CHAPTER 3.4
RISK ASSESSMENT: AVALANCHE

3.4 Risk Assessment: Avalanche

Description

Soldier Avalanche, January 29, 2010.

Crown of avalanche that resulted in a fatality. Estimated to be 300 ft wide and 2-3 ft deep, running on facets near the ground. Source: IOEM

An avalanche is a slope failure composed of a mass of rapidly moving, fluidized snow that slides down a mountainside. The flow can be composed of ice, water, soil, rock, and trees. The amount of damage depends on the type of avalanche, the composition and consistency of the material contained in the avalanche, the velocity and force of the flow, and the avalanche path.

The slope failure associated with an avalanche is caused by several factors, but primarily by large accumulations of snow on a steep slope. Avalanches occur on slopes averaging 25 to 50 degrees, and the majority is on slopes between 30 and 40 degrees. They are triggered by natural seismic or climatic factors such as earthquakes, thermal changes, and blizzards, or by human activities.

The most common types of avalanches are loose-snow and slab avalanches. A **loose-snow avalanche** is composed of dry, fresh snow deposits that accumulate as an unstable mass atop a stable snow and slick ice sub-layer. A loose-snow avalanche releases when the sheer force of its mass overcomes the underlying resistant forces of the cohesive layer.

A **slab avalanche** generally is composed of a thick, cohesive snowpack deposited or accumulated on top of a light, cohesion-less snow layer or slick ice sub-layer. At the starting surface or top of the slab, a deep fracture develops in the slab of well-bonded, cohesive snow. A slab avalanche release is usually triggered by turbulence or impulse waves. Release also occurs when the internal cohesive strength of the slab layer is greater than the bonding at the base and lateral slab boundaries. As a release occurs, the slab accelerates, gaining mass and speed as it travels down the avalanche path.

An **avalanche path** is determined by the physical limitations of the boundaries of the local terrain and man-made features. An avalanche may follow a path along a channelized or confined terrain, similar to debris flows or streams, before spreading onto alluvial fans or gentle slopes. The avalanche path itself varies in width as it transitions along the path, depending on the confinement of the terrain and the velocity of flow. An avalanche path is described as having three specific transition zones:

- The **Starting Zone** is typically located near the top of the ridge, bowl, or canyon, with steep slopes of 25 to 50 degrees;
- The **Track Zone** is the reach with mild slopes of 15 to 30 degrees and the area where the avalanche will achieve maximum velocity and considerable mass; and
- The **Runout Zone** is the area of gentler slopes (5 to 15 degrees) located at the base of the path, where the avalanche decelerates and massive snow and debris deposition occurs.

Figure 3.4.A Sawtooths Wet Loose, April 12, 2017.

Source: USFS, 2017

When avalanche material is deposited in the Runout Zone, it tends to harden quickly. Even very light avalanches of powdery, dry snow can form concrete-like masses after being "worked" by the mechanical forces involved in the slide. Victims are rarely able to extract themselves from even very shallow burials.

Location, Extent, and Magnitude

Avalanche activity is considered to be localized in the State and is most likely to occur in areas that have an avalanche starting zone slope of 25 to 50 degrees. The counties most prone to reported damaging avalanches are Bonner in the northern panhandle, Blaine and Camas in central Idaho and Bonneville, Fremont and Teton in the eastern portion of the State.

Avalanches can close transportation routes in mountainous areas, although damage and loss of life are rare. The 9-mile section of Highway 21 between Grand Junction and Banner Summit, called Canyon Creek, has 54 avalanche chutes and experiences about 90 percent of the highway-impacting avalanches in the State. Other transportation routes impacted by avalanches include Teton Pass on Highway 33/ WYO 22 in Teton County, US 12/Northwest Passage Scenic Highway between mile markers 125-174, and Highway 75 between Stanley and Salmon. No other critical infrastructure at risk in the State appears to be significant.

Several classification systems are used throughout the world in rating hazards and conditions associated with avalanches. In the United States, a five-level scale is used to classify the size of an avalanche, as shown in Table 3.4.B.

Table 3.4.B. United States Classification for Avalanche Size

Size	Destructive Potential
1	Sluff or snow that slides less than 50m (150 feet) of slope distance
2	Small, relative to path
3	Medium, relative to path
4	Large, relative to path
5	Major or maximum, relative to path

Source: www.avalanche.org, 2017

Impacts

Severity

Property damage associated with avalanches is a function of several factors. Large external lateral loads can cause significant damage to structures and fatalities. Table 3.4.C indicates the estimated potential damage for a given range of impact pressures. The measurement kPa represents the kilopascal (kPa) of 1,000 newtons per square meter. For example, standard atmospheric pressure (or 1 atm) is defined as 101.325 kPa.

Table 3.4.C. Avalanche Impact Pressures Related To Damage

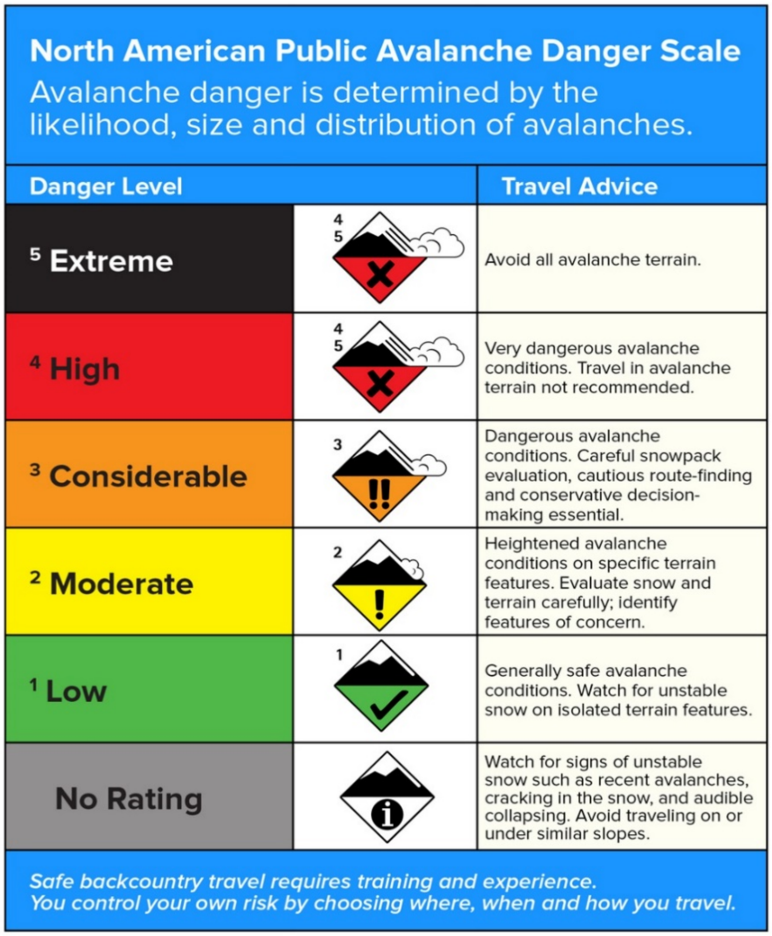
Impact Pressure		
Kilopascal (kPa)	Pounds per Square Foot (lbs/ft2)	Potential Damages
2-4	40-80	Break windows
3-6	60-100	Push in doors, damage walls, roofs
10	200	Severely damage wood frame structures
20-30	400-600	Destroy wood-frame structures, break trees
50-100	1000-2000	Destroy mature forests
>300	>6000	Move large boulders

Source: www.avalanche.org, 2017a

Warning Time

The North American Avalanche Danger Scale is a tool designed to facilitate communication of potential avalanches between avalanche forecasters and the public. It is used by regional avalanche forecast centers in the United States. As of 2010, the United States and Canada adopted and use this avalanche danger scale. As seen in Figure 3.4.D, the categories represent the probability of avalanche activity and recommended travel precautions.

Figure 3.4.D North American Public Avalanche Danger Scale



North American Public Avalanche Danger Scale
Avalanche danger is determined by the likelihood, size and distribution of avalanches.

Danger Level		Travel Advice
5 Extreme	4 5	Avoid all avalanche terrain.
4 High	4 5	Very dangerous avalanche conditions. Travel in avalanche terrain not recommended.
3 Considerable	3	Dangerous avalanche conditions. Careful snowpack evaluation, cautious route-finding and conservative decision-making essential.
2 Moderate	2	Heightened avalanche conditions on specific terrain features. Evaluate snow and terrain carefully; identify features of concern.
1 Low	1	Generally safe avalanche conditions. Watch for unstable snow on isolated terrain features.
No Rating		Watch for signs of unstable snow such as recent avalanches, cracking in the snow, and audible collapsing. Avoid traveling on or under similar slopes.

Safe backcountry travel requires training and experience.
You control your own risk by choosing where, when and how you travel.

Source: www.avalanche.org, 2017

Relationships to Other Hazards

Secondary Impacts

Locations of past avalanche paths do have the ability to increase the immediate area's susceptibility to future landslides and flooding, due to the removal and transport of trees, vegetation, and other ground materials.

The damaging effects of avalanches may be widespread or limited, depending on the factors which provoked them. A localized incident can have consequences beyond its immediate surroundings; notably when communication links such as roads and railways are interrupted or infrastructure is destroyed (critical facility, electric grids, power lines, telecommunication networks, water or gas pipelines) and an energy shortage occurs.

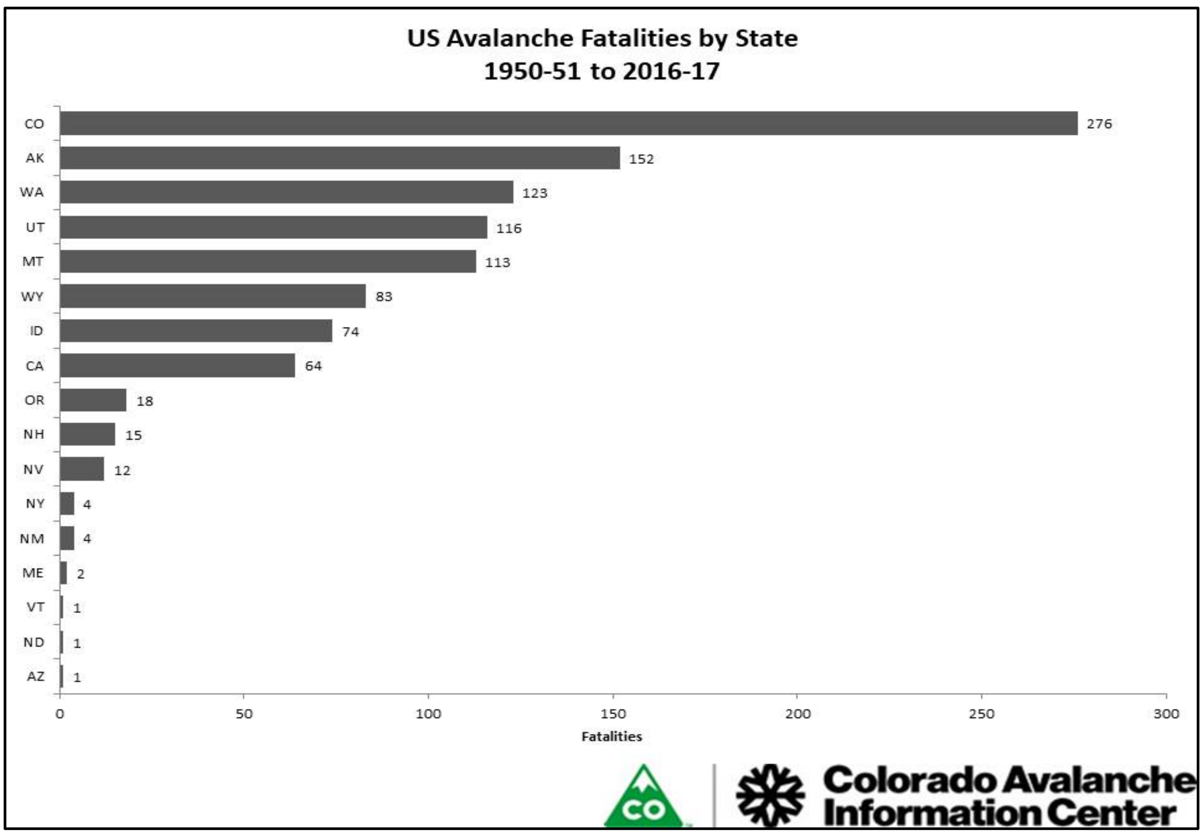
Past Occurrence

Avalanches are unique to mountainous terrain. In the 19th and early 20th century, mining and transportation-related activities (e.g., railroad construction and travel) accounted for a majority of the damages and casualties from avalanche events. Few individuals not engaged in these activities found themselves in hazardous locations. Subsequent reductions in backcountry mining activity and improvements in transportation-related avalanche safety such as use of signs and highway warnings, led to a decline in avalanche damages and casualties.

In the latter half of the 20th century, recreational use increased in the mountainous backcountry in the winter. Skiers, snowboarders, hikers, and snowmobilers, now account for nearly all avalanche casualties. In almost all cases, avalanche victims or their parties trigger the slides that catch them, and the vast majority of these occur outside of avalanche-patrolled and controlled areas

According to the Colorado Avalanche Information Center (CAIC), from 1950 through 2017, Idaho ranked the 7th most fatalities compared to other states (see Figure 3.4.E).

Figure 3.4.E. Past Avalanche Fatalities



Source: CAIA, 2017

Snowmobiling is currently the leading cause of avalanche fatalities in Idaho. Backcountry skiing/snowboarding, snowshoeing, and cross country skiing also involve serious avalanche risk. Slab avalanches account for almost all avalanche fatalities.

It is impossible to determine how many avalanches of all sizes occur in the State each year. Small avalanches occur throughout the winter and spring with no damage. Typically, avalanche activity that does not result in serious injury, death, or significant property damage is not reported. However, in 2004, a large avalanche buried two individuals in their home near the Soldier Ski Resort in Camas County.

The U.S. Avalanche Accidents Database, records avalanche activity resulting in injuries or losses in Idaho. Table 3.4.F includes events discussed in the 2013 Plan and is updated with avalanche events between January 1, 2012 and October 1, 2017.

Table 3.4.F. Avalanche Events in Idaho, 1999 - 2017

Date(s) of Event	Event Type / Location	Counties Affected	Description
February 9, 1999	Avalanche Town of Hailey	Blaine	3 houses damaged by avalanche
February 10, 1999	Avalanche Town of Hailey	Blaine	Park damaged, deer herd killed
February 20, 1999	Avalanche Portneuf Range Caribou National Forest	Bannock	1 skier caught and injured
January 22, 2000	Avalanche Clark Lake, near Lionhead Peak	Fremont	1 snowmobiler caught, buried and severely injured
January 28, 2000	Avalanche Smokey Mountains, near Sun Valley	Blaine	1 skier caught, totally buried, recovered with beacon
February 19, 2000	Avalanche St. Charles Canyon, near Bear Lake	Bear Lake	2 snowmobilers caught, 1 buried and killed
March 19, 2000	Avalanche Selkirk Mountains, west of Bonners Ferry	Boundary	1 snowmobiler caught and killed
March 12, 2002	Avalanche Grove Creek, near Victor	Teton	1 snowmobiler caught, buried, and killed
March 22, 2002	Avalanche East Fork of Targhee Creek	Fremont	1 snowmobiler caught, buried, and killed (wearing a transceiver)
December 14, 2002	Avalanche Central Idaho	Lewis	2 backcountry skiers caught and buried in separate accidents
December 19, 2002	Avalanche Steve Baugh Bowl, Jedediah Smith Wilderness	Teton	1 skier caught, buried, and rescued with transceiver
December 28, 2002	Avalanche Trinity Mountain area, west of Fairfield	Camas	2 snowmobilers caught and buried, 1 killed
January 4, 2003	Avalanche Darby Canyon	Teton	1 snowmobiler caught, carried, and injured

Date(s) of Event	Event Type / Location	Counties Affected	Description
February 22, 2003	Avalanche Echo Bowl near Priest Lake	Bonner	5 snowmobilers caught, 1 buried and killed
February 22, 2003	Avalanche Near Keokee Lake, NW of Schweitzer Mountain Resort	Bonner	1 backcountry skier caught buried and killed
January 2, 2004	Avalanche Soldier Mountain, near Soldier Mountain Ski Resort	Camas	House struck by an avalanche, 2 people buried and killed
February 28, 2004	Avalanche Apollo Creek, approx. 15mi NW of Ketchum	Blaine	1 snowmobiler caught, buried, and killed
March 7, 2004	Avalanche Jeru Peak, approx. 20mi N of Sandpoint	Bonner	1 snowmobiler caught, buried, and killed
January 16, 2005	Avalanche Lake Steven Area	Custer	2 snowboarders, caught, buried, and killed
March 25, 2005	Avalanche Galena Summit	Blaine	1 backcountry skier caught and seriously injured
March 30, 2005	Avalanche Fisher Creek drainage near Slab Butte	Adams	1 snowmobiler caught and buried. Rescued with beacon.
April 1, 2005	Avalanche Brodie Gulch, Baker Creek near Ketchum	Blaine	1 snowmobiler caught, buried, and killed
July 2, 2005	Avalanche Castle Peak, White Cloud Mountains	Custer	1 snowboarder caught, buried, and killed
March 1, 2006	Avalanche Mountains near Antelope Creek	Bonneville	1 snowmobiler caught, buried, and killed
April 2, 2006	Avalanche Mountains outside Spencer	Clark	2 snowmobilers caught, 1 killed
April 8, 2006	Avalanche Patriot Bowl, W of Trinity Mountain Lookout	Elmore	1 snowmobiler caught, buried, and killed
April 29, 2006	Avalanche Backcountry near Lookout Pass	Shoshone	1 skier caught, buried, and killed
February 17, 2007	Avalanche Palisades Peak Area	Bonneville	3 snowmobilers caught, 2 partially buried, 1 buried and killed
March 10, 2007	Avalanche Apollo Creek in the Baker Creek drainage	Blaine	1 snowmobiler caught, buried, and injured
February 8, 2008	Avalanche Garden Valley	Boise	1 killed when house struck by avalanche, Roof cave in
March 16, 2008	Avalanche Sheep Mountain on the North Fork Clearwater River	Clearwater and Shoshone	4 snowmobilers caught, 2 buried, 1 killed
February 24, 2009	Avalanche Trinity Mountains near Featherville	Elmore	1 snowmobiler caught, buried, and rescued
February 27, 2009	Avalanche Trapper Creek, N of Priest Lake	Bonner	1 snowmobiler caught, buried, and injured

Date(s) of Event	Event Type / Location	Counties Affected	Description
March 1, 2009	Avalanche Duck Lake area, N of Brundage Mountain ski area	Idaho	1 snowmobiler caught, carried, and seriously injured
March 6, 2009	Avalanche Black Lee Drainage, 7mi NE of McCall	Valley	4 skiers caught, 2 buried, 1 injured
March 6, 2009	Avalanche Gladiator Ridge, 20mi NW of Sun Valley	Blaine	2 skiers caught, 1 buried and killed, 1 seriously injured
April 5, 2009	Avalanche Norton Creek, 20m W of Ketchum	Blaine	1 snowmobiler caught, buried, and killed
December 18, 2009	Avalanche Rock Lake, W of Cascade	Valley	2 snowmobilers caught, 1 buried and killed, 1 fully buried and rescued
January 22, 2010	Avalanche Sun Valley Ski Resort, off trail run in bounds	Blaine	1 skier caught, buried, and killed
January 28, 2010	Avalanche Boardman Pass, Soldier Mountains W of Fairfield	Camas	1 snowmobiler caught, buried, and killed
January 30, 2010	Avalanche Garns Mountain in the Big Hole Range, W of Driggs	Teton	1 snowmobiler caught, buried, and killed
March 13, 2010	Avalanche North of Schweitzer Ski Area, Idaho Panhandle	Bonner	1 snowmobiler caught, buried, and killed
March 30, 2010	Avalanche Near Brundage Mountain	Valley	3 snowmobilers caught, 2 buried and killed
December 29, 2010	Avalanche Big Creek, NE of Calder	Shoshone	1 snowmobiler caught, buried, and killed
December 26, 2013	Avalanche Neely's Cove near Palisades Peak	Bonneville	1 snowmobiler caught, buried, and killed
February 16, 2014	Avalanche Frenchman Creek, northwest of Galena Summit	Blaine	4 snowmobiles caught and buried, 1 killed
January 31, 2016	Avalanche Twin Lakes near Brundage Mountain	Valley	1 snowmobiler caught and killed
February 26, 2016	Avalanche Island Park	Fremont	3 residents buried, 1 killed
February 9, 2017	Avalanche McCoy Creek, Caribou Range east of Idaho Falls	Bonneville	1 snowmobiler caught, buried, and killed

Sources: Atkins, D 2017; CAIA 2017

FEMA Disaster Declarations

Between 1954 and 2017, FEMA has not included avalanche in major disaster (DR) or emergency (EM) declarations (FEMA 2017). Based on all sources researched, known avalanche events that have affected Idaho and were declared a state and/or FEMA disaster, are identified in Table 3.4.G. This table provides information on the one state disaster declarations for avalanche, including date of event, state disaster declaration, and counties affected.

Table 3.4G. Flooding, Landslides, and Avalanche-Related State and Federal Declarations (1954 to 2017)

Year	Date	State	Federal	Counties Affected	Comments
2017	March 10 - 29, 2017	ID-02-2017	None	Clearwater, Benewah, Bonner, Kootenai, Latah, Shoshone, Boundary, Idaho, Lewis, Valley	Beginning on February 10, 2017, the effects of extraordinary flooding caused by warmer temperatures, rain and rapid snow melt were experienced within the State of Idaho.

Note: FEMA-DR-4313 occurred from this state declaration, but FEMA did not include the avalanche hazard.
Source: Idaho Emergency Management 2017; FEMA 2017

Future Occurrence

Probability

In the mountains of Idaho, many avalanches occur each winter. Idaho is in the top 10 states in the nation in the number of avalanche fatalities since 1950.

The geophysical processes that contribute to avalanches during a particular year are statistically independent of past events. Avalanche occurrence is not directly attributed to a specific major meteorological event, but it is more commonly a result of a combination of three factors: weather, snow pack, and terrain. Weather and the height of the snow pack are the most important factors when deciding whether avalanches are likely to happen. From the weather the temperature, wind speed, and wind direction are important to watch. With a quick change in any of the weather dynamics an avalanche could be expected. For example, if the temperature were to have a rapid increase then a wet slab avalanche is likely to occur.

It can reasonably be assumed, based on historical recorded events of injuries and losses from 1998 through 2017 that an avalanche can occur an average of 2-3 times per year. There is a 100-percent chance that an avalanche will occur in any given year in Idaho.

Currently, there are three avalanche centers (Coeur d'Alene, McCall, and Sun Valley) in the State that make observations and collect data regarding this hazard. Recent historical levels of avalanche events may be expected to continue. Based on the recorded fatalities due to avalanche in the State, Idaho will continue to be rated as having a moderate severity of avalanche hazard relative to other states.

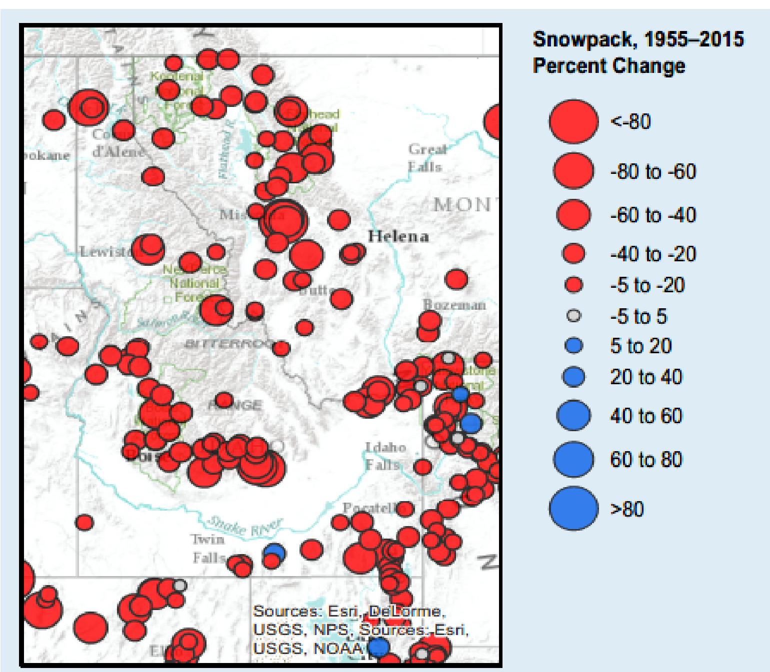
Environmental Impacts

Avalanches have minor environmental impacts compared to most other hazards. Large amounts of debris are often carried by avalanches and can be left in freshly scoured gullies. Trees may be broken due to the excessive force of the onrushing snow. Temporary dams can form, blocking the flow of rivers and streams and remaining as a threat to the downstream natural and built environment. Accumulated debris could potentially cover historic and archeological resources. It is unlikely that the continued existence of rare species or vegetative communities would be jeopardized by avalanches, because of the localized nature of the hazard.

Climate Change Impacts

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. Records have shown that over the past 100 years, the State has seen an increase in temperature of one to two degrees (°F). That has led to a trend in declining snowpack, especially in south-central Idaho (see Figure 3.4.H). Warmer temperatures can weaken snowpack and make it more difficult for the layers of snow to stick together. When combined with wind gusts or an earthquake, warmer temperature increases the possibility of an avalanche. The changing temperature has affected the quality of mountain snow cover, which is believed to have led to more frequent avalanches. (Erickson 2017).

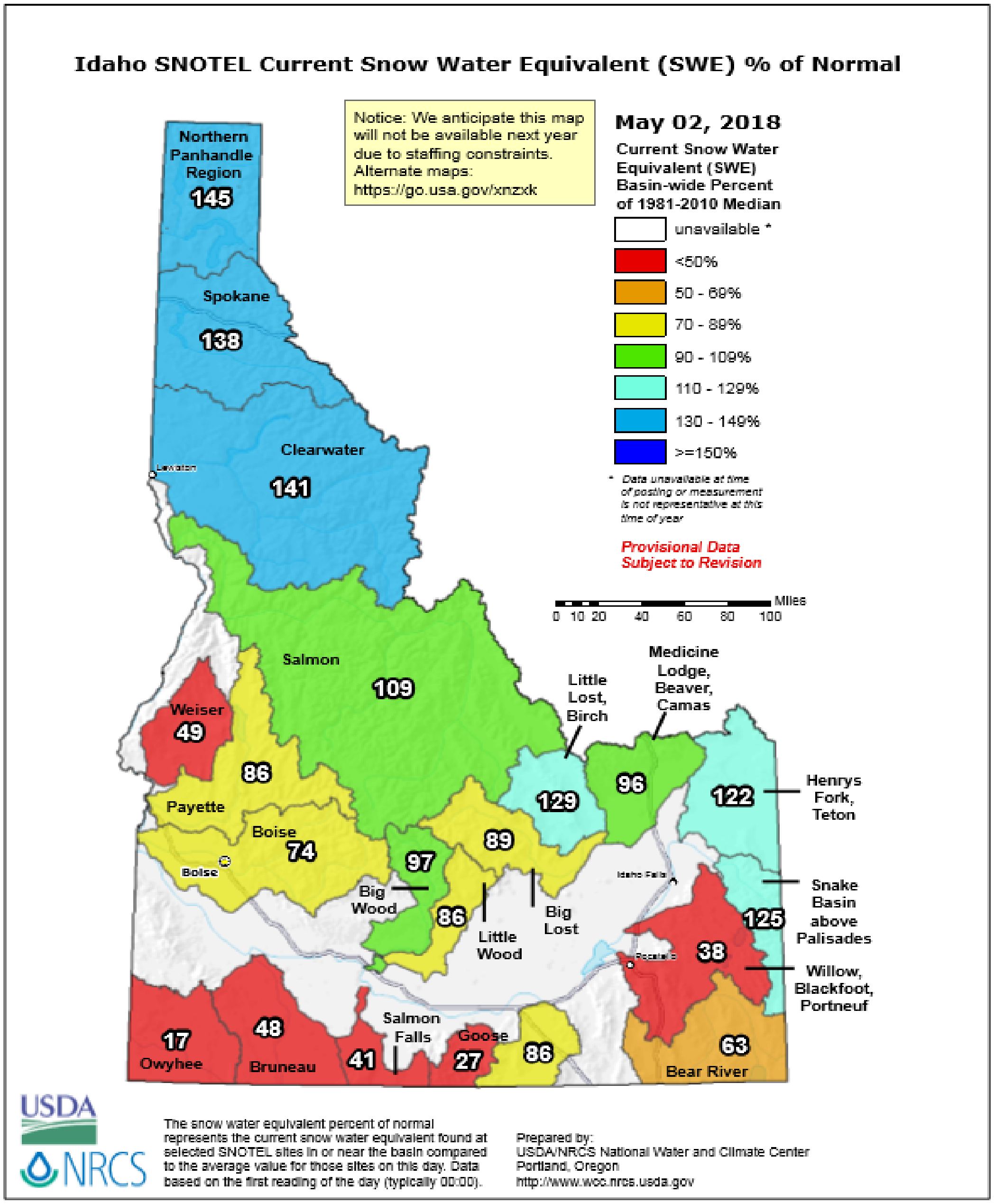
Figure 3.4.H Snowpack Percent Change in Idaho, 1955-2015



Source: USEPA 2016

While some years there is even above normal snowpack, especially in the northern part of the state, there is an overall declining trend in the south and south-central Idaho, as seen in Figure 3.4.I.

Figure 3.4.I. Idaho Snow Water Equivalent (SWE) % of Normal



Source: https://www.wcc.nrcs.usda.gov/ftpref/data/water/wcs/gis/maps/id_swepctnormal_update.pdf

Development Trend Impacts

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. Map 2.F. in Chapter 2 (State Profile) displays the projected population growth by 2026. Though population growth may not directly increase the number of people living in areas susceptible to avalanches, the increase in population may lead to more individuals utilizing winter recreational facilities and mountainous areas that are more prone to avalanche events.

Avalanches begin in areas that have slopes of 25 to 50 degrees, which are usually too steep for high-density development. However, because avalanches reach maximum velocity in the track zone and maximum deposition in the runout zone, where slopes range from 5 to 30 degrees, such areas could support higher density development. It is important to note that land in these zones would have to lie directly beneath areas that would be characterized as a starting zone. Development of new or expansion of existing ski resorts could place structures in these areas of greatest risk. Analysis of the historical data indicates relatively little property damage (five houses destroyed in 59 years of record) and does not indicate that as more development is occurring, more houses are destroyed. The increasing trend in loss of life suggests that more people are found in areas prone to avalanche occurrences but that the victims were only using these areas for recreation.

Overall, any development within known or suspected avalanche areas will increase the hazard somewhat, because it will also increase the use of the exposed areas. Even when infrastructure and buildings are specifically designed for avalanche forces, there remains the small risk that persons outside are exposed if an avalanche occurs. The City of Ketchum, located in Blaine County, commissioned a study to identify the areas where avalanche potential exists. As a result, the city established an avalanche zone overlay district, where special regulations and restrictions apply.

Vulnerability Assessment

No specific, statewide vulnerability assessment exists for the avalanche hazard. From a general perspective, a hazard arises whenever property or human activity lies in the path of a potential avalanche. The sliding snow or ice mass in an avalanche moves at high velocities. The risk of avalanche loss is greatest on the flatter slope of the runout zone, which is more conducive to development, transportation routes, and infrastructure. Exposure to the hazard has risen due to growth in winter recreational activities and resort facilities, mountain residences, highways, and telecommunication lines.

As discussed in the previous events section, Blaine County has experienced the greatest number of avalanche accidents, as reported in the U.S. Avalanche Accidents Database. However, Idaho experiences thousands of avalanches each winter, but the majority may go unreported in the database because of their remote location and no physical impact on people or the built environment. Figure 3.4.J displays the total number of avalanche events by county from the U.S. Avalanche Accidents Database. Idaho's three avalanche centers, the Idaho Panhandle Avalanche Center, the Sawtooth Avalanche Center, and the Payette Avalanche Advisory are critical resources to the State and individual jurisdictions for predicting and preparing for an avalanche.

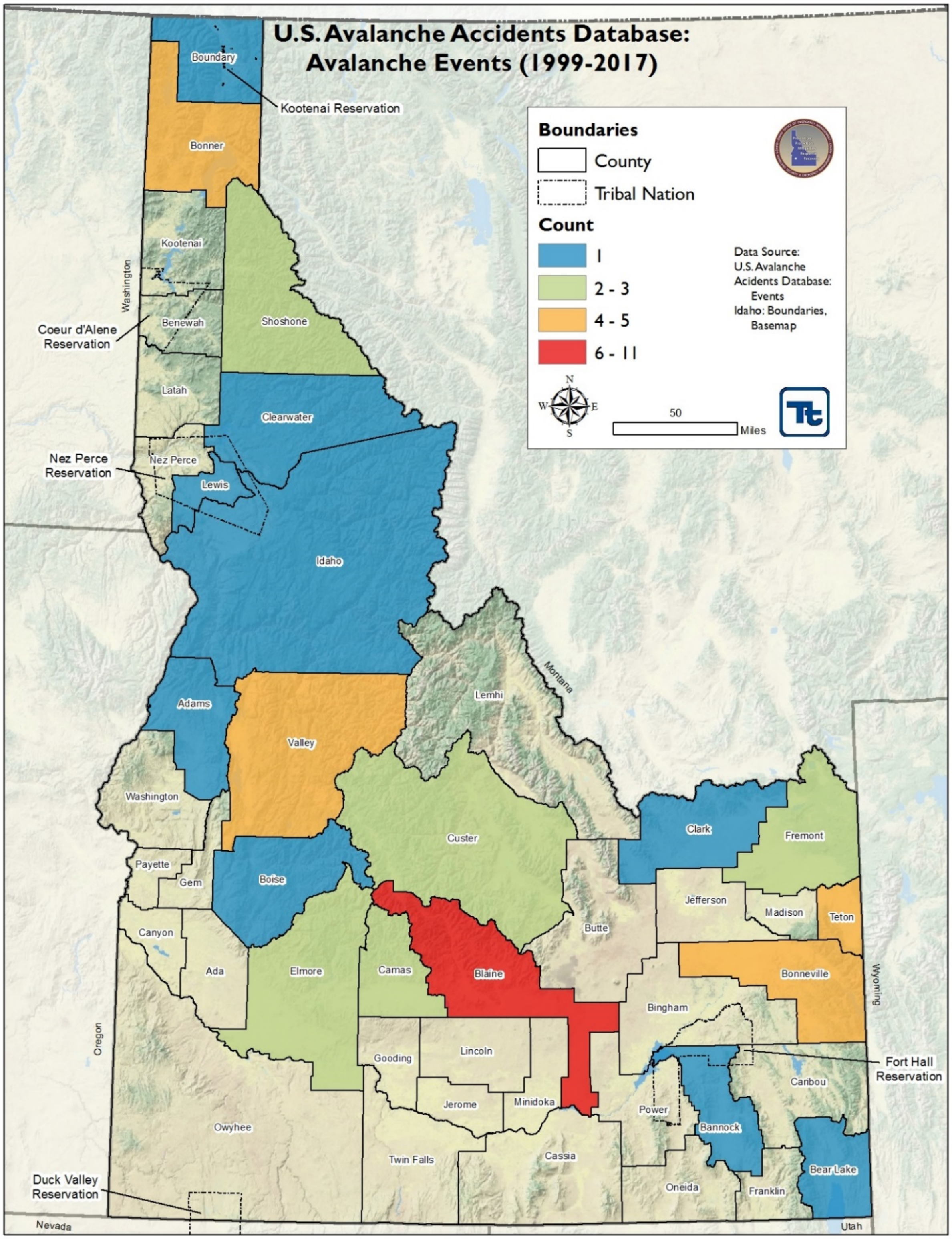
Critical Infrastructure and State Facility Impacts

From a general perspective, avalanche risk arises whenever property or human activity lies in the path of a potential avalanche. Major State-owned transportation infrastructure, such as highways and railways, would be the state assets most impacted by an avalanche event. Large avalanches can close vital transportation routes for days at a time, possibly stranding citizens and temporarily eliminating vital transportation and emergency response routes. As mentioned in the location section, the main highways impacted by avalanches include sections of Highway 21, Highway 33/WYO 22, US Route 12, and Highway 75. Likewise, power lines and pipelines and access to each are vulnerable when their locations intersect avalanche paths.

Loss Estimation

Avalanches can shear trees; completely cover entire communities and highway routes, and level buildings. The primary threat is loss of life for backcountry skiers, snowboarders, hikers, climbers, and snowmobilers. The trend from 1940 to the present shows an increase in recreation-related accidents. Avalanches kill and injure through burial and mechanical impact. Two-thirds of avalanche fatalities are due to suffocation; the majority of the rest are due to trauma (especially to the head and neck). Even small slides can carry victims over cliffs or into narrow gullies where deep burial is possible. North American statistics suggest that a completely buried victim has a 50-percent chance of survival if rescued within 30 minutes, with a rapid decline thereafter. Less than one-third of the completely buried victims are recovered alive.

Figure 3.4.J. Number of Avalanche Accidents (Injury and Fatality) from 1999 to 2017



Direct costs can be defined as the cost of maintenance, restoration, or replacement due to damage of property or structures within the boundaries of a specific avalanche. All other costs from avalanches are indirect and include (1) reduced real estate values in areas threatened by avalanches, (2) loss of productivity of forest lands, (3) loss of industrial productivity as a result of damage to land, facilities, or interruption of services, (4) loss of tax revenues on properties devalued as a result of avalanches, (5) loss of access to recreation lands and facilities, (7) cost of lost human productivity due to injury and death, and (8) the cost of litigation as a consequence of avalanches. Some of these indirect costs are difficult to measure and tend to be ignored. As a result, most estimates of avalanche costs are far too conservative. If rigorously determined, indirect costs probably exceed direct costs. The economic costs of these disruptions can be significant, especially in areas with limited access options. Forest resources, such as timber and wildlife habitat, may also be impacted by significant slides. Winter recreational facilities and resorts may need to close if impacted by an avalanche, resulting in economic losses.

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.

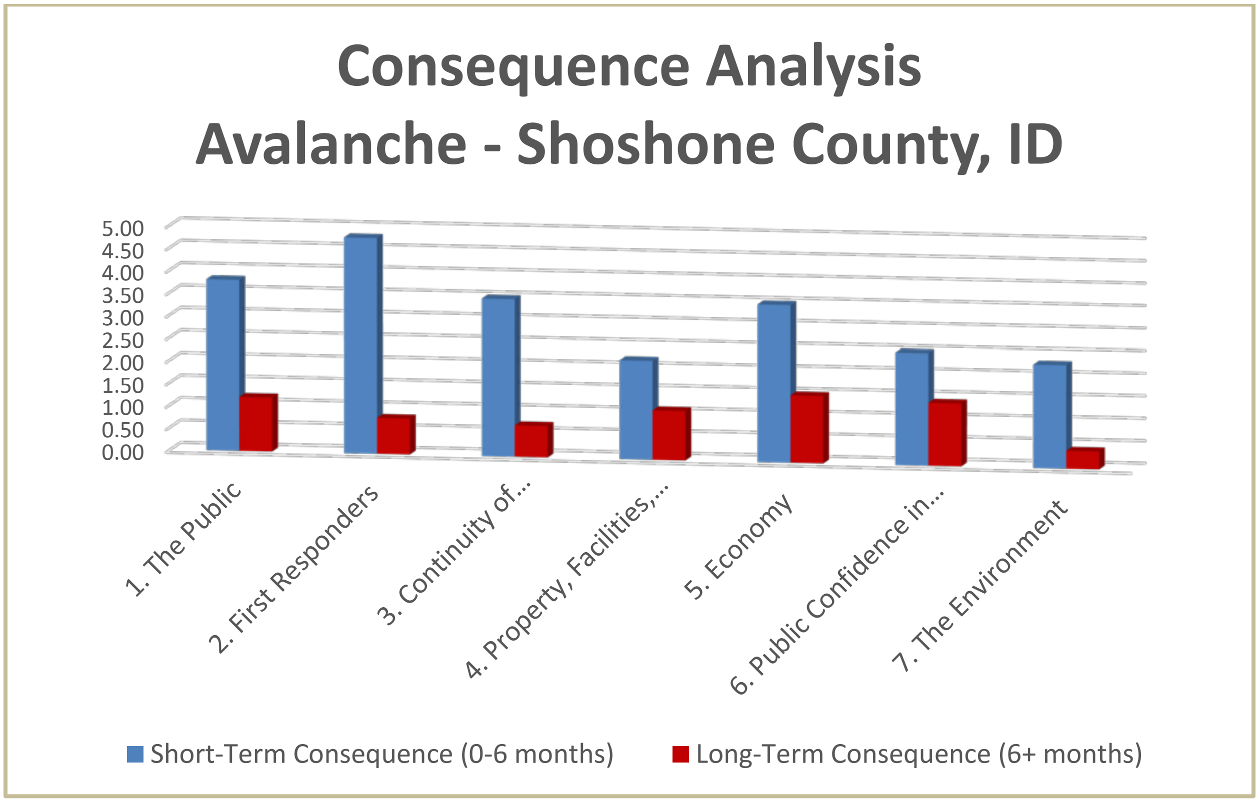
Systems Evaluated:

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

Scenario

January: An avalanche on Interstate 90 between Mullan and Lookout Pass in Shoshone County occurred yesterday at approximately 4:00 in the afternoon. A school bus loaded with children was traveling back home from Lookout Pass Ski Resort and was trapped by the avalanche. Search and rescue efforts were successful, and all occupants of the bus were safely rescued. Both east and westbound lanes of Interstate 90 have been closed since the avalanche and it is unknown how soon the road will be reopened.

Results



Looking at the short-term consequences of this avalanche event, exercise participants felt that the most severe consequences would be felt by the first responders and the public. Both the economy and continuity of operations would experience higher consequences as well. From a long-term standpoint, the systems suffering the most severe consequences include the economy, public confidence in government, continuity of operations, and the public. Overall, what stands out is that the short-term impacts of this type of avalanche event are far greater than the long-term.

Some observations of the group to note included:

- This would impact the only route serving commerce and goods/services across the area, which could present regional consequences.

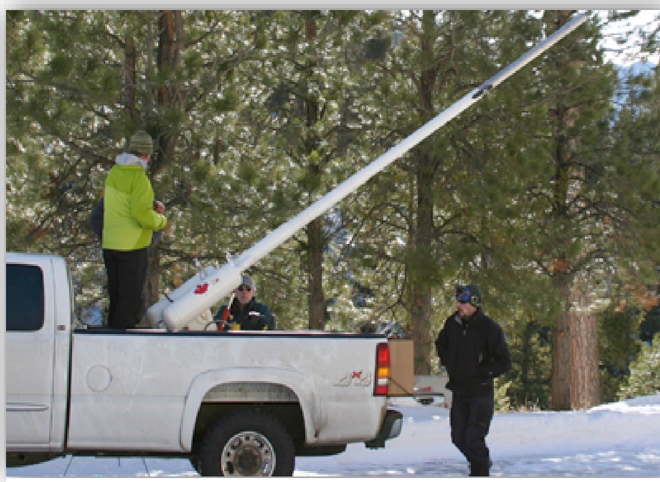
- The overall risk to avalanches has increased over the past few years as there are more backcountry uses and a perceived higher risk acceptance amongst these users.

Mitigation Rationale

Avalanches are not considered a major natural hazard, because they impact relatively small areas of Idaho. Compared with other hazards, avalanches have localized impacts and individually do not affect large numbers of people. However, the fatality numbers for avalanche are high given the small amount of people affected by this hazard. There have been 37 fatalities from avalanches in Idaho from 1999-2017.

The reoccurrence of avalanches at the same topographic site(s) means that mapping offers a route to hazard mitigation, if only through the qualitative recognition, and avoidance, of susceptible sites. Remote sensing has been used for many years to produce preliminary maps of landslide tracks, as many avalanche tracks also function as landslide gullies during the spring and summer. With the continued development of GIS, hazard-zoning maps can be improved and updated to provide local communities with the data necessary to adopt loss-reduction measures.

Recent avalanche mitigation approaches have included avalanche hazard zoning, evacuation, artificial release, and avalanche-control structures. Artificial release is the most common measure used in the United States. Where other methods are ineffective or cannot be used, control structures may be installed.



Source: Idaho Transportation Department

General Mitigation Approaches

Mitigation of avalanches 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. The Executive Order also assigns the Idaho Transportation Department the responsibility for providing engineering support to state mitigation activities relative to avalanches.

"The Idaho Transportation Department (ITD) forecasts for Highway 21 located 2.5 hours northeast of Boise, Idaho in an intermountain climate. The area typically sees moderate snowfall (300" average), extremely cold temperatures between storms, and rain on snow events throughout the winter. ITD has a limited explosive avalanche mitigation program due to the complex terrain of the start zones and highway location. Avalanche activity is mainly direct action avalanches due to storm snow or rain on snow, with at least one major wet slide cycle during the spring. Both lanes of Highway 21 are frequently covered during avalanche cycles and the road is often closed for several days at a time. Avalanche detection is performed using two experimental infrasound arrays that can accurately time avalanche events when manual observations are not possible due to road closure. Future work involves expanding this infrasound array network to include real time avalanche event information." (Havens)

Avalanche hazard can be mitigated in three ways:

- Terrain modification
- Snow-cover modification
- Human behavior modification

Terrain modification involves changing the ground surface or building structures in the release zone and/or track to prevent the release or stop the natural run of an avalanche. Possible mitigation techniques include: retention, redistribution, and retarding/catchment structures and reforestation.

- Retention structures, which prevent an avalanche release, include snow rakes, snow bridges, and nets. These structures are generally limited to areas with partial snow packs and may create negative aesthetic impacts.
- Redistribution structures, snow fences and similar techniques, reduce snow drifting and control the buildup of large snow loads.
- Retarding/catchment structures stop, divert, confine, or slow slides. These include ditches, terraces, dams, and mounds constructed on the ground surface. Some have been effectively carved into existing, stable snowpacks to mitigate slides of later snow accumulations.
- Reforestation provides a natural form of protection. Many of the above structures can be simulated with vegetation.

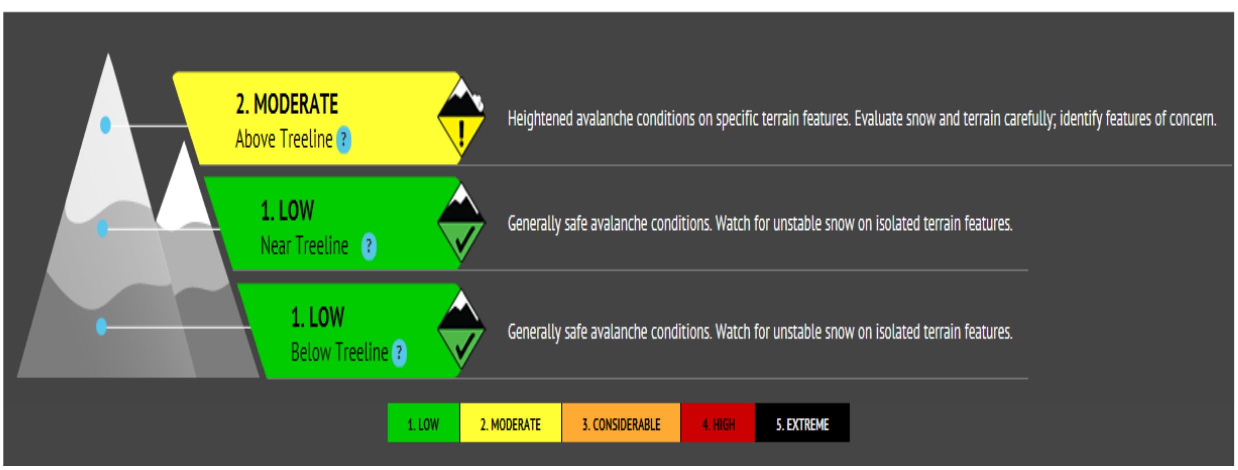
Snow-cover modification involves modifying the snow pack, either through stabilization or controlled releases, to prevent releases or minimize the volume of snow included in an avalanche. Stabilization can be accomplished through compaction, which may be performed by grooming equipment. This technique is most effective early in the season. Controlled release of potential avalanche slopes is the most common technique for reducing the avalanche hazard. Slopes are generally triggered through the use of explosives delivered by hand, aerial bombing (primarily by helicopters), and artillery (the predominant method of avalanche control in the U.S.).

Human behavior modification involves rendering avalanches harmless by keeping people out of their paths. It can also reduce the number of avalanche occurrences by eliminating potential triggers (people). Techniques include the closure of recreational areas and relocation of residences and businesses from hazardous areas.

Public education and outreach programs are essential for bringing avalanche information to the attention of the general public. Any hazard-reduction program depends on public understanding and support. Therefore, education on avalanche matters, oriented primarily toward those who live, work, or vacation in Idaho's mountainous regions, may be undertaken by individuals, agencies, schools, nonprofit organizations, and special-interest groups. Special attention should be given to snowmobile dealerships and user associations, Nordic ski shops, and backcountry equipment suppliers. The Idaho Department of Parks and Recreation has several online avalanche training videos, as well as avalanche descriptions, information, and advisories for certain parts of the state. The link to the Idaho Department of Parks and Recreation website is https://parksandrecreation.idaho.gov.

Additionally, there are currently three avalanche information centers located within Idaho; the Idaho Panhandle Avalanche Center, the Payette Avalanche Center (McCall), and the Sawtooth National Forest Avalanche Center (Sun Valley). These avalanche centers provide the public with educational training and events, observation information, current advisories, and event reporting. Links to these centers can be found through http://www.avalanche.org. Figure 3.4.K below is an example of an avalanche advisory issued by the Idaho Panhandle Avalanche Center.

Figure 3.4.K. Example Avalanche Advisory



Source: http://www.idahopanhandleavalanche.org/st-regis-silver/advisory#null

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