

Snow and Avalanche

Colorado Avalanche Information Center

Information Series 65

Annual Report 2001-02



Colorado Geological Survey • Division of Minerals and Geology
Department of Natural Resources • Denver, Colorado • 2002

Cover photo: Silverton forecaster Andy Gleason shot this photo of bikers and cars making their way through avalanche runout on Highway 550 near Silverton.

INFORMATION SERIES 65

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CENTER

Annual Report
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DOI: <https://doi.org/10.58783/cgs.is65.rgmw9551>



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Department of Natural Resources
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Foreword

CGS Information Series 65 is the Annual Report of the Colorado Avalanche Information Center for the winter of 2001-02. It describes the operations of the CAIC and the important events of the winter season.

Partial funding for this report came from the Colorado Department of Natural Resources Severance Tax Operational Fund. Severance taxes are derived from the production of gas, oil, coal, and metals.

Knox Williams
Director of the Colorado Avalanche Information Center

Vicki Cowart
State Geologist and Director

Director's Report

To Our Sponsors and Patrons:

The Colorado Avalanche Information Center (CAIC) has just completed its 19th year as a program of the State of Colorado. In several ways, it was a difficult year because of events far beyond the mission and control of the CAIC. The season began with a looming economic recession that put a damper on the recreation plans of many Americans. This was followed by an extraordinarily dry winter season, one that rivaled the infamous winters of 1976-77 and 1980-81. Poor snowfall exacerbated the economic situation (resorts reported that business was down 4.5%) and led to rotten conditions (literally) for backcountry skiers, snowboarders, and snowmobilers.

The work of the CAIC, however, does not stop when the snows falter. The challenge faced by the forecasters was to convince backcountry users that avalanche danger was lurking, even with the shallow snow cover. Despite our best efforts, eight people died by avalanche. This was sobering proof that shallow snow is weak snow is dangerous snow.

On a more positive note, this winter marked the 10th anniversary of the CAIC's contract with the Colorado Department of Transportation (CDOT) to provide avalanche forecast services for Colorado's mountain highways. This has proven to be a valuable and efficient program, with an excellent safety record both for the public and for CDOT maintenance personnel who must work in challenging, and potentially dangerous, conditions.

Looking forward, we will continue to provide the services asked of us by the public and our clients. As always I want to thank all our sponsors who make our mission of avalanche safety possible. Also I want to thank my staff of forecasters for the professionalism they bring to the job everyday. Nick Logan, Dale Atkins, Scott Toepfer, Mark Mueller, Lee Metzger, Stu Schaefer, Rob Hunker, Andy Gleason, Jerry Roberts, Halsted Morris, Denny Hogan, and Aleph Johnston-Bloom—thank you all. It's a pleasure to work with you.



Knox Williams

Director

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Executive Summary

Mission: The Colorado Avalanche Information Center promotes safety by reducing the impact of avalanches on recreation, industry, and transportation in the state through a program of forecasting and education.

Administration: The Center is a program of the Colorado Geological Survey of the Department of Natural Resources.

Funding: The Center is funded by the Severance Tax and cash-funded by contracts, grants and donations. In FY 01-02 total revenues were \$526,098.

Housing: The main office of the Avalanche Center is at the National Weather Service Forecast Office in Boulder. Offices for CDOT operations are located in Silverton, Pagosa Springs, Carbondale, and the Eisenhower Tunnel.

Staff: Total staff is 13. Five forecasters shared the duties of a seven-day work week during the winter season at the main office in Boulder, while one additional staff member serves as training coordinator and teaches classes as part of the outreach program. Three forecasters are at the Silverton office—two at the Eisenhower Tunnel, one at Pagosa Springs, and one at Carbondale; they provide specific training and forecasting for CDOT.

Avalanche events of 2001-02: Seasonal snowfall was far below normal. A few sites rivaled their lowest snowfall ever and flirted with the dismal totals of the infamously dry winters of 1976-77 and 1980-81. Not surprisingly, the mountain snowpack was shallow, sugary, and very weak all winter. A total of 1,495 avalanches was reported to the Center (31% below the average of 2,160 and the second lowest total on record). There were few large storms, few extensive avalanche cycles, and no large destructive avalanches. Avalanche warnings were posted on six days (a record low). Still though, the weak snow cover meant it was easy to trigger avalanches, and thus 60 people were reported caught by avalanches (right at the 10-year average). There were eight avalanche deaths (two above normal). Property damage was nil.

Dissemination of forecasts via hotlines, internet, e-mail, fax, and radio broadcasts:

- Estimated calls to the CAIC hotlines:.....41,147
- E-mails to observers and Friends of the CAIC:.....174,824
- Faxes to observers and media:4,920
- Visits to our website forecast page:202,161
- Total send outs (rounded):423,000
- Additionally, 11 radio stations broadcast our hotline messages daily.

Media contacts: As Colorado's spokes-agency for avalanche matters, we received or initiated 120 contacts with broadcast and print media.

Public education and outreach:

- We presented 92 avalanche seminars to 3,346 people.
- Our web site generated 680,907 hits for avalanche information.
- We publish our newsletter, The Beacon, three times a year for Friends of the CAIC.

Funding and Budget

For FY 2001–02, funding came from severance tax and from donations, grants, and contracts as listed below. Additionally, in-kind support is listed.

State	\$394,340	Loveland Basin Three-Pin Grin	201
CDOT contract for services	254,000	Great Adventure Sports Fundraiser	200
CDOT grant	22,000	Durango Mtn Resort/Steamworks	176
Parks, Snowmobile Fund	2,000		
Severance Tax Operational Fund	116,340		
Federal	\$24,000	Avalanche Seminars	\$19,547
US Forest Service	24,000	National Avalanche Foundation	4,946
		Colorado Mountain Club	3,175
		Silverton Avalanche School	2,509
		Colorado Snowmobile Assoc.	1,035
		Summit County Rescue	1,000
		Colorado School of Mines	900
		Ft. Collins Mountain Shop	800
		NOLS	765
		Telluride Avalanche School	750
		Denver Museum of Nature & Science	710
		Summit County Pro Course	660
		Steamboat Ski Haus	644
		Mountain Rescue - Aspen	473
		Bent Gate	360
		Babes in the Backcountry	350
		Boy Scout Troops	190
		Buena Vista Snowmobile Club	150
		Learning Cooperative	90
		Conifer High School	40
		Other Donors	\$12,866
		Koessler Foundation	5,000
		Silverton/Telluride Fundraisers	4,210
		Newt Wheatley Memorial Foundation	2,000
		Ericsson Wireless	850
		White River National Forest	680
		Sale of accident slide sets	75
		Book sales	26
		S. Deckenbach	25
Local Government	\$5,196	Total Funding	\$526,098
Summit County	1,500	Estimated In-kind Support	\$100,000
Town of Breckenridge	1,200	National Weather Service	40,000
Town of Frisco	1,000	Field observations	30,000
Town of Dillon	500	CDOT	20,000
Town of Silverthorne	250	Hotline sponsors	10,000
Summit County District Court	746		
		Grand Total	\$626,098
Ski Resorts	\$34,290		
Colorado Ski Country USA	20,000		
Vail Resorts	2,390		
Breckenridge	2,000		
Aspen Skiing Company	2,000		
Winter Park	1,500		
Steamboat	1,500		
Telluride	1,000		
Copper Mountain	1,000		
Keystone	1,000		
A Basin	500		
Keystone Pro Patrol	500		
Monarch	300		
Breckenridge Pro Patrol	600		
Friends of the CAIC	\$28,244		
Ski-related Businesses	\$7,615		
Backcountry Access	1,500		
Eldora DoJoe	1,420		
Rescue Technology	1,000		
Mountain Chalet, Colo. Springs	850		
Tenth Mountain Hut Association	500		
Teletips Fundraiser	510		
People Productions	458		
Fort Lewis Outdoor Pursuits	400		
Breckenridge Bar Golf Fundraiser	400		

Friends of the CAIC

The number of Friends totaled 630 for 2001-02. We thank each and every one for the grassroots support necessary to sustain the CAIC. We offer two levels of service, at base rates of \$30 or \$45. Many of our Friends generously gave an extra donation amount. Below is a list of special friends who donated \$100 or more.

Jeff Bergeron and Ellen Hollinshead
Bruce Berkowitz
David and Juli Booton
Jeff Bork
Hal Boyne
Walter and Mary Jane Briney
Lee Christian
Doc and Ann Cornwell
Greg Craig
Jackson Dennis
John Dobashi
Philippe Dunoyer
Sherry and Tim Gaines
Tom Hays
Brant Heidlebaugh
Christoph Henkel
Dixon Hutchinson
George Janson
Ann Jeffrey
Mark Karlok
Michael Kennedy
Kazumi Kuriyama

Larimer County S&R
Alice Lecinski
Chuck Lenzmeier
Mara Mactaggart
Annyce Mayer
Erik Miller
Russell Montgomery
Mary Carroll Sinclaire Morris
Kurt Morscher
David and Catherine Neal
Rick Parsons
Joe Puchek
Peter Rex
Robert Rich
James Richardson
Laura and Steve Rossetter
Tim and Kathryn Ryan
San Juan Ski Company
D. B. Tanner
Steve Williams
Charlie Ziskin

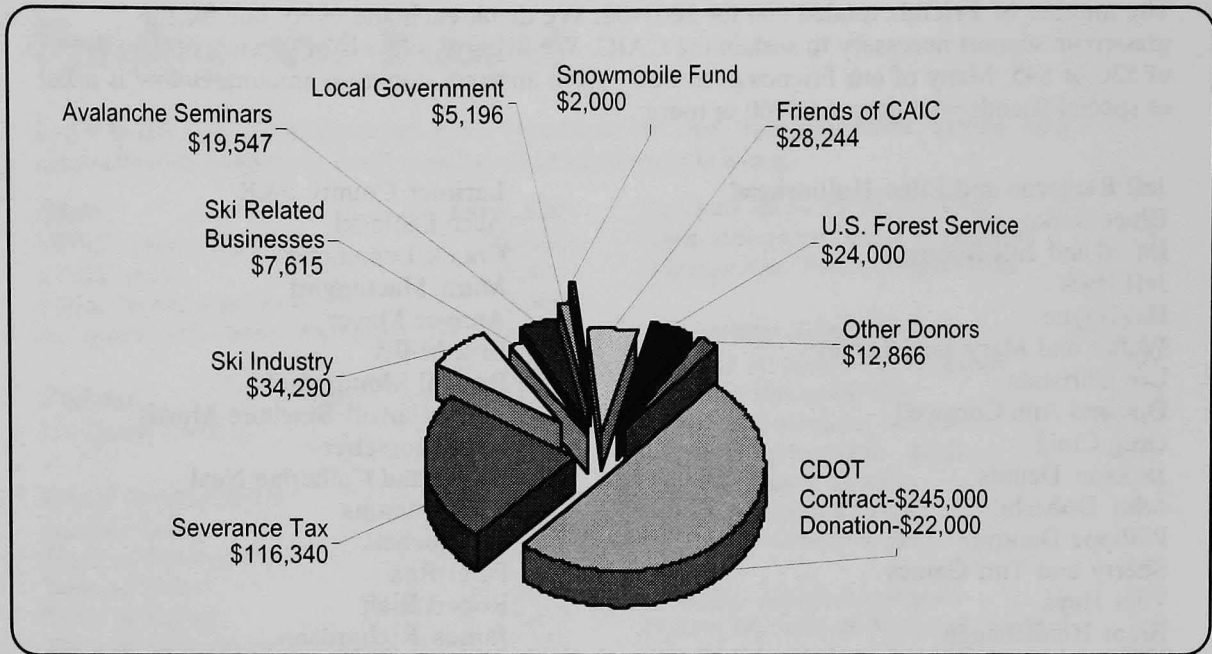


Figure 1. CAIC sources of funding.

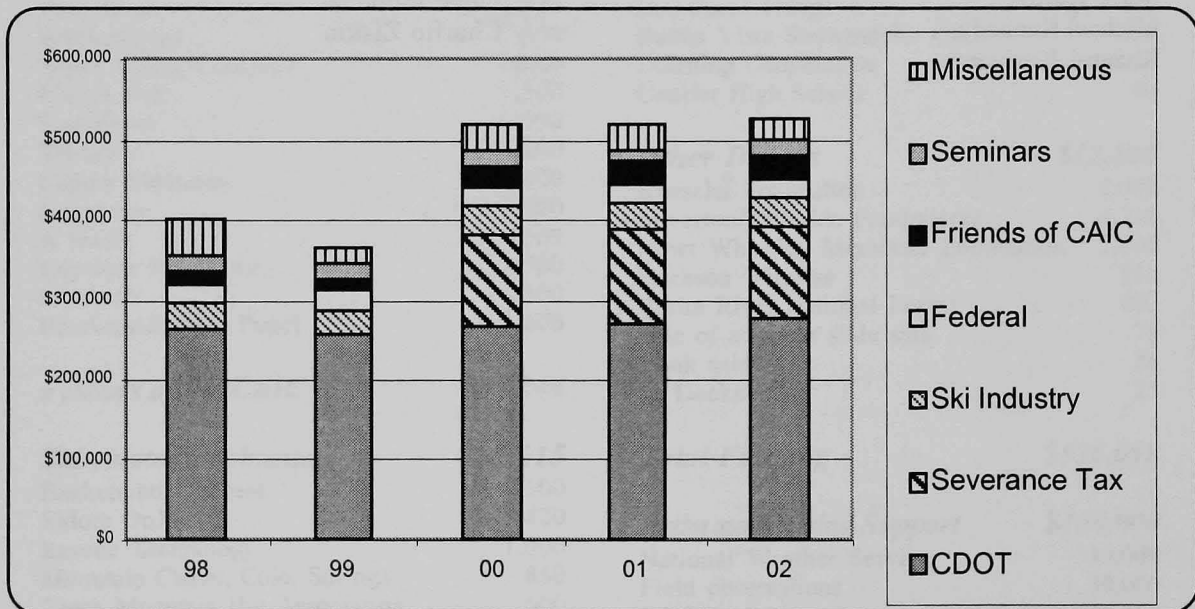


Figure 2. CAIC five-year budget trend.

Operations

Administration: The CAIC is a program of the Geological Survey under the directorship of State Geologist Vicki Cowart. It is cash-funded by grants and donations and from the Severance Tax Operational Fund.

Housing: The CAIC central office is with the National Weather Service in Boulder. For CDOT forecasting operations, the Center maintains offices in Silverton, Pagosa Springs, Carbondale, and the Eisenhower Tunnel.

Season: From November through April, the Center is fully operational seven days a week and is staffed with 13 forecasters/educators. From May through October, the Center is closed and three staff members provide administrative and other necessary services.

Purposes: The purposes of the Center are to:

- monitor the changing weather, snow cover, and avalanche conditions in the Colorado mountains (see Data Sites below);
- provide mountain weather and avalanche risk information to the public, via recorded hotline messages and via the Internet and e-mail (see Section VII);
- warn of dangerous avalanche conditions by issuing avalanche warning bulletins via the NOAA Colorado Weatherwire and news media (see Section VII);
- provide the Colorado Department of Transportation weather and snowpack data for reducing avalanche hazards along mountain highways (see Section IX);
- provide avalanche education through slide talks, seminars, videos, publications, and media contacts (see Section VIII);
- be the focal point in state government for all avalanche matters;
- provide specialized forecasts and consulting to sponsoring agencies;
- investigate all significant avalanche accidents (see Section VI);

Staffing and Duties at the Main Office: Personnel for the 2001-02 season were Knox Williams (Director), Nick Logan (Associate Director), Dale Atkins, Scott Toepfer, Halsted Morris, and Denny Hogan. The Center was manned daily from 4:30 am to 3:30 pm, from opening day on November 9, 2001, until closing on April 21, 2002.

The forecasters are responsible for:

- monitoring mountain weather, snow, and avalanche conditions;
- logging all incoming data from observers;
- evaluating field data and National Weather Service data;
- making daily snow stability evaluations and forecasts;
- updating public hotlines daily;
- issuing forecasts for five highway areas daily;
- issuing and terminating avalanche warnings when warranted;
- initiating or responding to calls from the news media;
- handling special requests from sponsors/clients.

Highway Forecast Offices: The CAIC maintains four mountain offices to provide specific forecasting and training services to CDOT maintenance personnel. Section IX gives details of this program. These offices are operational from November 1 to April 30, with forecasting services available earlier or later as needed.

- **Silverton:** This office is staffed by forecasters Andy Gleason, Jerry Roberts, and Aleph Johnston-Bloom, who coordinate the forecasting for the avalanche reduction program for CDOT along US 550 from Coal Bank Hill to Red Mountain Pass, Colorado 145 over Lizard Head Pass, and Colorado 110 along Cement Creek.
- **Pagosa Springs:** This office is staffed by forecaster Mark Mueller and provides forecasting for the avalanche reduction program along US 160 over Wolf Creek Pass, US 50 over Monarch Pass, and Colorado 17 over Cumbres and La Manga Passes.
- **Eisenhower Tunnel:** This office is staffed by forecasters Lee Metzger and Stu Schaefer and is the forecast center for CDOT's avalanche reduction program in District 1. The primary area of responsibility is the I-70 corridor from Georgetown to Vail, US 6 over Loveland Pass, and US 40 over Berthoud Pass. Outlying areas of responsibility are Colorado 82 over Independence Pass and Colorado 14 over Cameron Pass.
- **Western Slope:** This office is in Carbondale and is staffed by forecaster Rob Hunker. It is responsible for forecasting for Colorado 133 over McClure Pass, Colorado 139 over Douglas Pass, and Colorado 65 on Grand Mesa.

Data Sites: The Center maintains a network of observation sites for providing weather, snowpack, and avalanche data to the forecast office. Altogether there are about 35 manned sites, 20 of which are ski areas and the remainder are highway and backcountry sites. The Center has long supported a contract observer at Gothic, and this year began a network of back-country observers. The Highway Forecast Offices maintain and access data from remote weather stations, and also use the NRCS Snotel sites.

Education: One mission of the Center is to provide avalanche education opportunities to citizens, tourists, and avalanche practitioners. We do this through talks and field seminars. Halsted Morris is the CAIC's Training Coordinator and chief instructor. All staff members teach classes throughout the year to meet demand for this important safety training. Additionally, forecasters maintain frequent contact with news media personnel to give broad and accurate coverage of current avalanche conditions. Such news stories both inform and enhance avalanche education with the public. Section VIII details our efforts toward public education and safety.

Publications and Web Site Outreach: The Center publishes avalanche-related articles and produces videos as need and opportunity arise. Section VIII details this year's publications. Our Web site generated 680,907 visits for avalanche information. [Note: We do not use the misleading and inflated number commonly called "hits" (there were 2,410,603), because it contains multiple counts. For example, if a visitor goes to a page with 5 photos on it, it counts as 6 hits.].

Friends Association: The Center manages a grassroots support group called "Friends of the CAIC" which totaled 630 members in 2001-02. For an annual donation of \$30 or \$45, the Friends receive three issues of The Beacon newsletter and receive the daily forecast via e-mail once or twice a day. This program raised \$28,244 for the CAIC in FY 01-02.



Figure 3. CAIC staff for 2001-02.

Front row, l-r: Mark Mueller, Jerry Roberts, Stu Schaefer, Dale Atkins, Halsted Morris. Back row, l-r: Nick Logan, Lee Metzger, Aleph Johnston-Bloom, Rob Hunker, Denny Hogan, Knox Williams, Andy Gleason (stand-in), Scott Toepfer

Weather and Avalanche Synopsis

The winter of 2001-02 will be remembered for its lack of snow and high number of avalanche deaths. Many avalanche workers and powder hounds might describe the winter of 2001-02 as the winter that wasn't. Storms were few and far between. Many sites, especially in the central and southern mountains,¹ experienced near-record-low snowfall. Though snowfall was very light the snow cover created avalanche conditions that were far from uninteresting.

The timing of the season's storms produced a deceptive snow cover that revealed two distinct avalanche personalities. Abundant snows in late November and early December created a benign snow cover in the first half of the season, but a lack of mid-winter snows slyly turned the snow cover sinister, and it turned to depth hoar. Even in early March snowpack conditions resembled late December or early January. In March, the arrival of two storms caused the snowpack to crumble and avalanches were widespread. The new and long-awaited powder seduced backcountry adventurers and lured them into dangerous avalanche conditions. During a one-week period in mid-March one-third (21) of the season's 60 avalanche victims were caught.

In recent winters the dry months were offset by snowy months, but this winter's conditions only got drier as the months progressed. By season's end snowfall totals were far below normal, as were the number of reported avalanches and avalanche warning days. Deaths, on the other hand, were above the long-term average. Property damage was nil.

Snowfall

The snow cover in early November was thin and patchy. What little snow fell in a couple of small storms in September and late October was mostly gone when a third storm left a thin blanket right before the Center opened on November 9. To the delight of ski areas and backcountry adventurers winter roared into the mountains late on Thanksgiving. For the next week, a series of storms left behind good snows favoring the northern mountains and the west slope. Areas along and east of the Continental Divide saw less snow. After a dry fall, expectations for a snowy winter ran high.

The snowy end to November carried over to the first week of December. After this onslaught a series of small storms steadily dusted the mountains all month, but snowfall was slight and base depths barely rose. By the end of the month, the persistent temperature gradient was turning the shallow snow cover into depth hoar.

The hopes of a snowy winter begin to deflate as January was without significant snows. Only some sites in the northern mountains had near normal snows, while the central and southern mountains were below normal. Hope for snow shifted to February, but February was almost a carbon copy of January. As February drew to an end, cold arctic air settled over the state.

March began with some of the coldest temperatures in years settling over the mountains, but super cold temperatures in the -20-degree range and colder only weakened the shallow snow cover. It was not until the middle of the month when two storms struck that snow and slabs began to pile up.

¹ The geographical regions called northern, central, and southern mountains of Colorado are used extensively in this report. The northern mountains extend from the Wyoming border to a line from Denver to Hoosier Pass (just south of Breckenridge) to Glenwood Springs, as the southern boundary. This boundary roughly follows the I-70 corridor but dips south in the area of Breckenridge to include the Ten Mile Range. The central mountains extend south from the Denver-Hoosier Pass-Glenwood Springs line to a southern boundary line from Pueblo to Montrose. The southern mountains lie between this Pueblo-Montrose line and the New Mexico border.

During a one-week period, heavy snow and strong winds blasted the mountains. Hardest hit were the central and southern mountains. The shallow and weak snowpack crumbled under the weight of the new snows and produced widespread avalanches.

As quickly as the storms struck, the storms ended and dry, mild conditions moved back over Colorado. High pressure returned to the region in March and stayed through the end of the season. Under a steady onslaught of sun, warm and windy conditions, the thin snow cover melted away about six weeks earlier than normal. This season outdoor enthusiasts could only reminisce of long morning descents on velvety spring snow, and conversations about conditions almost always included the word “drought.”

In some circles of outdoors folks, avalanche workers, and water managers the use of the word “drought” was used as early as in January. In the months that followed as the snows remained absent, the word was heard more often as the impacts of a dry winter were more fully realized. In April the snow was disappearing fast, and by May the normal spring runoff failed to materialize, leaving reservoirs low. The snow was gone.

At the end of May, the snow cover in most Colorado river basins had disappeared. The National Resources Conservation Service (NRCS) monitors the snowpack in the western United States and reported only three of Colorado’s eight river basins (all in the Northern Mountains) still contained some snow. What snow remained was miniscule at best. The statewide average was only 2% of the 30-year average. On May 30, the drought became official. Because of the ongoing drought, the U.S. Secretary of Agriculture declared Colorado farmers and ranchers eligible for federal financial relief.

Table 1 presents the percent-of-normal totals for December through March. During this short period only Steamboat and Copper Mountain hit their long-term averages. The majority of our sites varied from 56–86%. Only a few sites have long-term snowfall records for the six months of November through April. For those, when the snowy November and dry April are added, the percent-of-normal values changed only a few percentage points, but values remained in the 54–64% range. The winter of 2001–02 was the driest since the infamously dry winters of 1976–77 and 1980–81, but when the shoulder months (October, April, and May) are considered, this winter was even drier.

According to the National Climatic Data Center, the March through May spring period was the driest on record for Colorado. The December through March winter period was not much better. This period was one of the 10 driest winter periods on record and that is for 107 years of records.

Table 1 below shows monthly and seasonal snowfalls for all sites that regularly reported data to the Avalanche Center this year.

Table 1. Snowfall in inches for 2001-02.

	Nov	Dec	Jan	Feb	Mar	Apr	Total Dec-Mar	% of Normal	Total Nov-Apr	% of Normal
Northern Mountains										
Arapahoe Basin	21.1	28.5	29.7	32.1	27.6	13.0	117.9	62	152.0	54
Bear Lake (RMNP)	16.3	28.7	31.2	20.4	34.4	14.7	114.7	71	145.7	62
Beaver Creek	53.5	57.2	54.6	41.5	42.1		195.4	86		
Berthoud Pass	52.0	41.0	52.0	40.0	26.0		159.0	76		
Breckenridge	32.5	37.0	52.0	46.0	27.5		162.5	81		
Copper Mountain	45.0	53.0	53.0	42.0	41.0	13.0	189.0	100	247.0	
Eldora	24.8	20.0	26.8	23.0	29.0		98.8			
Loveland	39.0	42.0	37.0	38.0	41.0		158.0	69		
Steamboat	49.0	64.0	79.5	57.5	43.5		244.5	100		
Vail	70.5	59.0	58.0	36.5	27.5	14.0	181.0	70	265.5	
Winter Park	49.7	60.5	67.7	35.7	27.1		191.0	75		
Central Mountains										
Aspen Highlands	29.5	24.0	26.0	19.5	40.6		110.1	64		
Aspen Mountain	33.0	31.0	33.3	22.2	37.4		123.9	73		
Aspen Snowmass	45.0	41.5	43.0	30.4	53.0		167.9			
Crested Butte	52.0	33.0	28.0	20.0	42.5		123.5	73		
Gothic	53.5	40.5	28.3	18.0	50.1	24.5	136.9	57	214.9	64
Irwin Lodge	90.0	35.0	45.0	42.0	61.0		183.0			
McClure Pass	35.0	46.5	32.5	25.5	53.0		157.5	89		
Monarch	33.0	30.0	25.0	28.0	24.0		107.0	56		
Southern Mountains										
Purgatory	22.0	25.0	17.0	12.2	35.7		89.9	49		
Red Mountain Pass	51.8	49.0	15.8	35.0	30.2	11.0	130.0	64	192.8	66
Telluride	56.1	55.5	21.2	21.6	43.1		141.4	74		
Wolf Creek Ski Area	44.5	59.0	45.0	6.5	53.0		163.5	63		
Wolf Creek Highway	40.0	41.0	27.0	6.0	46.0	4.0	120.0	60	164.0	58

Avalanches

This winter a total of 1,495 avalanches was reported to the Center from November to May. This number is 31% below the average of 2,160. Table 2 shows the monthly distribution of these events.

November 2001 was a typical avalanche month, but only because heavy snows caused avalanches in the last week of the month. December produced relatively few avalanches (172) because few old-snow weak layers existed. The absence of early November snows meant little depth-hoar and upper-level faceted grains. For many skiers and riders it was the best snow of the season. By the end of the month the snow conditions had changed and weak layers in the shallow snow cover became widespread, creating an unstable snow cover throughout the mountains. Significant snows failed to materialize in January, so that avalanches were few; however, the snowpack was so weak that even small storms produced avalanches. In February even less snow fell, and the shallow snow cover grew even weaker. The few small storms that arrived resulted in numerous but small avalanches.

By the end of the month, deep instabilities were widespread. Two significant storms in March resulted in widespread avalanches, but for the month, only 322 avalanche events were reported. Prior to the storms, many paths, especially in the central and southern mountains, held little snow or were even bare. A lack of snow in April compounded by warm, windy, and dry conditions meant few avalanches and a fast-melting snowpack. By May, the snowpack was almost completely gone.

Avalanche Danger and Warnings

Table 2 shows the daily danger ratings (low, moderate, considerable, high, extreme) for the northern, central, and southern mountains on a days-per-month basis. The table also shows avalanche counts, accidents, and warning periods by month.

Few storms meant few natural avalanches, which in turn meant few days of high danger and warnings. The avalanche danger was high on only 5 out of 172 days and avalanche warnings were in effect for only 6 days, far below the long-term average of 32 days. (A warning day is one on which the danger was rated high or extreme and an avalanche warning was issued.) Six warning days is a remarkably low number. Even the dry winters of 1976-77 and 1980-81 produced 23 and 35 warning days, respectively.

Avalanche Accidents

The last part of Table 2 is a monthly listing of avalanches involving people and property in 2001-02. During lean snow years, fewer avalanches and accidents are expected. Fewer people are in the backcountry during dry winters, but the consequences of an avalanche seem to be more serious.

During the winter of 2001-02 the number of people caught (60) was below the previous 10-year (1990-2000) average of 68. This decrease is attributed to the absence of snow in the early and late season and the generally poor snow-travel conditions in mid-winter. The 12 people partly buried were below the 10-year average of 15; however, the 18 people buried were much more than the average of 11. This increase might be in part due to better reporting. It might also be a result of where avalanche accidents happen. During dry snow years avalanche accidents may be more likely to occur on confined paths and gullies rather than broad, open slopes. Places that trap the snow also trap and bury victims. Though fewer people were caught, the number of people injured was average, and the number killed (8) was 2 above the average. The consequences of being caught are greater in a shallow snow cover. More rocks, trees and other obstacles that can injure and kill are exposed. During lean snow-years, large avalanches that destroy property are not expected and there were none this winter. No property was reported damaged.

Using the 3-year moving average to smooth out the peaks and valleys in the data, Figure 4 represents a 16-year look at the number of people caught and killed in avalanches each winter. Interestingly, the number of victims caught has increased dramatically. This is to be expected as Colorado has seen its population increase by well over one million new residents, while the number killed has stayed steady. We believe this demonstrates that the Center's avalanche forecasting and education efforts are making an impact.

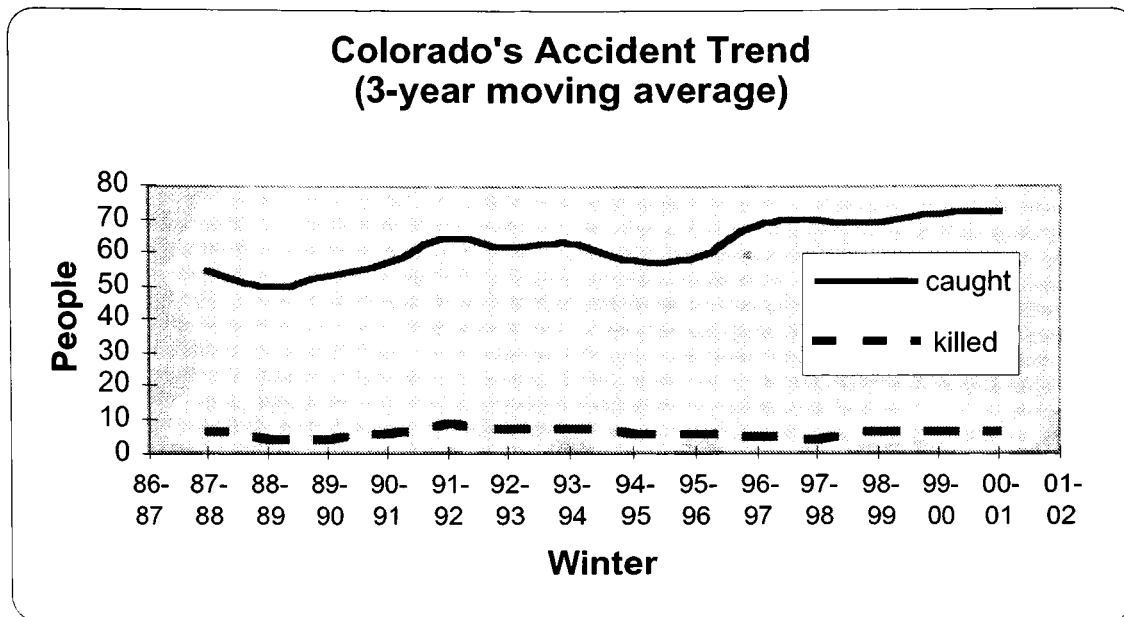


Figure 4. Colorado's accident trend in the last 16 seasons.

Table 3 lists all avalanche accidents reported this winter. The fatal accidents are italicized. Avalanche Center personnel investigate all fatal accidents (see Section VI). Accidents tended to occur during storms. One half of the avalanche accidents occurred during the winter's two stormy periods: late November to early December, and then in mid March.

Two of the fatal accidents involved exceptional circumstances. In November an avalanche crashed through 10-inch-thick ice as it swept two backcountry skiers into the frigid waters of Yankee Doodle Lake near Eldora. One man escaped but his friend drowned. The other accident with exceptional circumstances occurred in February at Aspen Highlands. There, a lone skier likely fell hard and then slid off a cat road and past the ski area boundary. His fall triggered a very small point release avalanche no wider than his skis. Momentarily incapacitated from his fall (as surmised in the autopsy findings) he was buried in loose depth hoar. Without a friend to uncover him, he died of asphyxiation.

Table 3 also reveals the results when eager, snow enthusiasts play on a very weak snow cover during a stormy period. From March 14-18, 22 people were caught, nine people were buried, and four were killed.

At the bottom of Table 3, notice the accident on Imogene Pass in late May. It serves notice that avalanches are still possible as long as some snow sits on steep slopes. Though the mountains between Telluride and Ouray looked more like mid-July with only a few patches of snow remaining, enough still lingered for an avalanche to catch an unsuspecting county plow driver.

Table 2. Summary of avalanches, hazard days, and accidents for 2001-02.

	Nov	Dec	Jan	Feb	Mar	Apr	May	TOTAL
Avalanches reported	187	172	281	433	322	99	1	1,495
Days with 1 or more slab avalanches	8	24	25	22	26	8	1	114
Avalanche warning periods	0	0	0	1	1	0	0	2
Days with warning in effect	0	0	0	3	3	0	0	6
NORTHERN MOUNTAINS								
Days with hazard rated ...								
LOW	22	0	0	0	0	12		34
MODERATE	2	21	24	19	22	9		97
CONSIDERABLE	6	10	7	7	9	0		39
HIGH	0	0	0	2	0	0		2
EXTREME	0	0	0	0	0	0		0
CENTRAL MOUNTAINS								
Days with hazard rated ...								
LOW	22	0	3	0	0	6		31
MODERATE	2	21	28	20	21	11		103
CONSIDERABLE	6	10	0	8	8	4		36
HIGH	0	0	0	0	2	0		2
EXTREME	0	0	0	0	0	0		0
SOUTHERN MOUNTAINS								
Days with hazard rated ...								
LOW	22	0	6	0	0	6		34
MODERATE	2	20	23	21	21	11		98
CONSIDERABLE	6	11	2	7	9	4		39
HIGH	0	0	0	0	1	0		1
EXTREME	0	0	0	0	0	0		0
AVALANCHE ACCIDENTS								
People caught	6	10	6	7	28	2	1	60
People partly buried	2	4	1	0	5	0		12
People buried	2	3	0	3	10	0		18
People injured	1	0	2	0	3	0		6
People killed	1	0	0	3	4	0		8
Vehicles caught	0	2	0	2	10	0	1	15
Property sites damaged	0	0	0	0	0	0		0

Table 3. Colorado avalanche accidents, 2001-02 (italics indicate fatal accident).

Date	Location	Details
11/11	Flattop Mtn, RMNP	1 climber caught and partly buried
11/24	Loveland Pass	2 backcountry skiers caught
11/28	Yankee Doodle Lake, Eldora	2 backcountry skiers caught, 1 buried, 1 submerged under ice, 1 injured, and 1 killed (drowned)
11/29	Monarch Pass	1 snowcat guide caught and partly buried
12/2	Willow Creek Pass	2 snowmobilers caught and buried
12/2	Cameron Pass, Diamond Peaks	1 backcountry snowboarder caught and partly buried
12/5	Berthoud Pass	1 backcountry skier caught and partly buried
12/6	Vail	1 ski patroller caught
12/8	Loveland Pass	1 backcountry skier caught
12/8	Loveland Pass	1 backcountry snowboarder caught and partly buried
12/17	Cameron Pass, Diamond Peaks	2 backcountry snowboarders caught, 1 partly buried, and 1 buried
12/29	Molas Pass, Sultan Mountain	1 backcountry skier caught
1/8	Tenmile Range, Peak 1	1 backcountry snowboarder caught
1/18	Berthoud Pass	1 backcountry skier caught and severely injured
1/19	St. Mary's Glacier	1 backcountry snowboarder caught
1/21	Berthoud Pass	1 backcountry skier caught
1/21	Berthoud Pass	1 backcountry snowboarder caught
1/23	Aspen Mountain, McFarlane's Bowl	1 out-of-bounds skier caught, partly buried, and severely injured
2/1	Aspen Highlands	1 lift skier caught, buried and killed
2/2	Vail Pass	1 snowmobiler caught
2/6	Elk Mountains, Crystal Peak, Friends Hut	1 backcountry skier caught, buried, and killed
2/9	Red Mountain Pass, Red Mtn 1	1 avalanche forecaster caught
2/17	Berthoud Pass	1 backcountry snowboarder caught
2/20	Telluride	1 ski patroller caught
2/24	Miner Basin, SW of Sunlight	1 snowmobiler caught, buried, and killed
3/3	Berthoud Pass	1 person caught
3/9	Wolf Creek Pass	1 ski patroller caught and partly buried
3/9	Cottonwood Pass	1 snowmobiler caught and buried
3/9	Mount Crested Butte	Condo unit struck
3/14	Aspen Mountain	1 out-of-bounds skier caught, buried, and killed
3/14	Ashcroft, Lindley Hut	5 backcountry skiers caught, 3 partly buried, 2 injured, 1 buried and killed
3/14	Grand County, Bower Mtn	5 snowmobilers caught and buried
3/15	Tenmile Range, Peak 6.5	3 backcountry snowboarders caught, 1 partly buried
3/15	Telluride	2 out-of-bounds snowboarders caught, 1 severely injured, 1 buried and killed
3/16	Flattops, Pagoda Peak	3 snowmobilers caught, 1 buried and killed
3/18	Aspen Highlands, Maroon Bowl	1 out-of-bounds snowboarder caught
3/18	Summit County, Mt. Guyot	1 snowmobiler caught
3/21	Berthoud Pass	1 backcountry skier caught and injured

Date	Location	Details
3/28	Purgatory	1 backcountry skier caught
3/31	Silverton, S. Mineral Creek	2 ice climbers caught and partly buried
4/2	Aspen Highlands, Five Finger Bowl	1 backcountry skier caught
4/3	Silverton Mountain	1 skier caught
5/28	Imogene Pass	1 county snowplow operator caught

This synopsis has presented a general and statistical overview of the 2001-02 winter season. For a more detailed description of events, please turn to the next section, the Detailed Winter Summary.

Detailed Winter Summary

November

November began with a thin, patchy snow cover above timberline in all mountain areas, and almost no snow at all in our snow study sites. A small storm on November 8 brought 4-10 in. of new snow, just in time for the opening of the Avalanche Center on November 9. But it was 10 days until the next light snow fell on the 18th, so the Center operated only on a part-time basis for most of November.

Thanksgiving Day, November 22, marked the beginning of a sustained storm. When it ended on the 27th, storm totals were Winter Park, 26 in.; Vail, 55 in.; Gothic, 33 in.; Red Mountain Pass, 34 in.; and Wolf Creek, 18 in. The storm was the catalyst for an active avalanche cycle, with 160 avalanches being reported from the 23rd-28th. On the 28th, the season's first avalanche death occurred when a backcountry skier near Eldora was swept into Yankee Doodle Lake and drowned. His companion was also swept into the lake and survived not only the avalanche but a four-mile walk to Eldora ski area, while soaking wet in near-zero temperatures.

The month ended with another storm dropping 1-6 in. of new snow in the northern and central mountains (though Grand Mesa got 15 in.) and 6-15 in. in the San Juans. Monthly snowfall proved to be highly varied: in the northern mountains, Steamboat got 151% of normal; Vail, 128%; Copper Mountain, 115%; Berthoud Pass, 108%; Loveland, 81%; Breckenridge, 79%; Winter Park, 76%; Arapahoe Basin, 50%; and Bear Lake, 47%; in the central mountains, Gothic got 108%; McClure Pass, 100%; Monarch, 87%; and Aspen Highlands, 70%; and in the southern mountains, Red Mountain Pass got 114%; and Wolf Creek, 77%.

During November there were 187 avalanches reported to the Avalanche Center, which was far above average. There were four reported avalanche incidents that caught six people, injured one, and killed one.

December

Late November snows carried into the first week of December for all mountain areas of Colorado. McClure Pass saw 22 in. fall in the first six days of the month, and Vail reported 27.5 in. during the first seven days of the month. By comparison, Wolf Creek Pass reported only 16.5 in. It was a windy start to the month as well. Gusts into the 50s and 60s were not unusual, with gusts into the 80s and 90s reported from the northern mountains on the 6th.

The next system slipped into Colorado on the night of the 10th. It slowed over Colorado and snow fell for the next six days as a series of weak systems kept light snow falling across the state. As expected, it favored the San Juans with the most precipitation: Wolf Creek Pass recorded 33 in. through the 17th, though Telluride only reported 10 in. Snow lingered an extra day in the northern mountains where Beaver Creek collected 11.5 in. The central mountains weren't nearly as fortunate as Gothic recorded only 3.5 in. during the same period, though Powderhorn on Grand Mesa recorded 12 in. on the morning of the 16th.

The two small weather systems in the first half of December brought an increase in avalanche activity. From the 2nd to the 16th, 37 slides were reported in the northern mountains, 44 in the central mountains, and 33 in the southern mountains.

Following winter's official arrival on the 21st the next storm brought pre-Christmas snows to all mountains. Telluride and Irwin Lodge reported 12 in. on the morning of the 22nd, and Vail, 10 in. A small avalanche cycle was reported from the 18th to the 23rd with 25 avalanches in the northern mountains.

This little Christmas present was followed by seasonably cool high pressure until the 27th when the high-pressure ridge eased a little further east. This brought Colorado the last snows for 2001 on a northwest flow that favored the north and central mountains, and the north side of the San Juan Mountains. Breckenridge saw 9 in. of snowfall before the year rang out, while Telluride got 9.5 in. A last small cycle ran during the last three days of the month, involving the northern mountains with 12 slides reported.

In December there were 172 avalanches reported to the Center, which is below normal. There were 8 avalanche incidents reported, which caught 10 people, partly buried 4, completely buried 3 and caught 2 vehicles (snowmobiles).

December snowfall showed a lot of variability, just like November. In the northern mountains, Copper Mountain got 119% of normal; Steamboat and Winter Park, 100%; Vail 96%; Bear Lake, 85%; Berthoud Pass, 82%; Loveland, 82%; Breckenridge, 77%; and A Basin, 63%; in the central mountains, McClure Pass, 133%; Aspen Mountain, 82%; Gothic and Crested Butte, 80%; Monarch, 75%; and Aspen Highlands, 62%; in the southern mountains, Telluride, 148%; Red Mountain Pass, 119%; Wolf Creek, 109%; and Purgatory, 60%.

An important feature of December snows was the absence of large storms. Every snowfall was shallow and put minimal load on the existing snow cover. The snowpack was building very slowly, one thin layer at a time, without adding any strong layers. With a strong temperature gradient from bottom to top, it was a recipe for facet growth (aka, sugar snow) in all layers of the shallow snow cover, and the resulting snowpack was extraordinarily weak.

January

Often January has the highest number of avalanches and accidents, due to the fact that snowpack through December is often too shallow to produce numerous avalanches, and the snowpack has grown very weak from faceting. January then brings the storms that overstress the weak snowpack, and avalanches become plentiful. Not this year, however, because the January storms did not appear.

The month began with light snow falling in the northern mountains. Most sites got 7-11 in. on the 1st-2nd. On the 4th, another small system came in on northwest flow and brought light snow to the northern mountains and the Aspen zone until the 7th. Amounts were 6-12 in. in the northern mountains and 4-8 in. in the Aspen area. Winds increased on the 5th-8th, and this built a layer of slab. Another shot of wind and snow on the 10th dropped 6-9 in. in the Summit County area and 3-9 in. in the central mountains. This was enough to cause a few avalanche releases on the 10th-11th: 20 were reported in the northern mountains and 8 in the central.

The next storm system hit the northern mountains on the 13th and proved to be the only sustained storm of January, finally exiting on the 19th. During this time, Steamboat got 23 in.; Winter Park, 24 in.; Breckenridge, 22 in.; and Beaver Creek, 19 in. In addition, persistent strong winds caused blowing snow and slab formation, and more than 70 avalanches were reported. On the 18th at Berthoud Pass, an avalanche swept a backcountry skier off a cliff; he survived but sustained injuries.

Snow also fell in the central and southern mountains on the 16th-19th, but amounts were small: Aspen Mtn., 10 in.; Snowmass, 13 in.; Gothic, 10 in.; Monarch, 13 in.; Wolf Creek, 11 in.; and

Telluride, only 4 in. Ten small avalanches were reported in the central mountains, and 15 in the San Juans.

On the 23rd a quick-hitting system brought more snow and wind. Most sites in the northern and central mountains got 4-6 in., but Steamboat got 13 in. (and 22 in. on the 21st-23rd). The San Juans only got 2 in. of snow, but blowing snow followed. This caused a mini-cycle of avalanche releases on the 23rd-26th: 17 in the northern, 25 in the central, and 25 in the southern mountains. On the 23rd, an out-of-area skier at Aspen Mountain was injured in a slide he triggered.

On the 29th a very selective system dropped 8 in. at Steamboat and 11 in. at Powderhorn, but none elsewhere. The 30th-31st brought 4-6 in. of snow to the northern and central mountains, while 6-10 in. fell in the southern mountains. Wolf Creek even got 20 in. This caused a flurry of small slides, with 11 being reported from the central mountains, and 20 from the San Juans.

For January, snowfall was near normal to below normal in the northern mountains, but well below normal in the central and southern mountains. In the north, Steamboat and Copper Mountain got 108%; Berthoud Pass, 101%; Winter Park, 98%; Breckenridge, 96%; Vail, 84%; Bear Lake, 75%; Loveland, 65%; and A Basin, 60%; in the central, Aspen Mountain, 89%; Aspen Highlands, 73%; Crested Butte, 63%; McClure Pass, 59%; Monarch, 52%; and Gothic, 46%; in the south, Wolf Creek, 68%; Telluride, 45%; Purgatory, 40%; and Red Mountain Pass, 30%.

The avalanche total for January was 281, which was far below normal. Only six avalanche incidents that caught six people (and injured two) were reported, for one of the quietest January's ever.

February

February started on a dry and somber note. There was nothing but dry weather for the first week of the month, but avalanches would make the news nonetheless. On a clear-sky day, the second avalanche fatality of the season happened on Feb. 1st, just outside the Aspen Highlands ski area boundary. The victim was alone and was buried in a remarkably small point-release slide in a thoroughly-faceted snowpack. Then another fatality was reported on the 6th, near the Friends Hut between Crested Butte and Aspen. A lone skier got out in front of his group and was caught and buried in a small hardslab. By the time the rest of his group discovered what had happened, it was too late.

With the exception of a puny storm on the night of the 4th, which left only a trace to 2 in. in the northern mountains, the first snows did not come until the 8th. The snowpack continued to lose strength due to the continued large temperature gradient within the shallow snow cover. Many observers continued to report collapsing and cracking snow in their areas.

This first storm brought snow that favored the northern mountains. It was short lived, but a thirsty mountain snowpack was grateful for the 5 in. that was reported by Winter Park, 10 in. at Copper, and a very nice 22 in. from Steamboat over the two-day storm. The central mountains were not as blessed, but 3 in. at Aspen Highlands and 1 in. at Gothic were appreciated. With the weak snowpack, it took little to bring on an small avalanche cycle: 20 slides were reported from the northern mountains during this short lived snow cycle. Strong winds contributed to this cycle, with wind speeds up to 92 mph from Breckenridge on the 8th. Cold temperatures followed this brief flurry with low temperatures falling below zero every night until the 14th.

Another quick 3-7 in. fell statewide on the 14th as a slow-moving cold front crossed the state. On the 18th a weak disorganized storm stalled over Utah, with some light snows falling in the northern and central mountains. On the 20th the storm suddenly strengthened, and up to 16 in. of snow fell in the Summit County area. By the 21st 15.5 in. had fallen at Steamboat, and 21 in. at Breckenridge. Many central mountain sites fared well too: Irwin Lodge totaled 22.5 in. from this surprise storm,

and Aspen Mountain, 11.5 in. In general the southern mountains fared less well: Telluride had 9.5 in. but Red Mountain Pass had 21 in.

This storm system brought about the first avalanche warning of the season, and 36 avalanches were sighted in the northern mountains, 56 in the central mountains, and 175 in the San Juans. This was one of the biggest avalanche cycles of the season. On February 24th a snowmobiler was killed in a slide about 15 miles southwest of Sunlight ski area. This brought the Colorado avalanche toll to four.

The big story for the rest of February was cold temperatures. All sites consistently reported overnight lows well below zero, with Bear Lake reporting the lowest at -19 on the night of the 27th. The cold northwest wind would continue to drag arctic air into Colorado into March. We hadn't seen the end to frigid temperatures, or avalanche fatalities yet.

The avalanche total for February was 411. In all there were seven avalanche incidents that caught seven people, and buried and killed three.

Snowfall in February was almost a carbon copy of January: normal to below normal in the northern mountains, but well below normal in the central and southern mountains. In the north, Breckenridge got 102% of normal; Steamboat and Copper Mountain, 100%; Berthoud Pass, 84%; Beaver Creek and Loveland, 75%; A Basin, 70%; Winter Park and Vail, 63%; and Bear Lake, 47%; in the central, Monarch, 61%; McClure Pass, 59%; Aspen Mountain, 51%; Crested Butte, 48%; Aspen Highlands, 45%; and Gothic, 27%; in the south, Telluride and Purgatory, 72%; Red Mountain Pass, 48%; and Wolf Creek, a sad 10%.

March

Though March would roar in like a lion, it still did not spell an end to the dry pattern Colorado had experienced through most of the 2001-02 season. Upslope snows ushered in the month as 12 in. fell in Fort Collins and 7 in. at Bear Lake. Some light snowfall amounts were reported from the mountains too on the 1st-3rd. Steamboat had a total of 6.5 in., while Powderhorn on Grand Mesa got 9 in.

It was brutally cold temperatures, however, that had the greatest impact. On the morning of the 2nd, Loveland recorded a low temperature of -30, and Powderhorn fell to -28. The high temperature in Breckenridge on the 2nd was -11 degrees. It wouldn't be until the night of the 5th that low temperatures would finally get above 0. A low pressure trough coming out of the Gulf of Alaska finally broke the cold north flow that Colorado had been under for over a week.

The next storm hit on the 7th with strong winds that gusted into the 60s. It began in the central and southern mountains and lasted two days. It initiated an avalanche cycle, and the CAIC issued its second avalanche warning of the season, this one covering the Elk Range near Aspen. Observers reported 84 avalanches in the warning area during the warning period. It was a good storm as 33 in. fell at Gothic, 31.5 in. at Irwin Lodge, 26 in. at Crested Butte, and 9 in. at Telluride. The northern mountains reported less snow, with Steamboat seeing a two-day total of 12 in. and A Basin, 6 in.

On the 9th strong winds with gusts into the 70s continued to load lee slopes, and this brought a rash of avalanche activity. A snowmobiler was completely buried in a slide on Cottonwood Pass on the 9th but was found alive by a random probe after an 8-minute burial. Also on the 9th an avalanche hit the Sunrise Condominiums in Mt. Crested Butte, which had been hit before. This time, however, a recently-constructed avalanche deflector prevented any damage.

The next storm produced a great deal of tragedy and sorrow. A strong short wave imbedded in zonal westerly flow pounded the Colorado Rockies on the night of the 13th. By the morning of the

14th, Winter Park had added 9 in.; Eldora, 11 in.; and Steamboat, another 14 in. Aspen was close behind with 9.5 in., and Ashcroft, 5 in. On the 14th, two separate avalanche fatalities ran rescue crews in the Aspen area to their limit. A backcountry skier staying at the Lindley Hut near Ashcroft was buried and killed and two other party members were injured in an avalanche they had triggered. Later that day, a woman left the boundary of Aspen Mountain Ski Area and was skiing alone when she triggered and was buried by a small avalanche in a gully. Rescuers uncovered her body several hours later.

The deaths did not end, however. Telluride reported another 1.5 in. new snow on the morning of the 15th, and the 7th avalanche fatality of the season was to happen soon after. Two snowboarders left the Telluride Ski Area boundary and entered Tempter Bowl about 12:30 in the afternoon. Tempter Bowl is a well-known and permanently closed area. Both were caught in a large slide; one was severely injured and the second was deeply buried and died.

Another avalanche on the 14th very nearly claimed several lives. A party of 15 snowmobilers was riding on Bower Mountain near Grand Lake when an avalanche buried 5 riders. One had a hand out of the snow, and another had a foot out. The 10 other riders began a frantic search that, over the next hour, located and uncovered all 5 victims. All survived, though it was a very close call for several: one was buried 4 feet deep.

Unfortunately, the string of accidents was not over yet. On March 16, three snowmobilers on Pagoda Peak in the Flattop Range were caught in a slide; one was buried and killed. The number of fatalities in Colorado had reached eight. There were a number of very close calls during this period as well. A snowmobiler near Mt. Guyot in Summit County was buried to his neck in a slide on the 18th. Also on the 18th, there was a very close call in Maroon Bowl near Aspen when four backcountry users narrowly missed catastrophe in a large slide. Ski patrollers from the area said the four young men "were very lucky to be alive."

A weak trough would bring continuing snow showers to the mountains until the 20th when a warm dome of high pressure again built over Colorado. High pressure lasted until the 24th when a broad trough developed over the Great Basin. With generally west winds, all mountains picked up less than 4 in. each day through the 26th, though light snows lingered through the 28th in the northern mountains.

The month ended under high pressure and warming temperatures. By the 29th, the central and southern mountains were starting to see a wet slide cycle. Daytime high temperatures were in the 40s and low 50s. The depth-hoar-dominant snowpack quickly fell apart as 16 wet slides were reported from Telluride to Crested Butte. There was one last near miss as well. Two ice climbers in South Mineral Creek near Silverton on the 31st had just finished their climb when a large wet slide released above them, burying them to their waists.

It had been a rather cold and decidedly deadly month, one most avalanche workers gladly put behind them. There had been 322 avalanches reported, resulting in 15 avalanche incidents that caught 31 people, buried 10, injured 3, and killed 4. Ten snowmobiles were caught in slides.

March snowfall was well below normal for all but two sites. In the northern mountains, Steamboat got 89% of normal; Bear Lake, 81%; Copper Mountain, 77%; Beaver Creek, 64%; Loveland Basin, 58%; A Basin, 54%; Breckenridge, 51%; Berthoud Pass, 45%; and Vail and Winter Park, 40%; in the central mountains, McClure Pass, 120%; Crested Butte, 104%; Gothic, 81%; Aspen Highlands, 76%; Aspen Mountain, 72%; and Monarch, 43%; in the southern mountains, Purgatory, Telluride, and Wolf Creek, all 72%; and Red Mountain Pass, 48%.

April

The wet-slide cycle that began in March continued and spread into the northern mountains, with 73 wet loose and wet slabs reported in the first six days of April. One large slide near Aspen in the Five Fingers Path on the 2nd caught a backcountry skier. She narrowly escaped with her life as she was able to ski out of it before it ran another 3,000 vertical feet to the valley floor. This proved to be the only reported avalanche incident in April.

April began on a dry note and then stayed that way. The first storm came into the southern mountains on the night of the 7th and brought 2 in. of snow to Red Mountain Pass and 1 in. to Silverton. After this weak storm, nighttime temperatures fell, and a freeze crust developed. This ended the wet-slide cycle.

The next storm cycle began on the 10th as a weak Pacific short wave finally broke through the dome of high pressure that had dominated Colorado's weather since the end of March. Vail reported 10 in. of new snow by the 13th, and Gothic, 6.5 in. Another very weak system brought a whopping 2 in. to Vail and Gothic on the 16th. Then came another weak storm on the 21st, and sites fared a little better as Bear Lake in Rocky Mountain National Park reported 6 in., and Gothic, 3.5 in. Snow would fall from the 26th to the 28th in all mountains, but with few reporting stations still operating, we can only say that Gothic was the big winner as 9 in. fell in the 3-day period.

The Avalanche Center ceased its daily backcountry forecasts on the 21st, but remained open for highway forecasting as warranted until the end of the month. No avalanches were reported after April 16th. A total of 99 slides were reported in April, most of which were wet slides caused from the warm temperatures. There was only one avalanche incident in April and one person caught.

April was another month with snowfall that was far below normal. Bear Lake got 35% of normal; Copper Mountain and A Basin, 25%; Gothic, 50%; and Red Mountain Pass, 25%. Almost all our snow study plots in the central and southern mountains had melted out entirely—with no snow on the ground—by April 30. This was unprecedented and pointed to severe water problems for Colorado's summer.

May

Only one wet avalanche was reported in May. It ran on the 28th on Imogene Pass near Ouray and caught an Ouray County bulldozer operator who was clearing snow from the jeep road. The man took a short ride but was not buried, and the dozer was almost taken over the edge of the road.

The lean winter snows resulted in Colorado's three main high-altitude mountain highways to open earlier than ever before. Trail Ridge Road, Independence Pass, and Mount Evans all saw their earliest openings. In fact Mount Evans usually requires 44 days to clear the winter snows. This spring the road was cleared in 16 hours.

Information Acquisition

Daily Weather, Snowpack and Avalanche Data

The Avalanche Center relies on incoming data to make accurate assessments of current avalanche stability, and to make mountain weather and avalanche hazard forecasts. There are multiple sources of these data, as described below:

Colorado Observer Network: The Center has established a network of about 35 manned observation sites in the Colorado mountains. Twenty-one sites are developed ski areas, from which snow-safety personnel report current weather, snowpack and avalanche data. The remaining sites are highway, heli-ski, and backcountry sites from which volunteers or contract observers report to the Center.

Snowmobile Observer Network: In cooperation with the Colorado Snowmobile Association, the Center has established a volunteer cadre of snowmobile observers. Trained by the Center's staff, these recreational snowmobilers take a few snow and avalanche observations during the course of their usual riding activities. Their observations are then e-mailed or faxed to the Center. This group supplies the Center with information and data from many distant mountain areas and has created a partnership unique in the avalanche industry. In addition, the trained riders then serve as focal points for avalanche safety in their clubs.

Backcountry Observers Network: During the past three seasons, Scott Toepfer has managed a small group of backcountry travelers dedicated and contracted to providing the Center with avalanche and snowpack observations. During the course of their recreational travels the observers gather information and data and send it to the Center before the next forecast day. This network supplies the Center with information and data from additional areas outside the normal observer network.

Remote Weather Net: The Center has established a network of remote, high-elevation weather stations. The seven stations are located on Mt. Abrams, Red Mountain, Lizard Head, Wolf Creek, Loveland, Berthoud, and McClure passes. Forecasters can access stations via computer modem for real-time data any time during the day or night, or via the Internet for hourly summaries. Forecasters can also access similar stations located at several ski areas.

National Weather Service: The Avalanche Center staff has access to all products and expertise of the NWS staff. Computerized weather maps, satellite imagery, radar data, and radiosonde data are all available from the state-of-the-art AWIPS workstations. Information is also available from manned and remote weather stations, and written analyses and forecasts. Additionally, discussions with NWS forecasters in interpreting data and products are an immense help.

Westwide Avalanche Network

As a cooperative member of the Westwide Avalanche Network (www.avalanche.org) the Center serves as a repository for avalanche accident data for the United States. Information on avalanche accidents is stored in a database maintained by the Center. The Center personnel use the accident data on a real-time basis and also for later analysis. Trends in accidents, relationships between survival and burial times and depths, and types and methods of rescues are essential information to be passed along to snow scientists, search and rescue teams, and the public. The Center's web site, lectures, field seminars, media contacts, and publications are some of the methods for disseminating this information.

Additionally, the Center responds to about 30 requests a year for raw or tabulated data. These requests come from the ski industry, the US Forest Service, universities and secondary schools, snow researchers, consultants, and lawyers.

Accident Investigation

An important goal and duty performed by the Avalanche Center is to investigate all significant avalanche accidents and fatal accidents. This winter, the staff investigated several accident sites and interviewed witnesses. The Center's staff visit the avalanche site and, especially if circumstances prevent a visit, speak with law enforcement officers, coroners, and rescuers to learn more about the accident. Timely information from these investigations is used for current stability evaluations while other information is available for future educational purposes. When serious accidents occur the Center is quick to post information about the accident on the Center's Web site.

Dissemination of Hazard Forecasts

The Colorado Avalanche Information Center provides vital information to the public, specialized audiences, and our sponsors. Following are the means by which the Center disperses information on mountain weather, avalanche, and snowpack conditions. Note that the TravelBank (Figure 5) has not been used since 1997.

Public Hotlines

Data from about 35 field observation sites are used to prepare forecasts for six hotlines in Colorado. People can call for three types of information: an up-to-date mountain weather forecast, a current snow condition report; and an avalanche hazard evaluation. Long-time phone sponsors include the U.S. Forest Service regional office in Lakewood, the Mountain Shop in Ft. Collins, the Mountain Chalet in Colorado Springs, Pine Needle Mountaineering in Durango, and the Summit County Rescue Group in Summit County.

This winter an estimated 41,147 calls were placed to the five avalanche hotlines updated from the Avalanche Center. (An additional avalanche hotline is located in Aspen but is not directly updated by CAIC staff.) We believe the number is lower than previous years due to the increasing number of people who are getting the forecast off of the CAIC Web site, and are receiving e-mailed forecasts through Friends of the CAIC. Even so, the Summit County hotline maintained an impressive 14,041 calls this winter.

E-mail to Friends, Observers and Forecasters

E-mail is an effective and efficient way to distribute CAIC's daily forecasts. Some 174,824 forecasts were sent via e-mail this season. They went to the Friends of the CAIC and to CAIC observers and highway forecasters. Our Friends also use e-mail to communicate frequently with the CAIC, making suggestions and reporting avalanche occurrences and accident information.

Web Site

The Center's Web site (www.geosurvey.state.co.us/avalanche) consists of over 20 different pages of data, which include forecasts, statistics, accident accounts, photos, basic avalanche information, and links to other sites. The CAIC site has become very popular in a short time, and an increasing number of people are now getting the daily forecast via the web. The most popular page is the daily forecast page, which received 202,161 hits by the end of May. The public made a total of 680,907 visits to all of the pages.

Figure 5 on the next page shows CAIC's product dissemination growth from these outlets. Note that hotline use has declined as e-mail and Web site distribution of the forecast has increased.

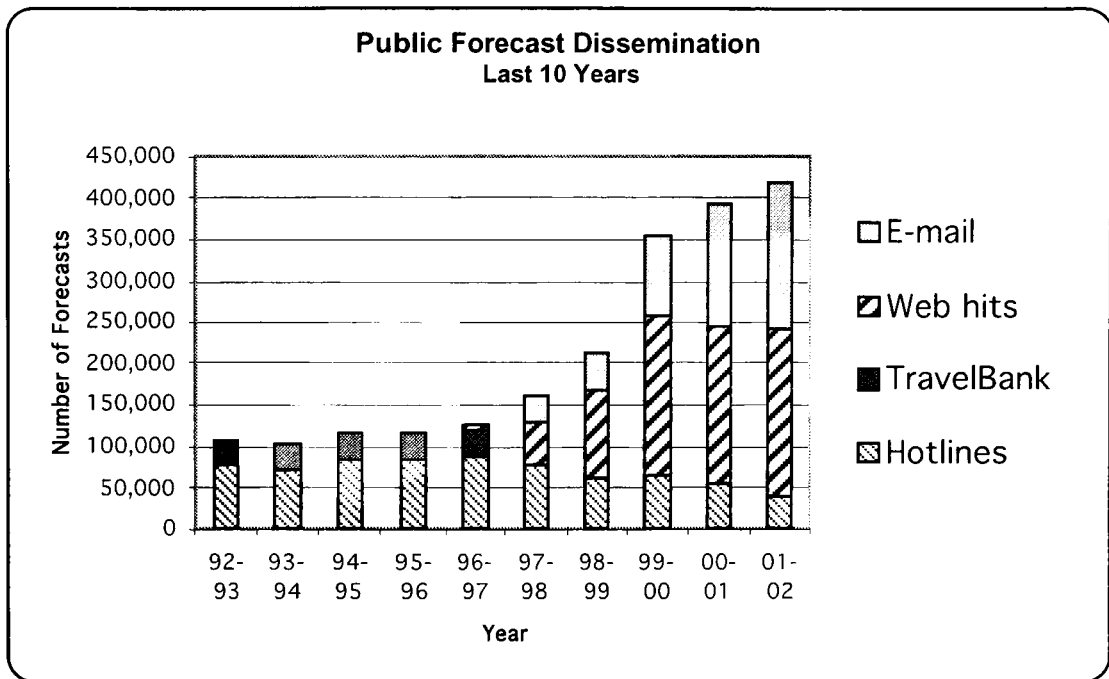


Figure 5. Public forecast dissemination for the last 10 years.

Radio Broadcasts

The Avalanche Center continues to enjoy a large listening audience through dedicated radio stations in mountain communities. This is especially beneficial to regions where long distance telephone calls to an avalanche hotline would be inconvenient and costly. While some stations broadcast our message daily, others have been most helpful by broadcasting avalanche warnings and special avalanche advisories when necessary. Some stations conveying these bulletins include public radio KVNF in Paonia, KOTO in Telluride, KVMT in Vail, KFMU in Steamboat, and KYSL in Frisco.

This winter KVNF radio in Paonia invited the CAIC to go on the air with them. On February 27, Rob Hunker and Scott Toepfer participated in an hour-long show to talk about the CAIC, avalanche safety, current conditions and answer questions from callers.

NOAA Colorado Weatherwire

When the avalanche danger is rated high or extreme, CAIC forecasters issue avalanche warning bulletins twice daily until the danger subsides and an Avalanche Warning Termination Bulletin is issued. Special Avalanche Advisories are issued when the avalanche danger could increase significantly if a storm forecast verifies. These bulletins are transmitted to the news media via the National Oceanic and Atmospheric Administration (NOAA) Weatherwire. Only two warning periods were initiated this winter that covered a total of six days. These low numbers, which are normally much higher, are a reflection of the lack of major storms this winter.

News Media

Throughout the winter avalanche-related incidents draw the public's and the media's attention. These events usually involve people, property, highways, or unusual mountain weather, and they trigger media calls to the Center. This winter the Center had 120 contacts with television, radio, newspaper, and magazine reporters. For reasons of timeliness, the daily forecast is not issued through the printed media. However, it is not uncommon for the media to follow up and write stories on avalanche warnings, special advisories and accidents.

Public Education

Education is essential to reducing avalanche accidents; thus, public education is a key component of the Center's mission to save lives. We achieve our education objective with the following:

Avalanche Courses

Demand for avalanche education has increased in recent years. This season courses began on September 29, 2001 and the last talk was given on June 7, 2002. By the end of the season the Center staff had spoken on 92 different occasions to nearly 3,400 people.

The courses vary from one-hour awareness seminars to multi-day field workshops. Table 4 lists all of the programs presented by CAIC staff. The awareness seminars offer a simple overview of avalanche hazard, while the multi-day programs cover mountain meteorology, avalanche terrain recognition, the Colorado snowpack, methods of safe winter travel, and survival and rescue techniques. Students this winter included backcountry enthusiasts, professional ski patrollers, search and rescue volunteers, law enforcement officers, snow-cat ski guides, members of ski and snowmobile clubs, the Colorado Mountain Club, USFS, National Park Service, and the Colorado Department of Transportation (CDOT).

Through our agreement with CDOT, the Avalanche Center staff provided specialized training to CDOT winter maintenance personnel on avalanche awareness, rescue, safety precautions, and avalanche reporting.

Table 4. Avalanche talks and seminars, 2001-02.

Date	Personnel	Group	Participants
9/29	HM	Snowmobile Expo, Denver	60
9/30	HM	Snowmobile Expo, Denver	40
10/4	DA	International Commission for Alpine Rescue, Makarska, Croatia	30
10/10	HM	REI for Earth Science Week, Denver	65
10/19	HM	Backcountry Skier's Alliance, Golden	110
10/19	DA	Colorado Scientific Society, Golden	64
10/24	HM	Mountain Miser, Englewood	65
10/29-11/2	KW, DA, NL	National Avalanche School, The Canyons, UT	191
11/1	LM, SS	CDOT, Hidden Valley	25
11/5	HM	Boy Scouts of America Troop 712, Denver	44
11/8	DA	Colorado Search and Rescue Board, Golden	25
11/16	LM, SS	CDOT, Walden	14
11/17	DH	Buena Vista Snowmobile Club	12
11/19	JR, AJB	CDOT	12
11/20	JR, AJB	CDOT	9
11/21	MM	CDOT, Pagosa Springs	9
11/26	DH	Custer County Search and Rescue	10
11/28	ST	Crested Butte	250
11/30	ST	Breckenridge Beacon Clinic	75
12/1	DH	Buena Vista Trailhead Talk	4
12/4	KW	The Mountain Shop, Fort Collins	65
12/4	AJB	CDOT, Cascade	2
12/5	MM	General awareness, Pagosa Springs	16
12/5	ST	General awareness, Vail	75
12/5	RH	CDOT, Grand Junction	12
12/6	MM	General awareness, Pagosa Springs	31
12/6	NL	Mountain Chalet, Colorado Springs	55
12/6-7	HM	Colo School Mines	20
12/8-9	HM, NL	Summit County Rescue Seminar	110
12/9	DH	Headwaters Shop, Salida	10
12/12	RH	CDOT, Eagle	14
12/13	DA	Neptune Mountaineering, Boulder	52
12/13	ST	Gore Range Nat Science School/Vail	12
12/13-16	HM	The Bent Gate, Golden	7
12/14	JR	EKW Memorial Fund	13
12/15	KW, NL, HM	Colorado Mountain Club Instructors	13
12/15-16	ST	Francie's Cabin/Summit Huts	20
12/20	MM	CDOT, Garfield County	12
12/23	RH	CDOT, Glenwood Springs	29
1/3	ST	Redlands Mesa Grange/ School Kids	12
1/4	NL	Breckenridge Ski Patrol	8
1/4-6	ST	Telluride Ski Patrol	50
1/5-6	HM, NL	Colorado Snowmobile Association, Steamboat Lake	22
1/7-9	AG, JR	Prescott College	8
1/8	DA	Alpine Rescue Team and Rocky Mtn Rescue Group	22
1/9	DA	Loveland Ski Patrol	18
1/10	DA, HM	Flight For Life, Denver	40
1/11-12	NL	Ski Haus, Steamboat	75
1/12	AG	Silverton Snowmobile Club	20

Table 4 continued

Date	Personnel	Group	Participants
1/15	AG	CDOT	2
1/8-15	DA	Alpine Rescue Team & Rocky Mtn Rescue Group	24
1/16	DA	Colorado Hydrology Society	26
1/18-20	HM, AG, AJB	Silverton Avalanche School	80
1/19	RH	Marble Fire Dept	12
1/19	RH	Town of Marble	11
1/21	DH	Buena Vista Boy Scout Troup No. 67	40
1/23-26	ST, KW	Ft Collins Mtn Shop	45
1/24	HM	Vail Ski Safety Day	120
1/25-26	HM	Aspen Mtn Rescue	82
1/25-27	DH, AG, AJB	Silverton Avalanche School	80
1/28-31	DA, HM	Colorado Mountain Club, Golden	40
1/29-30	DH, HM, AG, AJB, MM	CDOT Avalanche School, Silverton	44
1/31	JR	Sterling College	10
2/1	MM	General awareness, South Fork	31
2/multiple	LM, SS	CDOT, rescue beacon refreshers	24
2/1-3	DH	Silverton Avalanche School	49
2/2	LM, SS	CDOT beacon training	23
2/6-7	DA	National Outdoor Leadership School, Driggs, ID	12
2/6-7	NL, ST	Summit County Pro Course	20
2/8	JR	Sterling College	8
2/11-15	DA, KW	Colorado Mountain Club, Golden	40
2/11	HM	Boulder Boy Scout Troop 75	35
2/12	HM	Englewood Discovery School	20
2/18	AJB	Sterling College	8
2/20	JR	Telluride Mtn Club	30
2/22-24	AG, JR, AJB, ST	Silverton Avalanche School	50
2/23	MM	Search & rescue group	4
2/25-28	NL, DA	Colorado Mountain Club, Golden	35
2/26	JR	Minnesota State University students, Silverton	50
3/4-7	NL, HM	Colorado Mountain Club, Golden	37
3/8-9	JR, AJB	American Avalanche Institute, Silverton	22
3/10	AG	Silverton Snowmobile Club	12
3/13	AG	Multiple university students, Silverton	22
3/14	AG	Colo Rocky Mtn School	10
3/15	DA	Areo Club	17
3/21	HM	Denver Museum of Nat & Sci	65
3/22	AG, JR, AJB	American Avalanche Institute, Silverton	12
3/23	HM, LM	Denver Museum of Nat & Sci, Field	9
3/25-26	NL	Beaver Ck Ski Patrol, Beaver Creek	9
3/26	HM	Conifer High School	20
4/9-10	DA	Denali National Park, Hatcher Pass, AK	30
4/17	RH	CDOT, Independence Pass group	9
4/22	DA	Colorado Mountain Club, Golden	64
6/7	DA	Mt. Rescue Assn., National Meeting, Estes Park	30
		92 Courses	Total
			3,346

Figure 6 shows CAIC's education data for the last 10 years. While there are peaks and valleys, the figures remain fairly constant. When compared to the same data for the 1980s, the current numbers are significantly higher.

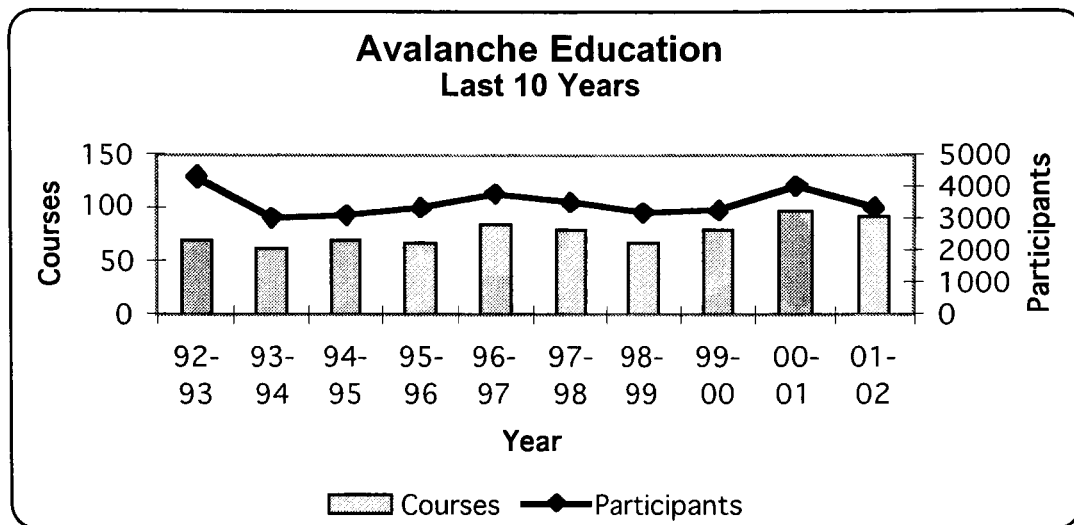


Figure 6. Avalanche education for the last 10 years.

Professional Conferences and National Avalanche School

Several of the Center's staff were featured speakers at several national and international conferences. Dale Atkins presented a paper on trends in U.S. Avalanche Accidents at the 2001 International Alpine Rescue Commission's annual meeting in Croatia, and Knox Williams, Nick Logan, and Atkins taught at the National Avalanche School in Park City, Utah.

Avalanche Education Materials

For the 14th season, Atkins made avalanche accident slide sets for use by avalanche educators throughout the U.S., and the rescue videos produced several years were again available to educators.

Publications

Center personnel worked on several projects for publication this year. Atkins had an article in the National Ski Patrol's *Ski Patroller Magazine* and co-authored a soon-to-be-published article for the geophysics magazine *The Leading Edge*.

Nick Logan completed two new publications. First, to assure that data coming into the CAIC remains accurate, consistent and efficient, the *CAIC Observers Guide 2001* was produced and distributed to all of the Center's observers. And second, a new color brochure, *Avalanche Areas of the Vail Pass Recreation Area*, was created to increase avalanche awareness and public safety. Complete with photographs and maps, we anticipate it will minimize accidents in this popular backcountry area.

Web Site

The Center's Web page (www.geosurvey.state.co.us/avalanche) provides avalanche and weather information useful to novices and experts alike. In addition to the popular daily forecast page, Internet surfers can get information, pictures, and graphics on various avalanche and weather related topics. This year there were 680,907 visits to our site.

Forecasting for Colorado's Highways

In 1992, Silverton was chosen for the location of the first CAIC-CDOT avalanche forecast office. Following a successful trial run under heavy winter conditions, the Statewide Avalanche Reduction Plan officially took effect on October 1, 1993. Now, six CAIC avalanche forecasters are based in Silverton, Pagosa Springs, Carbondale and at the Eisenhower Tunnel. They prepare daily stability evaluations, provide recommendations for avalanche reduction and road closures, maintain weather and avalanche records and conduct avalanche training for highway personnel. CDOT provides the funds necessary to run this program.

Table 5 shows the impact of avalanches this season on Colorado's mountain highways. It lists the number of natural and explosive-triggered avalanches that reached the roadways. There was a significant decrease (40%) from the previous winter. Read on to learn more about the highway forecasting program and the winter's events for each forecast region.

Table 5. Avalanches reaching Colorado highways (does not include bank-slips).

Forecast Office	Inclusive Highways	Natural Avalanches	Triggered Avalanches	Total
Silverton	US 550 Ouray to Coal Bank Pass; US 145 Lizard Head Pass; Colo. 110 (Silverton to Gladstone)	72	173	245
Eisenhower Tunnel	US 40 Berthoud Pass; US 6 Loveland Pass; I-70 Georgetown to Vail Colo. 82 Independence Pass	5	27	32
Pagosa Springs	US 160 Wolf Creek Pass; US 50 Monarch Pass; Colo. 17 Cumbres and La Manga passes	2	1	3
Western Slope	Colo. 133 McClure Pass; Colo. 139 Douglas Pass; Colo. 65 Grand Mesa; Colo. 24 Tennessee Pass; Colo. 82 Shale Bluffs, Snowmass Canyon; I-70 Glenwood Canyon	5	4	9
Total				289

CDOT/Silverton Forecast Office

The Silverton Forecast Office has completed its 10th winter monitoring and forecasting avalanches for more than 100 slide paths along the US 550 corridor from Coal Bank Pass on the south end to Ouray on the north end. Additionally, the office is responsible for avalanche forecasts along Colorado 145 (Lizard Head Pass) and Colorado 110 (Silverton to Gladstone).

The forecasters work closely with plow drivers who contribute valuable storm data and slide observations to help formulate the forecasts. Training, including procedures for avalanche rescue and personal safety, is provided to CDOT workers and others. This winter, lead forecaster Andy Gleason and assistant forecaster Jerry Roberts prepared daily evaluations to keep CDOT apprised of avalanche conditions in their region. In her second season with the CAIC, Aleph Johnston-Bloom worked as a full-time forecaster in November and December (while Andy was away at graduate school), did forecasting one day a week throughout the spring with supervision from Andy and Jerry, and did her normal intern duties of collecting study plot data, digging snowpits, monitoring avalanches and helping teach avalanche courses.

Synopsis

This season was one of the driest on record in the San Juans, and was the driest year since 1976-77. There was a little snowfall in October, and it did not snow again until a Thanksgiving storm that brought 30 in. and the first avalanche cycle of the season. December snow totals were close to average, but cold, clear weather between storms weakened the snowpack. January had below average snow amounts with only 12-20 in. of snow falling along the mountain passes. This contributed to a faceted snowpack that was very weak, but had no slab on top of it. February was also below average for snowfall. Until February 20, all the avalanches were point releases. On the 20th, enough new snow fell to create a slab and a large avalanche cycle ensued. Most of March's snow fell in the first week of the month, with very little snow after that. By March, the San Juans had the weakest snowpack observed since forecasting began here in 1992. April was very warm with only 2-9 in. of snow. Most of the paths had melted out and four of five Snetel sites were at 0% of average.

Weather Highlights

The lack of significant snowfall was a big factor in the weather this season. The largest storm was 22 in. in February, which caused the largest avalanche cycle of the season. Unusually cold temperatures in January and February contributed to the weakening of the snowpack on all aspects. Strong southwest winds scoured many of the upper starting zones in mid winter. These winds also brought three different dust layers from the desert, which were discernable in the snowpack. The first of these came on January 24 and two more occurred in March. They persisted until the end of the season and seemed to enhance melting at the surface layers by collecting more short wave solar energy. The lack of snow later in the season contributed to the very low percent-of-average snowpacks in many areas. The Snetel sites, weather stations maintained by the Natural Resources Conservation Service, have never read 0% at the end of the season before.

Snowfall and Water Equivalent

Station	Total snowfall (in.)	Total water equivalent (in.)	Comments
Red Mountain Pass	193	18.55	33% of average on April 30*
Molas Pass	145	13.25	0% of average on April 30*
Coal Bank Pass	169	12.44	0% of average on April 30*
Lizard Head Pass	48	04.74	0% of average on April 30*
Monument	135	11.61	0% of average on April 30*
Gladstone-CO Hwy 110	113	11.65	n.a.

*all data based on SNOTEL yearly averages.

Snowpack and Avalanche Highlights

There was no significant snowpack until Thanksgiving. After the big storm in November, avalanche control work was conducted and the season really began. During December, the snowpack weakened considerably due to small storms and cold temperatures. A warm period in early January caused some strengthening of the lower snowpack and initiated a small wet slide cycle. It was not enough to overcome the limited snowfall and the entire snowpack became faceted, with the depth hoar and the near surface facets merging by mid month. No significant storms occurred until February 20, when 22 in. of new snow initiated a large, natural avalanche cycle. Many paths ran full track and numerous size-4 avalanches were recorded. An interesting aspect of this cycle was the large number of small fractures on the steep banks at the top of Red Mountain Pass. From the top of Red Mountain Pass for about 1.5 miles north, every bank had a fracture, some of which propagated 1/4 of a mile. After the 20th, there was significant whumping and cracking in the snowpack. A High avalanche danger rating lasted to the end of the month.

The unstable snowpack persisted into March and was responsible for an avalanche fatality near Telluride on the 15th. The spring warm up began in March and the first wet cycle occurred on the 22nd, followed by a cold period. Usually when this occurs the snowpack gains enough strength that it does not have a second wet cycle. This year, because of the large amount of depth hoar which significantly weakened the lower snowpack, a second cycle occurred one week later after another period of warm temps. Another warm up in early April prompted control work for wet slides. Results were very good with the avalauncher, which is unusual, and was probably due to the very weak snowpack. By the end of April, most of the snow study sites had melted out. This has not happened in 10 years of forecasting in the San Juans.

Control work was conducted on 13 days this season. The earliest was on November 24 and the latest was on April 5. The avalauncher, 105 Howitzer and the helicopter were all used this year, with most control work done with the avalauncher. Due to the large amount of depth hoar this season, control work during the spring wet cycle was more effective than in previous years. The avalauncher was able to initiate numerous large, wet slides that typically would have taken 25-50 pound shots from the helicopter.

Road Closures

Full gate closures: Red Mountain Pass had 38 hours total; Molas/Coal Bank, 0 hours total. Spot closures occurred on 13 days this season on Red Mountain, Molas and Coal Bank passes from November through April for a total closure time of 13 hours.

Avalanches Affecting the Highways

Highway	Natural	Triggered	Depths and Total Length of Debris on Centerline
Hwy 550/RMP (Hit road)	37	52	1-9 ft x 2,103 ft (triggered) 1-10 ft x 1,073 ft (natural)
Hwy 550/RMP (did not hit road)	23	83	n.a.
Hwy 550 Molas/Coal Bank (hit road)	0	0	No avalanches hit the road
Hwy 550 Molas/Coal Bank (did not hit road)	7	33	n.a.
CO 145/Lizard Head Pass	0	0	No avalanches hit the road
CO 110 to Gladstone	5	5	No avalanches hit the road
Totals	72	173	Debris on Centerline = 3,176'

Avalanche Incidents

There were no avalanche incidents involving the highways. However, on March 15 an avalanche fatality occurred in Temptation Bowl just outside the Telluride ski area. A 31-year-old, female snowboarder was caught in an avalanche while riding out of bounds. She triggered a large soft slab avalanche that ran 2,200 vertical feet. CAIC personnel helped with the rescue efforts, but the body was not found until spring.

Also, an incident involving an Ouray County snowplow and operator was investigated by his office. The avalanche pushed the plow to the edge of the road on Imogene Pass during spring opening operations. The plow and operator stopped just short of going over the edge.

Media Contacts and Avalanche Training

Eleven media contacts were made this year including newspaper articles in the *Durango Herald*, *Telluride Times*, *Telluride Daily Planet*, *Ouray Plaindealer*, *Silverton Standard*, *Silverton Mountain Journal*, *Chicago Tribune*, *Christian Science Monitor*, *Ski* magazine, and *Solo Nieve* magazine.

The Silverton forecasters taught avalanche courses for CDOT personnel, schools, and the general public. These courses reached 503 people. To do this, they dedicated some 268 hours in preparation and teaching, and 28 hours driving to and from these courses.

Fundraisers

Three fundraisers took place in the fall at Durango, Ouray and Telluride. Silent auctions were held at Carvers Brewery in Durango, the Buen Tiempo restaurant in Ouray, and at the Swede Finn Hall in Telluride. All of these establishments were very generous in their donations of time and money. We were able to raise approximately \$4,150 for the CAIC.

CDOT/Pagosa Springs Forecast Office

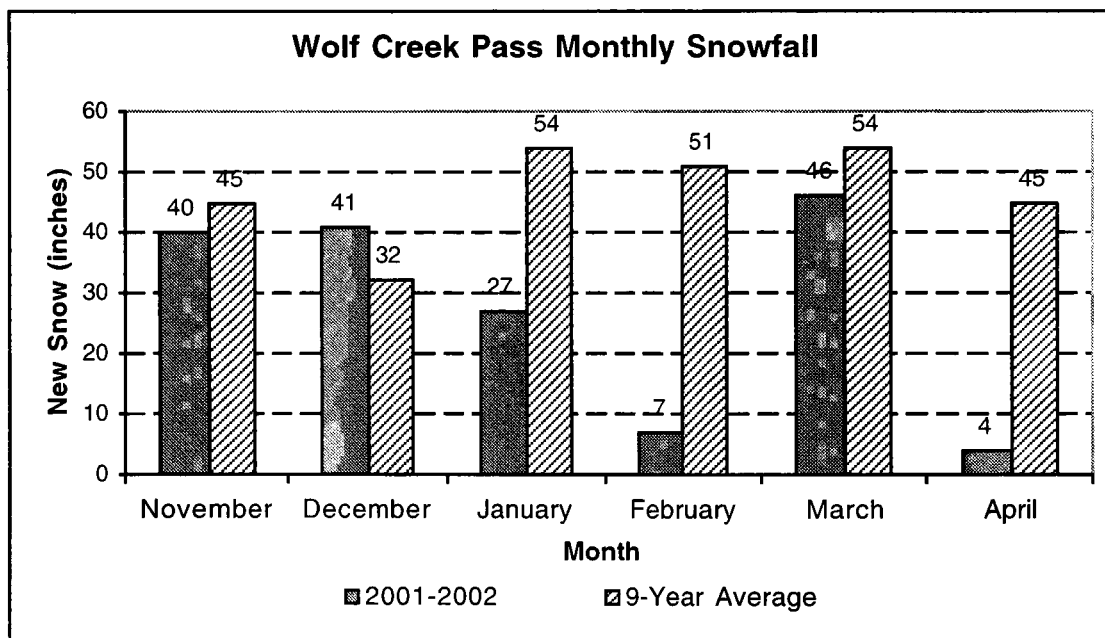
This office is located in the CDOT maintenance barn in Pagosa Springs and staffed by Mark Mueller. The office has completed its ninth winter of forecasting for US 160, Wolf Creek Pass; US 50, Monarch Pass; and Colorado 17, Cumbres and La Manga passes.

Synopsis

Snowfall was below average at mountain sites throughout the western U.S. but well below average in southern Colorado. Locally, this winter is being compared to the winter of 1976-77 which was the driest in the last 30 years. New snow water content totals for the winter were only 40-50% of average at representative sites at Wolf Creek, Monarch, and Cumbres Passes. Advisories were issued from November 16 to April 19. The Highway Avalanche Condition Rating remained LOW at the southern passes for the entire avalanche season. No avalanche control or highway closure was necessary except at Monarch, where explosives were recommended to test the snowpack on two occasions.

Weather Highlights

The seasonal snowfall was the lowest recorded (by nearly 4 feet!) at the Wolf Creek Summit in nine seasons. It was below average for all but one month this season. February and April were particularly dry as seen in the snowfall graph and precipitation table below. Temperatures were colder than usual. Average 24-hour maximum and minimum temperatures were 2 to 4 degrees colder than average from December through March. A minimum temperature of -13 was recorded at Wolf Creek in early March. This is the coldest temperature measured at this site in eight seasons. Average new snow density at Wolf Creek Pass was 7.8%, which is similar to last year's average of 8.1%. During the mid to late 1990's, the average new snow density was 10.3% and these winters were much more avalanche-filled.



Snow Water Equivalent (inches)

Site	Nov	Dec	Jan	Feb	Mar	Apr	Total from Oct. 1 and Percent of Average
Wolf Creek Summit ¹	3.2	3.5	1.7	0.7	3.7	0.0	14.5 / 40%
Upper San Juan ²	3.5	3.8	1.6	0.7	4.2	0.0	(missing)
Cumbres Trestle ³	3.0	2.8	1.5	0.7	1.8	0.0	10.8 / 39%
Porphyry Creek ⁴	1.7	1.1	0.6	1.3	1.1	0.5	7.9 / 46%

¹ Wolf Creek Pass Snotel site at Wolf Creek summit, south of the highway, 11,000 ft

² Wolf Creek Pass Snotel site at Wolf Creek access road, 10,200 ft

³ Cumbres Pass Snotel site NW of Cumbres Pass, 10,040 ft

⁴ Monarch Pass Snotel site NW of Monarch Pass, 10,760 ft

Snowpack and Avalanche Highlights

The snowpack was shallow and weak at all passes the entire winter. This was a concern, but sufficient stress delivered in the form of new snow was lacking. New snow amounts were small and the densities light. Avalanches remained isolated through the winter, but those avalanches that released were often Class 3 out of 5.

At the end of March, very warm temperatures brought non-freezing conditions overnight. This caused an early spring wet snow avalanche cycle that was more widespread than normal. There was little threat to the highways at the southern passes where snow depths were so shallow that little snow was available to avalanche. Several small, wet snow avalanches covered up to one lane of the highway at Monarch Pass during this period.

With a rather fragile snowpack but little significant snowfall, there was only isolated avalanche activity this winter. Avalanches were observed from November 6 through April 1. Due to relatively stable conditions and limited snow depth in the avalanche tracks with which to support avalanche flows to the highway, avalanche control was not necessary at Wolf Creek or Cumbres/La Manga Passes. Explosive testing was recommended twice at Monarch Pass, February 23 and March 8. Traffic was delayed 3 hours and 45 minutes, which was the season total. The highways safely remained open for virtually all season.

Avalanches Affecting the Highways

Highway	Natural	Triggered	Average depths and total length of debris on centerline
Wolf Creek Pass	0	0	n.a.
Monarch Pass	2	1	3 ft-5 ft x 100 ft
Cumbres/La Manga	0	0	n.a.

Avalanche Education

Mark Mueller taught several avalanche classes this winter to both CDOT personnel and the public. These courses reached 142 people and provided basic awareness to advanced topics.

CDOT/Eisenhower Tunnel Forecast Office

This season was the ninth season of operation for this office which is housed in the CDOT engineers building (Road Control) at the west portal of the Eisenhower Tunnel. Lead forecaster Lee Metzger and coworker Stu Schaefer staff this office.

The forecast area, CDOT Region 1, includes US 40, Berthoud Pass; US 6, Loveland Pass and Interstate 70 from Georgetown to Vail. Cameron and Independence passes are monitored when required. Snowfall and weather data are gathered daily from snow study plots located at Road Control, Berthoud Pass, Loveland Pass, Vail Pass and the highway shop near the Arapahoe Basin ski area. Forecasters are on duty from November 1 through April 30 but continue into May if snow conditions warrant.

Synopsis

The main weather highlight of the season was the lack of it. Storms brought only meager amounts of snow and only once did a 24-hour storm total exceed double digits, 10 in. on Vail Pass. Snowfall amounts were the lowest ever recorded at all of the study plots, including Berthoud Pass where records date back to 1950.

Compared to last winter, control missions were down by 25% and there were three helicopter missions compared to five in 2000-2001. This winter's snowpack, and its behavior, was significantly different than previous "normal" seasons. For example, the Stanley avalanche path on Berthoud Pass has released at least one large avalanche every year since 1993. This year no large avalanches ran. But the Little Professor avalanche path on Loveland Pass, which is usually stubborn and releases only small slides, released the largest slide observed since 1993.

Weather Highlights

Even though snowfall was light, winds were constant throughout the winter, as is customary on both Loveland and Berthoud passes. During early and mid winter, wind events were not accompanied by much snowfall. This resulted in significantly fewer and smaller avalanches attributed to wind slabs.

Average temperatures were slightly warmer than normal, although periods of extremes were observed. For example, in February a low temperature of -22°F was recorded on Berthoud Pass, but during March and April, the flow brought very warm temperatures in the 40s. This contributed to springtime snow loss in avalanche starting zones both faster and earlier than in previous years.

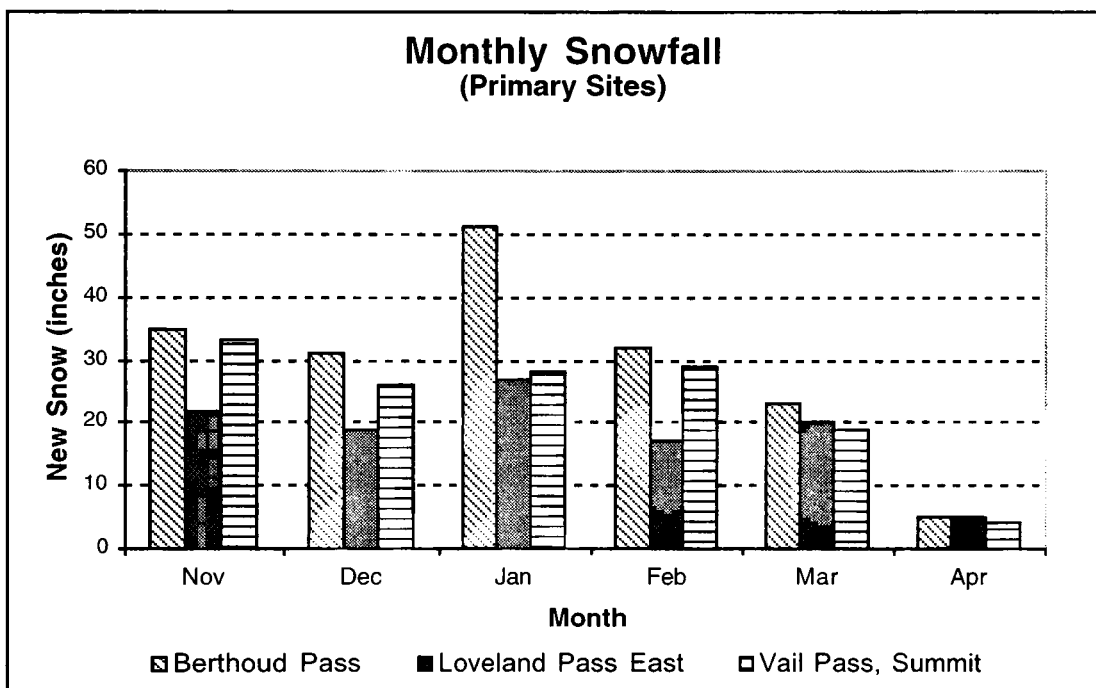
November began with a powerful high pressure cell that dominated Colorado and inhibited snowfall into mid-month. However, by month's end enough snow had fallen to require several avalanche reduction missions. December was dry. At the Loveland Pass snow study plot only 19 in. of snow fell, compared to 57 in. in December 2000. This dry trend continued throughout the season and resulted in fewer avalanche control missions.

The dryness continued into February with snowfall about 20% below average at the Berthoud Pass Q12 study plot. Avalanche control missions produced no notable avalanches. Arctic air slipped into the state and brought a 10-day cold snap that lasted into early March. It brought only a few inches of snow.

March started cold and windy but warmed up significantly by mid-month. The meager snowpack began to shrink even more with warm afternoon temperatures and winds up to 70 miles per hour. April was dry, windy, and fueled more heat to a rapidly-vanishing snowpack.

Snowfall and Water Equivalent (Inches)

Location	Total Snowfall	Water Equivalent	Comments
Berthoud Pass	177	14.75	58% of average; lowest since 1950
Loveland Pass East	109	8.68	
Loveland Pass West	121	10.89	
Road Control (Ike Tunnel)	129	9.89	50% of average
Vail Pass, summit	138	11.07	61% of average
Vail Pass, Narrows	125	9.69	

**Snowpack and Avalanche Highlights**

The best way to describe the snow in Region 1 this season was weak, from beginning to end. This was the result of a very shallow snow cover in all but the highest of wind-loaded starting zones. The snowpack consisted mostly of weak, granular grains that would not support the weight of a skier.

A rain event on January 8 affected only Vail Pass locally. It laid down a thin ice layer that was a contributory factor to good avalanche control results later in the month. However, the slides were small and snow barely reached the highway. January was uneventful but it formed a shallow, brittle and layered snowpack. This could have become a dangerous situation with ensuing heavy snowfall, but it never came.

Snowfall at the end of February finally formed a slab over the unconsolidated snowpack. While it made backcountry travel possible in areas that had not been previously compacted by skiers or snowmobiles, to the forecasters it signaled an increase in the avalanche danger. Because of the weak snow, the threat of large avalanches loomed in many areas but avalanche volumes remained small.

Concern mounted in February over a continued tendency for the Stanley avalanche path (a major threat to US 40) not to respond to reduction efforts. Portions of the starting zone released from time to time but the path did not produce a large avalanche this winter, which is uncommon. The weak snowpack persisted into spring and small wet snow slides were the result. Only one of these affected the highway and control work was not necessary.

By mid April most avalanche starting zones contained very little snow. Most tracks were completely bare and only a few high elevation northerly aspects were still holding snow. Warm temperatures in April resulted in widespread wet-slab avalanche activity throughout Region 1. But with only a shallow snowpack, this cycle presented little danger to the highways.

There were no avalanche control missions in April, but on the 15th a wet slab came down from the extreme west end of the Vail Pass Narrows and reached I-70. It deposited 4 feet of snow on one westbound lane, which was quickly cleaned up. By late April, as a result of minimal snowfall (50%-61% of average) and sunny spring days, only the Seven Sisters avalanche paths on Loveland Pass and the "80" path on Berthoud Pass had enough snow to reach the highway.

Avalanches Affecting the Highways

Highway	Natural	Triggered	Average depths and total length of debris on centerline
I-70—Georgetown to Vail	1	5	2 ft x 70 ft
US-6—Loveland Pass	0	18	4 ft x 410 ft
US-40—Berthoud Pass	4	4	3 ft x 200 ft
Loop Road (Ike Tunnel)	0	0	n.a.

Avalanche Incidents

On January 18, the season's only rescue took place. It was on the summit of Berthoud Pass and involved a slide path that does not affect the highway. Ray Mumford (CDOT avalanche supervisor) and Stu Schaefer assisted rescuers, including Flight For Life, in evacuating a skier who was swept over cliffs after triggering a small avalanche. CDOT highway crews ran traffic control until the rescue was completed.

Avalanche Education

Lee Metzger and Stu Schaefer conducted avalanche training for CDOT personnel throughout the season. They made regular visits to highway barns to discuss snow conditions as well as safety issues. The forecasters participated in the annual CDOT Silverton Avalanche School and other courses, including one sponsored by the Denver Museum of Nature and Science.

CDOT/Western Slope Forecast Office

The Western Slope Avalanche Forecast Office, based in Carbondale, provides avalanche forecasts to Region 3, Maintenance Section 2, for four highways in the Central Mountains and for the opening of Independence Pass in the spring. State Highway 133 over McClure Pass near Marble is the primary area of responsibility, with additional forecasting for Highway 139 over Douglas Pass, Highway 65 on Grand Mesa, and U.S. Highway 24 at Battle Mountain. Avalanche forecaster Rob Hunker is in charge of this office.

Synopsis

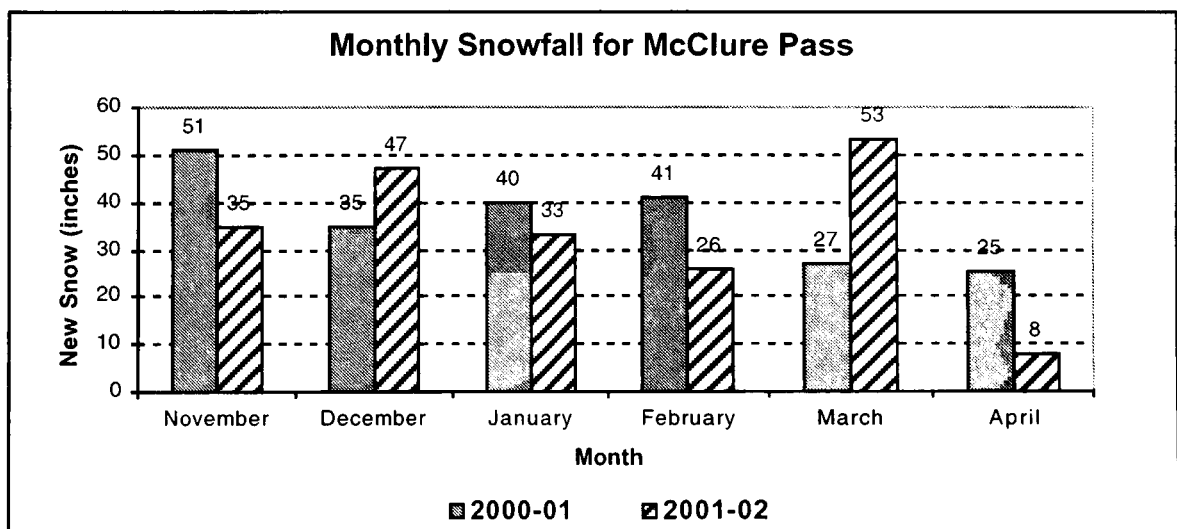
McClure Pass received more snow, percentage wise, than most areas in the state. There were 55 days of measurable precipitation from November 1 through April 22, but no major storms during the season. McClure Pass and Grand Mesa were closed only once each for avalanche control. In addition to his highway responsibilities, Hunker investigated two separate backcountry avalanche fatalities, on February 6 and 24. Additionally he used PowerPoint for the first time for CDOT avalanche training sessions presented through the winter.

Weather Highlights

The fall was dry until November 23, which was the start of a snowy period that lasted until the middle of December. This brought the snow depth and water content to 95% of average by the end of December. After this good start there were only small, intermittent storms until March 7.

Total new snow amounts on McClure Pass in January and February measured only 59 in. Average new snow amounts for March were reached by the 19th and then the dry, hot weather settled in for the remainder of the season. On April 21, total precipitation for the season was 77% of average. However, a very dry and warm period that lasted from mid March through April caused a major meltdown. The snowpack water content measured on April 21 was a dismal 2% of normal for that date.

Temperatures were near or slightly below normal until the major warm-up in March and April. There were no unusual rain or wind events, although during the last half of April winds were strong on a daily basis. The following chart compares monthly snowfall for the last two winters.



Snowpack and Avalanche Highlights

The early snows of late September, October and the first half of November melted off below 11,000 feet, so there was no snowpack in the region until late November. This, combined with consistent new snow through the middle of December, created a strong, stable snowpack with a depth on McClure Pass of 29 in. on the 16th. Then cold, dry weather dominated and kinetic metamorphism within the snowpack prevailed. By February 14 the snowpack was very weak and essentially was all depth hoar.

Backcountry travel was almost impossible because a skier or snowmobile would collapse through the snowpack to the ground. If you fell while skiing, you would wallow in the depth hoar. The snowpack continued to weaken. It reached its weakest stage during the middle of March when it became isothermal below 9,000 feet. But then, for a brief one-week period around March 17, the snowpack gained an incredible amount of strength with the first skiable slab of the season. Isothermal conditions soon weakened the snowpack again. It melted rapidly and completely disappeared by mid April.

There were five avalanche cycles on the western slope this winter. These occurred on November 25, January 23, February 15, March 8, 12, 13, 14, 19, 28, and April 7.

The November, January and February avalanches were small soft slabs; the March and April avalanches were small wet slabs and loose occurrences. There were two road closures during the season in the region for avalanche control work. McClure Pass was closed for one hour on March 19 for explosive testing but there were no slides. Highway 65 on Grand Mesa was also closed on March 19 for explosive control work that brought down four avalanches that crossed the highway. There were two avalanche days on Battle Mountain, but the slides didn't reach the highway. Douglas Pass saw no avalanches this winter.

Snowpack conditions throughout the season were fragile. Widespread natural avalanche activity was deemed likely with any major, multi-day storm or high intensity precipitation. The potential for avalanches to reach the highways in the region was real, but this never happened because of the absence of major storms. This was an unusual season.

A summary of road closures and avalanches reaching the highways is shown below.

Avalanches Affecting the Highways and Road Closures

Highway	Natural	Triggered	Road Closures
CO 133/McClure Pass	2	0	1
CO 65/Grand Mesa	3	4	1
CO 139/Douglas Pass	0	0	0
US 24/Battle Mountain	0	0	0

Avalanche Education

Rob Hunker conducted six avalanche courses over the winter. They were provided to CDOT, a local fire department and school and reached 87 people.