3.10 RISK ASSESSMENT: LIGHTNING

DESCRIPTION

Lightning is almost invariably associated with thunderstorms. Three factors are necessary for the formation of thunderstorms:

- **Moisture**
- **Unstable Air** – relatively warm air that can rise rapidly
- **Lift** – created by advancing cold or warm fronts, strong breezes, or mountains

Lightning in Rigby, ID

Thunderstorms typically follow a distinct lifecycle. In the Developing Stage, towering cumulus clouds form, indicating rising air. The moist air mass is lifted by terrain features or atmospheric conditions and destabilized by rapidly circulating air currents. There is usually little to no rain during this stage and only occasionally lightning. In the Mature Stage, the storm may take on a black or dark green appearance. This is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes, and lasts an average of 10 to 20 minutes but may persist much longer. Finally, in the Dissipating Stage, rainfall decreases in intensity and bursts of strong winds may occur. Lightning remains a danger during this stage. Thunderstorms may occur singly, in clusters or in lines. Thus, it is possible for several thunderstorms to affect one location in the course of a few hours. Some of the most severe weather occurs when a single thunderstorm affects one location for an extended time. Thunderstorms are most likely to happen in the spring and summer months and during the afternoon and evening hours. They can, however, occur year-round and at all hours.

The NWS defines a thunderstorm as “a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder.” Thunderstorms are produced when “unstable” atmospheric conditions exist, wherein warm, moist air is at the surface and cold, dry air is aloft. When, by some mechanism, a parcel of warm, moist air is forced upward, it will continue to rise because it is less dense than the cold, dry air above it. As it rises, moisture begins to condense, forming the tall cumulonimbus thunderstorm cloud. As the warm air rises, cold air is forced downward, and both strong updrafts and strong downdrafts coexist. A number of thunderstorm types are defined, including the following:

Dry Thunderstorm: Generally a high-based thunderstorm when lightning is observed, but little if any precipitation reaches the ground. Most of the rain produced by the thunderstorm evaporates into relatively dry air beneath the storm cell and may also be referred to as "dry lightning".

Pulse Severe Thunderstorms: Single-cell thunderstorms, which produce brief periods of severe weather (¾-inch hail, wind gusts in excess of 58 miles an hour, or a tornado).

Severe Thunderstorm: A thunderstorm that produces a tornado, winds of at least 58 mph (50 knots), and/or at least ¾-inch hail. Structural wind damage may imply the occurrence of a severe thunderstorm. A thunderstorm wind equal to or greater than 40 mph (35 knots) and/or hail of at least ½ inch is defined as approaching severe.

Supercell Thunderstorm: Potentially the most dangerous of the convective storm types. Storms possessing this structure have been observed to generate the vast majority of long-lived strong and violent (F2-F5) tornadoes, as well as downburst damage and large hail. It is defined as a thunderstorm consisting of one quasi-steady to rotating updraft, which may exist for several hours.

Lightning is defined by the NWS as "a visible electrical discharge produced by a thunderstorm. The discharge may occur within or between clouds, between the cloud and air, between a cloud and the ground or between the ground and a cloud." A lightning discharge may be over 5 miles in length, generate temperatures over 50,000°F, and carry 50,000 volts of electrical potential. Lightning is most often associated with thunderstorm clouds, but lightning can strike as far as 5 to 10 miles from a storm. The vigorous movement of air within a thunderstorm results in a buildup of electrical charge. This charge is released in a sudden discharge, the lightning "bolt" familiar to most. The average discharge of lightning carries enough electricity to light a 100-watt light bulb for more than 3 months. Sound waves caused by the rapid heating and cooling of air near the lightning are heard as thunder.

Lightning may strike in a number of distinct ways:

Direct Strike: The most dangerous; the person or structure is a direct path for lightning to seek ground.

Side Strike: Similar to a direct strike, but lightning diverts to an alternate path from the initial ground point.

Conducted Strike: The electrical current may be carried some distance from the initial ground point if the lightning strikes electrically conductive material (including electrical and electronic equipment).

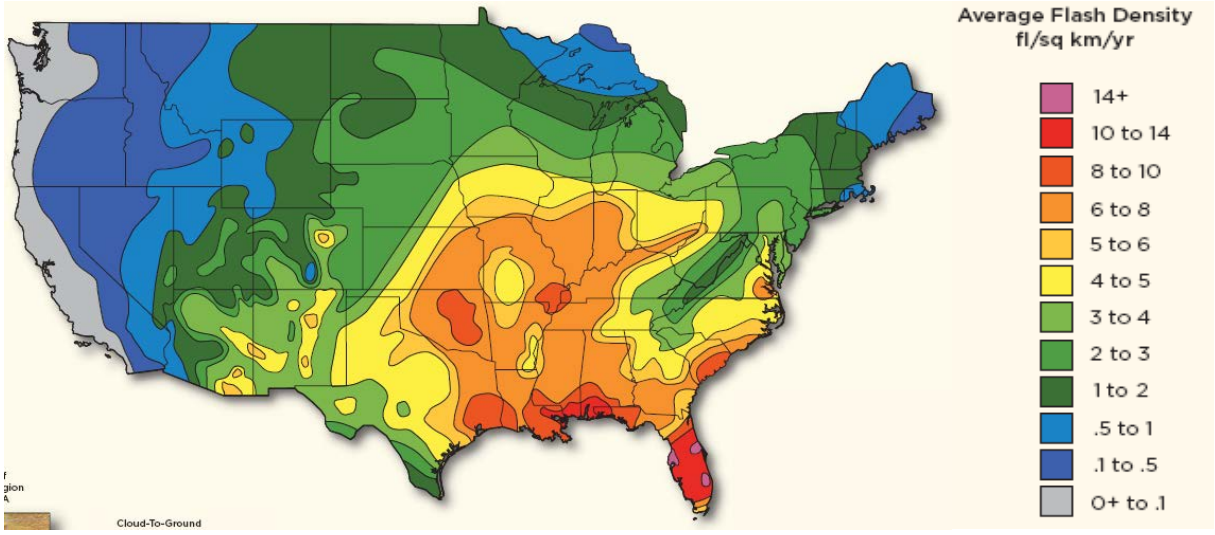
Other: The lightning strike may induce secondary discharges by altering the electrical potential between adjacent structures, through the earth's surface, or in electrical equipment.

LOCATION, EXTENT, AND MAGNITUDE

Lightning strikes can occur almost anywhere. Lightning is more likely to strike tall trees, mountaintops, and tall buildings. Currently, no classification system exists for lightning magnitude.

PAST OCCURRENCE

Cloud-to-ground lightning strikes occur with much less frequency in the northwestern U.S. than in other parts of the country (Map 3.10.A below). The National Lightning Detection Network reported an average of 81,633 strikes per year in Idaho from 1996 to 2008 (about one per square mile); while Florida received an average of 1,447,914 strikes per year (25.3 per square mile) during the same period.



Map 3.10.A: Flash Density Map
Source: www.lightningsafety.noaa.gov

Except when significant forest or range fires are ignited, lightning generally does not result in disasters. From 1959 to 2011, NOAA reported 27 deaths in Idaho caused by lightning. Only two fatalities were reported from 2002 through 2011.

The Spatial Hazard Events and Losses Database for the United States (SHELDUS) online database produced by the Hazards and Research Institute contains a comprehensive listing of recorded lightning activity resulting in loss for the State of Idaho.

Table 3.10.B summarizes recorded losses from 1993 through 2010. At the end of this section, Map 3.10.E also presents major past events, summarized at the county level.

TABLE 3.10.B: IDAHO LIGHTNING EVENTS (1993 - 2010)

Date	Location	Death	Injury	Property Damage	Critical Damage
4/4/1993	Canyon	0	0	$0.00	$0.00
5/20/1993	Ada	0	0	$5,000.00	$0.00
5/25/1993	Idaho	0	0	$0.00	$0.00
5/28/1993	Idaho	0	0	$0.00	$0.00
5/28/1993	Idaho	0	0	$0.00	$0.00
8/4/1993	Canyon	0	0	$0.00	$0.00
8/4/1993	Adams, Boise, Elmore, Valley, and Washington	0	0	$0.00	$0.00
8/4/1993	Cassia	0	0	$0.00	$0.00
8/7/1993	Canyon	0	0	$5,000.00	$0.00
8/7/1993	Boise	0	0	$0.00	$0.00
8/10/1993	Cassia	0	0	$0.00	$0.00
8/11/1993	Cassia	0	0	$50,000.00	$0.00
8/15/1993	Ada	0	0	$50,000.00	$0.00
9/5/1993	Bannock	0	0	$50,000.00	$0.00
2/17/1994	Owyhee	0	0	$5,000.00	$0.00
5/4/1994	Minidoka	0	0	$5,000.00	$0.00
5/27/1994	Canyon	0	0	$50,000.00	$0.00
10/5/1994	Power	0	0	$50,000.00	$0.00
11/1/1994	Bonner	0	0	$50,000.00	$0.00
6/10/1995	Payette	0	0	$50,000.00	$0.00
6/18/1995	Castleford	0	1	$0.00	$0.00
7/6/1995	Idaho Falls	0	0	$500,000.00	$0.00
7/22/1995	Idaho Falls	0	0	$5,000.00	$0.00
7/22/1995	Bonneville	0	0	$5,000.00	$0.00
7/28/1995	Kuna	2	0	$50,000.00	$0.00
7/28/1995	Glenns Ferry	0	0	$50,000.00	$0.00
7/29/1995	McCall	1	12	$5,000.00	$0.00
8/4/1995	Pocatello	0	0	$50,000.00	$0.00
8/6/1995	Trinity Lakes	0	0	$50,000.00	$0.00
8/17/1995	Ammon	0	0	$500,000.00	$0.00
8/21/1995	Jerome	0	0	$50,000.00	$0.00
8/21/1995	Nr Se Dietrich	0	0	$5,000.00	$50,000.00
9/3/1995	Soda Springs	0	0	$0.00	$0.00
9/3/1995	Boise	0	0	$50,000.00	$0.00
9/4/1995	Fairfield	0	0	$50,000.00	$0.00
9/7/1995	Post Falls	0	0	$50,000.00	$0.00
11/16/1995	CJ Strike Reservoir	0	0	$5,000.00	$0.00

TABLE 3.10.B: IDAHO LIGHTNING EVENTS (1993 - 2010)

Date	Location	Death	Injury	Property Damage	Critical Damage
12/16/1995	CJ Strike Reservoir	0	0	$5,000.00	$0.00
5/14/1996	Caldwell	0	0	$15,000.00	$0.00
5/16/1996	Pocatello	0	0	$0.00	$0.00
5/17/1996	Moscow	0	0	$0.00	$0.00
6/7/1996	Jerome County	0	0	$0.00	$0.00
6/14/1996	Oakley	0	0	$0.00	$0.00
6/21/1996	Ashton	0	0	$0.00	$0.00
7/16/1996	Rexburg	0	0	$0.00	$0.00
7/16/1996	Rexburg	0	0	$0.00	$0.00
7/17/1996	Burley	1	1	$0.00	$0.00
7/29/1996	Pocatello	0	0	$0.00	$0.00
6/17/1997	Pocatello	0	0	$1,000,000.00	$0.00
6/30/1997	Melba	1	0	$0.00	$0.00
7/15/1997	Bellevue	0	0	$0.00	$0.00
7/21/1997	Lewiston	0	0	$0.00	$0.00
7/31/1997	Boise	0	0	$0.00	$0.00
8/2/1997	Chubbuck	0	0	$0.00	$0.00
9/11/1997	Blackfoot	0	0	$1,000.00	$0.00
4/23/1998	Marysville	0	0	$1,000.00	$0.00
6/25/1998	Leadore	0	2	$0.00	$0.00
7/3/1998	Cascade	0	2	$0.00	$0.00
7/30/1998	Springfield	0	0	$0.00	$0.00
7/30/1998	Pocatello	0	0	$0.00	$0.00
7/31/1998	Blackfoot	0	0	$0.00	$0.00
8/31/1998	Ft Hall	0	0	$0.00	$0.00
9/7/1998	Boise	0	0	$10,000.00	$0.00
9/30/1998	Inkom	0	3	$0.00	$0.00
9/30/1998	Chubbuck	0	0	$0.00	$0.00
5/3/1999	Boise	0	0	$0.00	$0.00
5/29/1999	Pocatello	0	0	$10,000.00	$0.00
7/18/1999	Driggs	0	0	$21,000.00	$0.00
8/27/1999	Pocatello	0	0	$0.00	$0.00
8/18/2000	Rexburg	0	0	$20,000.00	$0.00
9/17/2000	Chesterfield	0	0	$150,000.00	$0.00
7/7/2002	Caldwell	1	2	$0.00	$0.00
8/30/2002	Oldtown	0	2	$0.00	$0.00
8/22/2003	Whitney	0	1	$0.00	$0.00
8/22/2003	Moreland	0	0	$1,000.00	$0.00

TABLE 3.10.B: IDAHO LIGHTNING EVENTS (1993 - 2010)

Date	Location	Death	Injury	Property Damage	Critical Damage
6/28/2004	Idaho Falls	0	0	$5,000.00	$0.00
5/29/2005	Burley	0	0	$10,000.00	$0.00
5/19/2006	Hayden	0	0	$10,000.00	$0.00
7/5/2006	Coeur D'Alene	0	0	$15,000.00	$0.00
6/4/2007	Coeur D'Alene	0	0	$30,000.00	$0.00
8/18/2008	Pinehurst	0	0	$2,000.00	$0.00
6/5/2009	Idaho Falls	0	0	$13,000.00	$0.00
6/29/2010	Bingham	0	0	$4,000.00	$0.00
8/10/2010	Lemhi	1	0	$0.00	$0.00
Totals:		7	26	$3,118,000.00	$50,000.00

Source: SHELDUS

FUTURE OCCURRENCE

The general weather patterns of the last several decades are expected to continue. Historical rates of injury are also expected to continue. An increasing dependence on electronics may lead to an increase in the amount and extent of property damage resulting from lightning strikes.

RELATIONSHIPS TO OTHER HAZARDS

Lightning strikes are a primary cause of a majority of the wildfires that occur throughout the State. The timing of these lightning-causing events mirrors the seasons when severe storms are most prevalent (see Figure 3.10.C). Lightning could also have an impact on some human-caused hazards. Lightning strikes do have the chance to damage communication towers and transmission cables, possibly resulting in energy shortages or cyber disruptions.

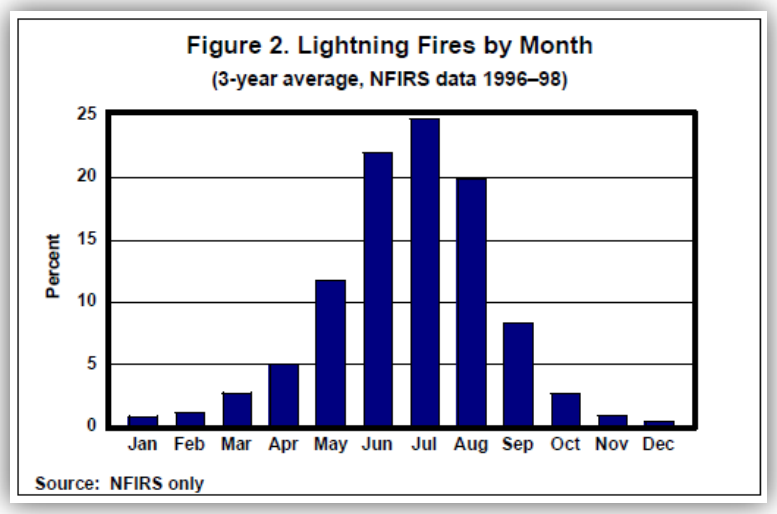


Figure 3.10.C: Lightning Fires by Month
Source: U.S. Fire Administration Topical Fire Research Series

ENVIRONMENTAL IMPACTS

Lightning strikes themselves have unsubstantial environmental impacts. Isolated, small-scale environmental impacts include damaged or killed trees and damage to historic structures. Far more

substantial are indirect impacts from the ignition of wildfire that can result from lightning. Lightning season coincides with dry season. Major concerns are "dry thunderstorms" or "dry lightning storms", which can produce lightning and high winds with no rain to extinguish or mitigate resulting fires. Environmental impacts due to wildfire are addressed in another section of this Plan.

DEVELOPMENT TREND IMPACTS

Any new development could be affected by lightning. This new development would equate to an increase in vulnerability and in potential losses, although historical data seems to show that these increased losses would be minimal. However, when the lightning strike results in a wildfire, this pattern would not hold true. The wildfire section in this chapter provides more detail on this issue.

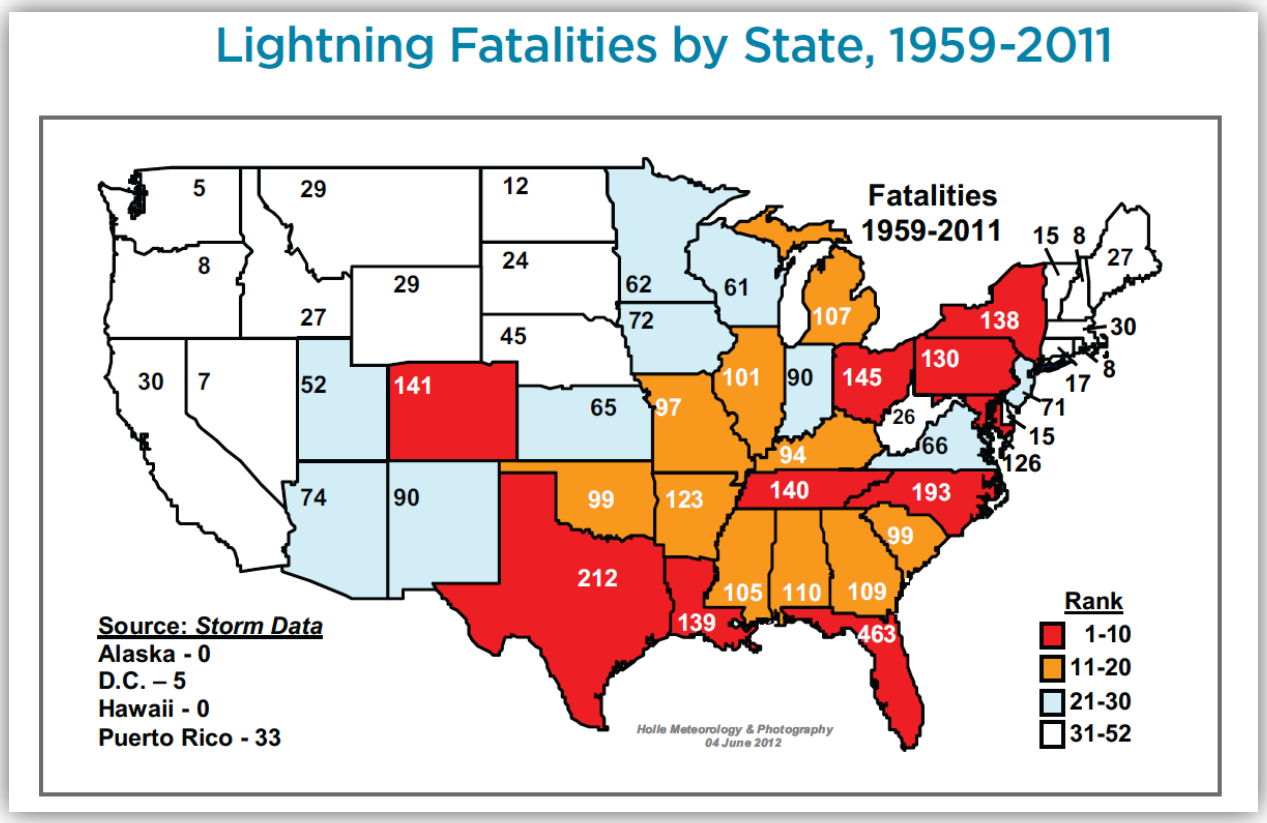
CRITICAL INFRASTRUCTURE AND STATE FACILITY IMPACTS

All infrastructure and State facilities could be at risk, although there are a number of mitigation measures that could help to lessen the impact to critical infrastructure and State facilities.

VULNERABILITY ASSESSMENT

While Idaho experiences thousands of strikes annually, lightning poses a minimal hazard to most individuals, especially when compared to other States (See Map 3.10.D below). There were, however, 27 fatalities due to lightning in Idaho from 1959 through 2011. In addition, the National Weather Service provided the following historical fatality, injury, and damage report rates for Idaho based on data from 1959 to 2009:

- Deaths per million of the population, per year – 0.50
- Injuries per million of the population, per year – 2.23
- Damage reports per million of the population, per year – 10.17



Map 3.10.D: Lightning Strike Fatalities in the U.S. (1959-2011)
Source: http://www.lightningsafety.noaa.gov/stats/59-11_fatalities_rates.pdf

Communication, utilities, and most critical facilities with electronic equipment employ techniques to minimize the impact to their operation. The general weather patterns of the last several decades are expected to continue. This will result in the continuance of spring and summer, afternoon and evening occurrences of lightning throughout Idaho. Historical rates of injury are also expected to continue. The increasing dependence on electronic equipment and its utilization in all aspects of daily life may lead to an increase in the amount and extent of property damage resulting from lightning strikes.

Lightning is also a major contributor to the ignition of wildland fires in the State. Of particular concern are "dry thunderstorms" or "dry lightning storms" (defined above), where lightning strikes are accompanied by high winds but with no rain to extinguish or mitigate resulting fires.

Local Hazard Mitigation Plan Vulnerability Assessments

Forty-seven local mitigation plans were analyzed to determine the major hazards in each jurisdiction. Lightning was not ranked as such by any jurisdiction.

LOSS ESTIMATION

No specific, statewide loss estimation exists for the hazard of lightning. Historical losses tend to be reported with the wildfire events that are triggered by the lightning.

Local Hazard Mitigation Plan Loss Estimations

Since the local mitigation plans didn't rank lightning as a major hazard, the data were not aggregated and it is assumed that loss estimates would be low. Many of the local mitigation plans grouped lightning with severe weather.

MITIGATION RATIONALE

Lightning is the second most deadly weather phenomenon in the U.S., led only by floods. On average, 60 to 70 deaths per year are attributed to lightning nationally. In Idaho, the average is less than one per year. Individuals struck by lightning are subject to severe injuries or death. Studies report that 20 percent of strike victims die, and 70 percent of the survivors suffer serious long-term aftereffects. Injuries that do not require hospitalization likely go unreported. Over 90 percent of incidents involve only a single victim, and only 1 percent involves more than two victims.

Source: ThinkStock.com

Typical injuries include external burns, numbness/paresthesias, severe headaches, dizziness, stiffness in joints, loss of strength/weakness, hearing loss, muscle spasms, chronic fatigue, and coordination problems. Typical physiological injuries include memory deficits and loss, depression, attention deficits, sleep disturbance, fear of crowds, and storm phobia.

The majority of lightning victims are children and young men engaged in recreation or work. Most lightning deaths and injuries occur when people are caught outdoors, most often in the summer months and during the afternoon and early evening. People under or near tall trees, in or on water, or on or near hill or mountain tops are particularly at risk.

Property damage resulting from lightning strikes includes mechanical impacts to trees and structures, the ignition of flammable materials (natural and manmade), and disruption of electrical and electronic equipment. Forest fires are a common outcome in Idaho, as the lightning season coincides with the dry season. The magnitude of economic losses is difficult to estimate. Government figures suggest annual

national costs at around $30 million, but some researchers find evidence that losses may be in the billions of dollars.

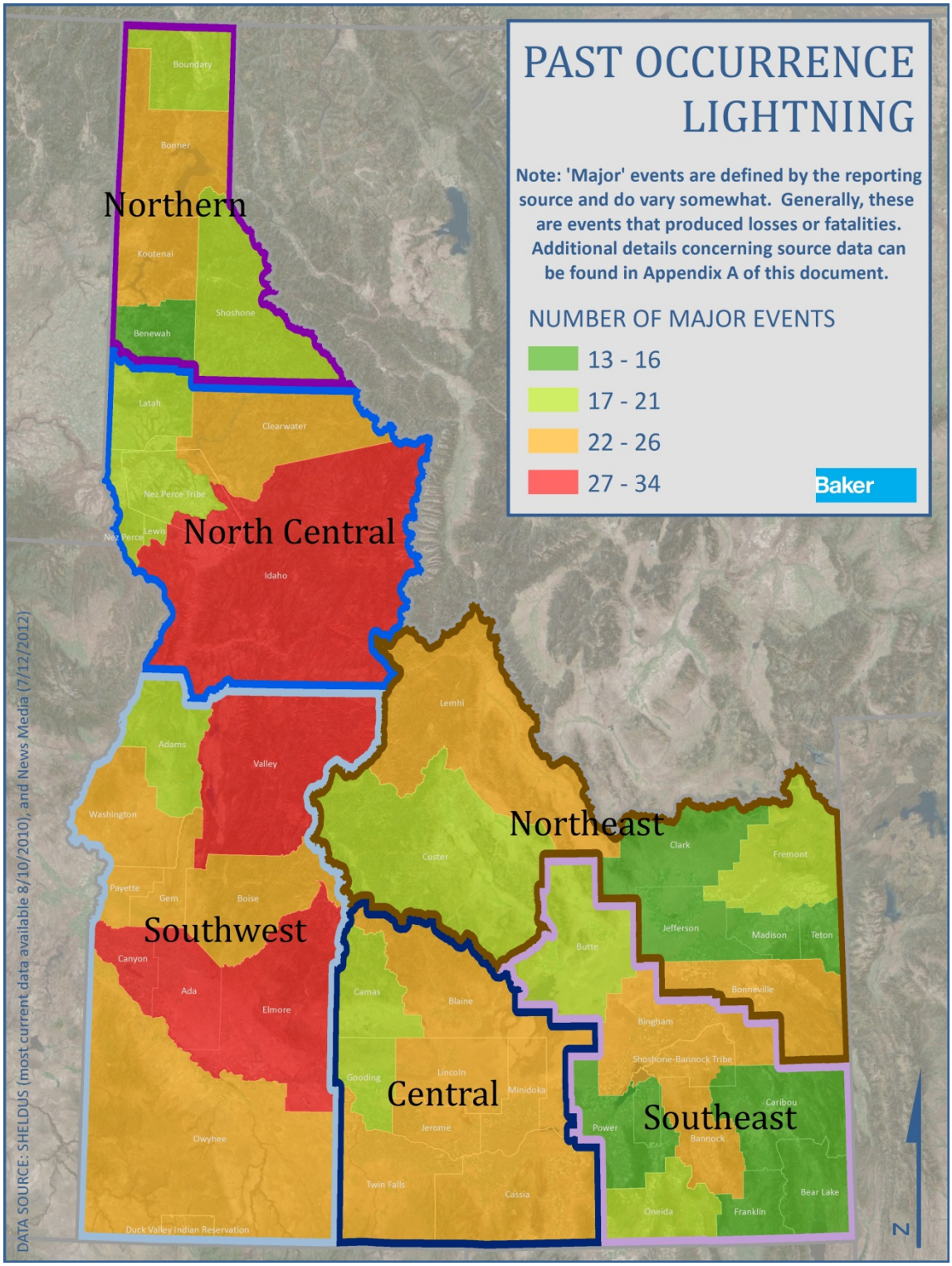
GENERAL MITIGATION APPROACHES

Mitigation of lightning is established, generally, in the Idaho Disaster Preparedness Act of 1975 as amended (Idaho State Code Chapter 10, Title 46) and, more specifically, in the Governor's Executive Order, 2000-04. No agency is specifically assigned responsibility for lightning-related mitigation, but the BHS is assigned general responsibility for coordinating mitigation for all hazards.

Aside from the NOAA/NWS Storm Ready program, there are no lightning-specific mitigation programs in Idaho. Some education is conducted by land management agencies, which provide educational materials for recreational users. The NWS, NOAA, Underwriters Laboratories, Lightning Safety Alliance Corporation, and Lightning Protection Institute also collaborate to provide general educational programs for parents, coaches, and athletes through the Storm Ready Program (among others). Storm Ready is a community preparedness program in the United States that encourages government entities and commercial gathering sites to prepare for severe storms. Communities subscribe to the program and benefit by receiving preferred CRS ratings, public awareness support, and grant application support. The Storm Ready program takes a strong hazard mitigation approach, and all local hazard mitigation programs are encouraged to subscribe and actively participate (http://www.stormready.noaa.gov/com-maps/id-com.htm).

Updating building codes and practices can be a useful mitigation tool. Jurisdictions may adopt building safety codes such as NFPA-780 Standard for the Installation of Lightning Protection Systems (1997). Additional incentives may be provided by requiring the insurance industry to promote lightning-safe practices. Electronic equipment in particular can be safeguarded through commonly available tools (e.g., grounded outlets and surge protectors).

Source: ThinkStock.com



Map 3.10.E: Lightning Past Occurrence

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