3.3. Risk Assessment: Severe Storms

Description

A severe storm is an atmospheric disturbance that results in one or more of the following phenomena: strong winds and large hail, thunderstorms, tornadoes, rain, snow, or other mixed precipitation. Of the 47 Presidential Disaster declarations in Idaho since 1954, 10 have been attributed to include "storms" or "severe" storms. Several damaging elements of severe storms are detailed as their own hazard in Chapter 3.2 (flooding to include dam/levee/canal failure). The sub-sections in this chapter include details for winter storms, lightning, hail, straight-line winds, and tornadoes.

Winter Storms

Winter storms range widely in size, duration, and intensity. These storms may impact a single community or a multi-State area. They may last hours or days. The severity of storms can range from a small amount of dry snow to a large, blanketed area of wet snow and ice. Generally, winter storms are characterized by low temperatures and blowing snow.

Snow-covered Weiser, Idaho is photographed on Friday, Dec. 23, 2016 during Winter Storm Europa. (gandolfjohn/instagram)

A severe winter storm is defined as one that drops 4 or more inches of snow during a 12-hour period, or 6 or more inches during a 24-hour span. A blizzard is a winter storm with winds exceeding 35 miles per hour accompanied by snow or blowing snow and reduced visibility. Strong winds can lower the effective temperature through "wind chill." An ice storm occurs when damaging accumulations of ice are expected during freezing rain situations, and when cold rain freezes immediately on contact with the ground, structures, and vegetation. Significant accumulations (1/4" of ice or greater) of ice pull down trees and utility lines resulting in loss of power and communication (National Weather Service (NWS) 2017).

The principal hazards associated with severe winter storms are:

- Snow and/or ice accumulation
- Extreme cold
- Significant reduction of visibility

Thunderstorm

A thunderstorm is a rain event that includes thunder and lightning. A thunderstorm is classified as "severe" when it contains one or more of the following: hail with at least 1" diameter, winds gusting in excess of 50 knots (58 mph), or tornado.

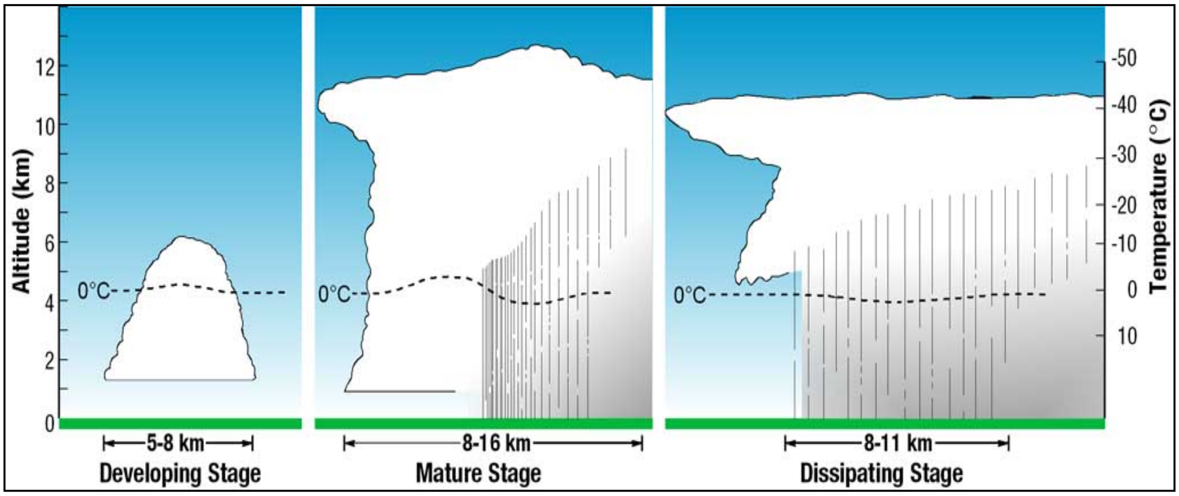
Three factors cause thunderstorms to form moisture, rising unstable air (air that keeps rising when disturbed), and a lifting mechanism to provide the disturbance. The sun heats the surface of the earth, which warms the air above it. If this warm surface air is forced to rise (hills or mountains can cause rising motion, as can the interaction of warm air and cold air or wet air and dry air), it will continue to rise as long as it weighs less and stays warmer than the air around it. As the air rises, it transfers heat from the surface of the earth to the upper levels of the atmosphere (the process of convection). The water vapor it contains begins to cool and it condenses into a cloud. The cloud eventually grows upward into areas where the temperature is below freezing. Some of the water vapor turns to ice and some of it turns into water droplets. Both have electrical charges. Ice particles usually have positive charges, and rain droplets usually have negative charges. When the charges build up enough, they are discharged in a bolt of lightning, which causes the sound waves we hear as thunder. Thunderstorms have three stages (see Figure 3.3.A):

The *developing stage* of a thunderstorm is marked by a cumulus cloud that is being pushed upward by a rising column of air (updraft). The cumulus cloud soon looks like a tower (called towering cumulus) as the updraft continues to develop. There is little to no rain during this stage but occasional lightning. The developing stage lasts about 10 minutes.

The thunderstorm enters the *mature stage* when the updraft continues to feed the storm, but precipitation begins to fall out of the storm, and a downdraft begins (a column of air pushing downward). When the downdraft and rain cooled air spread out along the ground, they form a gust front, or a line of gusty winds. The mature stage is the most likely time for hail, heavy rain, frequent lightning, strong winds, and tornadoes. The storm occasionally has a black or dark green appearance.

Eventually, a large amount of precipitation is produced and the updraft is overcome by the downdraft beginning the *dissipating stage*. At the ground, the gust front moves out a long distance from the storm and cuts off the warm moist air that was feeding the thunderstorm. Rainfall decreases in intensity, but lightning remains a danger.

Figure 3.3.A. Thunderstorm Life Cycle



There are four types of thunderstorms:

Single-Cell Thunderstorms—Single-cell thunderstorms usually last 20 to 30 minutes. A true single-cell storm is rare, because the gust front of one cell often triggers the growth of another. Most single-cell storms are not usually severe, but a single-cell storm can produce a brief severe weather event. When this happens, it is called a pulse severe storm.

Multi-Cell Cluster Storm—A multi-cell cluster is the most common type of thunderstorm. The multi-cell cluster consists of a group of cells, moving as one unit, with each cell in a different phase of the thunderstorm life cycle. Mature cells are usually found at the center of the cluster and dissipating cells at the downwind edge. Multi-cell cluster storms can produce moderate-size hail, flash floods, and weak tornadoes. Each cell in a multi-cell cluster lasts only about 20 minutes; the multi-cell cluster itself may persist for several hours. This type of storm is usually more intense than a single cell storm.

Multi-Cell Squall Line—A multi-cell line storm, or squall line, consists of a long line of storms with a continuous well-developed gust front at the leading edge. The line of storms can be solid, or there can be gaps and breaks in the line. Squall lines can produce hail up to golf ball size, heavy rainfall, and weak tornadoes, but they are best known as the producers of strong downdrafts. Occasionally, a strong downburst will accelerate a portion of the squall line ahead of the rest of the line. This produces what is called a bow echo. Bow echoes can develop with isolated cells as well as squall lines. Bow echoes are easily detected on radar but are difficult to observe visually.

Super-Cell Storm—a super-cell is a highly organized thunderstorm that poses a high threat to life and property. It is similar to a single-cell storm in that it has one main updraft, but the updraft is extremely strong, reaching speeds of 150 to 175 mph. Super-cells are rare. The main characteristic that sets them apart from other thunderstorms is the presence of rotation. The rotating updraft of a super-cell (called a mesocyclone when visible on radar) helps the super-cell to produce extreme weather events, such as giant hail (more than 2 inches in diameter), strong downbursts of 80 mph or more, and strong to violent tornadoes.

Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. An estimated 100,000 thunderstorms occur each year in the United States, with approximately 10 percent of them classified as severe. During the warm season, thunderstorms are responsible for most of the rainfall.

Lightning

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.

Figure 3.3.B. Lightning Strike in Boise

Source: Anderson 2013

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.

In the United States, an average of 300 people are injured and 80 people are killed by lightning each year. Based on information measured by the National Lightning Detection Network, the State of Idaho receives up to three cloud-to-ground lightning flashes per square mile from 2007 to 2016 (National Lightning Detection Network 2017).

Hail

Hail is almost invariably associated with thunderstorms. The NWS definition of "hail" is showery precipitation in the form of irregular pellets or balls of ice more than 5 mm in diameter, falling from a cumulonimbus cloud. Hail is a product of thunderstorms and their dynamic internal winds. Air cycles vertically through the storm mass, known as a "cell." At the earth's surface, air is warmed and rises through the cell. Hail forms inside a thunderstorm where there are strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32°F or colder. As the frozen droplet begins to fall, it may thaw as it moves into warmer air toward the bottom of the thunderstorm. However, the droplet may be picked up again by another updraft and carried back into the cold air and re-freeze. As it reaches the higher atmosphere (cells can rise tens of thousands of feet above the surface), it cools and drops back to the surface, replacing warm air rising from the base of the cell. This ongoing cycle captures and carries water droplets up to a height where freezing occurs. The resultant ice particles grow during each up and down cycle within the storm cell, until; too heavy to be carried by the rising air, they fall to the ground as hail. Hail is produced in a wide range of sizes and falls in varied quantities. Most hail is small less than two inches in diameter (NWS 2010). Hail of 1 inch or greater diameter is sufficient to classify a thunderstorm as "severe."

Wind and Tornadoes

The term "straight-line winds" is used to distinguish common, non-rotating winds from tornado related winds. Straight-line winds are responsible for most thunderstorm wind damage, with wind speeds in excess of 100 miles per hour on occasion. A "downburst," a small area of rapidly descending air beneath a thunderstorm, is a particularly damaging type of straight-line wind. Downbursts can have wind velocities equal to that of a strong tornado and can be extremely dangerous to aviation and cause significant damage to some buildings (NWS 2017).

Straight-Line Winds

Straight-line winds are experienced in all parts of the United States and can also be referred to as high, strong, and thunderstorm winds. Areas that experienced the highest wind speeds are coastal regions from Texas to Maine and the Alaskan coast; however, exposed mountain areas experience winds at least as high as those along the coast (FEMA 1997). Wind begins with differences in air pressures. It is rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. Effects from high winds can include downed trees and power lines, and damages to roofs, windows, etc. (Ilicak 2005).

Like tornadoes, strong straight-line winds are generated by thunderstorms and can cause similar damage. Straight-line wind speeds can approach 150 mph, equivalent to those in an F3 tornado. Two categories of straight-line winds are "downbursts" and "derechos." A downburst is a small area of rapidly descending rain and rain cooled air beneath a thunderstorm. The winds produced from a downburst often travel in one direction, and the worst damage is usually on the forward side of the downburst. Derechos are created by the merging of many thunderstorm cells into a cluster or solid line extending for many miles. The width of such a storm can range from 20 to 65 miles, and the length can reach 100 miles or more. In extreme cases, these storms can create maximum wind gusts of 150 mph and are also capable of producing small tornadoes. Damaging straight-line winds are much more common than tornadoes, and their damage is often incorrectly attributed to tornadoes. Derechos are not common in Idaho, averaging less than one per year, while downbursts associated with straight-line winds occur more frequently.

Tornadoes

Tornado in Boise, ID / Source: www.kboi2.com/weather/blog/44562952.html

Tornadoes develop from severe thunderstorms. Tornadoes are nature's most violent storms and can cause fatalities and devastate neighborhoods in seconds. A tornado appears as a rotating, funnel shaped cloud spinning like a top, that extends from a thunderstorm to the ground with whirling winds that can reach from 40 to over 300 miles per hour. The tornado itself can move across the ground at up to 70 miles per hour. Damage is generally confined to a narrow path (approximately one quarter mile), but the tornado may travel over and devastate a large distance (typically up to 10 miles, but 200-mile tracks have been reported). Tornadoes can be on the ground from an instant to several hours. The average is about five minutes. (https://www.nssl.noaa.gov/education/svrwx101/)

The State of Idaho has a relatively low risk of tornadoes compared to states in the Midwest and Southern United States. Idaho has experienced tornadoes on occasion, with some producing significant damage, injury or death. Multiple tornadoes may occur during a single storm, resulting in highly destructive events.

Location, Extent, and Magnitude

Winter Storms

The magnitude or severity of a severe winter storm depends on several factors including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day and week (e.g., weekday versus weekend), and time of season.

The NWS operates a widespread network of observing systems such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into what will happen next, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts (NWS 2013). In Idaho, the NWS criteria (National Weather Service – Pocatello, Idaho) for issuing winter storm and accompanying hazardous condition notifications to the public are:

Avalanche Warning: Issued by Sawtooth National Forest Avalanche Center when snow pack conditions indicate the potential for significant avalanches.

Blizzard Warning: Winds of at least 35 mph and falling/drifting snow frequently reduce visibility to less than ¼ mile, for 2 hours or more;

Freezing Rain/Drizzle Advisory: Freezing rain/drizzle that is occurring or imminent that may lead to life threatening circumstances;

Ice Storm Warning: Ice accumulations of at least ¼ inch are expected over the next 24 hours;

Snow Advisory: (Snake Plain Only) 3 to 5 inches of snow accumulation expected in the next 24 hours;

Winter Storm Warning: Heavy snow in combination with wind, freezing rain, or wind chill is occurring or expected. Snowfall typically greater than six inches in the valleys and greater than 10 inches in the mountains over the next 24 hours. Sleet accumulations of greater than ¾ inches expected over the next 24 hours;

Winter Storm Watch: Potential exists for a blizzard, heavy snowfall, ice storm, and/or strong winds within the next 96 hours; and

Winter Weather Advisory: A combination of snow, wind, freezing rain, etc. that will create inconvenience but not reach warning criteria. Blowing/drifting snow is occurring or imminent that will cause significant travel problems (Pocatello Weather Forecast Office 2012).

Past winter storm disasters have been focused in the western and northern portions of the State, but severe winter storms are possible throughout Idaho. Table 3.3.C presents the winter storm hazard ranking for Idaho's 44 counties.

Table 3.3.C. Winter Storm Risk Impact and Probability for Counties in Idaho

IMPACT/PROBABILITY	LOW	MEDIUM	HIGH
LOW (GREEN)			
MEDIUM (YELLOW)		Ada Bannock Bear Lake Bingham Bonneville Butte Cassia Franklin Jefferson Owyhee Shoshone Twin Falls	
HIGH (RED)		Minidoka	Adams Benewah Blaine Boise Bonner Boundary Caribou Camas Canyon Clark Clearwater Custer Elmore Fremont Gem Gooding Idaho Jerome Latah Lemhi Lewis Lincoln Madison Nez Perce Oneida Payette Power Teton Valley Washington

Source: Idaho Office of Emergency Management

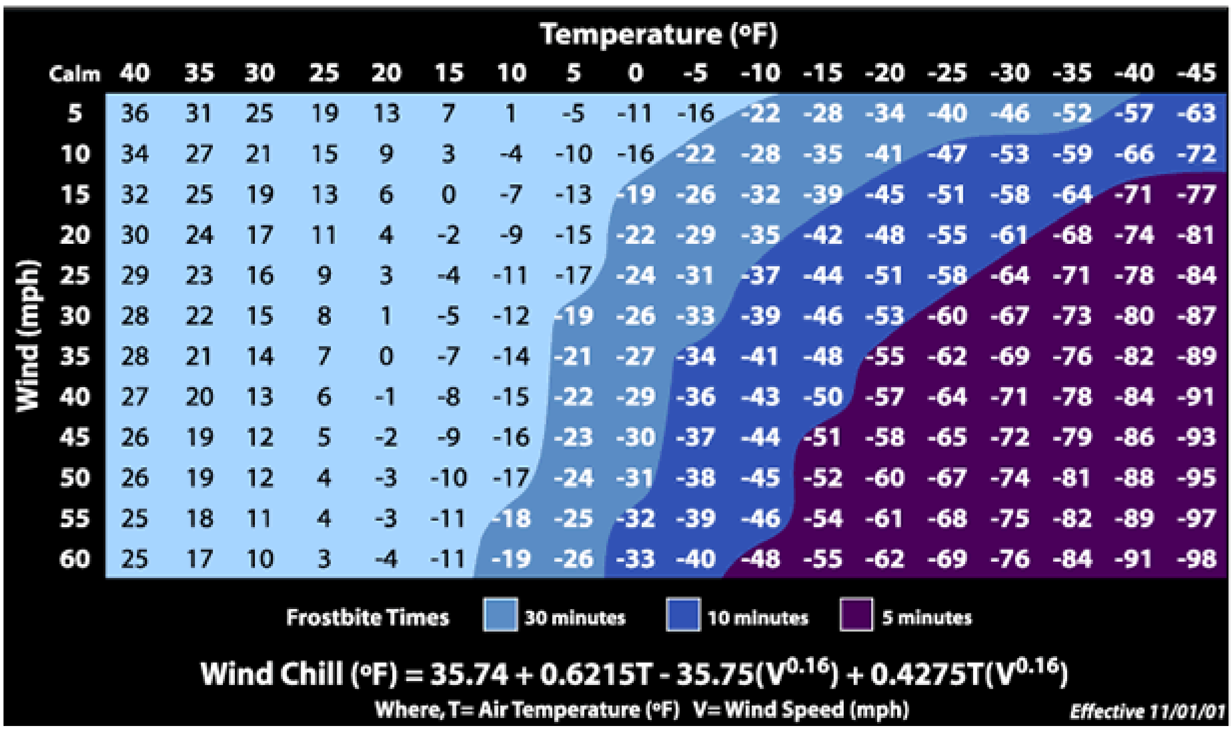
Notes: Definitions for Probability: High = Situated in winter storm patterns, severity and duration of storms, proximity to higher elevations, Medium = Situated in less severe storm patterns, lower elevations, shorter duration of storms, Low = Normally mild winter seasons, infrequent winter storms

Definitions for Impact: High = Population congestion and concentration, transportation corridors and power delivery significantly disrupted, agricultural operations hampered or damaged, susceptibility to hardships caused by cold, excessive snow and wind, vulnerable population, Medium = More dispersed population, transportation corridors more easily maintained, population acclimatized towards and experienced in severe weather, Low = Population adapted to severe winter weather, transportation corridors regularly maintained, situated in milder climate patterns.

Aspects of a snowstorm's magnitude can be measured in inches of snow accumulation and wind speeds. For winter storm disaster declarations, a county must have experienced a record or near record snowfall (or meet FEMA's contiguous county criteria). A record snowfall is defined by FEMA as one that meets or exceeds the highest record snowfall within a county over a 1, 2, 3 day or longer period of time, as published by the NCDC. A near record snowfall means a snowfall that approaches, but does not meet or exceed, the historical record snowfall within a county as published by the NCDC; FEMA generally considers snowfall within 10 percent of the record amount to be a near record snowfall.

In 2001, the NWS implemented an updated wind chill temperature index (see Figure 3.3.D). This index describes the relative discomfort or danger resulting from the combination of wind and temperature. Wind chill is based on the rate of heat loss from exposed skin caused by wind and cold. As the wind increases, it draws heat from the body, driving down skin temperature and eventually the internal body temperature.

Figure 3.3.D. National Weather Service Wind Chill Chart



Wind (mph) \ Temperature (°F)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

Wind Chill (°F) = $35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Winter weather affects the entire State of Idaho and brings the threats of blizzards and snow, wind chill, frostbite and hypothermia, ice and road hazards, flooding, and power outages. Winter storm conditions and cold waves can be one of the deadliest types of weather. Cold temperatures can put an extra strain on your heart; heavy exertion (shoveling snow, clearing debris, etc.) can increase a person's risk of a heart attack. Accumulation of ice has the potential of causing collapse of trees, utility poles, and communication towers. Ice can disrupt communications and power for days. Even small amounts of ice can create dangerous conditions for motorists and pedestrians.

The NWS operates a widespread network of observing systems such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into what will happen next, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts (NWS 2013).

Thunderstorms

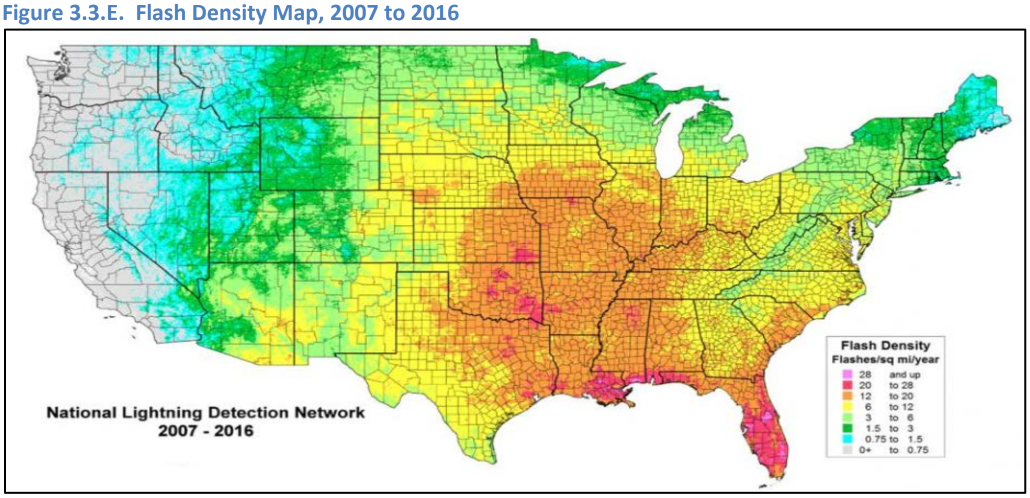
Thunderstorm and hail events can and do occur across the entire state. Severe thunderstorm watches and warnings are issued by the local NWS office. The NWS will update the watches and warnings and will notify the public when they are no longer in effect. Watches and warnings for thunderstorms in Idaho are as follows:

- ***Severe Thunderstorm Warning***: Issued when a thunderstorm is imminent or occurring producing wind gusts of greater than 58 mph and/or hail greater than one inch in size;
- ***Severe Thunderstorm Watch***: Issued when conditions are favorable for severe thunderstorm development within the next two to six hours; and
- ***Severe Weather Statement***: Provides follow-up information regarding severe thunderstorms or tornadoes that are occurring or have occurred (Pocatello Weather Forecast Office 2012).

Lightning

The entire State of Idaho is exposed to some degree of lightning hazard, though exposed points of high elevation have significantly higher frequency of occurrence. Approximately 90 deaths and 400 injuries are caused by lightning in the United States each year (Federal Alliance for Safe Homes 2015). Each strike has the potential to injure people and damage property. Cloud to ground lightning strikes occur with much less frequency in the northwestern U.S. than in other parts of the country (Figure 3.3.E). The National Lightning Detection Network reported an average of 77,232 strikes per year in Idaho from 2007-2016 (about one per square mile), while Florida received an average of 1,193,735 strikes per year (20 per square mile) during the same period (http://www.lightningsafety.noaa.gov/stats/07-16_Flash_Density_State.pdf).

Figure 3.3.E. Flash Density Map, 2007 to 2016



Source: National Lightning Detection Network 2016

Dozens of range fires have been ignited by humans, vehicles and lightning in Idaho along the Interstate 84 corridor between Boise and Glenns Ferry for decades. In fact, over the last 35 years, more than 170,000 acres have burned in the 294,000 acre area. Eighty percent of the fires were human caused and 20 percent were ignited by lightning. "But we also have a lot of lightning every summer. This is a lightning belt. So you not only have the human factor overriding it, you've got the invasion of cheatgrass, and then you've got the continuing lightning. All those three things together are why we've lost a lot of habitat out here."(Stuebner, 2016)

Lightning severity is typically assessed based on property damage and life safety (injuries and fatalities). Since lightning accompanies thunderstorms, it can be assumed that lightning occurs more often than damages are reported. Severe storm warnings are not issued based on lightning, and lightning does not determine severe storms but can be present as a part of severe storms.

The National Weather Service does not have an extent scale for lightning. The extent of lightning depends upon the severity of the storm. Lightning becomes more hazardous when there are positive strikes. While a single point of lightening can cause damage and even death, when equated to severe storms the extent of a lightning event can be very wide ranging, especially if there are multiple lighting strikes in one area.

Meteorologists can often predict the likelihood of thunderstorms which produce lightning. This can give several days' notice of the possibility of lightning. However, the exact time and location of lightning cannot be predicted.

Hail

The entire State of Idaho is exposed to hail as a component of thunderstorm events. Hail causes $1 billion in damage to crops and property each year in the United States. Hail occurs most frequently in the southern and central plain states. However, since hail often occurs in conjunction with thunderstorms, the potential for hail damage exists throughout the United States (Federal Alliance for Safe Homes 2015).

The severity of hail is measured by duration, hail size, and geographic extent. All of these factors are directly related to thunderstorms, which creates hail. There is wide potential variation in these severity components. The most significant impact of hail is damage to crops. Hail also has the potential to damage structures and vehicles during hailstorms. The State has a relatively low potential for significant hail events, based on previous records. The size of hail is estimated by comparing it to a known object. Most hailstorms are made up of a variety of sizes, and only the very largest hail stones pose serious risk to people, when exposed. Table 3.3.F shows the different sizes of hail and the comparison to real world objects.

Table 3.3.F. Hail Size

Size	Inches in Diameter
Pea	0.25 inch
Marble/mothball	0.50 inch
Dime/Penny	0.75 inch
Nickel	0.875 inch
Quarter	1.0 inch
Ping-Pong Ball	1.5 inches
Golf Ball	1.75 inches
Tennis Ball	2.5 inches
Baseball	2.75 inches
Tea Cup	3.0 inches
Grapefruit	4.0 inches
Softball	4.5 inches

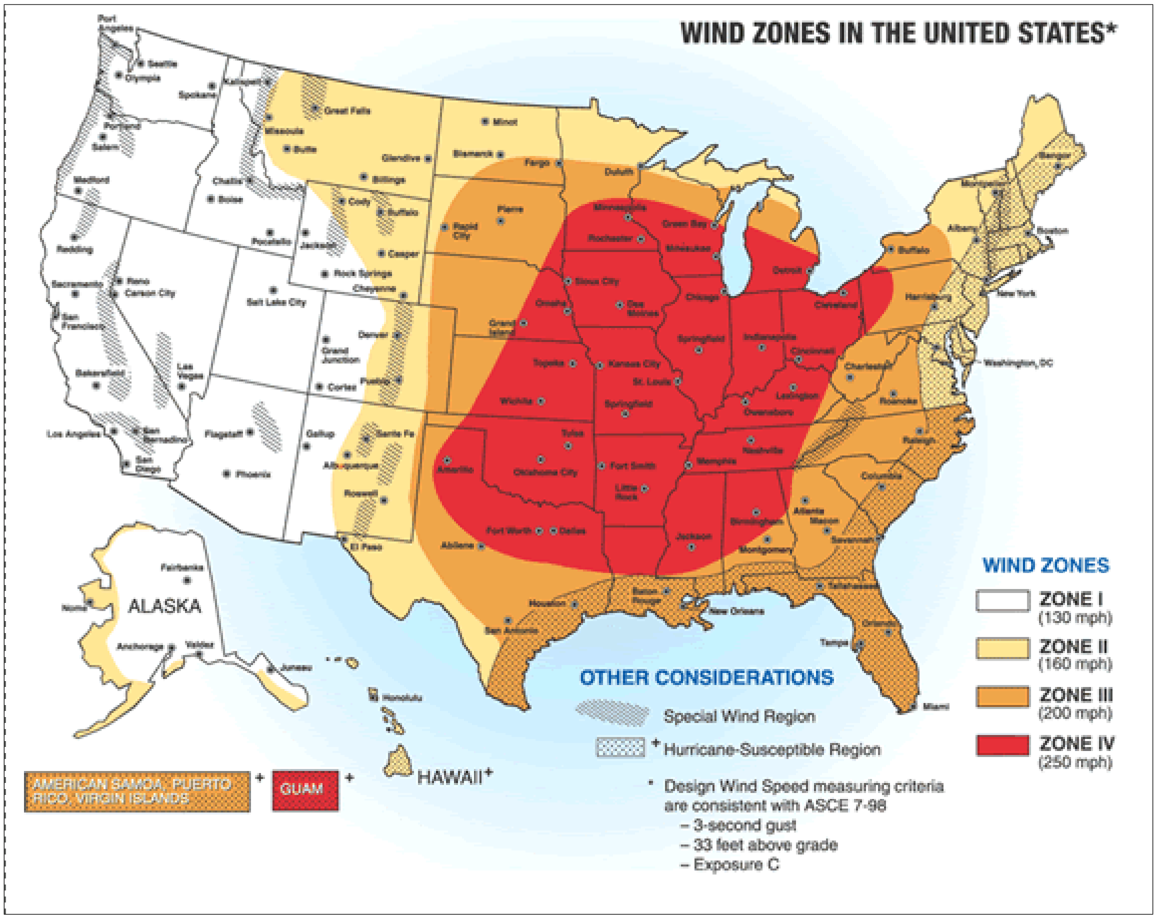
Source: NOAA 2012

Like high wind events and thunderstorms, meteorologists can forecast the potential of hailstorms, often giving several hours of notice that hail may form. In addition, meteorologists can give live updates during severe weather to indicate areas that are experiencing or will experience hail. Since hailstorms often occur as part of other events, such as thunderstorms, forecasts indicating the potential for hailstorms may be available several days in advance.

Wind Zones

3.3. G indicates how the frequency of windstorms impacts the United States and the general location of the most wind activity. This is based on 40 years of tornado data and 100 years of hurricane data, collected by FEMA. States located in Wind Zone IV have experienced the greatest number of tornadoes and the strongest tornadoes. The State of Idaho is located in Wind Zone I, which may experience wind speeds up to 130 mph (FEMA 2012). As seen in the figure below, along the Montana boarder are termed a ‘Special Wind Region’, where wind speed anomalies are known to exist. This means that those areas harbor winds that can be substantially higher than Zone I wind speeds. 3.3. H shows the predicted mean annual wind speeds at an 80-meter height (U.S. Department of Energy 2017).

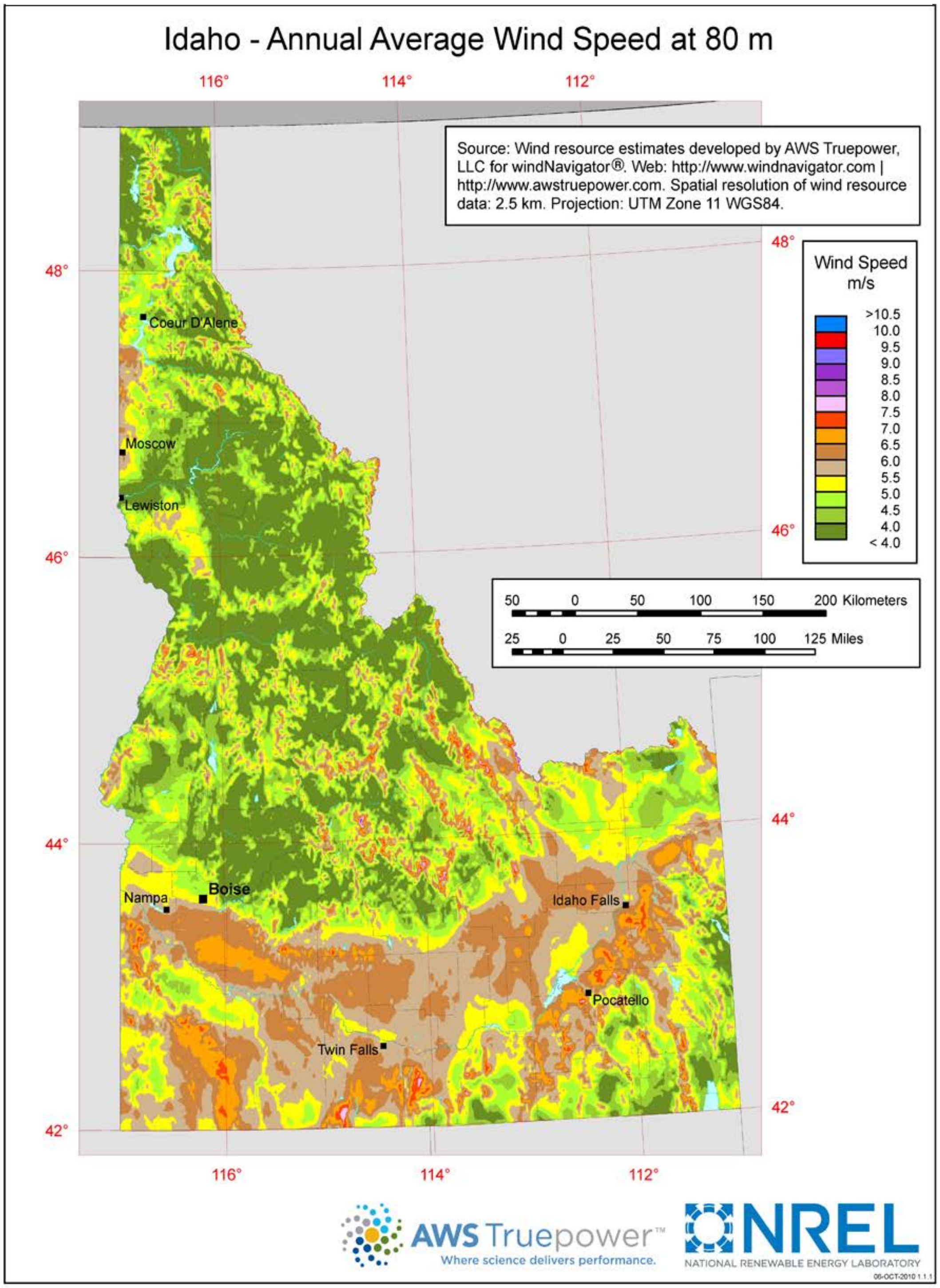
Figure 3.3.G. Wind Zones in the United States



Source: FEMA 2012
Source: Office of Energy Efficiency and Renewable Energy 2010

Straight-line winds can be encountered anywhere storms form. The events that present the most risk are often the result of thunderstorms. Figure 3.3.G, above, details the Wind Zones across the United States. It shows that Idaho as a whole falls into the Zone I rating, stating that maximum wind speeds should not top 130 mph. It should be noted that areas along the Montana boarder are termed a 'Special Wind Region', where wind speed anomalies are known to exist. This means that those areas harbor winds that can be substantially higher than Zone I wind speeds. Map 3.3.H shows the annual average wind speeds at 80 meters across Idaho.

Map 3.3.H: Idaho Average Wind Speed



Source: Office of Energy Efficiency and Renewable Energy 2010

Straight-line winds of concern are "high winds," defined by the NWS as "sustained wind speeds of 40 mph or greater lasting for one hour or longer, or winds of 58 mph or greater for any duration." The following table provides the descriptions of winds used by the NWS.

Table 3.3.I. NWS Wind Descriptions

Descriptive Term	Sustained Wind Speed (mph)
Strong, dangerous, or damaging	≥40
Very Windy	30-40
Windy	20-30
Breezy, brisk, or blustery	15-25
None	5-15 or 10-20
Light or light and variable wind	0-5

Source: NWS 2010
mph miles per hour

High wind advisories, watches, and warnings are issued by the NWS according to the following criteria:

Wind Advisory: Issued for Snake Plain only; winds between 30 and 39 mph and/or gusts between 45 and 57 mph not associated with thunderstorms, below 7,000 feet;

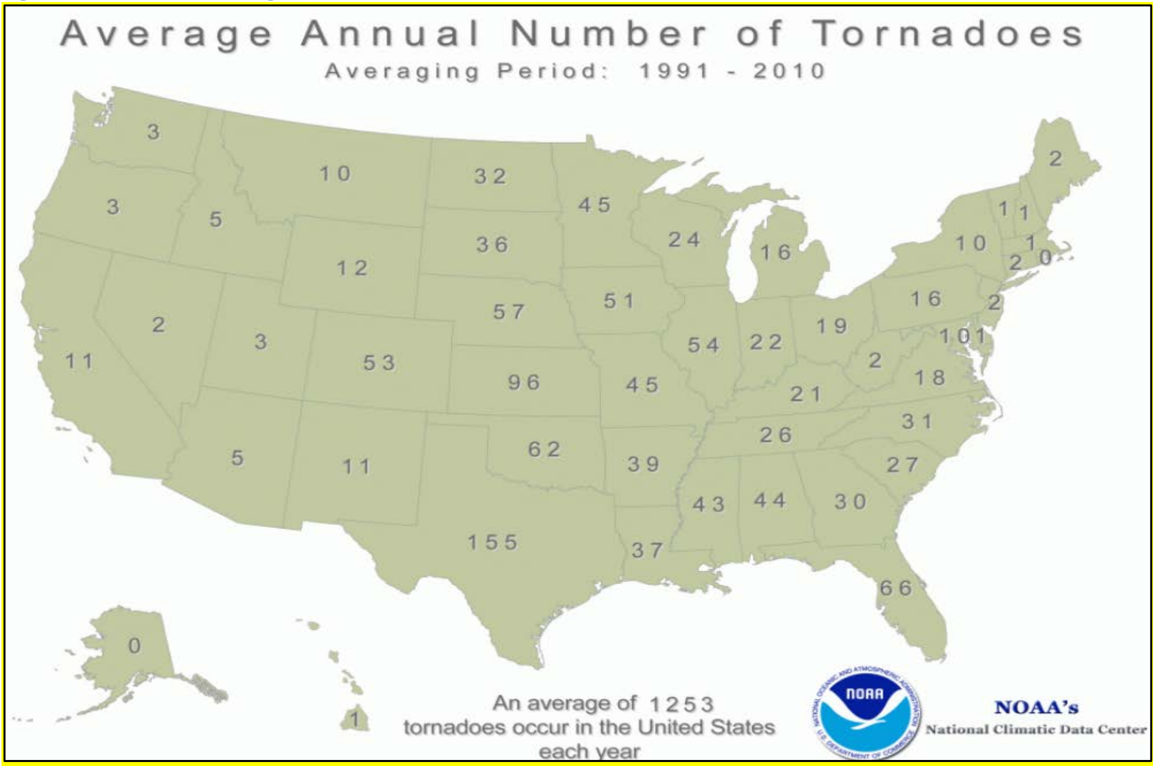
High Wind Warning: Issued when sustained winds of greater than 40 mph and/or gusts of greater than 58 mph for at least one hour are imminent or occurring and are not associated with thunderstorms; and

High Wind Watch: Issued when there is a potential for winds of greater than 40 mph and/or gusts of greater than 58 mph and are not associated with thunderstorms (Pocatello Weather Forecast Office 2012).

Tornado

The United States experiences more tornadoes than any other country. In a typical year, approximately 1,000 tornadoes affect the United States. The peak of the tornado season is April through June, with the highest concentration of tornadoes in the central United States. Figure 3.3.J shows the annual average number of tornadoes between 1991 and 2010 for the United States. According to this figure, Idaho experienced an average of five tornadoes each year. However, based on the number of tornadoes that occurred in Idaho between 1950 and 2016 (208 events); Idaho can expect to experience an average of three tornadoes each year (SPC 2017).

Figure 3.3.J. Annual Average Number of Tornadoes in the United States, 1991 to 2010



Source: NOAA NCEI 2017

The magnitude or severity of a tornado was originally categorized using the Fujita Scale (F-Scale) or Pearson Fujita Scale introduced in 1971. This used to be the standard measurement for rating the strength of a tornado. The F-Scale categorized tornadoes by intensity and area and was divided into six categories, F0 (gale) to F5 (incredible). Table 3.3.K explains each of the six F-Scale categories.

Table 3.3.K. Fujita Damage Scale

Scale	Wind Estimate (mph)	Typical Damage
F0	< 73	Light damage. Some damage to chimneys; branches broken off trees; shallow-rooted trees pushed over; sign boards damaged.
F1	73-112	Moderate damage. Peels surface off roofs; mobile homes pushed off foundations or overturned; moving autos blown off roads.
F2	113-157	Considerable damage. Roofs torn off frame houses; mobile homes demolished; boxcars overturned; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
F3	158-206	Severe damage. Roofs and some walls torn off well-constructed houses; trains overturned; most trees in forest uprooted; heavy cars lifted off the ground and thrown.
F4	207-260	Devastating damage. Well-constructed houses leveled; structures with weak foundations blown away some distance; cars thrown and large missiles generated.

Scale	Wind Estimate (mph)	Typical Damage
F5	261-318	Incredible damage. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); trees debarked; incredible phenomena occur.

Source: *Storm Prediction Center (SPC) Date Unknown*
mph *miles per hour*

The Enhanced Fujita Scale (EF-Scale) is now the standard used to measure the strength of a tornado. It is used to assign tornadoes a 'rating' based on estimated wind speeds and related damage. When tornado related damage is surveyed, it is compared to a list of Damage Indicators (DI) and Degree of Damage (DOD), which help better estimate the range of wind speeds produced by the tornado. From that, a rating is assigned, similar to that of the F-Scale, with six categories from EF0 to EF5, representing increasing degrees of damage. The EF-Scale was revised from the original F-Scale to reflect better examinations of tornado damage surveys. This new scale considers how most structures are designed (NOAA 2008). Table 3.3.L displays the EF-Scale and each of its six categories.

Table 3.3.L. Enhanced Fujita Damage Scale

EF-Scale Number	Intensity Phrase	Wind Speed (mph)	Type of Damage Done
EF0	Light tornado	65–85	**Light damage**. Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over.
EF1	Moderate tornado	86-110	**Moderate damage**. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	Significant tornado	111-135	**Considerable damage**. Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	Severe tornado	136-165	**Severe damage**. Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	Devastating tornado	166-200	**Devastating damage**. Well-constructed houses and whole frame houses completely leveled; cars thrown and small missiles generated.
EF5	Incredible tornado	>200	**Incredible damage**. Strong frame houses leveled off foundations and swept away; automobile-sized missiles fly through the air in excess of 100 meters (109 yards); high-rise buildings have significant structural deformation; incredible phenomena occur.

Source: *SPC Date Unknown*
EF-Scale *Enhanced Fujita Scale*
mph *miles per hour*

Tornado watches and warning are issued by the local NWS office. For the State of Idaho, tornado watches are issued when a tornado (a rotating column of air from a thunderstorm in contact with the ground) is occurring or imminent. A tornado watch is issued when conditions are favorable for tornadoes within the next two to six hours (Pocatello Weather Forecast Office 2012).

Windstorms can be a frequent problem throughout the State of Idaho and have been known to cause damage to utilities. The predicted wind speed given in wind warnings issued by the National Weather Service is for a one minute average; gusts may be 25 to 30 percent higher. Lower wind speeds typical in the lower valleys are still high enough to knock down trees and power lines and cause other property damage. Mountainous sections experience much higher winds under more varied conditions.

Tornadoes are nature's most violent storms. Every state in the United States is at some risk from tornadoes (FEMA 2013). However, tornadoes are not a common occurrence in the State of Idaho. If a major tornado were to strike within the populated areas of the State, damage could be widespread. Businesses could be forced to close for an extended period or permanently, fatalities could be high, many people could be homeless for an extended period, and routine services such as telephone or power could be disrupted. Buildings could be damaged or destroyed.

The NWS issues watches and warnings for high wind storms, tornadoes, and severe thunderstorms that may cause damaging winds. Like the prediction of thunderstorms and other severe weather events, the NWS can provide accurate forecasts several days prior to an event. Refer to the 'Extent' section of this profile for details regarding the details of watches and warnings for high winds, tornadoes, and thunderstorms. The current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly, that little, if any, advance warning is possible (NOAA 2013; FEMA 2013).

Relationships to Other Hazards

Winter Storm Secondary Impacts

The aftermath of a winter storm can have an impact on a community or region for days, weeks or even months. Winter storms can bring cold temperatures, floods, storm surge, closed and/or blocked roadways, downed utility lines, and power outages. Secondary hazards resulting from winter storms can also include structural damage (snow and ice load), wind damage, impact to life safety, disruption of traffic, loss of productivity, economic impact, loss of ability to evacuate, taxing first responder capabilities, service disruption (power, water, etc.), and communication disruption. Heavy snow and ice can knock out heat, power, and communication services, sometimes lasting for several days. People may be in their homes without utilities or other services. Pipes and water mains can break as well.

Severe Storm Secondary Impacts

Severe storms do influence a large number of other hazards, mainly due to the associated precipitation that accompanies those events. Rainfall, hail, and snowfall from storms play a major role in the hazard of flooding, where rainfall amount, intensity, and duration can correlate with the impacts of a flood event. This flooding can also then increase the likelihood for dam, levee, and canal failures. Precipitation, as well as the associated freeze and thaw cycles that storms can create, are also major causes of landslides, through a number of mechanisms. This is also true for avalanches, where snow loading or rain on snow events can trigger a slide.

Lightning Secondary Impacts

Lightning strikes are no longer the primary cause of a majority of the wildfires that occur throughout the State. The 2016 Idaho Department of Land's (IDL) Year-End Fire Report shows that human activity has become the primary fire start cause. In 2016, human activity ignited 121 fires (72 percent of the year's total) that burned 1,489 acres. Human caused fires accounted for 99 percent of the burned area while lightning started 47 fires (28 percent of the year's total) and burned 22 acres, or 1 percent of the total area.

2016 LIGHTNING VS HUMAN FIRES

Year	# of Lightning Fires	Lightning Acres Burned	# of Human Fires	Human Acres Burned	Total # of Fires	Total Acres Burned
2016	47	22	121	1,489	168	1,511
2015	150	68,221	171	10,350	321	78,571
2014	217	74,104	134	8,421	351	82,525
2013	212	2,554	110	4,654	322	7,208
2012	81	295	106	4,460	187	4,755
10-Yr Avg.	135	21,426	139	3,877	274	25,303
20-Yr Avg.	160	16,177	146	3,516	306	19,693
34-Yr Avg.	195	10,552	166	3,143	361	13,695

Minor discrepancies exist due to rounding

Source: https://www.idl.idaho.gov/fire/2016-year-end-fire-report.pdf

The timing of these lightning caused events mirrors the seasons when thunderstorms are most prevalent. This correlation was evident in the 2016 fire season, it was a windy summer caused by periodic dry cold front passages, but with few thunderstorms (IDL Year-End Fire Report, 2016). 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 power or communication disruptions.

Hail Secondary Impacts

Hailstorms, like many of the other hazards discussed, are often accompanied by other severe weather. One secondary effect of hailstorms is the damage to critical infrastructure which in turn may lead to utility failure. Additionally, extreme hailstorms impact traffic routes and may lead to transportation accidents.

Tornado Secondary Impacts

High wind and tornado events could impact the initiation of other hazards. Wildfires could be ignited by downed or damaged electrical transmission systems. From a human caused perspective, a high wind or tornado event could produce hazardous material releases, cyber disruptions, or energy shortages, although these would most likely be smaller scale events. It is also possible that a large scale tornado could cause localized civil disturbances.

Tornadoes can also occur anywhere thunderstorms form. Although no data currently exist to help identify regions of particular risk, records of past wind and tornado events provide useful information in this regard.

Past Occurrence

Winter Storms

According to NOAA's National Centers for Environmental Information (NCEI) storm events database, Idaho experienced 717 winter storm events between 1950 and 2017. Total property damage was estimated at over $100 million, eight injuries and seven fatalities. These events included blizzards, heavy snow, and winter storms. Many sources provided information regarding previous occurrences and losses associated with winter storm events throughout the State of Idaho. For the 2018 Plan update, winter storm events were summarized between January 1, 2012 and October 1, 2017. Table 23.3.M includes events discussed in the 2013 Plan and events that occurred between 2012 and 2017. With winter storm documentation for Idaho being so extensive, not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, 3.3.M may not include all events that have occurred in the state and the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP update.

Table 3.3.M. Winter Storm Events in Idaho, 1933 – 2017

Date(s) of Event	Event Type	Counties Affected	Description
March 3, 1972	Severe Storms, Snowmelt and Flooding	Latah	Federal disaster declared for severe storms and associated snowmelt and flooding conditions in Idaho.
January 1974	Severe Storms and Flooding	Adams, Benewah, Bonner, Boundary, Clearwater, Kootenai, Latah, Shoshone, and Washington	Federal disaster declared for severe storms and associated extensive flooding in Idaho.
1989	Blizzard	Clark	Severe winds and blizzard conditions kept ranchers from reaching livestock.
January 1996	Winter Weather (DR-1102)	Benewah, Bonner, Boundary, Clearwater, Idaho, Kootenai, Latah, Lewis, Nez Perce, Payette, Shoshone	The third week of January brought large amounts of low-elevation snow, especially in the Panhandle region, where stations measured an additional 10 inches of snow. By the end of January, sites in the north had as much as 2½ feet of snow on the ground. During the last week of January, temperatures dropped below 0, and highs remained in the single digits, causing ice to form on many rivers. Subsequent warming led to extensive flooding throughout the region. On February 11, 1996, the President declared a major disaster in the State of Idaho (designated DR-1102). Ten counties and the Nez Perce Indian reservation were declared eligible for assistance. As of February 1, 2001, this assistance included $22,635,325 in

Date(s) of Event	Event Type	Counties Affected	Description
			public assistance, $71,639 in individual assistance, $301,081 from the NRCS, and $5,022,353 in hazard mitigation grants. Although much of this damage derived from flooding, the preceding storm clearly contributed to the disaster.
November 1996 – January 1997	Winter Storms (DR-1154)	Kootenai, Clearwater, and Idaho	In the last months of 1996, significant early season storms caused extensive damage and subsequently led to severe landslides and flooding throughout Northern Idaho. By many measures, this was a significant series of storms. Mountain snow packs were holding more than 150 percent of their normal water content. Snowfall in areas of the Panhandle counties sometimes exceeded the design loads of buildings. During November 16-21, 2 to 3 feet of snow were dumped in the Bonners Ferry area, collapsing roofs of businesses, schools, and homes. On November 19, freezing rain produced 1 inch of ice in Kootenai, Clearwater, and Idaho Counties. Strong winds and the ice toppled numerous trees and power lines. Power outages lasted for weeks. Additional above-normal snowfall fell in late December throughout Northern and Central Idaho. Subsequent warm rains produced heavy runoff that overwhelmed rivers and led to flooding and widespread landslides. On January 4, 1997, the President declared a major disaster (DR-1154) in 18 counties, making them eligible for Federal assistance. As of February 1, 2001, assistance included $19,404,105 in public assistance, $39,988 in individual assistance, $125,937 from the NRCS, $576,314 from the U.S. Army Corps of Engineers, and $5,593,892 in hazard mitigation grants.
December 30, 2005 – January 4, 2006	Winter Storm	Owyhee	A Federal disaster was declared for a storm that hit Owyhee County between December 30, 2005, and January 4, 2006.
2008	Heavy Snow	Bonner, Boundary, Kootenai, Latah, and Shoshone	A State disaster was declared for a storm that brought heavy snow to Bonner, Boundary, Kootenai, Latah, and Shoshone counties
2009	Severe Winter Weather	Benewah	A State disaster was declared for a storm that brought severe winter weather to Northern Idaho, specifically for Benewah County.
2012	Severe Winter weather	Northern Idaho - Bonner, Idaho, Latah, and Shoshone	A State disaster was declared for a storm that brought severe winter weather to Bonner, Idaho, Latah, and Shoshone counties.
January 23-24, 2013	Icing Conditions	Treasure Valley area	Icing conditions, the worst in 30 years according to Boise NWS forecasters, were reported in Idaho's Treasure Valley on Wednesday (1/23/13) and Thursday (1/24/13) due to a prolonged cold snap. Roadway icing forced closure of 83 miles of Interstate 84 between Boise and Bliss where dozens of long-haul trucks were observed sliding off the highway. I-84 was reported reopened Thursday afternoon after de-icing operations. Burst frozen piping affected over a thousand customers in Boise and surrounding communities and prompted fire department responses to fire sprinkler water flow alarms.

Date(s) of Event	Event Type	Counties Affected	Description
December 16-27, 2015	Severe Winter Storms (DR-4252)	Benewah, Bonner, and Kootenai	On January 21, 2016, Governor Otter requested a major disaster declaration due to severe winter storms during the period of December 16-27, 2015. The Governor requested a declaration for Public Assistance for three counties and hazard mitigation statewide. On February 1, 2016, President Obama declared a major disaster exists in Idaho, which made Public Assistance available to the State and eligible local governments and certain private non-profit groups. The primary impact to the State was damage to public utilities. The State requested over $5.2 million in public assistance.
February 5, 2017	Severe Winter Storms and Flooding (DR-4310)	Bingham, Cassia, Elmore, Franklin, Gooding, Jefferson, Jerome, Lincoln, Minidoka, Twin Falls, and Washington	Extreme snowfall amounts in December and January led to extensive flooding issues in February. The hardest hit counties included Cassia, Minidoka, Jefferson, Lincoln and Bingham Counties but all counties in the state experienced at least minor flooding. Flooding began February 4th and continued to affect low lying areas until the end of the month and continued into March. Overall, the State of Idaho had approximately $9.06 million in property damage from this event. In Ada County, neighborhood roads and yards along Cole Road were inundated due to Five Mile Creek flooding. In Bannock County, field flooding occurred throughout the County. A house on Andrew Street in Pocatello also flooded on February 8th. Wallin Road was closed on February 10th in Chubbuck due to water on the road. The area of Marsh Creek also flooded. The Portneuf River in Pocatello reached flood stage on the 11th with flooding in Sacajawea Park. In Benewah County, an ice jam on the St. Joe River flooded portions of St. Joe River Road and making it impassable. Minor field flooding was reported downstream as the ice jam broke up and released the dammed water. Other counties reported sheet flooding, fields flooding, flooded roadways that become impassable, damaged roads, basement flooding, and ice jams. Custer County declared a county disaster due to damages from the flooding and snow melt. On February 10th, an ice jam developed on the St. Joe River between St. Maries and Calder. Water backed up behind the ice jam causing minor flooding upstream in the Town of Calder. St. Joe River Road also flooded in places which led to closing of the road. An ice jam also occurred on Weiser River, just south of Weiser and caused flooding on U.S. Highway 95. Jefferson County was declared a disaster area by the State due to the magnitude of damage. Roadway flooding occurred near Roberts on February 11th and 12th, but extreme flooding commenced after the 19th. Numerous roads were closed throughout the county due to flooding. Water on some roads reached levels that caused cars to float. Road crews described some roads similar to waterfalls. Lincoln County was also declared a disaster area by the State due to significant damage to homes and roadways. Many roads were closed by the 11th with water over roadways from east of Shoshone to the Minidoka County line. The Town of Kimana had significant flooding as well.

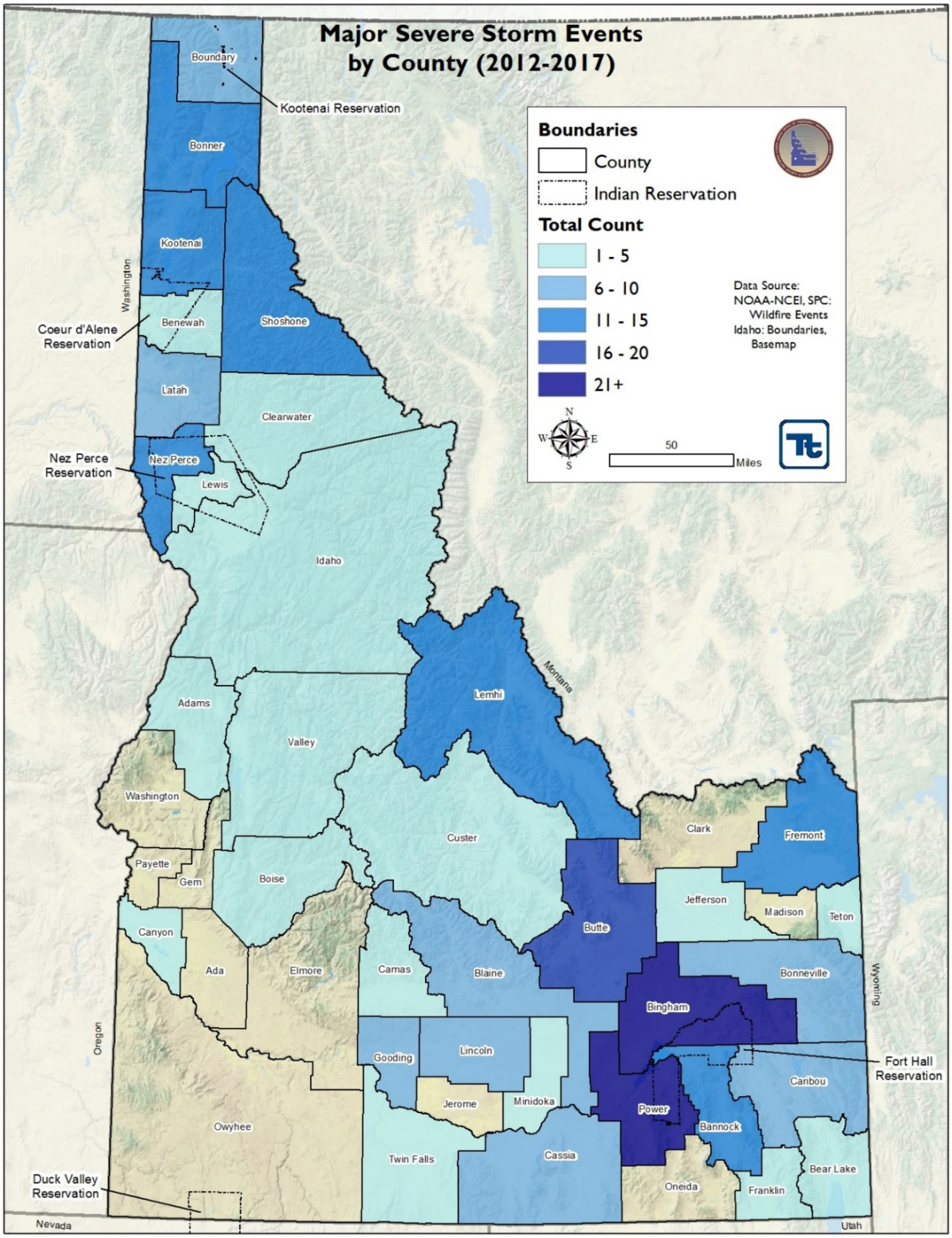
Date(s) of Event	Event Type	Counties Affected	Description
			On March 30, 2017, Governor Otter requested a major disaster declaration due to the severe winter storms and flooding experienced during the period of February 5-27, 2017. The Governor requested a declaration of Public Assistance for 11 counties and hazard mitigation statewide. On April 21, 2017, President Trump declared that a major disaster declaration exists in the State of Idaho. The declaration made Public Assistance available and eligible local governments and certain private non-profit organizations. The primary impact from this disaster was damage to roads and bridges. The State requested over $8.7 million in public assistance.

Sources: NOAA NCEI 2017; FEMA 2017; Idaho State HMP 2013

Other notable storms in the recent past that were not declared, but worthy of documenting in this plan can be found below.

Treasure Valley, 2013*:* Icing conditions, the worst in 30 years according to Boise NWS forecasters, were reported in Idaho's Treasure Valley on Wednesday (1/23/13) and Thursday (1/24/13) due to a prolonged cold snap. Roadway icing forced closure of 83 miles of Interstate 84 between Boise and Bliss where dozens of long haul trucks were observed sliding off the highway. I-84 was reported reopened Thursday afternoon after de-icing operations. Burst frozen piping affected over a thousand customers in Boise and surrounding communities and prompted fire department responses to fire sprinkler water flow alarms.

Figure 3.3.N. Major Severe Storm Events in Idaho



Lightning

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 or damage for the State of Idaho. Lighting events were summarized between January 1, 2011 and October 1, 2017.

Table 3.3.O. Lightning Damage or Loss Events in the State of Idaho, 1993 to 2017

Dates of Event	Event Type	Counties Affected	Losses / Impacts
May 20, 1993	Lightning	Ada	$5,000 in property damage
August 7, 1993	Lightning	Canyon	$5,000 in property damage
August 11, 1993	Lightning	Cassia	$50,000 in property damage
August 15, 1993	Lightning	Ada	$50,000 in property damage
September 5, 1993	Lightning	Bannock	$50,000 in property damage
February 17, 1994	Lightning	Owyhee	$5,000 in property damage
May 4, 1994	Lightning	Minidoka	$5,000 in property damage
May 27, 1994	Lightning	Canyon	$50,000 in property damage
October 5, 1994	Lightning	Power	$50,000 in property damage
November 1, 1994	Lightning	Bonner	$50,000 in property damage
June 10, 1995	Lightning	Payette	$50,000 in property damage
June 18, 1995	Lightning	Castleford	one injury
July 6, 1995	Lightning	Idaho Falls	$500,000 in property damage
July 22, 1995	Lightning	Idaho Falls	$5,000 in property damage
July 22, 1995	Lightning	Bonneville	$5,000 in property damage
July 28, 1995	Lightning	Kuna	$50,000 in property damage; two fatalities
July 28, 1995	Lightning	Glenns Ferry	$50,000 in property damage
July 29, 1995	Lightning	McCall	$5,000 in property damage; one fatality and 12 injuries
August 4, 1995	Lightning	Pocatello	$50,000 in property damage
August 6, 1995	Lightning	Trinity Lakes	$50,000 in property damage
August 17, 1995	Lightning	Ammon	$500,000 in property damage
August 21, 1995	Lightning	Jerome	$50,000 in property damage
August 21, 1995	Lightning	Nr Se Dietrich	$5,000 in property damage
September 3, 1995	Lightning	Boise	$50,000 in property damage
September 4, 1995	Lightning	Fairfield	$50,000 in property damage
September 7, 1995	Lightning	Post Falls	$50,000 in property damage
November 16, 1995	Lightning	CJ Strike Reservoir	$5,000 in property damage
December 16, 1995	Lightning	CJ Strike Reservoir	$5,000 in property damage

Dates of Event	Event Type	Counties Affected	Losses / Impacts
May 14, 1996	Lightning	Caldwell	$15,000 in property damage
July 17, 1996	Lightning	Burley	one fatality and one injury
June 17, 1997	Lightning	Pocatello	$1 million in property damage
June 30, 1997	Lightning	Melba	one fatality
September 11, 1997	Lightning	Blackfoot	$1,000 in property damage
April 23, 1998	Lightning	Marysville	$1,000 in property damage
June 25, 1998	Lightning	Leadore	two injuries
July 3, 1998	Lightning	Cascade	two injuries
September 7, 1998	Lightning	Boise	$10,000 in property damage
September 30, 1998	Lightning	Inkom	three injuries
May 29, 1999	Lightning	Pocatello	$10,000 in property damage
July 18, 1999	Lightning	Driggs	$21,000 in property damage
August 18, 2000	Lightning	Rexburg	$20,000 in property damage
September 17, 2000	Lightning	Chesterfield	$150,000 in property damage
July 7, 2002	Lightning	Caldwell	one fatality and two injuries
August 30, 2002	Lightning	Oldtown	two injuries
August 22, 2003	Lightning	Whitney	one injury
August 22, 2003	Lightning	Moreland	$1,000 in property damage
June 28, 2004	Lightning	Idaho Falls	$5,000 in property damage
May 29, 2005	Lightning	Burley	$10,000 in property damage
May 19, 2006	Lightning	Hayden	$10,000 in property damage
July 5, 2006	Lightning	Coeur D'Alene	$15,000 in property damage
June 4, 2007	Lightning	Coeur D'Alene	$30,000 in property damage
August 18, 2008	Lightning	Pinehurst	$2,000 in property damage
June 5, 2009	Lightning	Idaho Falls	$13,000 in property damage
June 29, 2010	Lightning	Bingham	$4,000 in property damage
August 10, 2010	Lightning	Lemhi	one fatality in Salmon
June 12, 2013	Lightning	Bingham	In Blackfoot, lightning damaged a home on South Adams Avenue, damaging utility lines and appliances in the home. A telephone pole was knocked down near the courthouse. A trailer at the Sage Hill Travel Center was struck by lightning and destroyed. Overall, property damage was estimated at $20,000.
August 10, 2013	Lightning	Kootenai	A bolt of lightning started a fire in a home on Good Hope Road in Althol, destroying the house. Overall, property damage was estimated at $200,000.
October 13, 2013	Lightning	Teton	Lightning struck a tree that was connected to a barbed wire fence on a ranch in Tetonia. The current from the fence killed 15 cattle that were adjacent to the fence. Overall, property damage was estimated between $15,000 and $20,000.
June 28, 2016	Lightning	Kootenai	A thunderstorm near Coeur D'Alene produced a lightning bolt that struck a home and set it on fire. Damage to the home was estimated at $50,000.

Sources: Idaho State HMP 2013; NOAA-NCEI 2017

Except when significant forest or range fires are ignited by lightning, it generally does not result in disaster declarations. Between 1959 and 2015, NOAA reported 27 lightning fatalities in Idaho (NOAA 2016). According to NOAA's NCEI storm events database, Idaho experienced 59 lightning damage events (defined as a sudden electrical discharge from a thunderstorm, resulting in fatality, injury, and/or damage) between 1993 and 2018. Total property damage was estimated at over $1.6 million (NOAA NCEI 2017).

Hail

Hail falls in various locations throughout the State every year. Significant events are most common in summer. For example, in June 1996, golf ball sized hail was reported in Bonneville County. According to NCDC data, an August 1997 storm caused a $1 million of property damage in Bannock County, and a July 1998 storm caused $5 million in crop damage in Latah County. No State or Federal Disaster declarations or any deaths were reported as the result of hail damage in the State.

Hailstorms, like thunderstorms, occur as a routine part of severe weather in Idaho. The potential for hail exists all over the State. There are at least a few incidences each year, but they are typically minor in magnitude. Significant events are most common during summer months.

For the 2018 Plan update, hail events were summarized between January 1, 2012 and October 1, 2017. Table 3.3.P includes events discussed in the 2013 Plan and events that occurred between 2012 and 2017. Please note that not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, Table 3.3.P may not include all events that have occurred in the state and the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP update.

Table 1.3.P. Thunderstorm – Hail Events in Idaho Between 1996 and 2017

Event Date	Event Type	Counties Affected	Description/Losses
June 1996	Hail	Bonneville	Golf-ball-sized hail was reported in Bonneville County
August 1997	Hail	Bannock	Storm caused a $1 million of property damage in Bannock County
July 1998	Hail	Latah	Storm caused $5 million in crop damage in Latah County
August 1, 2013	Hail	Lemhi	A large, long-lived supercell developed across south-central Idaho and moved north and east across northeastern Lemhi County. A spotter in Salmon reported quarter size hail. Insurance companies reported at least 200 damage claims to cars and homes in Salmon and Carmen. Hail fell for at least 15 minutes damaging roofs, siding, stucco, and windows. Overall, the County had approximately $490,000 in property damage.
July 23, 2014	Hail	Kootenai, Benewah, Latah, and Shoshone	One inch hail was observed at Conkling Park on Lake Coeur d'Alene. Strong winds in northern Kootenai County resulted in a corridor of tree damage from Coeur d'Alene to Althol. The strongest winds near Althol downed trees in an RV park. One person suffered minor injuries. Hail sizes ranged from 1 inch to 1.25 inch in diameter. Overall, the impacted counties experienced approximately $210,000 in property damage.

Table 1.3.P. Thunderstorm – Hail Events in Idaho Between 1996 and 2017

Event Date	Event Type	Counties Affected	Description/Losses
August 14, 2014	Hail	Clearwater and Lewis	Major property and crop damage was reported by a farmer in Clearwater County due to large hail and wind. Hail was approximately 1.25 inches in diameter. Property damage included five rental homes, siding from three homes, several windows, and 12 garage doors that either were dented or destroyed. The farmer lost about 75% of their spring wheat crop. Overall, there was $104,000 in property damage and $175,000 in crop damage.
May 18, 2015	Hail	Bingham	Small hail accumulated on Interstate 15 in Fort Hall (Bingham County) and many cars slid off the road into ditches and the median. There was one reported injury due to a vehicle collision. There was approximately $15,000 in property damage from this event.
August 7, 2016	Hail	Gem and Lemhi	A spotter in Elk Bend reported golf ball sized hail that smashed approximately 6 car windows. Hail ranged in size from 0.75 inch diameter to 1.75 inch diameter. There was approximately $10,000 in property damage.

Sources: Idaho State HMP 2013; NOAA-NCEI 2017; SPC 2017

Straight-Line Winds

Significant straight-line wind events have been recorded in the Lowman area (large scale forest damage in the 1970s) and the Payette and Weiser area (in the 1990s).

For the 2018 Plan update, wind events were summarized between January 1, 2012 and October 1, 2017. 3.3. Q includes events discussed in the 2013 Plan and events that occurred between 2012 and 2017. Please note that not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, Table 3.2.Q may not include all events that have occurred in the state and the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP update.

Table 3.3.Q. Straight-Line Wind Events in Idaho, 1936 to 2017

Dates of Event	Event Type	Counties Affected	Losses / Impacts
July 23, 2014	Thunderstorm Wind	Bonner	Damaging winds led to widespread tree damage across central Bonner County. Wind gusts of 75 mph were measured in the County. Multiple trees were knocked down across the City of Sandpoint. Many roads were closed due to downed trees and power lines. Power outages were reported across the impacted areas. The winds created three to six foot waves in sections of Lake Pend Oreille. The County had approximately $2 million in damages from this event.
August 2, 2014	Thunderstorm Wind	Bonner	Widespread wind damage was observed across the Cities of Priest Lake, Sandpoint, Ponderay, Kootenai, Oden, and Lake Pend Oreille, all in Bonner County. Hundreds of trees were snapped or downed

Dates of Event	Event Type	Counties Affected	Losses / Impacts
			by strong winds. Some trees landed on homes while others downed utility and power lines. At one point, the entire City of Sandpoint was without power. The County had approximately $2 million from this event.
November 17, 2015	Severe Storm and Straight-Line Wind (DR-4246)	Coeur d'Alene Indian Reservation, Benewah, Bonner, Boundary, and Kootenai	High winds as a result of a cold front brought substantial damage across northern Idaho. This led to widespread power outages and the most damaged seen by Avista utilities in its 126 year history. An estimated 180,000 customers were without power at the peak of the windstorm. There was one direct fatality from the storm. Wind gusts ranged from 59 mph to 116 mph. A state disaster declaration was issued for Benewah, Bonner, Boundary and Kootenai Counties. On December 16, 2015, Governor Otter requested a major disaster declaration due to severe storm and straight-line winds in Idaho. The Governor requested a declaration for Public Assistance for four counties and one tribe, and hazard mitigation statewide. On December 23, 2015, President Obama declared that a major disaster declaration exists in the State. The declaration made Public Assistance available to state and eligible local governments and certain private non-profit groups. The primary impact from this event was damage to utilities. The State requested over $2.4 million in public assistance. Overall, damages associated with this event was estimated at $2.6 million.
December 20, 2016	High Wind	Lemhi	Very strong winds caused a sale barn from the County Fairgrounds to collapse. Wind gusts of up to 53 mph were recorded. The County had approximately $500,000 in property damage from this event.

Sources: NOAA NCEI 2017; FEMA 2017; SPC 2017; Idaho State HMP 2013

Tornadoes

Over the course of the last 20 years, the State of Idaho has experienced 85 tornadoes, with an annual frequency of 4.25 per year. 3.3. R illustrates the locations of the confirmed tornadoes that touched down in Idaho from 1950 to 2016. According to this figure, there have been 208 tornadoes in Idaho. These tornado events resulted in 11 injuries. Of those 208 tornadoes:

138 were EF-0/F-0
60 were EF-1/F-1
10 were EF-2/F-2

According to the SPC, between 1950 and 2016, the State of Idaho experienced 208 tornadoes with 11 injuries and 1,527 damaging wind events with 15 fatalities and 163 injuries (SPC 2017). According to

NOAA's NCEI storm events database, Idaho experienced 206 tornadoes, resulting in over $9.4 million in property damage, $10,000 in crop damage, and nine injuries (NOAA 2017).

Tornado events were summarized between January 1, 2012 and October 1, 2017. Table 3.3.R includes events discussed in the 2013 Plan and events that occurred between 2012 and 2017. Please note that not all sources have been identified or researched. Additionally, loss and impact information for many events could vary depending on the source. Therefore, Table 3.3.R may not include all events that have occurred in the state and the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP update.

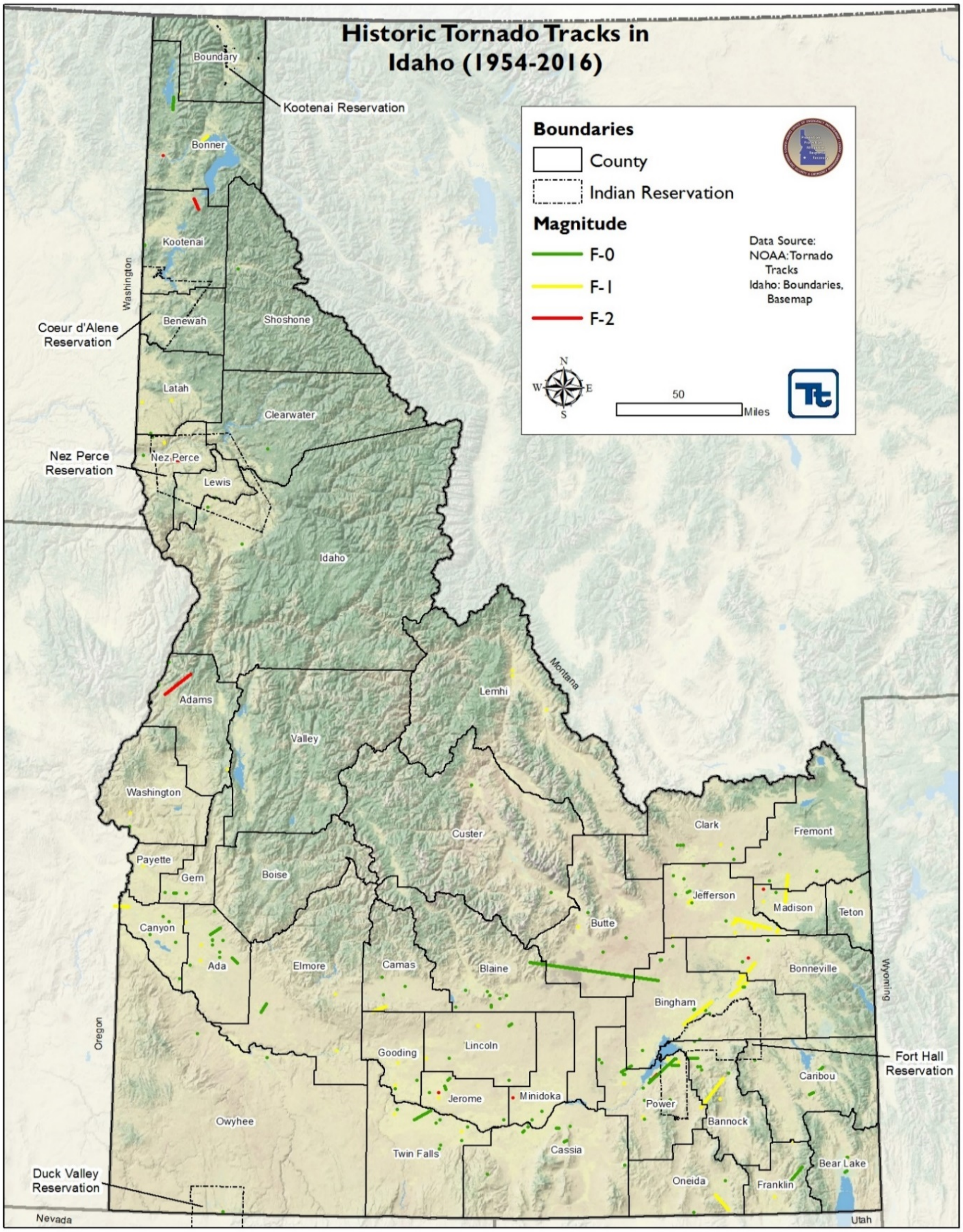
Table 3.3.R. Tornado Events in Idaho, 1936 to 2017

Dates of Event	Event Type	Counties Affected	Losses / Impacts
June 7, 1936	Tornado	Nez Perce	A tornado hit north of Reubens; a house and a barn were nearly leveled
April 26, 1940	Tornado	Gooding	A widely visible funnel cloud hit five farms west of the City of Gooding; three homes were destroyed.
April 7, 1978	Tornado (F2)	Bonneville	A tornado hit the edge of Idaho Falls, damaging the roofs of nine homes and 23 businesses
August 19, 1978	Tornado (F1)	Bonner	A poorly formed tornado did minor damage in Sandpoint; a woman was struck by a tree.
June 5, 1987	Tornado (F0)	Shoshone	A funnel cloud briefly touched down at a street fair in Pinehurst.
April 9, 1991	Tornado (F2)	Bonner	A tornado touched down at Priest River; no injuries were reported.
June 11, 1993	Tornado (F1)	Bannock	A tornado traveled 10 miles south to southeast of Pocatello, ending in the Town of Inkom. The tornado uprooted several trees, knocked down a grain elevator, overturned a truck, and knocked down several outbuildings. This event resulted in a State Disaster declaration for Bannock County.
May 29, 1994	Tornado (F1)	Bonner	Tornado recorded near Priest Lake; no injuries reported
April 25, 1995	Tornado (F0)	Bingham	A series of tornadoes touched down in central Bingham County, causing damage to mobile homes, highway signs, and recreational equipment.
July 10, 1998	Tornado (F0)	Owyhee	A manufactured home was flipped over by an F0 tornado at Oreana.
February 14, 2000	Tornado (F1)	Bingham	One injury
June 24, 2004	Tornado (F0)	Bonner	Priest Lake experienced a tornado with no injuries.
June 4, 2006	Tornado (F2)	Adams	A tornado struck the community of Bear in Adams County, resulting in extensive tree damage. Because downed trees and debris caused elevated wildfire risk and blocked roads, a State Disaster declaration was issued. The tornado path was 12 miles long and over half a mile wide along portions of its track. One serious injury occurred during this tornado, which was rated F2. Significant straight-line wind events have been recorded in the Lowman area (large-scale forest damage in the 1970s) and the Payette and Weiser area (in the 1990s).

Dates of Event	Event Type	Counties Affected	Losses / Impacts
June 23, 2011	Tornado (EF0)	Bingham	An EF0 tornado hit near the City of Moreland along Pioneer Road, damaging four homes. A shed at one home was destroyed and a garage to the back of another home was destroyed. A third home had wood siding removed and damaged trees. A camper was flipped over. The Jensen Grove Park near Blackfoot had 19 trees snapped or uprooted. The County experienced approximately $7,000 in property damage from this event.
September 1, 2012	Tornado (EF0)	Cassia	A weak tornado was confirmed about 4 to 5 miles east northeast of the City of Albion and east of the City of Declo. It was in open land and did no damage.
May 7, 2013	Tornado (EF0)	Jefferson	A weak tornado was confirmed with photographs and radar signatures just southeast of Monteview. The tornado was in open fields and no damage occurred.
May 8, 2013	Tornado (EF0)	Jerome	A Jerome County deputy reported a brief tornado touchdown. No damage was reported.
May 26, 2013	Tornado (EF0)	Elmore	An EF-0 tornado was spotted about 10 miles northwest of the City of Mountain Home. No damage was reported.
July 7, 2013	Tornado (EF0)	Bear Lake	A tornado was spotted by the public three miles west southwest of Wardboro in between City of Paris and Dingle. No damage reported as tornado occurred in open area.
September 17, 2013	Tornado (EF0)	Clark, Fremont	Clark County - A COOP observer witnessed a tornado with debris being lifted about five miles east-southeast of City of Dubois. The tornado was in open area with no damage occurring and path unknown. Fremont County - A tornado was witnessed by the public in open land in Fremont County approximately 10 miles north-northwest of the City of St Anthony. No damage was reported with the open land storm.
May 10, 2014	Tornado (EF0)	Jefferson	A brief tornado touched down six miles northwest of Monteview. Tornado occurred over open land with no damage reported.
May 21, 2014	Tornado (EF0)	Power	A tornado was spotted about 10 miles west-northwest of the City of American Falls and it moved slightly north-northwest. It was then located 1.2 mile north-northwest of the intersection of North Pleasant Valley Road and County Line Road. A damage survey showed damage to a residence on North Pleasant Valley Road between Schritter and County Line Roads. Multiple trees were uprooted or had branches torn off. Shingles were torn off the hours and a shed door was damaged and blown off its hinges. There were also isolated reports of irrigation line damage as the tornado moved through mostly open fields. No other damage was found.
August 20, 2014	Tornado (EF0)	Custer	A funnel cloud was spotted as it briefly touched down two miles southeast of the Town of Mackay.
July 11, 2015	Tornado (EF0)	Jefferson	A tornado was spotted over in between the Cities of Mud Lake and Sage Junction in Jefferson County on July 11th.
June 30, 2016	Tornado (EF0)	Jerome	An EF0 tornado was spotted moving northwest to southeast along a gust front from a thunderstorm northeast of the City of Jerome. It was about 150 feet wide and moved through agricultural fields; no damage was reported.
July 31, 2016	Tornado (EF0)	Caribou	A weak tornado was spotted in open country just north of the City of Soda Springs; no damage was reported.

Sources: NOAA NCEI 2017; FEMA 2017; SPC 2017; Idaho State HMP 2013

Figure 3.3.S. Tornadoes in Idaho, 1950 to 2016



FEMA Disaster Declarations Severe Storms

Between 1954 and 2017, FEMA declared that Idaho experienced nine severe storm related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: severe storms, flooding, straight-line winds, severe winter storms, landslides, and mudslides. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations as determined by FEMA (FEMA 2017).

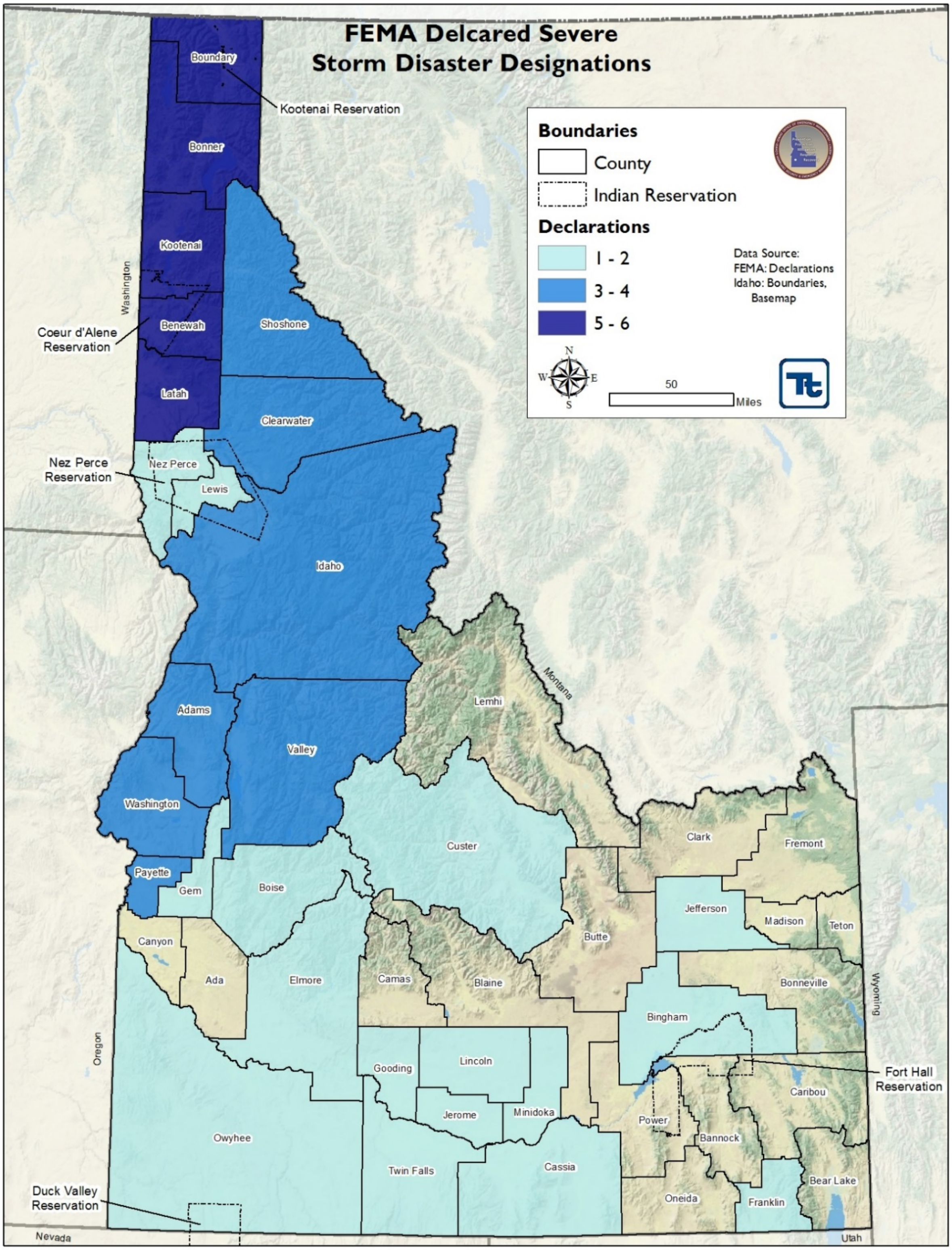
Based on all sources researched, known severe storm events that have affected Idaho and were declared a state and/or FEMA disaster, are identified in Table . This table provides information on the disaster declarations for severe storms, including date of event, state disaster declaration, federal disaster declaration and disaster number, and counties affected. Figure illustrates the number of FEMA declared disasters by county.

Table 3.3.T. Severe Storm-Related State and Federal Declarations (1954 to 2017)

Year	Date	State	Federal	Counties Affected
1972	March 2, 1972	X	DR-324	Latah
1974	January 25, 1974	X	DR-415	Adams, Benewah, Bonner, Boundary, Clearwater, Kootenai, Latah, Shoshone, and Washington
1989	January	X		Bonner, Clark
1993	January	X		Jerome
1994	January	X		Elmore
1996	February 11, 1996	X	DR-1102	Benewah, Bonner, Boundary, Clearwater, Idaho, Kootenai, Latah, Lewis, Nez Perce, Payette, Shoshone
1997	January 4, 1997	X	DR-1154	Adams, Benewah, Boise, Bonner, Boundary, Clearwater, Elmore, Gem, Idaho, Kootenai, Latah, Nez Perce, Owyhee, Payette, Shoshone, Valley, Washington
2006	February 27, 2006	X	DR-1630	Owyhee
2008	N/A	X		Bonner, Boundary, Kootenai, Latah, Shoshone
2009	N/A	X		Benewah
2010	July 27, 2010	X	DR-1927	Adams, Gem, Idaho, Lewis, Payette, Valley, Washington
2012	July 5, 2012	ID-02-2012		Bonner, Idaho, Latah, Shoshone
2015	November 12, 2015	ID-03-2015	DR-4246	Benewah, Bonner, Boundary, Coeur d'Alene Indian Reservation, and Kootenai
	December 16, 2015	ID-04-2015	DR-4252	Benewah, Bonner, and Kootenai
2017	February 5, 2017	ID-01-2017	DR-4310	Bingham, Cassia, Elmore, Franklin, Gooding, Jefferson, Jerome, Lincoln, Minidoka, Twin Falls, and Washington
	March 6, 2017	ID-02-2017	DR-4313	Benewah, Bonner, Boundary, Clearwater, Idaho, Kootenai, Latah, Shoshone, and Valley

Source: Idaho State HMP 2013; FEMA 2017
N/A Not Available

Figure 3.3.U. FEMA Severe Storm Declarations in Idaho



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.

Severe thunderstorms are most likely in Idaho during the spring and summer months. The probability of severe thunderstorms is increased if strong upper-level winds are present in conjunction with a moist and unstable atmosphere. Such conditions are most likely in association with the passage of a cold front from west to east across the State, with warm, moist air ahead of the front. Strong areas of upper-level low pressure over the Pacific Northwest can also create favorable conditions for severe thunderstorms in Idaho. Other weather patterns favorable for severe thunderstorm formation include monsoon moisture from the desert southwest working its way northward into Idaho. This weather pattern is usually associated with an unstable atmosphere conducive to the formation of thunderstorms in mid-summer. Hail damage can be expected to continue for all areas of the state.

Lightning

Looking at all lightning events that have occurred in the State between 1950 and 2017, there have been 59 lightning strikes causing either loss, damage, or a combination. Based on this data, Idaho may experience approximately 1 lightning strike each year (NOAA NCEI 2017). The probability of lightning occurring in the State of Idaho is 100%.

Hail

Hailstorms occur regularly but not at the frequency or intensity of thunderstorms across the State. To calculate the probability of future occurrence, all hail events that occurred in the State between 1950 and 2017 were considered. Looking at all hail events, there have been 872 events in Idaho. Based on this data, Idaho may experience approximately 13 hail events each year (NOAA NCEI 2017; SPC 2017).

The meteorological processes that produce wind and tornado events are statistically independent of past events. As with other similar natural processes, a return period and probability of future occurrence can be developed from the historical records that are available. Based on historical probability, there is a 100-percent chance that a tornado will occur any given year in Idaho.

Straight-Line Winds

High wind events will occur regularly as part of severe weather events in the State. As noted in the previous occurrences section, high wind events occur annually, and in most cases several times per year across the State. Based on historical record, Idaho has only experienced one major (State and Federal declarations) straight-line wind event since 1956. Looking at all straight-line wind events, between 1950 and 2017, there have been 1,527 wind events. Based on this data, Idaho may experience approximately 23 wind events each year (Storm Prediction Center 2017). However, this number may be greater in the northern portion of the State. Westerly winds are common in the northern part of Idaho, which also has a greater frequency of cyclonic activity (Western Regional Climate Center 2017).

Tornado

Tornadoes occur approximately three times per year in Idaho. Generally these events will be rather minor and will not cause significant damage. Since there have been no major (State and Federal declarations) tornado events in Idaho, the probability of occurrence was calculated using all events that occurred between 1950 and 2017. Based on this data, Idaho may experience approximately three minor tornadoes a year or a tornado once every 0.32 years (Storm Prediction Center 2017).

Environmental Impacts

Lightning

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.

Hail

The loss of crops or livestock due to hail can have far-reaching economic effects (detailed more under "Vulnerability"). Damage to trees from hail or heavy snowfall can have a relatively short-term alteration of the visual landscape, but the long-term recovery of natural resources from these effects is likely.

Wind and Tornadoes

Impacts to vegetation and wildlife from tornadoes and high winds can include damage and death; however, it is unlikely that such events would jeopardize the existence of rare species or vegetative communities throughout the State. The loss of crops or livestock can have far reaching economic effects. Tree blow downs can alter the visual landscape and dramatically change the local vegetation. Fallen trees can create dams, causing flooding upstream and disruption of aquatic habitats. Tornadoes and high winds can damage historic structures, particularly roofs, requiring restoration activities. Tornadoes and high winds are unlikely to impact geologic features; however, soils and farmlands could be impacted, particularly in dry seasons. Blowing dust can impact vegetation and structures. Tornadoes and high winds can temporarily halt recreational activities and damage parks.

Climate Change

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

Climate change is already impacting water resources, and resource managers have observed the following:

- Historical hydrologic patterns can no longer be solely relied upon to forecast the water future;
- Precipitation and runoff patterns are changing, increasing the uncertainty for water supply and quality, flood management, and ecosystem functions; and
- Extreme climatic events will become more frequent, necessitating improvement in flood protection, drought preparedness, and emergency response.

The climate of Idaho is changing. Records have shown that over the past 100 years, the State has seen an increase in temperature of one to two degrees (°F). In the coming years, it is predicted that streams will be warmer, populations of several fish species will decline, wildfires will become more common, deserts may expand, and water may be less available for irrigation (USEPA 2016). Additionally, Idaho may see an increase in the frequency and intensity of some extreme weather such as droughts, floods, frosts, cloudiness, frequency of extreme temperature events, and the intensity of fire and pest outbreaks.

In addition to a warming climate, Idaho has been impacted by El Niño and La Niña. El Niño is a weather pattern that is characterized by unusually warm ocean temperatures along the equator in the Pacific Ocean and has important consequences for weather and climate over the United States. El Niño in general acts to tilt the odds toward wetter and cooler than average conditions across much of the south, and towards drier and warmer conditions in many of the northern regions (FEMA 2016). El Niño typically brings below normal temperatures and less precipitation to Idaho. This can impact the rain and snowfall, impacting the State's water supply (Boise State Public Radio 2015).

La Niña refers to persistent colder than normal sea surface temperatures across the central and eastern equatorial Pacific and brings cooler and wetter weather patterns to the northwest United States. This brings more snow to Idaho during La Niña events; however, as the snow melts, the potential for flooding, ice jams, mudslides, and avalanches increase (Sowell 2017; NOAA 2017).

Much of the water needed for agriculture, public supplies and other uses comes from mountain snowpack, which melts in the spring and summer and runs off into rivers and fills reservoirs. As the climate warms, it is predicted that less precipitation falls as snow and more snow will melt during the winter months. Diminishing snowpack may also shorten ski season and other forms of winter tourism and recreation.

Lastly, National Aeronautics and Space Administration (NASA) scientists suggest that the United States will face more severe thunderstorms in the future, with lightning, damaging hail, and the potential for tornadoes in the event of climate change. A recent study conducted by NASA predicts that "a consensus is emerging: for several types of storms, global warming may prime the atmosphere to produce fewer but stronger storms" (Voiland, 2013).

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.

Hail can have a devastating impact on crops, although the timing of the storm in relation to the maturity of the crop greatly influences the amount of damage.

As long as development trends continue to focus on mitigation measures as they relate to severe storms, increased development may not correlate to an increase in potential losses.

All future development will be affected by severe storms. The ability to withstand impacts lie in sound land use practices and consistence enforcement of codes and regulations for new construction. Land use policies identified in comprehensive plans within a specified jurisdiction may also address many of the secondary impacts (flood, landslide, wildfire, etc.) of severe storm events. Jurisdictions with the capability to plan for and mitigate losses to these secondary hazards, will be well equipped to deal with future growth and the associated impacts of severe storm events.

The threat of wind and tornado events does not appear to have affected the occurrence of development in Idaho. Any new development could be affected by these hazards and will increase the State's vulnerability and potential losses for an event.

An understanding of population and development trends can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The State considered the following factors to examine previous and potential conditions that may affect hazard vulnerability: potential or projected development; projected changes in population; and other identified conditions as relevant and appropriate.

The U.S. EPA’s Integrated Climate and Land-Use Scenarios (ICLUS) project generated projected population and land use projections for the United States through 2100. The project examined multiple scenarios taking into account various population growth and economic development parameters that have been used as the baseline for the Intergovernmental Panel on Climate Change’s (IPCC) Special Report on emissions Scenarios (SRES). Population change took into account assumptions regarding fertility, mortality, and immigration, which was then used to drive the land use projections. The SRES provides two development scenarios: economic development (A) and environmentally driven development (B), where the A scenario will result in more sprawled development, and the B scenario will result in more compact developments close to the existing urban centers. Additionally, the model scenarios included parameters for global development (1) and regional development (2) (EPA, 2013). The model estimated projections for each decade from 2010 to 2100.

The ICLUS scenario 'A2' was selected to examine if changes in land use and housing density estimates from 2010 to 2020 are projected in the severe storm hazard area. The 2010 data was used as a baseline to determine if any changes in development by 2020 may result in increases or decreases in the hazard area. The resulting housing density and land use categories are defined as follows: Urban, which equates to 0.25 acres/unit; Suburban, which equates to 0.25 to 2 acres/unit; Exurban, which equates to 2 to 40 acres/unit; Rural, which equates to 40 acres/unit; Commercial and Industrial.

Table 3.3.V lists the estimated land-use area (square miles) located in the identified landslide hazard area for 2010 and projected area for 2020 by jurisdiction. Due to rounding, the minute changes in land-use area are not reflected in the table. Changes in land-use are seen in the exurban and rural categories. Overall, a decline in exurban and rural area is projected in the severe storm hazard area by 2020, though the difference is negligible (less than 1 square mile combined for both categories). Despite the overall statewide decline, minute increases in Blaine County and Bonner County are projected for exurban areas.

Table 3.3.V. Projected Development Change from 2010 to 2020 in the Wind Power Class 6 and 7 Areas (square miles)

Jurisdiction	Urban			Suburban			Exurban			Rural			Commercial/ Industrial		
	2010	2020	Change	2010	2020	Change	2010	2020	Change	2010	2020	Change	2010	2020	Change
Adams County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bannock County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Blaine County	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Bonner County	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	4.5	4.5	0.0	0.0	0.0	0.0
Bonneville County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Boundary County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	1.7	0.0	0.0	0.0	0.0
Butte County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
Cassia County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0
Coeur d'Alene Tribe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Custer County	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Elmore County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.0	0.0	0.0
Fort Hall Tribe	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.6	2.6	0.0	0.0	0.0	0.0

Jurisdiction	Urban			Suburban			Exurban			Rural			Commercial/ Industrial		
	2010	2020	Change	2010	2020	Change	2010	2020	Change	2010	2020	Change	2010	2020	Change
Idaho County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	3.8	0.0	0.0	0.0	0.0
Kootenai County	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	1.2	1.2	0.0	0.0	0.0	0.0
Lemhi County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.0
Owyhee County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.6	0.0	0.0	0.0	0.0
Shoshone County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1	4.1	0.0	0.0	0.0	0.0
Twin Falls County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Washington County	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0
Idaho Total	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.8**	**0.8**	**0.0**	**20.0**	**20.0**	**0.0**	**0.0**	**0.0**	**0.0**

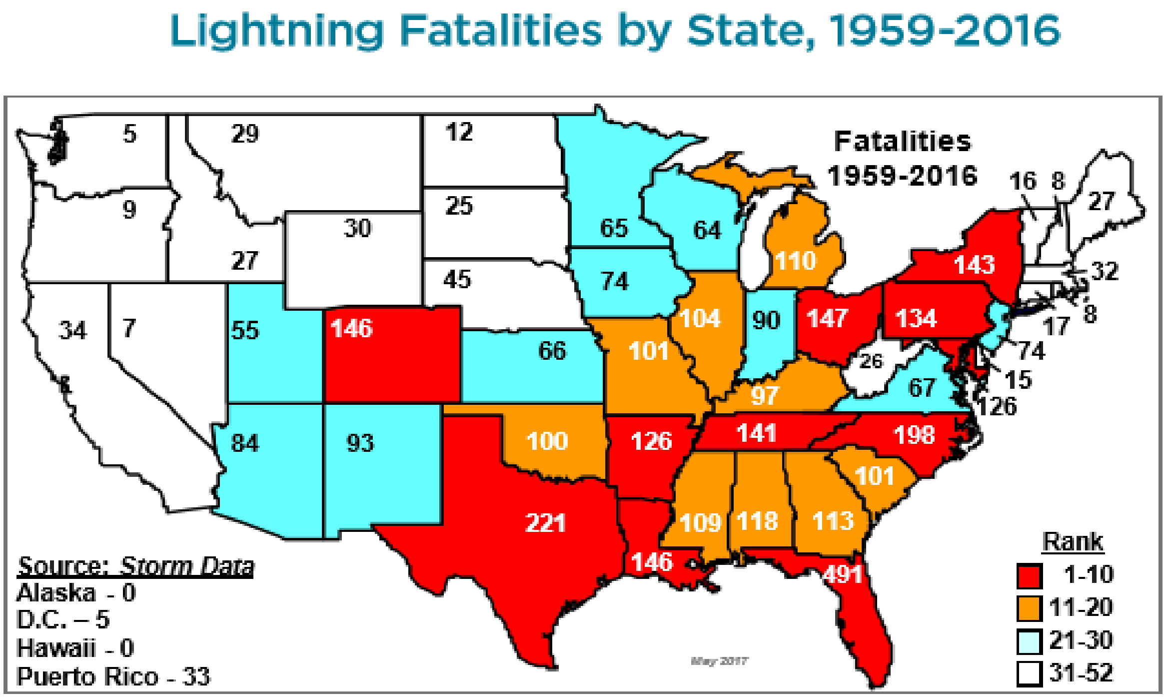
Source: EPA 2013, NREL 2002

Notes: Projected development includes changes in housing density and land use. Only the counties located in the landslide hazard area are listed.

Vulnerability Assessment

Severe storms can be particularly difficult to mitigate for and recover from because of their varied and widespread nature. The rural nature and difficult terrain found in much of the State can make repairs particularly challenging for utility and transportation resources. While Idaho experiences thousands of strikes annually, lightning poses a minimal hazard to most individuals, especially when compared to other States (See Map 3.3.W below). There were, however, 27 fatalities due to lightning in Idaho from 1959 through 2016. In addition, the National Weather Service provided the following historical fatality, injury, and fatality report rates for Idaho based on data from 1959 to 2016 report Deaths per million of the population, per year – 0.47.

Map 3.3.W Lightning Fatalities



Source: http://www.lightningsafety.noaa.gov/stats/59-16_State_Ltg_Fatality+Fatality_Rate_Maps.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.

Based on past events, tornadoes can be expected to occur infrequently, averaging two to three events per year. Most Idaho tornadoes are considered “moderate,” with winds less than 113 miles an hour. A few have had winds up to 130 miles an hour, which are considered “significant.”

Tornadoes in Idaho have usually occurred from March to October, with the majority occurring in June. The majority also occur during the afternoon; between 12:00 and 6:00 p.m. Tornadoes are most often reported in the Magic and Upper Snake River valleys.

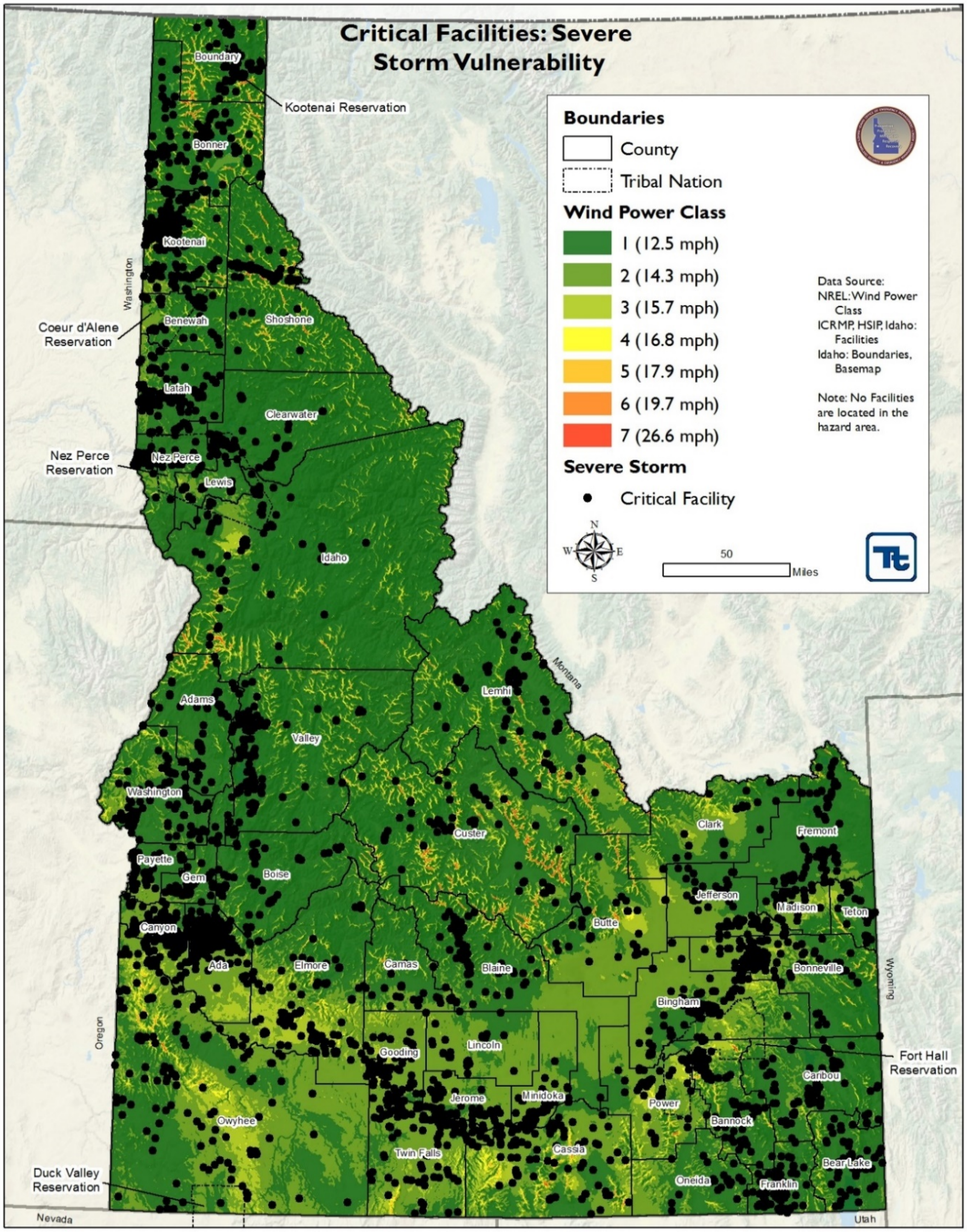
The Disaster Center (www.disastercenter.com) performed a nation-wide risk assessment for tornadoes. The assessment was performed "by dividing the square mileage of each state against the frequency of death, injury, number of tornadoes, and cost of damages for each state. We then rank each State by these individual categories. We then add the total of each State's individual rankings and divided by the number of factors (four). The data used covers the period of 1950 -1995." The results of this assessment have Idaho ranked as the 46th lowest state at risk to tornado.

The National Renewable Energy Laboratory (NREL) has produced a GIS dataset that defines the average annual sustained wind speeds across the State. This data was produced as part of a Wind Power Classification study and the wind speeds are measured at a height of 50 meters. Although a majority of the state facilities in Idaho do not reach this height, it was assumed for the sake of analysis that a higher sustained wind speed at 50 meters would equate to a higher wind speed at the structure level.

Using the NREL data layer, vulnerability analysis was performed on the ICRMP locally owned facilities data. Vulnerability was defined as those regions that were classified as being in the two highest Wind Power Classes (6 or 7), which roughly equates to average sustained wind speeds of 19 MPH or greater (at 50 meters height). The results of this analysis show that none of these facilities fall within those highest wind risk areas. Map 3.3.X presents this information, although it is difficult to visually present structure related information on a State-wide map. Additional details regarding the ICRMP data can be found in the introductory section of this chapter, Section 3.0.

The vulnerability assessment documented above was unable to also provide any loss estimates as they relate to possible State losses for the hazard of wind. None of the ICRMP facilities were located in the wind zones termed of highest risk.

Figure 3.3.X. Critical Facilities: Severe Storm Vulnerability



Note: A vulnerable facility means that the facility is located in the identified hazard area.

Critical Infrastructure and State Facility Impacts

No critical or State facilities in Idaho are completely safe from threat of severe storms. Threats include loss of power and productivity from damages to utilities and transportation corridors to these places of work. 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.

No critical or State facilities in Idaho are completely free of the threat of wind or tornados. Threats include loss of power and productivity from damages to utilities and the means of transportation to these places of work. Wind and tornado events can directly affect these facilities through damage to roofs/structures or falling trees and limbs.

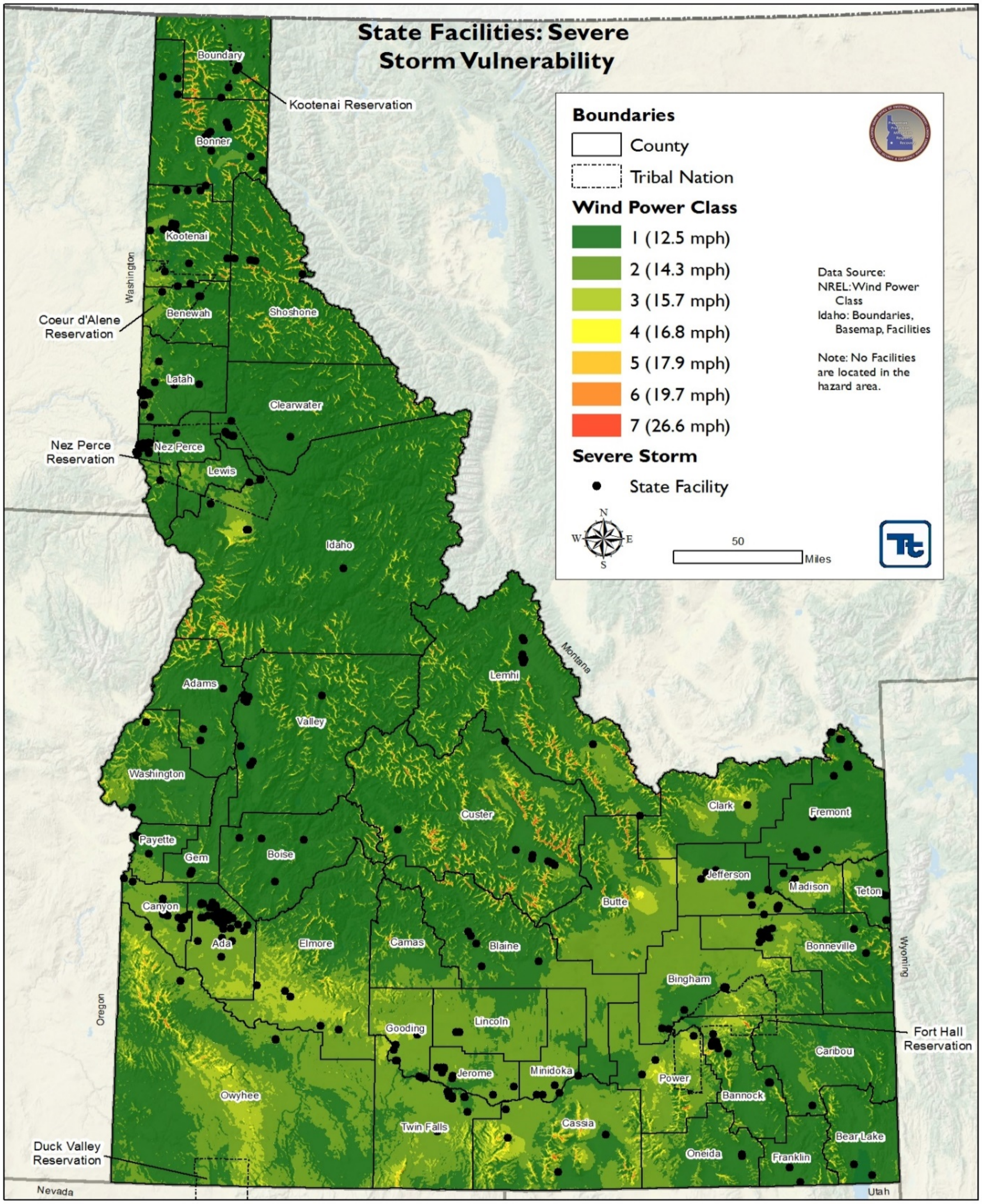
A statewide severe storm analysis was conducted using best available data for the State of Idaho. This section discusses statewide vulnerability of areas susceptible to severe storm and potential losses to state assets (State owned and leased buildings) and critical facilities.

Windstorms often occur in eastern Idaho with power outages as a cascading effect. Economic loss may occur as businesses are without power, phones service, and communications are down and not restored ranging from hours to days. Medical services including hospitals are also impacted as backup generators and fuel are used. Counties should plan for these contingencies especially for windstorms during the winter season.

The National Renewable Energy Laboratory (NREL) has produced a GIS dataset that defines the average annual sustained wind speeds across the U.S. This data was produced as part of a Wind Power Classification study and the wind speeds are measured at a height of 50 meters. Using the NREL data layer, vulnerability analysis was performed on the State owned and leased facilities. The severe storm hazard area was defined by zones that were classified as being in Wind Power Classes 6 and 7, which roughly equates to average sustained wind speeds of 19 MPH or greater (at 50 meters height). Although a majority of the state facilities in Idaho do not reach this height, it was assumed that a higher sustained wind speed at 50 meters would equate to a higher wind speed at the structure level.

For the purposes of this risk assessment, an asset is considered potentially vulnerable if it is located in an identified hazard area. To assess the vulnerability of the State owned and leased facilities, geographic information system (GIS) software was used to overlay the severe storm hazard area with the State owned and leased buildings and critical facilities. The spatial analysis indicates that no State owned and leased facilities are located within the identified severe storm hazard area. Additionally, there are no critical facilities located in the hazard area. Refer to Figure 3.3.Y which illustrates the location of State facilities within the various wind power classes.

Figure 3.3.Y. State Facilities: Severe Storm Vulnerability



Note: A vulnerable facility means that the facility is located in the identified hazard area.

Loss Estimation

No specific, statewide loss estimation exists for the hazard of severe storms. Historical losses are sometimes reported with the resulting flooding or avalanche events that are triggered by severe storms. However, severe storms can also have losses reported uniquely as their own event. Historical losses for lightning tend to be reported with the wildfire events that are triggered by the lightning. Historical losses from wind and tornadoes tend to be related to property damage and loss of life and injury.

From a general perspective, severe storms damage and destroy public, commercial, and private property, including livestock, structures, and infrastructure. Additional costs can stem from snow/debris removal, maintenance, and response. Road and railroad closures are not uncommon. The economic costs of these disruptions can be significant, especially in areas with limited access options.

Tornadoes damage and destroy public, commercial, and private property. The resulting costs are for debris removal, maintenance, repair, and response. The economic costs of these disruptions can be significant, especially in areas with limited access options. Direct costs can be defined as the cost of debris removal, property damage, and response for a specific tornado event. All other costs are indirect and include loss of industrial and commercial productivity as a result of damage to infrastructure, facilities, or interruption of services. As a result, most estimates of loss are far too conservative.

This section discusses the vulnerability of jurisdictions to areas susceptible to severe storms. It provides a summary of vulnerability and potential losses to population and buildings by county and Tribal Nation and discusses the jurisdictions most threatened by the severe storm hazard. Similar to the analysis for state assets, a spatial exposure analysis was conducted using the NREL wind data to determine the population (2010 U.S. Census) and general building stock (default HAZUS-MH 4.0 dasymetric census block data) located in the hazard area. Census blocks with their centroid in the hazard area were deemed exposed and potentially vulnerable. The following summarizes the results of this analysis.

It can be assumed that the State's entire population is exposed to severe storm events. Certain areas are more at risk due to their geographic location and local weather patterns. Populations living at higher elevations with large stands of trees or power lines may be more susceptible to wind damage and loss of utilities, while populations in low lying areas are more at risk to possible flooding which can accompany severe storm events.

While all people located in the severe storm hazard area are considered exposed and potentially vulnerable, populations considered most vulnerable include the elderly (persons over the age of 65) and individuals living below the United States Census poverty threshold. These socially vulnerable populations are most susceptible based on a number of factors including their physical and financial ability to react or respond during a hazard, the location and construction quality of their housing, and the ability to be self-sustaining for prolonged periods of time after an incident because of limited ability to stockpile supplies. Chapter 2 (State Profile) summarizes the State's demographics by jurisdiction.

Table 3.3.Z displays the total population located in the severe storm hazard area. Idaho County has the greatest population count located in the hazard area, and the greatest number of socially vulnerable population in the hazard area. Idaho County accounts for nearly 1/3 of the vulnerable population statewide. Overall, less than 1% of the State's total population is located in the severe storm hazard area. Based on the spatial analysis conducted, the following jurisdictions have population located in the severe storm hazard area: Bonner County, Boundary County, Fort Hall Tribe, Idaho County, Lemhi County and Shoshone County.

Table 3.3.Z. 2010 U.S. Census Population Located in the Wind Power Class 6 and 7 Areas by Jurisdiction

Jurisdiction	Total Population	Population Located in the Severe Storm Hazard Area	Percent (%) of Total Population	Population Over 65 Located in the Severe Storm Hazard Area	Percent (%) of Total Population	Low Income Population Located in the Severe Storm Hazard Area	Percent (%) of Total Population
Ada County	392,365	0	0.0%	0	0.0%	0	0.0%
Adams County	3,976	0	0.0%	0	0.0%	0	0.0%
Bannock County	80,722	0	0.0%	0	0.0%	0	0.0%
Bear Lake County	5,986	0	0.0%	0	0.0%	0	0.0%
Benewah County	4,743	0	0.0%	0	0.0%	0	0.0%
Bingham County	42,775	0	0.0%	0	0.0%	0	0.0%
Blaine County	21,376	0	0.0%	0	0.0%	0	0.0%
Boise County	7,028	0	0.0%	0	0.0%	0	0.0%
Bonner County	40,877	33	<1%	13	0.0%	0	0.0%
Bonneville County	104,234	0	0.0%	0	0.0%	0	0.0%
Boundary County	10,858	50	<1%	6	<1%	5	<1%
Butte County	2,891	0	0.0%	0	0.0%	0	0.0%
Camas County	1,117	0	0.0%	0	0.0%	0	0.0%
Canyon County	188,923	0	0.0%	0	0.0%	0	0.0%
Caribou County	6,963	0	0.0%	0	0.0%	0	0.0%
Cassia County	22,952	0	0.0%	0	0.0%	0	0.0%
Clark County	982	0	0.0%	0	0.0%	0	0.0%
Clearwater County	3,038	0	0.0%	0	0.0%	0	0.0%
Coeur D'Alene Tribe	6,765	0	0.0%	0	0.0%	0	0.0%
Custer County	4,368	0	0.0%	0	0.0%	0	0.0%
Duck Valley Tribe	356	0	0.0%	0	0.0%	0	0.0%
Elmore County	27,038	0	0.0%	0	0.0%	0	0.0%
Fort Hall Tribe	5,769	15	<1%	1	<1%	2	<1%
Franklin County	12,786	0	0.0%	0	0.0%	0	0.0%
Fremont County	13,242	0	0.0%	0	0.0%	0	0.0%

Gem County	16,719	0	0.0%	0	0.0%	0	0.0%
Gooding County	15,464	0	0.0%	0	0.0%	0	0.0%
Idaho County	11,936	55	<1%	18	<1%	9	<1%
Jefferson County	26,140	0	0.0%	0	0.0%	0	0.0%
Jerome County	22,374	0	0.0%	0	0.0%	0	0.0%
Kootenai County	136,271	0	0.0%	0	0.0%	0	0.0%
Kootenai Tribe	114	0	0.0%	0	0.0%	0	0.0%
Latah County	37,244	0	0.0%	0	0.0%	0	0.0%
Lemhi County	7,936	13	<1%	1	<1%	2	<1%
Lewis County	36	0	0.0%	0	0.0%	0	0.0%
Lincoln County	5,208	0	0.0%	0	0.0%	0	0.0%
Madison County	37,536	0	0.0%	0	0.0%	0	0.0%
Minidoka County	20,069	0	0.0%	0	0.0%	0	0.0%
Nez Perce County	34,664	0	0.0%	0	0.0%	0	0.0%
Nez Perce Tribe	18,440	0	0.0%	0	0.0%	0	0.0%
Oneida County	4,286	0	0.0%	0	0.0%	0	0.0%
Owyhee County	11,170	0	0.0%	0	0.0%	0	0.0%
Payette County	22,623	0	0.0%	0	0.0%	0	0.0%
Power County	6,997	0	0.0%	0	0.0%	0	0.0%
Shoshone County	12,765	7	<1%	4	<1%	0	0.0%
Teton County	10,170	0	0.0%	0	0.0%	0	0.0%
Twin Falls County	77,230	0	0.0%	0	0.0%	0	0.0%
Valley County	9,862	0	0.0%	0	0.0%	0	0.0%
Washington County	10,198	0	0.0%	0	0.0%	0	0.0%
Idaho Total	**1,567,582**	**173**	**<1%**	**43**	**<1%**	**18**	**<1%**

Source: US Census 2010, NREL 2002

All property is vulnerable to severe weather events, but properties in poor condition or in particularly vulnerable locations may risk the most damage. Those in higher elevations and on ridges may be more prone to wind damage. Those that are located under or near overhead lines or near large trees may be vulnerable to falling ice or may be damaged in the event of a collapse.

The general building stock inventory was overlaid with the severe storm hazard area to assess vulnerability. Table 3.3.AA lists the number of buildings and total replacement cost by county and Tribal Nation located in the severe storm hazard area. Overall, Bonner County has the greatest building stock exposure to the severe storm hazard area with 55 total buildings at an estimated $29.7 million in replacement cost value. Bonner County's general building stock located in the hazard area accounts for more than 75% of the potentially vulnerable statewide building stock.

Table 3.3.AA. Estimated General Building Stock Located in the Wind Power Class 6 and 7 Areas by Jurisdiction

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value	Number of Buildings Located in the Hazard Area	Percent (%) of Total Buildings	Value Located in the Hazard Area	Percent (%) of Total Value
Ada County	94,345	$67,917,280,000	0	0.00%	$0	0.00%
Adams County	2,824	$768,231,000	0	0.00%	$0	0.00%
Bannock County	16,672	$12,223,383,000	0	0.00%	$0	0.00%
Bear Lake County	3,911	$1,196,118,000	0	0.00%	$0	0.00%
Benewah County	2,456	$698,652,000	0	0.00%	$0	0.00%
Bingham County	6,206	$5,405,079,000	0	0.00%	$0	0.00%
Blaine County	12,602	$5,476,705,000	0	0.00%	$0	0.00%
Boise County	5,475	$1,497,585,000	0	0.00%	$0	0.00%
Bonner County	24,133	$7,701,597,000	55	<1%	$29,709,000	<1%
Bonneville County	21,966	$18,775,427,000	0	0.00%	$0	0.00%
Boundary County	5,112	$1,556,926,000	0	0.00%	$0	0.00%
Butte County	1,127	$452,406,000	0	0.00%	$0	0.00%
Camas County	762	$247,126,000	0	0.00%	$0	0.00%
Canyon County	25,059	$24,048,014,000	0	0.00%	$0	0.00%
Caribou County	2,880	$1,176,048,000	0	0.00%	$0	0.00%
Cassia County	1,389	$3,061,608,000	0	0.00%	$0	0.00%
Clark County	419	$124,419,000	0	0.00%	$0	0.00%
Clearwater County	2,028	$625,216,000	3	<1%	$596,000	<1%
Coeur D'Alene Tribe	3,651	$1,379,028,000	0	0.00%	$0	0.00%
Custer County	2,603	$987,374,000	0	0.00%	$0	0.00%
Duck Valley Tribe	52	$15,524,000	0	0.00%	$0	0.00%
Elmore County	954	$3,778,122,000	0	0.00%	$0	0.00%
Fort Hall Tribe	250	$596,710,000	0	0.00%	$0	0.00%
Franklin County	4,943	$1,742,513,000	0	0.00%	$0	0.00%
Fremont County	8,810	$2,807,781,000	0	0.00%	$0	0.00%
Gem County	7,294	$2,308,168,000	0	0.00%	$0	0.00%
Gooding County	907	$1,934,143,000	0	0.00%	$0	0.00%
Idaho County	4,252	$2,057,570,000	31	<1%	$7,400,000	<1%
Jefferson County	2,127	$3,163,139,000	0	0.00%	$0	0.00%
Jerome County	1,461	$2,620,168,000	0	0.00%	$0	0.00%
Kootenai County	50,322	$22,058,607,000	0	0.00%	$0	0.00%
Kootenai Tribe	50	$13,200,000	0	0.00%	$0	0.00%
Latah County	12,216	$5,264,747,000	0	0.00%	$0	0.00%
Lemhi County	4,833	$1,429,223,000	0	0.00%	$0	0.00%

Lewis County	34	$11,318,000	0	0.00%	$0	0.00%
Lincoln County	156	$629,652,000	0	0.00%	$0	0.00%
Madison County	4,371	$3,682,487,000	0	0.00%	$0	0.00%
Minidoka County	2,141	$2,594,005,000	0	0.00%	$0	0.00%
Nez Perce County	14,271	$6,382,936,000	0	0.00%	$0	0.00%
Nez Perce Tribe	8,389	$2,580,646,000	0	0.00%	$0	0.00%
Oneida County	1,995	$684,026,000	0	0.00%	$0	0.00%
Owyhee County	1,140	$1,258,911,000	0	0.00%	$0	0.00%
Payette County	8,108	$2,900,679,000	0	0.00%	$0	0.00%
Power County	80	$1,011,694,000	0	0.00%	$0	0.00%
Shoshone County	7,056	$2,248,057,000	3	<1%	$1,137,000	<1%
Teton County	5,156	$1,793,082,000	0	0.00%	$0	0.00%
Twin Falls County	17,970	$11,430,233,000	0	0.00%	$0	0.00%
Valley County	11,335	$3,764,632,000	0	0.00%	$0	0.00%
Washington County	4,642	$1,615,788,000	0	0.00%	$0	0.00%
Idaho Total	**420,935**	**247,695,983,000**	**92**	**<1%**	**$38,842,000**	**<1%**

Source: HAZUS-MH v4.0, NREL 2002
Value = Estimated replacement cost of structure and contents

Consequence Analysis Evaluation

On June 8, 2017, a Consequence Analysis Evaluation was conducted aligning with hazards profiled in the State Hazard Mitigation Plan. The assessment was conducted by a diverse planning team comprised of subject matter experts from across the State. This effort mirrored a similar exercise that occurred during both the 2010 and 2013 State Hazard Mitigation Plan updates.

The exercise is intended to provide another way to assess the State's vulnerability to its hazards and was conducted as a group exercise. Participants were asked to individually rank the following systems on a scale from 0 (no consequences) to 5 (most severe consequences), separately evaluating both the short-term (0-6 month) and long-term (6+ months) consequences of the scenario.

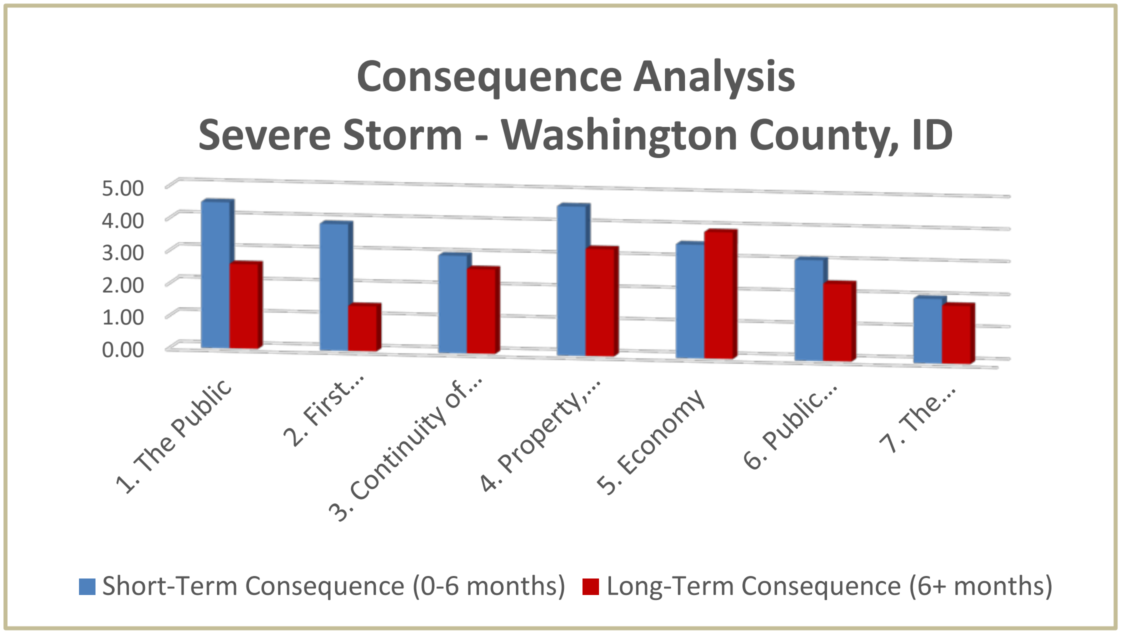
Systems Evaluated:

- The public
- First responders
- Continuity of operations
- Property, facilities, and infrastructure
- Economic conditions
- Public confidence in government

Scenario

January: Between December 22 and January 19, over 45 inches of snow fell in Washington County and surrounding counties in Idaho. More than 100 building roofs have collapsed in the area, including a grocery store, a bowling alley and several onion storage facilities. One death has been reported when a woman was trapped when the roof of her house collapsed under the extreme weight of the snow.

Results



Looking at the short-term consequences of this severe storm event, exercise participants felt that the most severe consequences would be felt by the built environment, the public, and first responders. From a long-term standpoint, the two systems suffering the most severe consequences include the economy and the built environment. Overall, what stands out is that the economy is expected to experience greater impacts long-term (as compared to short-term), whereas all other systems are expected to have greater short-term consequences.

Some observations of the group to note included:

- Depending on the season, this event could initiate a number of other hazards, including flooding, mudslides, landslides, ice jams, and avalanches.
- Consequences to the onion industry would be regional.
- Regional transportation and commerce could also be greatly affected by this event.
- Building code updates and awareness are thought to have reduced the consequences from this event as compared to years past.
- Economic impacts could include both shelter roof collapses as well as missed crop plantings.

Mitigation Rationale

Lightning

Lightning is the fourth most deadly weather phenomenon in the U.S., following heat, floods, and tornadoes. On average (30-year avg), 44 deaths per year are attributed to lightning nationally (NOAA, 2017).

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.

Typical injuries include external burns, numbness/paresthesia, 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 those engaged in recreation or outdoor 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. Education programs such as statistics, public service announcements, and safety tips are a way to mitigate against lightning.

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.

Wind and Tornadoes

Two types of significant wind hazards are possible in Idaho, straight-line winds and tornadoes. Both are generally associated with severe thunderstorms.

Lesser, similar wind events (such as “dust devils”) may occur during small storms and even during clear weather, but they generally do no damage. Strong winds are also often associated with dramatic atmospheric pressure differentials across weather fronts. These winds may be accelerated by terrain features such as canyons and mountain passes, where they can reach high speeds. Although they may contribute to the overall impact of a storm, they are rarely damaging by themselves.

Tornadoes often cause injury and death. There are, on average, about 60 tornado related deaths per year in the United States. Severe property damage is also caused by tornadoes, with average annual losses estimated at around $1.1 billion nationally. Buildings with large surface areas and those that are not structurally sound are most susceptible to tornado damage. Nearly 40 percent of all tornado fatalities take place in mobile homes. Automobiles and other vehicles, including train equipment and aircraft, are vulnerable to tornado damage. Loss of utilities (primarily due to fallen trees) is common following tornadoes and, depending on circumstances, communities might be deprived of almost any kind of goods and services including food, water, and medical care. Crop and livestock loss is also possible, as is loss of timber production.

The impacts of straight-line winds are virtually the same as those from tornadoes with similar wind speeds. The damage is distinguishable from that of a tornado only in that the debris is generally deposited in nearly parallel rows. Downbursts are particularly hazardous to aircraft in flight. One report (http://www.colorado.edu/hazards/awards/paper-competition/walker_grad.pdf) covering the 18-year period from 1986 through 2003 attributed 153 deaths and 2,605 injuries to derechoes (a type of straight-line wind) nationally. This report also estimated the economic loss from a single derechoes event on May 31, 1998, which struck the States of Michigan, Minnesota, and Wisconsin at nearly $0.5 billion. In the areas around Twin Falls County (U.S. Highway 93) and Cassia County (U.S. I-84), anecdotal information indicates that there have been fatalities along both of these corridors attributable to straight-line winds.

General Mitigation Approaches

Lightning

Mitigation of thunderstorms to include lightning and hail 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 IOEM is assigned general responsibility for coordinating mitigation for all hazards.

Hazard Management

Some ways to manage lightning and reduce vulnerability are:

- weather spotter training.
- Safety awareness.
- Evacuation of large outdoor sports venues upon lightning sighting.

Public Outreach and Education

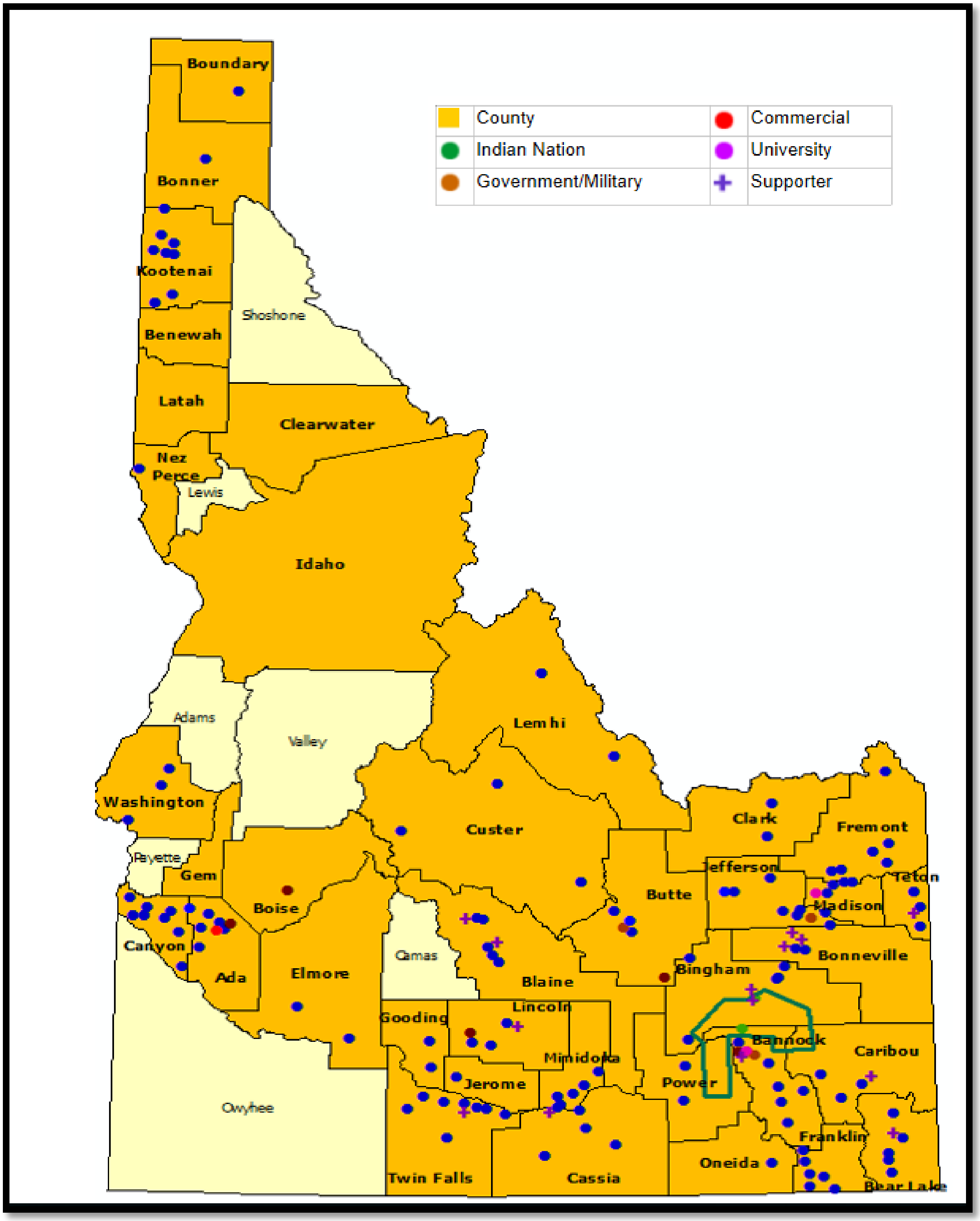
The National Weather Service website (https://www.weather.gov/safety/lightning) offers lightning safety tips and other resources to help educate the public.

- Lightning Safety Brochure
- Statics of U.S. Lightning Deaths
- YouTube videos: Lightning Safety for the Deaf and Hard of Hearing, Lightning Safety Tips and Don't Catch the Big One: PSA1, PSA2
- Games for kids and resources for teachers.

Idaho also participates in Lightning Safety Awareness Week, the same time as the National Safety week which is typically the last week of June. National Lightning Safety Awareness week was started in 2001 to call attention to this underrated killer. Since then, U.S. lightning fatalities have dropped from about 50 per year to about 30. This reduction in fatalities is largely due to greater awareness of the lightning danger, and people seeking safety when thunderstorms threaten. (National Lightning Safety Council 2018).

An area may be less vulnerable if it participates in the NWS "StormReady" Program. There are presently 37 counties, 130 communities, and nine government sites that have StormReady status within Idaho (https://www.weather.gov/stormready/id-sr). These numbers have increased from those reported in the 2013 State Plan, similarly to the increase observed between the 2013 and 2010 Plans. In addition, one Indian Nation, two universities, one commercial site, and fifteen supporting entities (e.g., an airport or news broadcaster) have StormReady status. Map 3.3.BB illustrates the number and location of jurisdictions that have attained StormReady status.

Map 3.3.BB. Idaho Storm Ready Status.



Source: NOAA Stormready website https://www.weather.gov/stormready/id-sr

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 (https://www.weather.gov/stormready/id-sr).

Regulatory

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).

Other mitigation strategies conducted in Idaho are:

- Lightning rods for grounding and structure safety
- Creating fuel breaks for reduction of fuels in the event of lightning caused wildfires
- Monitoring lightning strike areas for identification of additional mitigation efforts
- Lightning detecting and monitoring for airport operations
- Backup generators and power supply in critical facilities for lightning strike caused power outages

Wind and Tornadoes

Hazard Management

Structures in wind hazard areas should be designed and built to withstand the projected wind speeds. Wind resistant construction techniques include proper anchoring of walls to foundations, use of hurricane straps and clips to hold the roof of a structure to its walls, and lateral roof and wall bracing. Manufactured and mobile homes, in particular, need anchoring. Structural retrofitting of existing structures can reduce damages; particular concern should be given to the roof, windows, doors, and anchoring to the ground or foundation. In areas of very high hazard, hardened “safe roofs” can be constructed for shelter during events.

Information/Outreach and Public Education

In areas that have not seen recent wind events, the hazard may be seriously undervalued. Many residents and property owners may be unaware that their lives and properties are in high-risk areas. Residents and property owners should be informed of known wind hazards and educated in mitigation techniques. Manufactured and mobile homes is high-risk areas should be specifically targeted by education efforts. High wind advisories and warnings are issued by the National Weather Service. The Idaho Transportation Department has wind advisory signs along main high wind hazard transportation corridors, as well as reader boards for various hazard warning messages. Lakes and Reservoir recreation areas that are susceptible to high wind hazards receive wind advisories and high wind warnings. Red flag warnings are issued by the National Weather Service which are a combination of relatively low humidity and strong winds.

Regulatory

Wind susceptible critical facilities should not be placed in high-risk areas. Adoption and enforcement of wind resistant building codes and construction standards can significantly reduce damages caused by high winds. Manufactured and mobile homes should be restricted, or sufficient anchoring should be required, in very high-risk areas.

In Idaho, Idaho Code 39-4109 permits cities to adopt and amend the Building Codes that have been adopted by the Idaho Building Code Board, so not all cities have the same standard building codes.

Wind mitigation retrofit projects are defined as modifications to the elements of a building to reduce or eliminate the risk of future wind damage and to protect inhabitants. These programs comply with local, State, or national building codes, standards, and regulations—such as the IBC, the FBC, and the ASCE and ASTM standards—for structural retrofits. (https://www.fema.gov/media-library-data/20130726-1753-25045-5423/ch5_804.pdf). FEMA Hazard Mitigation Assistance funding requires compliance with ASCE standards which will improve structure resiliency to hazards.

Nonstructural retrofitting can also be effective at reducing damages (and will mitigate seismic hazards). Examples of nonstructural retrofitting include anchoring loose objects (potential missiles) and water heaters, removing trees from the immediate vicinity of the house, securely anchoring outbuildings and other outdoor objects, and installing plastic film on windows and doors to minimize the impact of shattering glass. Other nonstructural methods might include both natural vegetation and engineered windbreaks, which would serve in all seasons (i.e., snow fences). Blowing dust caused from high winds limits visibility and can cause transportation corridor closures. Mitigation efforts to reduce blowing dust include additional safety signs, living windbreaks, and agriculture practices to reduce erosion.

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