

Biological Food Contamination

Accidental conditions where introduction of a biological agent (e.g., *Salmonella*, *E.coli*, botulinum toxin) into the food supply results in 100 hospitalizations or greater and a multi-state response. This event does not include food contamination caused by malicious acts.

Data Summary

In the following table, note that the low and high likelihoods do not correspond to the low and high impacts. In addition, low and high impacts are not necessarily correlated with each other between different impact categories.

Category	Description	Metric	Low	Best	High
Health and Safety	Fatalities ¹	Number of Fatalities	0	11	42
	Injuries and Illnesses ²	Number of Injuries or Illnesses	200	17,000	45,000
Economic	Direct Economic Loss	U.S. Dollars (2011)	N/A ³		
Social	Social Displacement ^{4,5}	People Displaced from Home ≥ 2 Days	0	400	950
Psychological	Psychological Distress	Qualitative Bins	See text		
Environmental	Environmental Impact ⁶	Qualitative Bins ⁷	Moderate ⁸		
LIKELIHOOD	Frequency of Events ⁹	Number of Events per Year	0.2	0.64	1.2

Event Background

The risk data estimated for this summary sheet are applicable to a contamination event (or a series of interconnected events) where a biological agent is accidentally or unintentionally

¹ Low, average, and high adjusted fatalities of the set of multistate outbreaks with 100 or more reported hospitalizations between 1998 and 2008 from the CDC FOOD database. Reported fatalities were multiplied by a factor of 2 to compensate for underreporting (see text).

² Low, average, and high adjusted illnesses from the set of events described in note 1. Reported illnesses were multiplied by the CDC's recommended multipliers (see Table 2 below) to compensate for underdiagnosis and underreporting.

³ The SNRA project team judged that the single data point calculated (see text) was insufficient to determine a representative range of economic impact estimates for this event.

⁴ The SNRA measure of Social Displacement is the number of people displaced from their homes for two or more days.

⁵ Low and best estimates of 0 and 400 respectively reflect expert judgment. The high estimate of 950 is a judgment based on a historic incident where contamination of the water by *E. coli* in the Ontario community of Kashechewan forced the evacuation of the town (see discussion for references).

⁶ The United States Environmental Protection Agency (EPA) convened an ad hoc group of environmental experts representing the fields of environmental science, ecological risk, toxicology, and disaster field operations management to estimate environmental impacts for this event. The comments and rankings presented in this Risk Summary Sheet have not undergone review by the EPA and only represent the opinions of the group. Estimates pertain to the potential for adverse effects on living organisms associated with pollution of the environment; they are grouped into high, moderate, low, and de minimus (none) categories.

⁷ In 2011, the U. S. Environmental Protection Agency (EPA) convened an ad hoc group of environmental experts representing the fields of environmental science, ecological risk, toxicology, and disaster field operations management to estimate environmental impacts for this event. The comments and rankings presented in this Risk Summary Sheet have not undergone review by the EPA and only represent the opinions of the group. Estimates pertain to the potential for adverse effects on living organisms associated with pollution of the environment; they are grouped into high, moderate, low, and de minimus (none) categories. Experts provided both first and second choice categories, allowing the experts to express uncertainty in their judgments as well as reflect the range of potential effects that might result depending on the specifics of the event. The first choice represents the 'best' estimate.

⁸ Experts provided both first and second choice categories, allowing the experts to express uncertainty in their judgments as well as reflect the range of potential effects that might result depending on the specifics of the event. The first choice represents the 'Best' estimate.

⁹ Frequency estimates correspond to the inverse of the number of years of the longest interval between accident events (low), the mean frequency of the accident events (best), and the greatest number of accidents within one year (high) of the set described in note 1 above.

introduced into the U.S. food supply resulting in national level public health impacts and product recalls. This event may include contamination of domestic food products, international food imports, or food products or ingredients that are utilized as a component of a supply chain. Such an incident may span multiple months as the investigation on the disease agent or contaminant is identified through laboratory analysis and traced to the product origin. This assessment only addresses outbreaks that result directly in harm to human health, and does not assess the impacts of crop or animal diseases, such as Foot and Mouth Disease in cattle, which could have catastrophic effects on the Nation. Nor does it address intentional contamination of the food supply by a terrorist; that risk is captured in a different National Level Event.

Data from the CDC's Foodborne Outbreak Online Database (FOOD)¹⁰ were used to identify events that rose to a level of national significance. Data in FOOD come from CDC's national Foodborne Disease Outbreak Surveillance System database. Most foodborne outbreaks are investigated by the state, local, territorial, and tribal health departments where the outbreak occurs. Outbreak information is then reported to CDC by the public health agency that conducted the investigation. CDC is only directly involved in outbreak investigations that involve more than one state, or are particularly large, or when the state or local health department requests assistance. Because of this only multistate outbreaks that resulted in reported hospitalizations of more than 100 persons were considered to be National Level Events. There have been seven such events between 1998 and 2008, the years included in FOOD.

The best-estimate frequency is the average frequency of occurrence of this set of events in the selected eleven year period. The low frequency is the inverse of the longest time interval between outbreaks in this set (5 years); the high frequency is the greatest number of outbreaks which occurred in one year (two, in 2006).

Assumptions

Fatalities and Illnesses

The SNRA project team used the following assumptions to estimate health and safety impacts resulting from an accidental biological food contamination event:

- Outbreaks included in FOOD report a number of illnesses and fatalities. These reported numbers are known to be low because they do not account for underreporting or underdiagnosis. Consequently, the reported numbers were adjusted using the latest multipliers provided by the CDC.¹¹
- Fatalities were increased by a factor of two, while illnesses were increased with the following multipliers:

¹⁰ Centers for Disease Control and Prevention (CDC). Foodborne Outbreak Online Database. Atlanta, Georgia: U.S. Department of Health and Human Services, Center for Disease Control and Prevention. Available from URL: <http://www.cdc.gov/foodborneoutbreaks>. Accessed 08/17/2011.

¹¹ Scallan E, Hockstra RM, Angulo FJ, Tauxe RV, Widdowson M-A, Roy SL, et al. Foodborne illness acquired in the United States—major pathogens. *Emerging Infectious Diseases*. Volume 17 Number 1 January 2011. Available from URL: <http://www.cdc.gov/EID/content/17/1/7.htm>. Accessed on 08/22/2011.

Table 1: Multipliers Used to Adjust Reported Illnesses

Pathogen	Multipliers	
	Underreporting	Underdiagnosis
STEC O157 (<i>E. Coli</i>)	1.0	26.1
<i>Salmonella</i> spp., nontyphoidal	1.0	29.3
<i>Listeria Monocytogenes</i>	1.0	2.1

- The “Low,” “Best,” and “High” values of illnesses and fatalities are populated with the minimum, mean, and maximum of these adjusted values.

Table 2: Reported and Adjusted Values for SNRA Events

Outbreak	Reported Illnesses	Adjusted Illnesses	Reported Fatalities	Adjusted Fatalities
1998 <i>Lysteria</i> -Hot Dog	101	212	21	42
2004 <i>Salmonella</i> -Roma Tomato	429	12,570	0	0
2006 <i>E. Coli</i> -Spinach	238	6,212	5	10
2006 <i>Salmonella</i> -Peanut Butter	715	20,950	9	18
2007 <i>Salmonella</i> -Pot Pie	401	11,749	3	6
2008 <i>Salmonella</i> - Jalapeno/Serrano Peppers	1,535	44,976	2	4
2008 <i>Salmonella</i> -Peanut Butter	716	20,979	9	18

Economic Loss

The SNRA project team used the following assumptions to estimate economic impacts resulting from an accidental biological food contamination event:

- For each of the seven outbreaks, the costs of lost productivity due to illness as well as medical costs were calculated using the USDA Economic Research Service’s Foodborne Illness Cost Calculator,¹² with the Value of Statistical Life reset to \$0.

Table 3: Economic Impact (Adjusted to 2010 USD)

Outbreak	Lost Productivity & Medical Costs	Business Interruption Costs	Total
1998 <i>Lysteria</i> -Hot Dog	N/A		
2004 <i>Salmonella</i> -Roma Tomato	\$4.2 Million		
2006 <i>E. Coli</i> -Spinach	\$6.0 Million	\$61.4 Million ¹³	\$67.4 Million
2006 <i>Salmonella</i> -Peanut Butter	\$4.7 Million		
2007 <i>Salmonella</i> -Pot Pie	\$3.6 Million		
2008 <i>Salmonella</i> Jalapeno/Serrano Peppers	\$11.0 Million		
2008 <i>Salmonella</i> -Peanut Butter	\$5.7 Million		

Business interruption costs could be determined for only one event. However, its magnitude indicated that the unknown business interruption cost estimates for other events were likely to

¹² United States Department of Agriculture, Economic Research Service. Foodborne Illness Cost Calculator. Available from URL: <http://www.ers.usda.gov/Data/FoodBorneIllness>. Accessed on 08/19/2011.

¹³ United States Department of Agriculture, Economic Research Service. Consumers’ Response to the 2006 Foodborne Illness Outbreak Linked to Spinach. Available from URL: <http://www.ers.usda.gov/AmberWaves/March10/Features/OutbreakSpinach.htm>. Accessed on 08/19/2011.

dominate total direct costs. As a representative range of total costs could not be determined for additional data points, the SNRA project team elected not to report economic impacts for the Biological Food Contamination event.

Social Displacement

For the purposes of the SNRA, social displacement was defined as the number of people forced to leave home for a period of two days or longer. Note that there are limitations to this measure of social displacement, as the significant differences between temporary evacuations and permanent displacement due to property destruction are not captured.

- Social displacement estimates for the accidental Biological Food Contamination event were provided by staff researchers and subject matter experts at the National Consortium for the Study of Terrorism and Responses to Terrorism (START).¹⁴
- The low and best estimates of 0 and 400 respectively reflect expert judgment. The high estimate of 950 is a judgment based on a historic incident where contamination of the water by *E. coli* in the Ontario community of Kashechewan forced the evacuation of the town.¹⁵

Psychological Distress

Psychological impacts for the SNRA focus on *significant distress* and *prolonged distress*, which can encompass a variety of outcomes serious enough to impair daily role functioning and quality of life. An index for significant distress was created that reflected empirical findings that the scope and severity of an event is more important than the type of event. The equation for this index uses the fatalities, injuries, and displacement associated with an event as primary inputs; a factor elicited from subject matter experts weights the index for differing psychological impact based on the type of event, but as a secondary input.¹⁶ The numerical outputs of this index formula were used to assign events to bins of a risk matrix for a semi-quantitative analysis of psychological risk in the SNRA.

Environmental Impact

The United States Environmental Protection Agency (EPA) convened an ad hoc group of environmental experts representing the fields of environmental science, ecological risk, toxicology, and disaster field operations management to estimate environmental impacts for this event. Estimates are based on the following assumptions:

¹⁴ START is a Department of Homeland Security University Center of Excellence that focuses on social and behavioral aspects of terrorism, natural disasters, and technological accidents, and the social, behavioral, cultural and economic factors influencing responses to and recovery from catastrophes.

¹⁵ Contamination of the water by *E. coli* in the Ontario community of Kashechewan forced the evacuation of the town. Source: Virchez, Jorge, and Ronald Brisbois. 2007. "A Historical and Situational Summary of Relations between Canada and the First Nations: The case of the Community of Kashechewan in Northern Ontario." *Asociacion Mexicana de Estudios sobre Canada*, AC. 87-100. Note that contamination of the food supply is likely to cause minimal displacement.

¹⁶ The Significant Distress Index is calculated from these inputs using a formula proposed by subject matter experts consulted for the SNRA project: $N_{SD} = C_{EF} \times (5 \text{ Fat} + \text{Inj} + \frac{1}{2} D)$, where N_{SD} represents the number of persons significantly distressed, C_{EF} is the expert assessed Event Familiarity Factor, Fat is the number of fatalities, Inj is the number of injuries and/or illnesses, and D is the number of persons displaced (Social Displacement). In words, this formula suggests that there are 5 significantly distressed persons for each life lost; 1 for each person injured; and 1 for each 2 people displaced. This formula was constructed to reflect the empirical finding that the most severe stressor of a disaster is losing a loved one, followed by injury, followed by displacement. Uncertainty was captured by applying the index formula to the low, best, and high estimates of these three human impact metrics.

The Event Familiarity Factor is intended to capture the extent to which the event entails an ongoing threat with uncertainty regarding long term effects, is unfamiliar, or that people dread, exacerbating psychological impacts. This factor, ranging from 1.0 for familiar events to 1.3 for unfamiliar events, was provided by subject matter experts for each national-level event included in the SNRA: accidental Biological Food Contamination was given a C_{EF} of 1.0.

The numerical estimates calculated from this formula are reported in Appendix G. The semi-quantitative risk matrix is discussed in the Findings (Psychological Distress Risk).

- Experts were elicited to provide estimates in the environmental impact category based on assumptions. Actual environmental/ecological harm that occurs as a result of the events described in a given scenario may vary considerably, and will depend on numerous variables (e.g., as chemical or biological agents, contamination extent, persistence, toxicity—both chronic and acute toxicity—and infectivity).
- EPA defined environmental consequence (impact)¹⁷ as the potential for adverse effects on living organisms associated with pollution of the environment by effluents, emissions, wastes, or accidental chemical releases; energy use; or the depletion of natural resources.
- Experts identified the best estimate for environmental impacts as “Moderate.” Moderate impacts would most likely result from either waste disposal (e.g., disposing of the contaminated food supply) or dissemination of an infectious agent through some type of accidental application (e.g., pesticide application on crops). In either event, the result could be the introduction of a non-native pathogen into native species, thus causing extinction and permanent change to the ecosystem if disseminated over a wide geographic area. If the agent infects only humans, the environmental/ecological risk would be “Low.” There may also be increased environmental/ecological risk if the food production cycle were disrupted. Changing the mechanisms of food production could increase the environmental/ecological risk.

Potential Mitigating Factors

The impacts caused by an accidental introduction of an infectious agent into the food supply can be mitigated through several preparedness strategies. Effective investigative capability, early warning systems and emergency information dissemination are necessary to rapidly detect contamination, locate its source and notify the public of the event and necessary safety measures. Monitoring and warning systems should be regularly tested to ensure that they are functioning properly when an event occurs. Further, a properly prepared and deployed response team could potentially aid in containing the spread of the contamination.

¹⁷ The 2011 SNRA referred to impacts as ‘consequences’ because of prior usage in quantitative risk assessment (Kaplan and Garrick [1981, March], On the quantitative definition of risk: *Risk Analysis* 1(1) 11-32). Except where it will cause confusion, ‘impact’ is used synonymously in this document because of pre-existing connotations of the word ‘consequence’ within FEMA.

