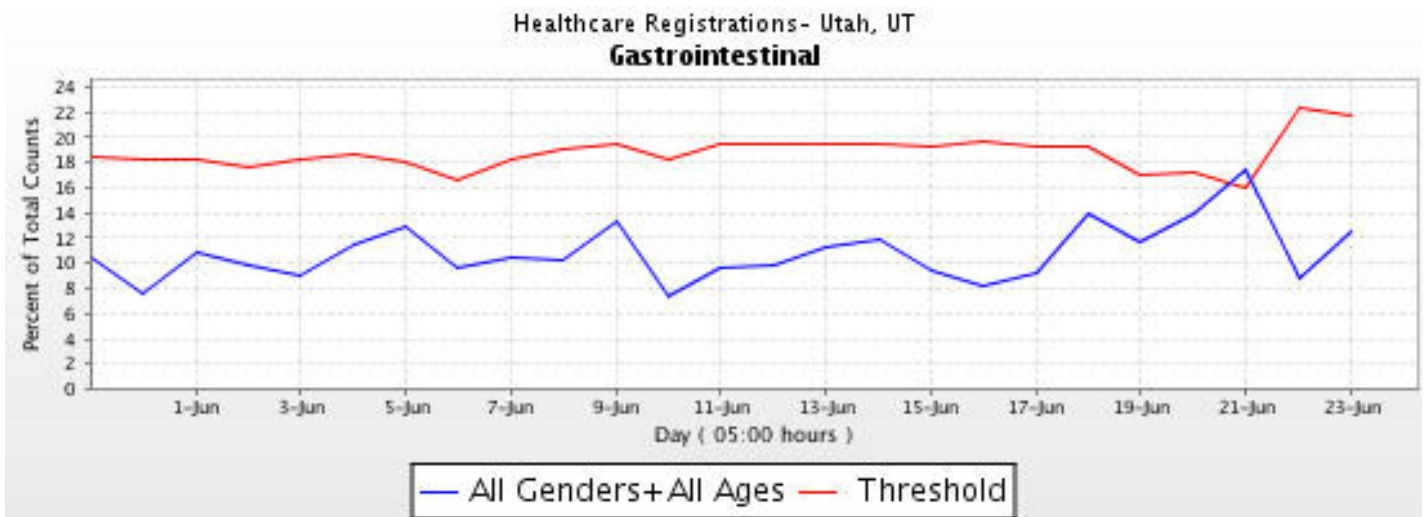
Figure 21. Use of different investigation forms during the outbreak with epidemic curve of case reports indicated, July 22-October 27, 2007

## VII. Other Data Sources

### A. Syndromic Surveillance

Real-time Outbreak and Disease Surveillance (RODS) is open-source public health surveillance software. RODS has been in development since 1999 by the RODS Laboratory -- a collaboration of the University of Pittsburgh and Carnegie Mellon University. In 2002, the Utah Department of Health used the software for monitoring during the Winter Olympic Games. At present, health departments and other groups in the United States, Canada, and Taiwan use the software. RODS collects and analyzes disease surveillance data in real time and emits alerts if a threshold value, which is calculated based on data from the preceding # days, is exceeded.

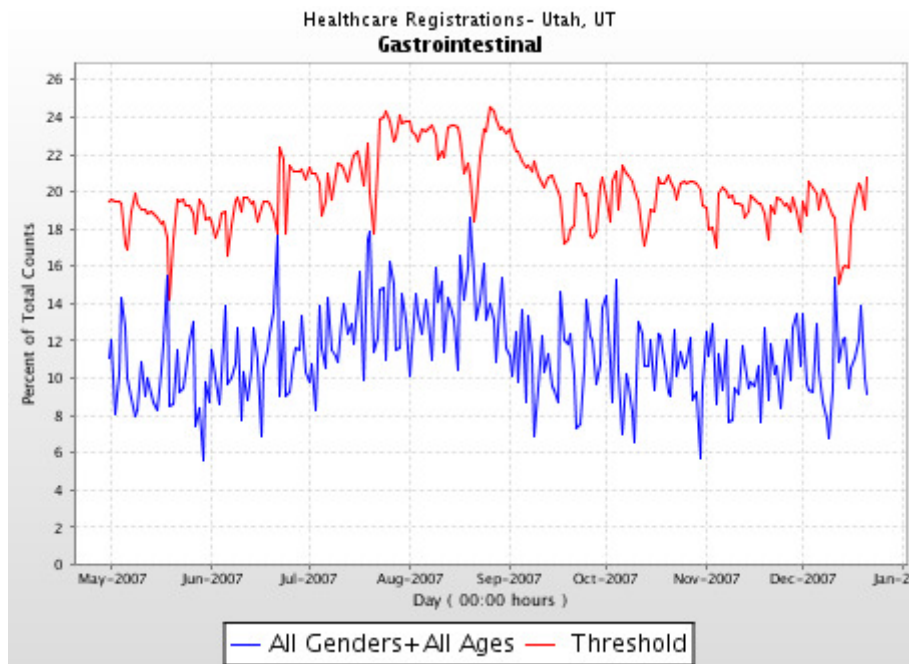
On June 21, 2007 a RODS alert was received for Utah County for gastrointestinal syndrome. It was believed to be due to random variation of the data temporarily exceeding the established threshold.



**Figure 22. Gastrointestinal syndrome as percent of total emergency department visits, Utah County, May 30-June 23, 2007**

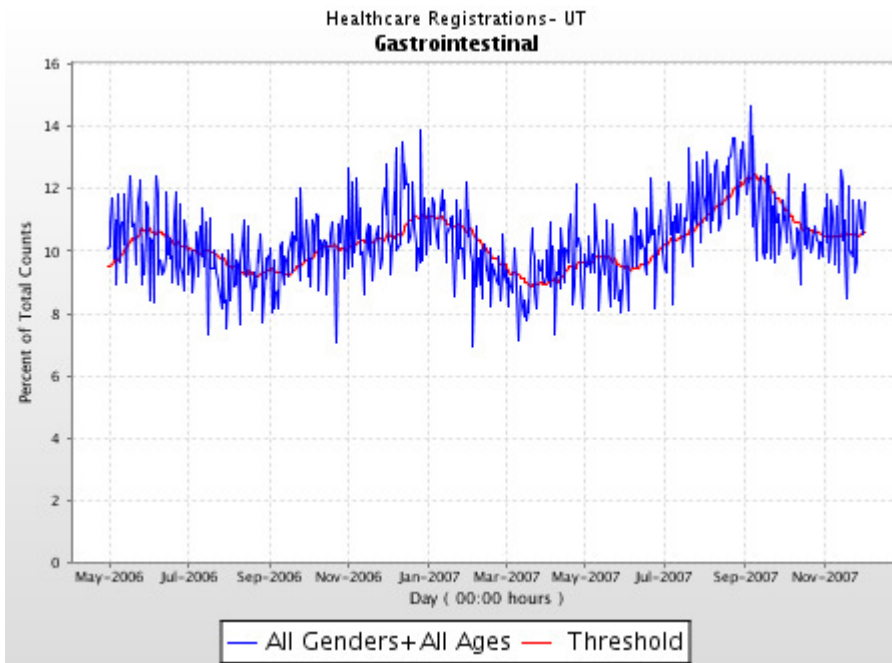
\*permission needs to be obtained from RODS to use this graph in any published report according to the terms of service. Threshold is defined as

No other RODS alerts were received throughout the duration of the outbreak. Figure 22 shows data for Utah County during May-December 2007. The percent of total counts does not cross the threshold (based on cusum with a threshold value of 4.0).



**Figure 23. Gastrointestinal syndrome as percent of total emergency department visits, Utah County, Utah, May-December 2007**

Despite this lack of additional alerts, retrospectively, it is possible to see the RODS Gastrointestinal data mimic the epidemic curve. RODS is fairly inflexible in how you are able to view the data and the random variation of the daily data stream makes trends difficult to see. To improve the visibility of the trend, the graphs presented below use the moving average statistical function with a threshold of zero. The red line represents a smoothed curve for incidence.



**Figure 24. Gastrointestinal syndrome as percent of total emergency department visits, Utah (statewide), May 2006-December 2007**

On figure 22, data on gastrointestinal syndrome as percent of total emergency department visits for the current outbreak (May 23-November 11, 2007) can be compared with data for the same time frame of the previous year. In 2006, there was a peak at approximately 11% in June, and there was a similar peak at 11% in January 2007. During April-September 2007 the percent of total counts increased over 3%. The curve during the outbreak period mirrors the epidemic curve for the outbreak, except that the peak occurred later (early September compared with a peak in the week of August 19 for onset of illness). It is also evident by this entire curve that detection of the outbreak was difficult during its earliest stages.

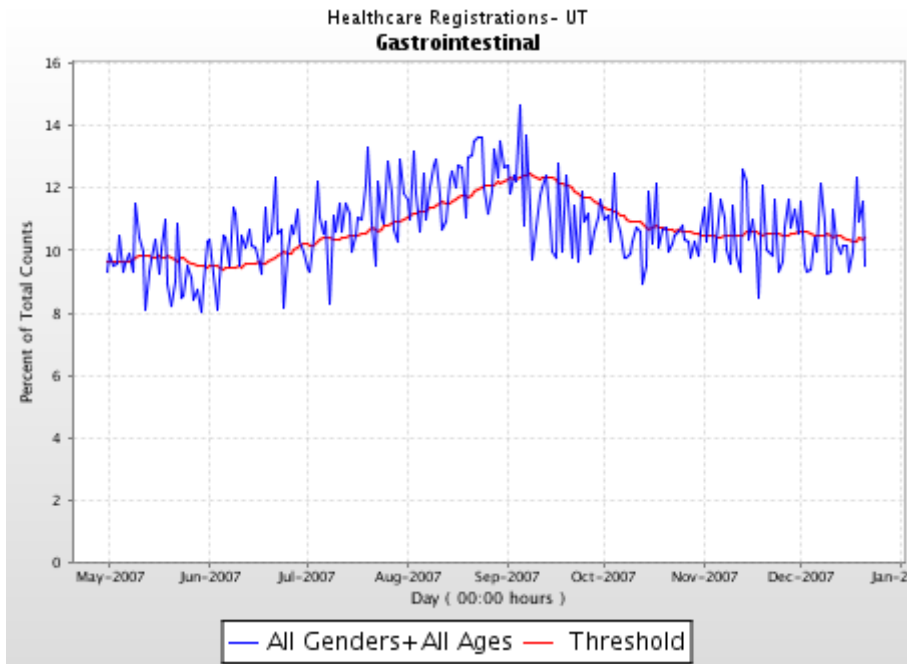


Figure 25. Gastrointestinal syndrome as percent of total emergency department visits, Utah (statewide), May-December 2007

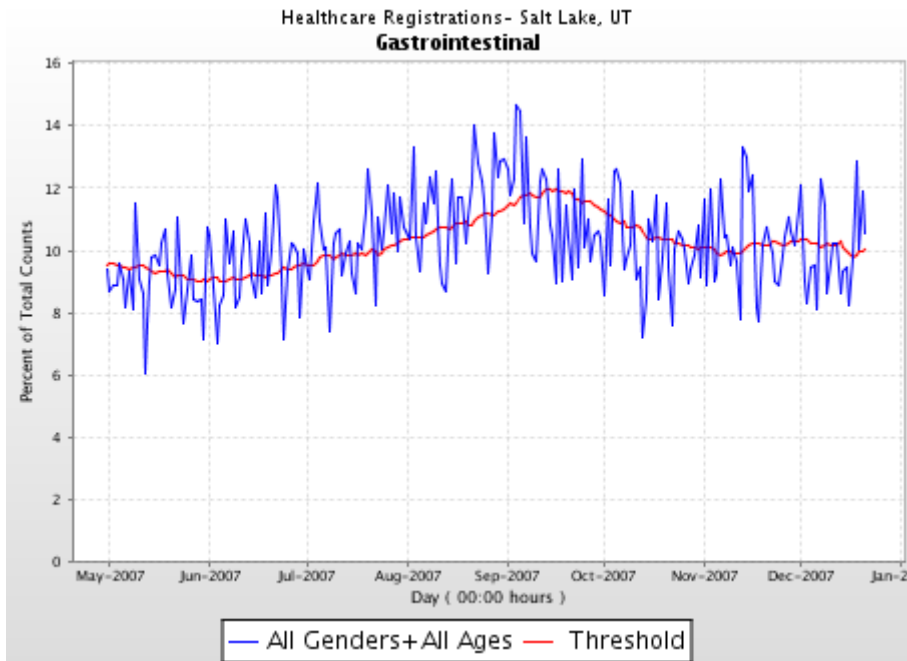
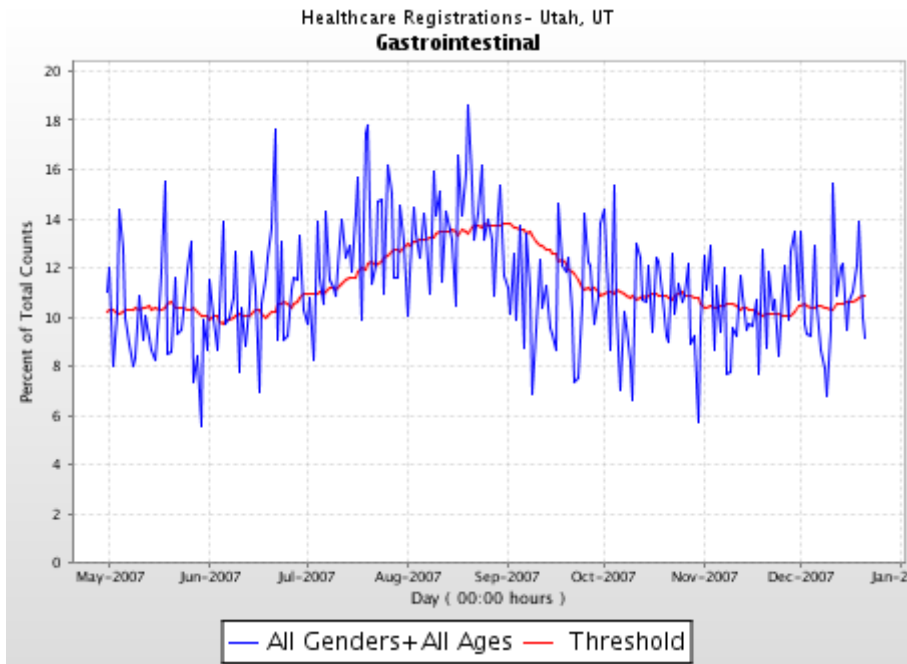
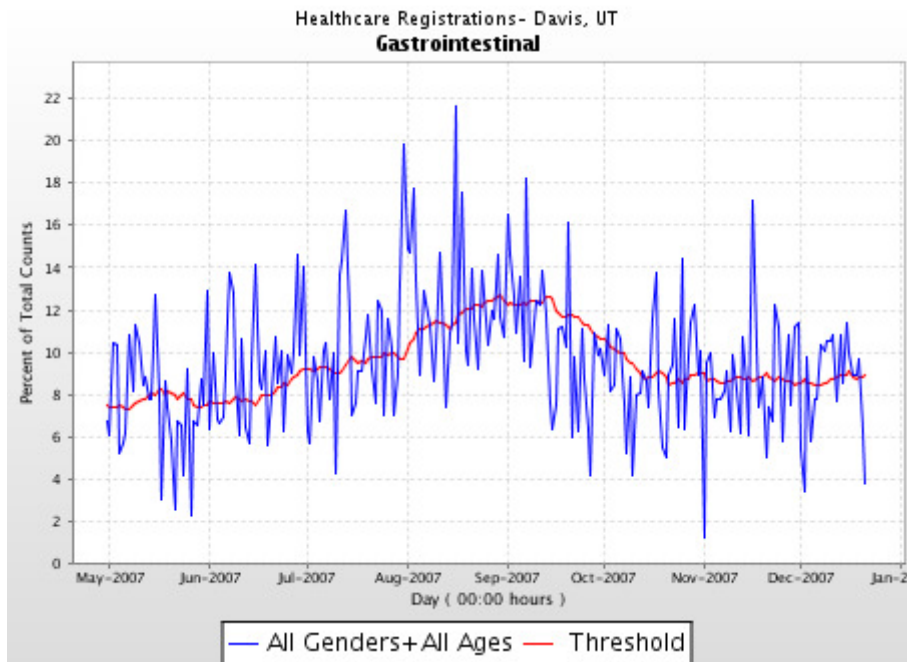


Figure 26. Gastrointestinal syndrome as percent of total emergency department visits, Salt Lake County, Utah, May-December 2007

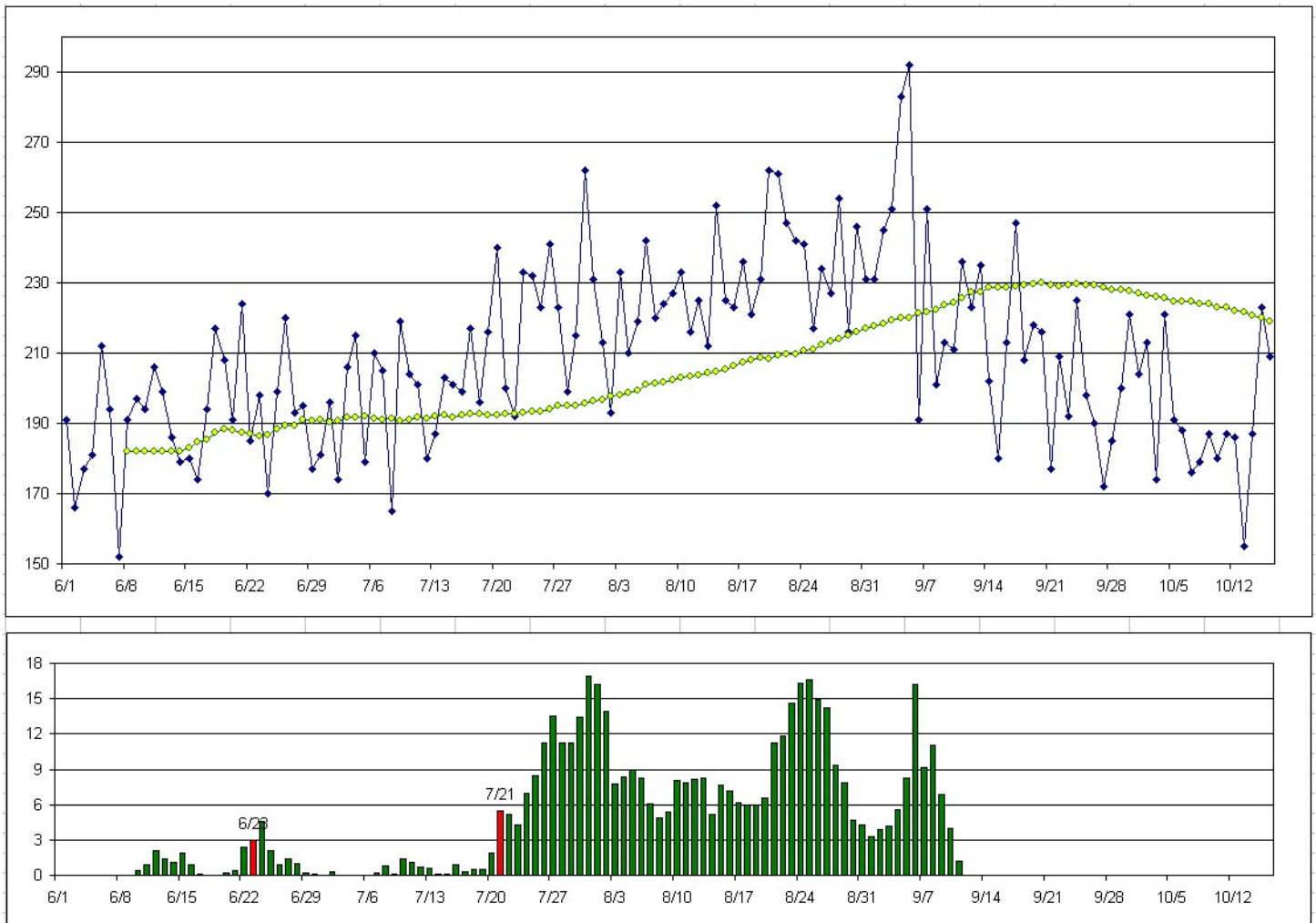


**Figure 27. Gastrointestinal syndrome as percent of total emergency department visits, Utah County, Utah, May-December 2007**



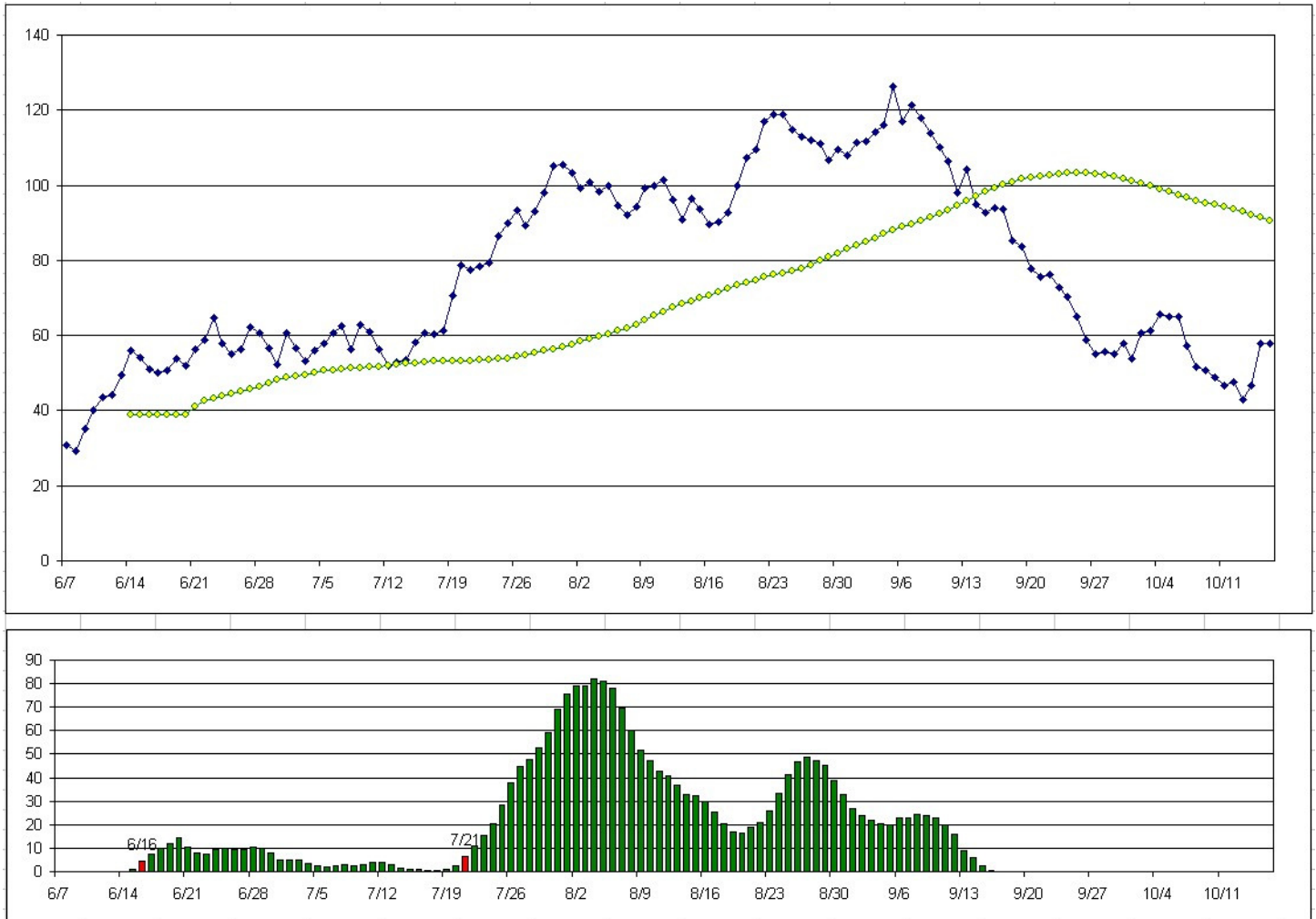
**Figure 28. Gastrointestinal syndrome as percent of total emergency department visits, Davis County, Utah, May-December 2007**

Other methods, involving exporting the data with external data analysis, were explored to see if the outbreak could be detected. Two temporal scan statistics methods were explored. The first uses a normal ScanG statistic on the RODS data stream, which first flags on 6/23 and then again 7/21 (ignoring consecutive flags).



In the top graph, the y-axis indicates the total counts from RODS data. In the bottom graph, the y-axis indicates the value of the test statistic.

The second method uses a hybrid approach with historical data, involving the difference of the current smoothed data stream from the one the previous year. This method flags on 6/16 and also on 7/21 (ignoring consecutive flags). The first flag on 6/16 is considered unreliable because it is based on limited data with its early position in the data stream.



In the top graph, the y-axis indicates the difference in counts between 2007 and 2006. In the bottom graph, the y-axis indicates the value of the test statistic.

Currently, the major drawback for these surveillance methods is that they are time intensive. RODS only allows 30 days of summary data to be downloaded at one time per variable of interest (county, possibly syndrome, additional periods for historical). These data need to be extracted, imported, merged and then added to the statistic and analyzed. Automation of some of these steps may be possible. Further analysis could evaluate county level data and could use longer periods to determine if these methods are valid for daily surveillance. RODS, as it is currently used, may be better for detecting outbreaks with a more sudden increase in disease. Since it utilizes data from the preceding days, gradual increases may not be detected as anomalies.

### **B. Laboratory Data**

SLVHD received *Cryptosporidium* laboratory test surveillance numbers (percent positive tests by week) from Primary Children's Medical Center after the outbreak was over. Preliminary data analyses suggest that this data mirrors the epidemic curve for the outbreak. This data will be pursued in the future to enhance surveillance.

### **C. Pharmacy Data**

SLVHD requested unofficial pharmacy data from a few pharmacies to aid surveillance methods. RODS pharmacy data was not utilized during this outbreak, but should be investigated as another source of surveillance data.

### **D. School absentee data**

(was this investigated for use during this outbreak or future outbreaks?)

## **VI. Conclusions and Discussion**

During May 23-December 11, 2007, 1,902 laboratory-confirmed cryptosporidiosis cases were reported to UDOH. The total reported number of cases that occurred in this outbreak is considered an underestimation of the true burden during the outbreak, primarily because diarrheal diseases are often underreported (*1*). Calculating the sensitivity of Utah's surveillance system in estimating the disease burden in the population is difficult. One way to estimate the burden is to look at the estimated proportion of persons with diarrheal illness who seek medical care and the proportion of cases reported. According to estimates from FoodNET, and active surveillance system for estimating the burden of foodborne disease transmission in the U.S., only 8% of persons with a diarrheal illness seek medical care, and subsequently, only 1%-5% of foodborne disease cases are reported to CDC through passive surveillance systems (*2*).

Assuming this is also a good estimation for cryptosporidiosis, the estimated true number of cases of cryptosporidiosis in Utah during the outbreak could have been 38,040-190,200. Because cryptosporidiosis is a self-limiting diarrheal illness, because diagnosis of the illness is often not considered, and because laboratories do not routinely test stool specimens for cryptosporidiosis infection, this disease continues to be under-diagnosed and under-reported (insert reference).

Recognition of waterborne disease outbreaks is dependent on certain outbreak characteristics;

outbreaks associated with serious illness or affecting a substantial number of persons are more likely to receive attention from health authorities.(Yoder and Beach)

Although it is quite clear that an outbreak with significant incidence rates occurred during the summer of 2007 in Utah, there are a number of factors that could lead to an increase in cases of cryptosporidiosis, in general. These same factors may also contribute to the occurrence of and detection of an outbreak of the disease. These include, but are not limited to: increased use of pools, changes in types of pools (more waterparks, splash parks, spray fountains, toddler wading pools, and other interactive water features), and increased testing for *Cryptosporidium* because of the availability of treatment (nitazoxanide was only licensed for treatment of children aged 1-11 years until 2004, when it became licensed for treatment of older children and adults).

#### **A. Mode of Transmission**

Summer 2007 was a particularly hot summer, the hottest summer on record in Salt Lake City (summer average temperature 79.3F compared with average for previous years of 73.9F <[http://www.wrh.noaa.gov/slc/river/presentations/climate\\_2007\\_summer.ppt](http://www.wrh.noaa.gov/slc/river/presentations/climate_2007_summer.ppt)>). Pools and waterparks experienced above average attendances. For example, South Davis community pool in Davis County had average daily attendance almost three times that of the previous year (1,250 versus 486 per day, respectively). Attendance during May at three other Davis County pools was up at least 50%. No data on the proportion of Utah residents who have recreational water exposures during any given time are available.

A formal analytic study, which could compare the proportion of case patients who reported recreational water exposures to controls without disease, was not conducted. It was assumed early in the outbreak that the mode of transmission was recreational water exposure because of the great proportion of cases who named these exposures. Further, as the outbreak progressed and investigation forms were shortened, much of the data collected on exposures were variables on recreational water venues. This created much missing data on other potential exposures. Furthermore, because case patients often named multiple exposures (particularly multiple recreational water exposures and contacts ill with similar symptoms), especially early in the outbreak, it was difficult to determine the source of infection for many patients. Also, there were

a number of patients with neither recreational water exposure nor contacts ill with similar symptoms, and the likely source of infection could not be determined.

We assessed the percentages of patients with other enteric diseases (campylobacter, diarrhea caused by *Escherichia coli*, salmonella, or shigella) whom had onset dates during the same time period, May 23-November 11, 2007 and reported that they had recreational water exposure during their exposure period and/or had contacts ill with similar symptoms. For these 325 non-cryptosporidiosis enteric disease cases, 27% (80/298) reported recreational water exposure and 33% (103/308) reported contacts ill with similar symptoms. Both of these percentages are much lower than those for cryptosporidiosis cases, 80% and 55%, respectively.

Some cases had data on swimming while ill and reported names of recreational water venues exposed to while ill. This data was incomplete, even for cases early in the outbreak. More complete data would be valuable in tracking spread of disease to different venues.

There were general trends of (1) decreasing recreational water exposures, (2) increasing exposure to contacts ill with similar symptoms, and (3) increasing median age of case patients. A disproportionate number of case patients were less than 5 years of age. It is hypothesized that recreational water exposures, particularly community pools and waterparks, were the main source of transmission throughout the outbreak and particularly during the first half of the outbreak. As the outbreak progressed and more and more children were becoming ill, their caregivers and close contacts may have become infected through person-to-person transmission. A large percentage of case patients were 20 to 44 years of age. It is also interesting to note that very few patients were 45+ years of age; older persons may be less likely to have recreational water exposures or provide childcare for diaper-aged children. Data provide no evidence of other modes of transmission (e.g., drinking water, contaminated food or drink, or animal-to-person).

#### Recommendations:

- Conduct a formal analytic study to determine the likely mode of transmission; consider use of BRFSS for control data.
- Do not use shortened investigation forms for cases early in the outbreak.

## **B. Delay in Detection (and/or Response)**

There was a delay in detection of the outbreak. The most significant factor causing this delay was the delay that cases had in being tested for *Cryptosporidium*. It is unclear whether this delay was in cases seeking treatment from a health care provider or the health care provider specifically testing for *Cryptosporidium*. There were also delays in reporting – local health departments had delays in reporting to UDOH, but, more significantly, there were delays in laboratories reporting to UDOH. One potential limitation of the data available for this investigation was the potential for long-term recall error due to delays in testing and reporting, which caused case interviews to be conducted sometimes more than a month after onset of disease.

The communication between UDOH and local health departments at the beginning of the outbreak was not optimal. This is easy to say in retrospect, but improved and quicker communication between UDOH and local health departments would help in response to any potential disease outbreak. UCHD detected an increase in cases on July 12 and notified UDOH. Surrounding health districts were not notified at this time. On July 26, UDOH detected an increase in cases, but notification was not sent to local health departments until August 2. A statewide conference call was organized on August 9. At this time, there were over 60 reported cases (and it was later determined that over 180 cases had onset dates prior to August 9). On August 10, UDOH issued a press release, which received a lot of attention by newspapers, television, and radio. An informational website was also created by UDOH. Throughout the outbreak a public health education campaign was ongoing (messages were sent to health care providers, pool operators, hospitals, etc.). As at least one laboratory was not aware that cryptosporidiosis was a reportable disease, these messages should also be sent to laboratories. This public health education campaign was not effective in decreasing the incidence of disease, as the rate increased from 269.4/100,000 July 27-August 9 to 461.6/100,000 August 10-August 16. Despite another press release and more messages being sent to physicians, pool operators, etc., the rate increased again to 537.1 August 17-August 28. On August 28, pool restrictions and increased chlorination schedules were implemented. Increased chlorination schedules enforced earlier in the outbreak may have helped to slow the spread of disease. Pool restrictions are a more sensitive issue (many people were angry that they could not take their children to the pool).

Control measures reported in previously published outbreak reports included that non-toilet trained toddlers should be restricted to toddler wading pools and wearing waterproof diapers.(Puech 2001) This is one potential alternative to total restriction from pools, which could be implemented earlier in the outbreak. Toddler wading pools would need special attention with regard to hyperchlorination.

#### Recommendations:

- Conduct a public education campaign just prior to the 2008 outdoor pool season.
- Improve communication between local health departments and UDOH.
- Ensure that UDOH keeps all local health departments informed of potential outbreaks.
- Ensure that laboratories understand that cryptosporidiosis is a reportable disease (reportable within three working days after identification).
- Compare case counts between local data and UDOH data, especially early in an outbreak.
- Follow up with contacts ill with similar symptoms who are named by cases.
- UDOH should offer and local health departments should request help with completing case interviews, if necessary.
- Implement thresholds for decision-making on control and prevention measures.
- Implement hyperchlorination and/or increased chlorination schedules earlier in an outbreak setting; consider special control measures pertaining to incontinent persons.
- Plan for negative effects of control and prevention measures (persons angry they cannot swim, extreme hyperchlorination causing problems with pool equipment and possible chemical burns to swimmers, cost to pools).
- Determine ways in which CDC could help in future outbreaks.

#### **C. Effectiveness of Response**

During the outbreak, an accurate evaluation of the effectiveness of the interventions was complicated by lag times between onset date, laboratory test date, and report to public health. In retrospect, the evaluation of the effectiveness of the interventions is also complicated because the timing of the major interventions (pool restrictions and increased chlorination schedules) was one week prior to many seasonal pools closing. The initial public health education campaign and press releases were not deemed to be effective as rates of disease subsequently increased. The

pool restrictions and increased chlorination schedules appear to have been effective in controlling the outbreak. The incidence rate decreased from 534.9/100,000 during August 17-September 1 to 326.4/100,000 during September 2-September 8, which represents a period five days after the intervention to a date five days after many pools closed for the season. Note that periods five days after intervention and pool closings were chosen to account for the mean incubation period, which was determined to be 5 days. Figures 13-17 also provide some evidence of the effectiveness of the intervention. The pools named most frequently in this outbreak are included in figures 13-17. The frequency of these pools being named decreased (quite substantially in some pools) between the week of 8/26 and the week of 9/2, when the effects of the intervention were expected to have been manifest. Smaller decreases were observed the following week beginning 9/9.

Because many pools closed, it is unknown whether the intervention impacted the further decline in incidence to 98.0/100,00 during September 9-September 24. When the pool restriction for children less than 5 years of age who do not wear diapers was lifted on September 25, the incidence rates did not increase. Similarly, incidence rates did not increase after increased chlorination schedules were no longer recommended on October 11.

[more research could be done comparing indoor and outdoor pools]

#### **D. Lessons Learned**

Lessons learned included the importance of responding before widespread contamination, the need to plan for surveillance lag in evaluating interventions, and the importance of good communication/coordination between local health districts, UDOH, laboratories, environmental health, and CDC. Furthermore, there was a lot of public responsibility in this outbreak, and another lesson learned was the difficulty in changing a person's behaviors. Public health is limited in what can be done to try to change behaviors. In an outbreak involving community pools and waterparks, enforcement of pool rules and chlorination might be the best control measures.

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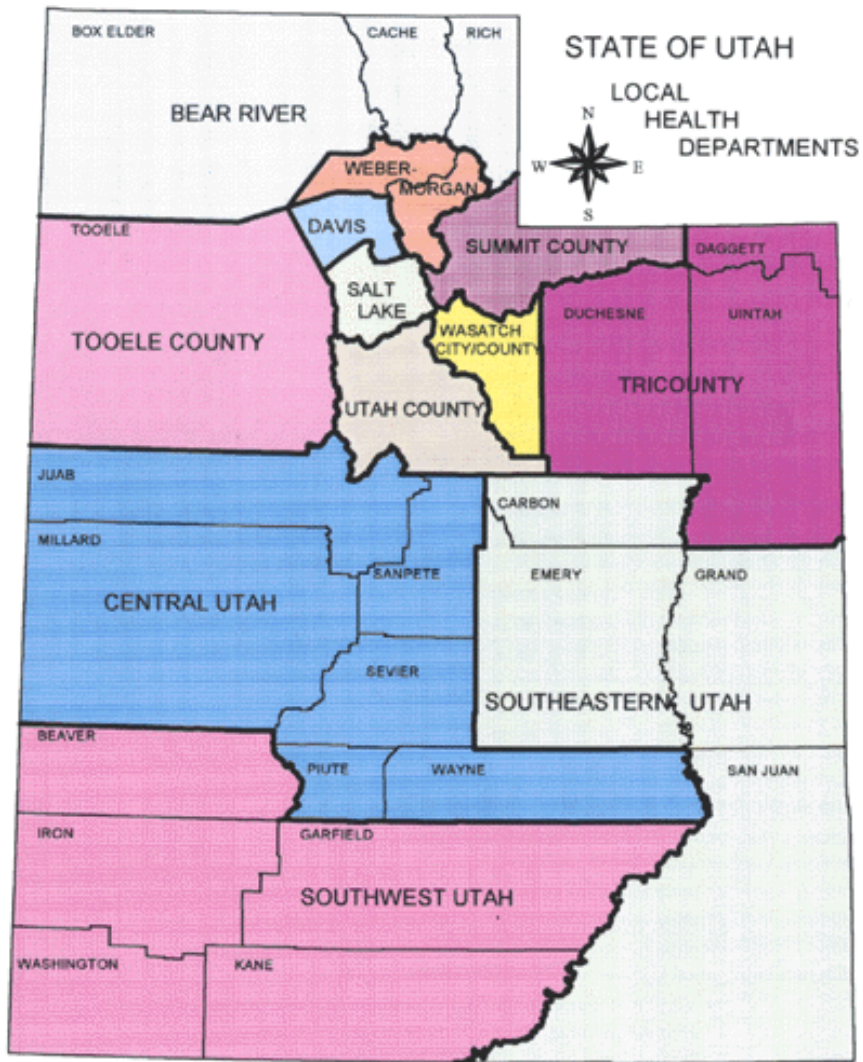
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**VIII. Appendices (need to add #3-10)**

1. Map of Utah's 12 health districts
2. Line listings of early cases
3. Protocol for response to cryptosporidiosis outbreak
4. Investigation forms
  - i. Enteric Disease Investigation Form
  - ii. Enteric Disease Investigation Form (short version)
  - iii. Cryptosporidiosis Mini Investigation Form
  - iv. Morbidity Report
5. Public health alerts from counties/state
6. Press releases
7. Signage displayed at pools
8. Notice to daycare centers/ school nurses/healthcare providers (email)/assisted living centers
9. Other informational materials received from CDC
10. Anecdotal evidence and other information from local health departments

**Appendix I. Map of Utah's 12 health districts**





**Appendix 2a. Line Listing of Early Cases with Potential Incubation Period\* Indicated for Each Water Exposure Venue Named, May 23-July 5, 2007**

| Onset Date | District | Swim | Seven Peaks  | Pleasant Grove   | Lagoona Beach | Other 1                           | Other 2                | Other 3             | Other 4                    | Other 5 | Other 6 |
|------------|----------|------|--------------|------------------|---------------|-----------------------------------|------------------------|---------------------|----------------------------|---------|---------|
| 05/23/2007 | UC       | Yes  |              |                  |               | Veterans<br>0 days                |                        |                     |                            |         |         |
| 05/26/2007 | UC       | Yes  | 0 days       |                  |               | Veterans<br>3 days                |                        |                     |                            |         |         |
| 05/30/2007 | SL       | Yes  |              |                  |               | Hot tub<br>2 days                 |                        |                     |                            |         |         |
| 05/31/2007 | DA       | Unk  |              |                  |               | Unknown                           |                        |                     |                            |         |         |
| 06/01/2007 | SL       | Yes  |              |                  |               | Sugarhouse Park<br>Unk            | 1700S 1700E<br>Unk     | Ruth's<br>Unk       | Park City<br>stream<br>Unk |         |         |
| 06/03/2007 | UC       | Yes  | Unk          |                  |               | Christofferson<br>Creek<br>3 days |                        |                     |                            |         |         |
| 06/04/2007 | UC       | Yes  |              |                  |               | American Fork<br>Unk              | Sprinkler<br>Unk       |                     |                            |         |         |
| 06/04/2007 | UC       | No   |              |                  |               |                                   |                        |                     |                            |         |         |
| 06/07/2007 | DA       | Yes  |              |                  |               | Coalville<br>Unk                  |                        |                     |                            |         |         |
| 06/08/2007 | UC       | Yes  |              | Unk              |               |                                   |                        |                     |                            |         |         |
| 06/10/2007 | UC       | No   |              |                  |               |                                   |                        |                     |                            |         |         |
| 06/10/2007 | UC       | Yes  | 9 days       |                  |               |                                   |                        |                     |                            |         |         |
| 06/11/2007 | UC       | Yes  | 11 days      |                  |               | Scera<br>3 or 7 days              | Private pool<br>6 days | Utah Lake<br>7 days |                            |         |         |
| 06/15/2007 | UC       | Yes  |              | 0-14 days        |               |                                   |                        |                     |                            |         |         |
| 06/22/2007 | UC       | Yes  | 4-11<br>days | 3 days           |               | Brighton Camp<br>7-10 days        |                        |                     |                            |         |         |
| 06/23/2007 | SL       | Yes  |              |                  |               | Apartment<br>0-12 days            |                        |                     |                            |         |         |
| 06/23/2007 | UC       | Yes  |              | 10 or 12<br>days |               | Lake Michigan<br>1-6 days         |                        |                     |                            |         |         |
| 06/23/2007 | UC       | Yes  |              |                  |               | Nelson Grove<br>5 days            |                        |                     |                            |         |         |
| 06/26/2007 | UC       | Yes  | 10 days      |                  |               | Private pool<br>0-7 days          |                        |                     |                            |         |         |

|            |    |     |        |  |         |                                |                           |                            |               |                            |                     |
|------------|----|-----|--------|--|---------|--------------------------------|---------------------------|----------------------------|---------------|----------------------------|---------------------|
| 06/26/2007 | SL | Yes |        |  | 8 days  |                                |                           |                            |               |                            |                     |
| 06/27/2007 | SW | Yes |        |  | Unk     |                                |                           |                            |               |                            |                     |
| 06/30/2007 | UC | No  |        |  |         |                                |                           |                            |               |                            |                     |
| 06/30/2007 | DA | Yes |        |  |         | Lake Powell<br>0-7 days        |                           |                            |               |                            |                     |
| 06/30/2007 | SL | Yes |        |  | 0 days  |                                |                           |                            |               |                            |                     |
| 07/01/2007 | UC | Yes | 1 day  |  |         |                                |                           |                            |               |                            |                     |
| 07/01/2007 | DA | Yes |        |  |         | Wasatch PT pool<br>Unk         |                           |                            |               |                            |                     |
| 07/01/2007 | UC | Yes |        |  |         | Scera<br>Unk                   | Riverside CC<br>Unk       | American<br>Fork<br>Unk    | Legacy<br>Unk | Utah Lake<br>Unk           | AF<br>Canyon<br>Unk |
| 07/01/2007 | UC | Yes |        |  |         | Sprinklers<br>Unk              |                           |                            |               |                            |                     |
| 07/01/2007 | SW | Yes |        |  |         | Private pool<br>Unk            |                           |                            |               |                            |                     |
| 07/03/2007 | UC | Yes | Unk    |  |         | Payson<br>Unk                  | Private pool<br>Unk       | Lake-<br>Uintahs<br>6 days |               |                            |                     |
| 07/03/2007 | UC | No  |        |  |         |                                |                           |                            |               |                            |                     |
| 07/03/2007 | UC | Yes | 3 days |  |         | Sprinklers<br>Unk              |                           |                            |               |                            |                     |
| 07/04/2007 | TO | Yes |        |  |         | Lake<br>Unk                    |                           |                            |               |                            |                     |
| 07/04/2007 | SL | Yes |        |  | 16 days |                                |                           |                            |               |                            |                     |
| 07/04/2007 | DA | Yes |        |  |         | Bear Lake<br>Unk               | Raging<br>Waters<br>Unk   |                            |               |                            |                     |
| 07/05/2007 | UC | Yes |        |  |         | Cancun resort<br>1-14          |                           |                            |               |                            |                     |
| 07/05/2007 | UC | Yes |        |  |         | Pineview<br>Reservoir<br>1 day |                           |                            |               |                            |                     |
| 07/05/2007 | SL | Yes |        |  |         | Kamas<br>1 day                 | Sugarhouse<br>Park<br>Unk | 1700S<br>1700E<br>Unk      | Ruth's<br>Unk | Park City<br>stream<br>Unk |                     |

\* Potential incubation period (days) calculated from reported swim date and onset date.

SL= Salt Lake; UC= Utah County; SW= Southwest; DA= Davis; TO=Tooele

Unk= Unknown; Ruth's= stream behind Ruth's Diner; CC=country club; AF=American Fork; PT=physical therapy

**Appendix 2a. Line Listing of Early Cases with Reported Instances of Water Exposure While Ill Indicated for Each Water Exposure Venue Named, May 23-July 5, 2007** (incomplete data – not all cases were asked this information)

| Onset Date | Swim ill? | Location 1    | Dates              | Location 2      | Dates    | Location 3     | Dates     | Location 4 | Dates     |
|------------|-----------|---------------|--------------------|-----------------|----------|----------------|-----------|------------|-----------|
| 05/23/2007 | Yes       | Seven Peaks   | 5/26               |                 |          |                |           |            |           |
| 05/26/2007 |           |               |                    |                 |          |                |           |            |           |
| 05/30/2007 | Yes?      | Jordanelle    | 7/24               |                 |          |                |           |            |           |
| 05/31/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/01/2007 | Yes       | Kamas         | 7/4                | Sugarhouse Park | several  | 1700S 1700E    | several   | Ruth's     | several   |
| 06/03/2007 | Yes       | Seven Peaks   | several            | Legacy          | 8/3      | Christofferson | Unk       |            |           |
| 06/04/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/04/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/07/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/08/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/10/2007 | Yes       | American Fork | 7/10-7/28          | Legacy          | 6/25-7/4 | private        | 6/12-6/17 |            |           |
| 06/10/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/11/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/15/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/22/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/23/2007 | Yes       | Apartment     | several            |                 |          |                |           |            |           |
| 06/23/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/23/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/26/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/26/2007 | Yes       | Lagoon        | 7/9 & 7/23         | Moose Hollow    | 7/13     | Pineview       | 7/14      | Kearns     | 7/25-7/26 |
| 06/27/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/30/2007 |           |               |                    |                 |          |                |           |            |           |
| 06/30/2007 | Yes       | Williard      | 7/1                |                 |          |                |           |            |           |
| 06/30/2007 | Yes?      | Camp Lomondi  | 7/26-7/28          |                 |          |                |           |            |           |
| 07/01/2007 |           |               |                    |                 |          |                |           |            |           |
| 07/01/2007 |           |               |                    |                 |          |                |           |            |           |
| 07/01/2007 |           |               |                    |                 |          |                |           |            |           |
| 07/01/2007 |           |               |                    |                 |          |                |           |            |           |
| 07/01/2007 |           |               |                    |                 |          |                |           |            |           |
| 07/03/2007 |           |               |                    |                 |          |                |           |            |           |
| 07/03/2007 |           |               |                    |                 |          |                |           |            |           |
| 07/03/2007 |           |               |                    |                 |          |                |           |            |           |
| 07/04/2007 |           |               |                    |                 |          |                |           |            |           |
| 07/04/2007 | Yes       | Lagoon        | Between 7/5 & 7/23 | Moose Hollow    | 7/13     | Pineview       | 7/14      | Kearns     | 7/25-7/26 |
| 07/04/2007 |           |               |                    |                 |          |                |           |            |           |
| 07/05/2007 |           |               |                    |                 |          |                |           |            |           |
| 07/05/2007 | Yes       | Pineview      | Between 7/5 & 7/17 |                 |          |                |           |            |           |
| 07/05/2007 |           |               |                    |                 |          |                |           |            |           |

“Yes?” means unsure if patient was still ill at the time