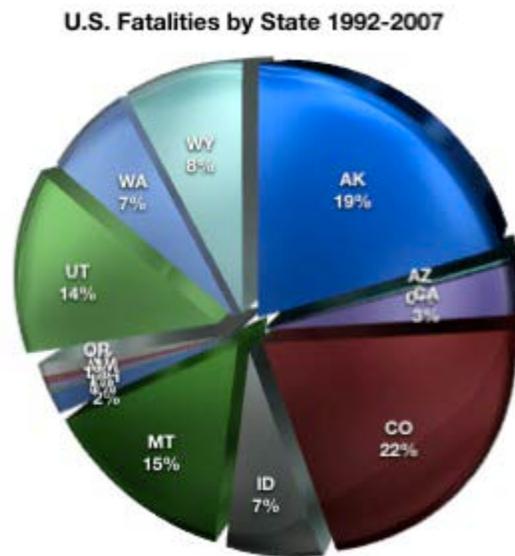


## CHAPTER 15

### SNOW AVALANCHE

Wyoming is one of the top-ranking states for avalanche hazard because of its weather and mountainous terrain coupled with outdoor recreation. Skiers, snowboarders, and snowmobile operators are most commonly associated with avalanche hazards. However, motorists and others not engaging in recreation are also at risk of being caught in an avalanche. An avalanche is defined as a large mass of snow, ice, earth, rock, or other material in swift motion down a mountainside or over a precipice (Merriam-Webster). In the case of this evaluation, avalanche medium refers to snow.

Avalanche fatalities provide the best indicator for locations of where events occur and what populations are most threatened. According to the U.S. Forest Service, Utah Avalanche Center, Wyoming ranks fifth among the eight states with the most avalanche fatalities. Wyoming comprised 8% of avalanche deaths in the U.S. from 1992 through 2007 (**Figure 15.1**).



**Figure 15.1 - Chart highlighting Wyoming as the fifth most at-risk U.S. state for fatalities from avalanches. Figure adapted from the USDA Forest Service, Utah Avalanche Center.**

Since 1913, there have been 77 fatalities from avalanches with the majority resulting from individuals partaking in mountain recreation, most predominantly snowmobilers and backcountry skiers (**Figure 15.2**). Although deaths occur primarily in the backcountry, motorists, residents, and workers in high angle, avalanche-prone terrain must be aware of the danger; at least five individuals have perished this way. In **Figure 15.3** it is apparent that the majority of fatalities occurred in western Wyoming, in particular the Teton area. This area presents an increased population of outdoor enthusiasts; an increased population engaging in extreme winter sports; and the high angle, avalanche-prone character of the terrain.

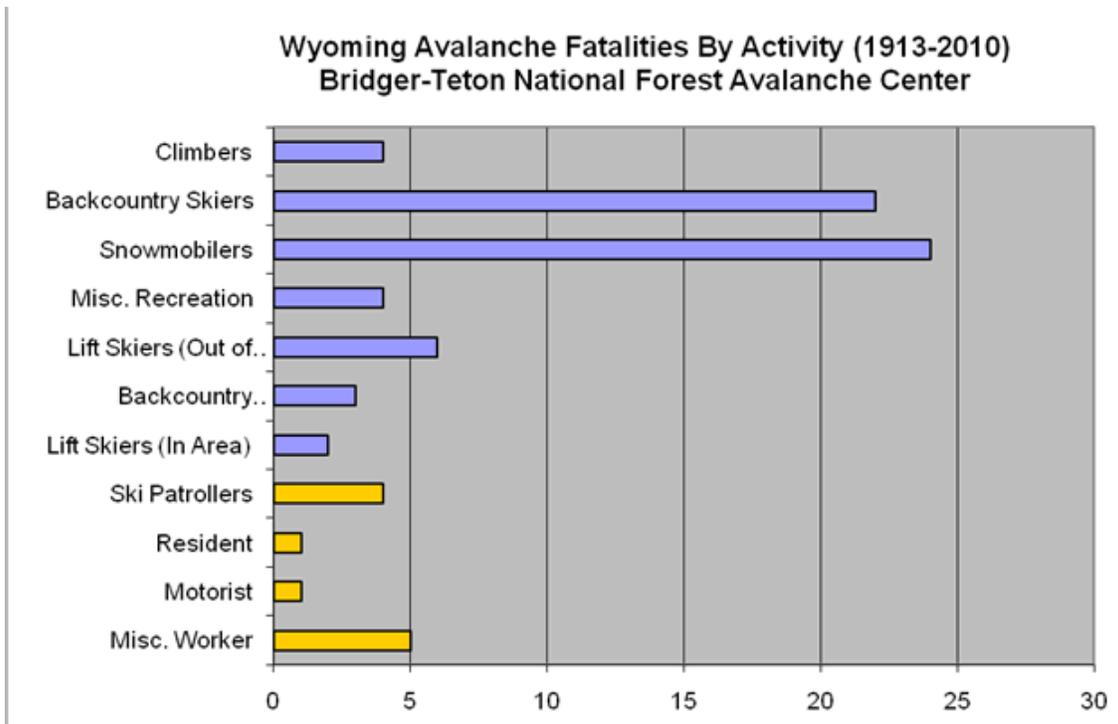


Figure 15.2 - Wyoming Avalanche Fatalities by Activity. Graph from the Bridger-Teton National Forest Avalanche Center. <http://www.jhavalanche.org/fatalityGraph/type/activity> Accessed 12/20/2010

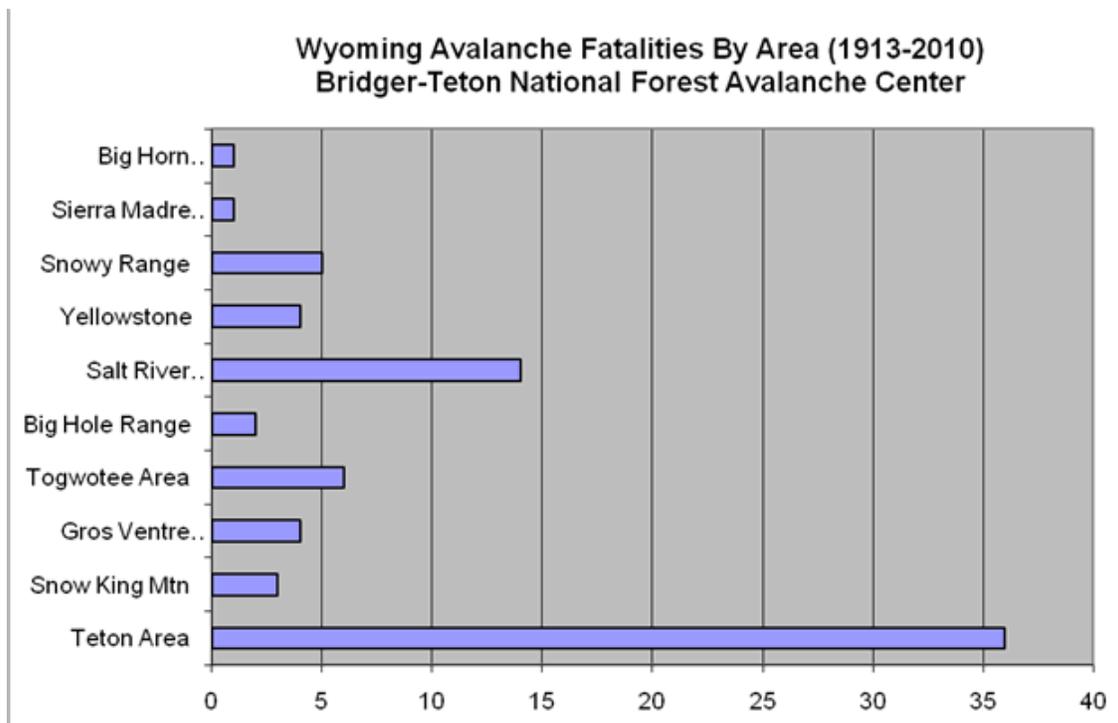


Figure 15.3 - Wyoming Avalanche Fatalities by Location. Graph from the Bridger-Teton National Forest Avalanche Center. <http://www.jhavalanche.org/fatalityGraph/type/area> Accessed 12/20/2010

## History

Western Wyoming and Teton County have achieved notoriety nationwide for their avalanche hazard susceptibility. A U.S. Forest Service (USFS) summary report from the Bridger-Teton National Forest Avalanche Center (BTNFAC) dated March 31, 2003 discusses the Teton area:

*Our community has the unfortunate distinction of leading the country in avalanche fatalities in two of the past three years. Sixteen of the 94 avalanche fatalities which occurred in the United States during this three year period occurred in Wyoming. Of these eleven or 12% of the national total occurred in Teton County, Wyoming or Teton County, Idaho.*

According to statistics from another USFS report from the BTNFAC, “during the past three seasons 10 people have died in avalanches in Teton County, Wyoming alone.” The report continues saying that “this number accounts for 11% of the 94 US fatalities recorded during this 3-year period.” The report concludes, “[a] total of 15 have died in avalanches during this same period if you include the surrounding areas of the forest abutting Teton County, WY.”

The same USFS report defends the massive increase in numbers of winter forest users who venture into avalanche-prone terrain on a daily basis:

*Last season a total of 19 backcountry avalanche events with significant human involvement were reported to the avalanche center. Six of the 24 people who were caught died. There were five full burials with avalanche transceivers and successful recoveries, five partial burials and five serious injuries.*

According to Bob Comey, director of the BTNFAC in Jackson Hole, in recent years snowmobile technology and backcountry skiing equipment (e.g., randonnée gear) has advanced to allow users to access backcountry areas that are not groomed and have not undergone mitigation measures for avalanche hazard. This too is a contributing factor in an increase in deaths by avalanche.

**Table 15.1** lists all fatal avalanche events from 1913 to 2010. Of the seven counties that have had avalanches resulting in death, Teton County has the most events.

Table 15.1--Wyoming Fatal Snow Avalanche Events (1913-2010)

Date	Name	Age	Location	Activity/Travel
1913	Clarence Curtis		Mail Trail, Teton Pass	Mail Carrier
1914	Frankie Parsons		Mail Trail, Teton Pass	Mail Carrier
1914	Freighter		Freight Trail, Teton Pass	Freighter Horse Team
1/9/1916	Soldier	25	NW of Cleopatra Terrace, Yellowstone YNP	Soldier
2/11/1932	Harry Swanson	17	Crater Lake, Teton Pass	Woodcutter Foot
12/15/1945	Bob MacLeod	15	Crater Lake, Teton Pass	In-Vehicle Skier
2/13/1949	Harold Ross	32	Horse Creek Ranch	Rancher Horse Team
3/5/1956	John Stanley	57	Leeks Canyon, Snow King Mt	Alpine Skier Out of Area
2/10/1962	Dr. Max Stock	34	Swift Creek, Salt River Range	Snowshoer
3/12/1964	Dick Pittman	30	Patroller, Snow King Mt	Alpine Patroller
1/16/1974	Wes Krause	20	Glacier Gulch, Teton Range	Backcountry Skier
1/16/1974	Bart Brodsky	18	Glacier Gulch, Teton Range	Backcountry Skier
1/16/1974	David Silha	20	Glacier Gulch, Teton Range	Backcountry Skier
1/19/1975	Rick Caller	24	Near Owen Creek, Big Horn Range	Backcountry Skier
2/8/1975	Perry Despain	14	Near Centennial, WY	Snow Player
1/12/1976	Phillip Gartland	26	Jackson Peak, Gros Ventre Range	Backcountry Skier
1/12/1976	Jim Rierson	19	Jackson Peak, Gros Ventre Range	Backcountry Skier
3/20/1976	Wayne Farrell	20	South Leigh Canyon, Teton Range	Backcountry Skier
3/26/1977	Steve Karl	23	Near Ski Cabin, Gros Ventre Range	Backcountry Skier
4/26/1979	Tim Drew	24	Grand Teton, Teton Range	Climber
4/26/1979	Jerry Lucas	22	Grand Teton, Teton Range	Climber
2/16/1984	Pierre Muheim	27	Ferrin's Slide, Snow King Mt	Alpine Skier Out of Area
2/3/1985	Bruce Melliger	29	Mt Wister, Teton Range	Climber
2/9/1985	Dennis Jeperson		Rock Creek Knoll, Snowy Range	Snowmobiler
12/2/1985	Paul Driscoll	48	Rendezvous Mountain, Teton Range	Alpine Patroller
2/17/1986	Tom Raymer	37	Rendezvous Mountain, Teton Range	Alpine Patroller
2/22/1992	Gregory Felzien	26	Mount Norris, Yellowstone NP	Snowshoer
2/28/1992	Dan Schwendiman	21	Dry Ridge, Teton Range	Snowmobiler
12/28/1992	Richard Saenoff	41	Simpson Peak, Togwotee Pass	Backcountry Skier
2/25/1994	Rick Clayton	37	Poison Creek, Salt River Range	Snowmobiler
4/19/1995	Kevin Marriot	22	Taylor Mountain, Teton Range	Backcountry Skier
1/15/1996	Ginger Shaw	38	Bradley Mountain, Near Alpine	Helicopter Skier
1/21/1996	Christopher Garber		Centennial Ridge, Snowy Range	Backcountry Skier
2/10/1996	Chris McGee	29	Strawberry Creek, Salt River Range	Snowmobiler
3/3/1997	Rick Hutchinson	49	Factory Hill, Yellowstone	Backcountry Skier
3/3/1997	Diane Dustman	37	Factory Hill, Yellowstone	Backcountry Skier
1/11/1998	Benjamin Romios	21	Battle Lake, Sierra Madre Range	Snowmobiler
1/4/1999	Dave Reyberg	35	Dry Lake Creek, Togwotee Pass	Snowmobiler
1/19/1999	Michael Langer	17	Rendezvous Mountain, Teton Range	Alpine Skier
11/27/2000	Marl Nielson	41	Hoodoo Creek, Absaroka Range	Hunter

Table 15.1--Wyoming Fatal Snow Avalanche Events (1913-2010)

Date	Name	Age	Location	Activity/Travel
12/1/2000	Joel Roof	28	Glory Bowl, Teton Range	Snowboarder
12/9/2000	Jonathan Beall	29	Titmouse Ridge, Teton Pass	Backcountry Skier
12/25/2000	Sara Campbell	26	South Badger Creek, Teton Range	Backcountry Skier
2/6/2001	Ralph Toscano Jr.	43	Rock Springs, Teton Range	Alpine Skier Out of Area
2/23/2001	Allen Wagner	24	Granite Canyon, Teton Range	Alpine Skier Out of Area
3/3/2001	Jay Almos		Leigh Bowl, Salt River Range	Snowmobiler
3/12/2002	Chance Schiess	16	Grove Creek, Big Hole Range, ID	Snowmobiler
3/21/2002	Mike Dollarhide	32	Jackson Peak, Gros Ventre Range	Backcountry Skier
12/26/2002	Snowmobiler		West Side of the Snowy Range	Snowmobiler
1/4/2003	Tristan Picot	19	Near Ski Lake, Teton Range	Snowboarder
1/5/2003	Joshua Roy Richins	16	Balls Mountain, Salt River Range	Snowmobiler
1/25/2003	Marshall Heverly	44	Kettle Creek, Togwotee Pass	Snowmobiler
1/27/2003	Pavel Wolf	27	Avalanche Bowl, Teton Pass	Snowboarder
2/10/2003	Steve Haas	41	Hourglass Couloir, Teton Range	Skier Permanently Area
2/24/2003	Mark Loveland	41	Smiths Fork, Salt River Range	Snowmobiler
1/31/2004	Ray Azar	48	Peak 9670, Teton Range	Backcountry Skier
12/27/2005	Jesse Humphries	21	Split Rock, Togwotee Pass	Snowmobiler
1/5/2006	Laurel Dana	43	Mt. Taylor, Teton Range	Backcountry Skier
12/16/2006	Daniel Boschae	30	Stewart Peak	Snowmobiler
1/5/2007	Justin Kautz	25	Rock Springs, Teton Range	Alpine Skier Out of Area
2/17/2007	Nicolas Steinman	26	Palisades Peak, Snake River Range	Snowmobiler
3/10/2007	Paul Maniuci	24	Darby Canyon, Teton Range	Backcountry Skier
12/27/2008	David Nodine	31	Rendezvous Mountain Teton Range	Lift Skier
2/27/2009	Robert Clark	48	Dry Fork Wolf Creek, Snake River Range	Snowmobiler
2/27/2009	Scott Smith	45	Dry Fork Wolf Creek, Snake River Range	Snowmobiler
2/27/2009	Bob Tiechert	55	Dry Fork Wolf Creek, Snake River Range	Snowmobiler
1/6/2010	Mark Wolling	58	Rendezvous Mountain, Teton Range	Patroller
2/21/2010	Wray Landon	30	South Teton, Teton Range	Backcountry Skier
4/2/2010	Bart Weekes	39	Indian Creek, Snake River Range	Snowmobiler

Reference: Bridger Teton National Forest Avalanche Center  
<http://www.jhavalanche.org/areaFatalities> Accessed 12/20/2010

## Impacts

Avalanches cause two primary hazards—road blocks and death—for those buried by them. Since 1994 there has been a trend of at least one fatality per year. Fatalities are the best-documented impact related to avalanches and are significant simply because of the nature of the hazard. Furthermore, there are costs associated with “search and rescue” and removal of the deceased.

Road blocks are another major concern where roads intersect an avalanche path. The major costs associated with road blocks are snow removal and traffic diversion, which both necessitate personnel and equipment. Another less frequent issue is the cost associated with rescuing motorists involved in the avalanche.

## **Local Mitigation Plan Risk Assessments**

A review of Wyoming's local mitigation plans reflects counties in mountainous western Wyoming consider snow avalanches a hazard to their residents as one might expect. However, it is considered a low risk by each of those counties, despite loss of life over the past century. Many counties do not address snow avalanches as a hazard within their plan which would be expected of counties located in Wyoming's plains. Those counties addressing the issue of snow avalanches utilize data available to them through the State Multi-Hazard Mitigation Plan with little additional information. However, counties addressing snow avalanches have ranked avalanche risks within their borders based on the population impacted, probability of occurrence within their borders and the property impacted.

Below is a table outlining information mined from the local plans' snow avalanches hazard sections. The table shows previous historical incidents of avalanche within each county's borders as outlined in their plans, deaths resulting from avalanches, and extrapolates, based on population impacted, probability of occurrence within their borders, and property impacted, the risk perceived by each county relative to avalanche hazards. One county, Teton County, also indicates historical damages of approximately \$500,000 with another, Lincoln County, reflecting the potential loss estimate of \$2 million.

**Snow Avalanche  
Information Mined from Local Plans**

COUNTY	Plan Y/N	Year Approved	Included in Plan	Rank-High, Medium, Low	Loss Potential	Previous Incident(s)
ALBANY	Y	2010	Y	Low	Not Stated	3 deaths
BIG HORN	Approvable	2010	N			
CAMPBELL	Expired	2005	N			
CARBON	Y	2008	Y	Low	Not Stated	3 deaths
CONVERSE	N/Draft	2005			Incomplete Information	
CROOK	N/Draft	2003	Y		State-level Info from State Plan	
FREMONT	Expired	2005	N			
GOSHEN	Y	2007	N			
HOT SPRINGS	N					
JOHNSON	Y	2008	N			
LARAMIE	Expired	2005	N			
LINCOLN	Y	2006	Y	Low	\$2 million / death	7 deaths
NATRONA	Approvable	2010	N			
NIOBRARA	Y	2009	N			
PARK	Y	2006	Y	Low	Not Stated	2 deaths (1 every 10 yrs)
PLATTE	Expired	2004	N			
SHERIDAN	Y	2009	N			
SUBLETTE	Y	2008	Y	Low	Not Stated	4 deaths (1 every 7 yrs)
SWEETWATER	N					
TETON	Y	2009	Y	Low	historical- \$500,000	37 deaths
UINTA	N/Draft	2011	N			
WASHAKIE	Expired	2005	N			
WESTON	N					
NORTHERN ARAPAHO TRIBE	N					
EASTERN SHOSHONE TRIBE	N					

Because avalanches are typically a back-country hazard in mountainous areas and do not typically occur in populated areas, there is limited risk to significant portions of the population. The one segment of the population most vulnerable to avalanche danger is individuals taking advantage of winter recreation opportunities in the mountains, typically skiers, snow boarders and snowmobilers. Skiers and snow boarders recreating within developed ski areas are less vulnerable to avalanche hazards, as ski area staff ensure mitigation of known areas of avalanche hazard within their boundaries are mitigated utilizing various methods. Those most vulnerable are those drawn to recreate outside developed ski areas where mitigation efforts may or may not be taken.

Avalanche areas known to have the potential to interfere with highways and roads are typically mitigated prior to danger to citizens. However, in the event an avalanche crosses a highway, blocking traffic or burying cars, following is a table and map depicting the vulnerability of each county's population based on composition and density. The vulnerability of the population ranges from very low to medium low in each of the counties who reference avalanche as a hazard in their local plans.

In the case of development's impact on avalanche risk, this is one area where the risk actually seems to diminish as areas are developed. This is true, not because of development itself, but because of mitigation efforts undertaken to protect the population within developed areas. (See **mitigation efforts, Page 15.9-15.11**) Avalanche is recognized as a hazard and mitigated in avalanche-prone locations throughout the state where development exists.

## **Existing Mitigation Projects**

The WSGS contacted the BTNFAC and the Wyoming Department of Transportation (WYDOT) for input on possible mitigation projects for snow avalanches. There are a number of existing mitigation projects already in effect through those organizations.

### **Ski Areas**

The Jackson Hole Mountain Resort has had an avalanche mitigation program since it opened in 1965. An avalanche-forecasting laboratory operates from October through April. The avalanche hazard is assessed and addressed every day during this period. Artillery, explosive hand charges, ski cutting, and area closures are employed as abatement efforts. This area pioneered the use of remote automated weather stations to continuously monitor the development of conditions that lead to the formation of avalanches and developed a state-of-the-art avalanche mitigation program that became an industry standard.

In the mid 1970's a significant increase in backcountry avalanche fatalities lead the national forest avalanche forecasters in the BTNFAC laboratory to start issuing daily backcountry avalanche advisories.

The Snow King Ski Area and Grand Targhee Resort also use explosive charges, ski cutting, and area closures to mitigate the avalanche hazard at their resorts.

### **Highways**

WYDOT has two full-time avalanche specialists on duty from November to April to monitor conditions and then initiate and oversee avalanche mitigation efforts on Teton Pass and in the Hoback and Snake River canyons. Their program uses artillery, hand charges, GAZ-EX, Avalanche Guard, snow sails, and road closures to mitigate the hazard from avalanches.

Four GAZ-EX units have been used on Teton Pass for about fifteen years. These units have been permanently installed near the starting zones of two major avalanche paths that frequently impact the highway. They have a chamber that can be remotely filled with a mixture of propane and oxygen. A spark in this chamber then initiates an explosion that is directed from the chamber onto the snow surface in an attempt to trigger avalanches.

WYDOT also permanently installed two Avalanche Guard units on Teton Pass. These units contain explosive charges that can be remotely propelled from a secure box mounted on a vertical mast into avalanche starting zones.

A passive avalanche mitigation snow sail project was installed beginning in 2001 by WYDOT on the Mile 151 slide path that impacts Highway 89 south of Jackson. This project used specially designed snow fencing to redistribute snow as it deposits in the starting zone in an attempt to abate the formation of dangerous slabs that cause avalanches. The starting zone of this path is in critical game habitat and therefore the use of explosives is an issue.

## Helicopter Skiing

The helicopter skiing operations based out of Jackson access the avalanche hazard on a daily basis and use route finding, snowpack stability evaluations, and ski cutting to mitigate the hazard. Explosive test charges are occasionally used to confirm stability evaluations.

## Backcountry

Artillery and explosives are not used in the backcountry except on paths that could impact highways and ski areas, or as the occasional test shot to evaluate stability by helicopter guides.

“Most people trigger the avalanche that kills them.” With this in mind the primary mitigation methods used in the backcountry are education, information dissemination, and ski cutting. A by-product of the huge increase in backcountry use has been some increase in stability by skier/rider compaction.

Avalanche education efforts are huge in western Wyoming. The BTNFAC and numerous private entities including the American Avalanche Institute, Jackson Hole Mountain Guides, and Exum Mountain Guides provide avalanche education courses to skiers, snowboarders, snowmobilers, snowshoers, guides, and workers who venture into avalanche terrain. These courses teach backcountry users to identify avalanche terrain, evaluate snowpack stability, and rescue techniques. Many backcountry users frequent avalanche terrain on a daily basis. The goal of this education is to enable these users to be better informed on when not to go. The American Avalanche Association has developed standards for Level I, II, and III avalanche courses and recently developed a certification program for professional instructors.

The BTNFAC issues daily specific avalanche advisories for three areas (the Teton area, the Continental Divide/Towgotee Pass area, and the Southwest Trails/Greys River area). The Gallatin National Forest Avalanche Center in Bozeman, Montana issues daily advisories for the West Yellowstone and Cooke City areas, which overlap into abutting portions of Wyoming. These daily advisories are available on the Internet and on a recorded phone message by 7:00 a.m. MST. They contain 24-hour snowfall, wind, and temperature data; area-specific weather forecast from the NWS; and a discussion of current conditions with respect to avalanche hazards including a rating of conditions on the international avalanche hazard scale.

The huge increase in skier and rider (snowmobilers and snowboarders) traffic in the backcountry and at ski resorts have had a significant impact on the stability of the snowpack. Skiers and riders disturb the snow and breakup the snowpack stratigraphy comprised of weak layers and sliding surfaces. These actions provide some increase in stability at times in frequently used areas, however, avalanches still occur in these areas especially during extended storm cycles.

## Proposed State Mitigation Projects

The following mitigation projects have been proposed by state, federal, and local entities in the process of generating the Wyoming Multi-Hazard Mitigation Plan. Chapter 22 has all proposed mitigation projects.

- Perform expanded study to determine extent and dollar impacts of avalanche hazard in Wyoming.
- Research feasibility and costs of adding new frontage roads/detour routes to I-80, I-90, and I-25 to prevent significant delay in traffic flow and resultant economic loss and possible loss of life.
- Provide hazards information to shelters, emergency facilities in public buildings, campgrounds, and phone books.
- Provide geographic information systems training for local jurisdictions with emphasis on hazards recognition and analysis for application to mitigation planning.
- Investigate opportunities for developing or improving warning systems as a means to reduce loss of life and damage to property.
- Encourage purchase of NOAA weather radios statewide for placement in homes, government buildings, schools, motels, hotels, etc.
- Provide public education on all hazards.
  - Distribute brochures and provide talks on avalanches, drought, earthquakes, hazardous materials, landslides, liquefaction, and windblown deposits.
  - Develop summary reports and brochures for expansive soils, floods, hail, tornadoes, wildland fire, and winter storms.
  - Develop video spots on earthquakes and landslides.
  - Continue NFIP education and outreach.
  - Continue education on wildland fire, including reducing fuel loads, fire-resistant landscaping, and home and building design.
  - Continue education on utilizing safe rooms.
- Continue outreach to counties on local all-hazard plan approvals by Federal Emergency Management Agency and plan updates.
- Continue outreach to counties on identifying cost effective and feasible mitigation projects.
- Maintain and continue to expand hazards databases generated for the Wyoming Multi-Hazard Mitigation Plan. Seek new sources of information.
- Formation of committee to investigate design standards and site investigation protocols for state-funded buildings and infrastructure.