

Snow & Avalanche



Colorado
Avalanche
Information
Center

Annual Report
1990-91

*Colorado
Department of
Natural Resources*

*Colorado
Geological Survey
1313 Sherman, Rm. 715
Denver, CO 80203*

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Colorado Avalanche Information Center

ANNUAL REPORT
1990-'91

JULY 1991

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Colorado Department of Natural Resources
1313 Sherman, Room 715
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STATE OF COLORADO



ROY R. ROMER
GOVERNOR

JOHN W. ROLD
DIRECTOR

COLORADO GEOLOGICAL SURVEY
DEPARTMENT OF NATURAL RESOURCES

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DENVER, COLORADO 80203 PHONE (303) 866-2611

TO: Ken Salazar, Executive Director, Department of Natural Resources
FROM: John W. Rold, Director, Colorado Geological Survey
DATE: June 25, 1991

JWR

SUBJECT: CAIC Annual Report

The Colorado Avalanche Information Center has completed its fourth year under the management of the Colorado Geological Survey and its eighth year within the Department of Natural Resources. I am pleased that the program has been even more successful than in its previous years. The Center plays an increasingly important role in achieving the Colorado Survey's statutory goal to increase the safety of the citizens and reduce the economic losses from geologic hazards.

We continue to see strong support by a growing number of sponsors, annual increases in the use of the public hotlines and a steadily increasing demand from the public and news media for the educational and informational services provided. Even with rapidly growing backcountry use by skiers and snowmobilers and increasing recreational and business travel through our mountains, Colorado has maintained a level trend in serious avalanche incidents.

The purpose of the Center is to minimize the economic and human impact of snow avalanches on recreation, tourism, commerce, industry and the citizens of Colorado. Director Knox Williams and his able staff achieve this through a dual mission of forecasting and public education.

The Center remains wholly funded by grants and donations from both the public and private sectors with no appropriation from the Colorado General Funds. This year the Center managed to increase revenues by about 7 per cent over last year and thus stemmed several years of declining revenues. This positive outcome resulted from hard work by the staff of the Avalanche Center in attracting new sponsors and the affirmation by current sponsors of their commitment to funding the Center.

The enclosed copy of this year's Annual report highlights the operations and accomplishments of the Center. This report is prepared primarily for the Center's sponsors, whose belief in its mission and support have made the Center possible. I would welcome your suggestions for improving or expanding the Center's services.



Colorado Department of Natural Resources

Colorado Avalanche Information Center

10230 Smith Road
Denver, Colorado 80239
(303) 371-1080

DIRECTOR'S STATEMENT

To Our Sponsors and Patrons:

A new decade. As the calendar ushered in the winter of 1990-91, the Colorado Avalanche Information Center entered its second decade. With the formative years of the 1980s behind us, the Avalanche Center is now a more mature organization. We foresee the new decade bringing continued challenges and opportunities, but we feel confident that we can achieve the same levels of success that we experienced in the 1980s.

How do we measure success? We have no precise measures, such as sales volume or earnings per share. Rather, we rely on numbers such as calls to our hotlines and attendance at our seminars. We have seen steady growth in both these figures. We also take pride in small, qualitative measures of success: a personal "thank you" from someone attending an avalanche class; letters from school children in Summit and Eagle counties in appreciation of programs that we had done for them; a "thanks" from magazine or newspaper writers and from radio and TV reporters for providing them the information to help them complete their stories; letters from hotline users; letters from listeners who hear our voices daily on radio KVNF in Paonia and KOTO in Telluride; chance meetings with people on a ski trail who say, "I know you. I attended an avalanche talk you gave last year. Thanks"; employees of the ski industry, highway department, Forest Service, or search and rescue teams who tell us thanks for a good job.

The bottom line is that we measure success the old-fashioned way -- through customer satisfaction.

The Colorado Avalanche Information Center remains committed to providing the best possible service to the public and our sponsors. It is your support that makes the Center possible. We thank you.

Sincerely,

A handwritten signature in black ink that reads "Knox Williams". The signature is written in a cursive style with a large initial "K".

Knox Williams
Director

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EXECUTIVE SUMMARY

Administration: The Colorado Avalanche Information Center is managed by the Colorado Geological Survey, a division of the Department of Natural Resources.

Funding: The Center is totally cash and federally funded. In FY 1990-'91, total revenues were \$117,475 (compared to \$109,759 last year).

Housing and Staffing: The Center is housed at the National Weather Service in Denver, with an office also at the U.S. Forest Service in Fort Collins. Four forecasters shared the responsibilities of a seven-day work week during the winter season from November through April.

Summary of avalanche events: A total of 2,242 avalanches were reported to the Center this season (21% above normal). Avalanche Warnings were posted on 30 days (four below normal). Five people died by avalanche (one above normal). There was negligible property damage.

Avalanche hotlines: The Center maintains avalanche message phones in seven Colorado cities and towns for the public to call for current conditions. Some 55,841 calls were made to the hotlines this winter, up 13% from last year. Users of the Colorado TravelBank, a computer bulletin board into which we put our daily forecasts, made 25,421 contacts seeking weather and avalanche information.

Media contacts: The Center logged 163 contacts with broadcast and print media, once more achieving a timely and accurate dissemination of avalanche information and a high profile for the Center. Additionally, five mountain radio stations broadcast our hazard evaluations and forecasts daily.

Public education: Center personnel presented 54 avalanche awareness talks and field seminars, personally reaching some 2,211 people. For the fourth year, we participated in Avalanche/Back Country Safety (ABC'S) Week. We continued to distribute the Center's avalanche awareness cards, brochures, and posters.

Hazard grading: Each year the Center grades itself on its daily avalanche hazard forecast. This year the results were 91% correct forecast, 4% over-forecast, and 5% under-forecast.

FUNDING and BUDGET

The Colorado Avalanche Information Center is totally funded by grants and donations. A year ago funding was \$109,759. For FY 1990-'91, funding of \$117,475 came from the 28 sponsors listed below.

Federal

U.S. Forest Service	\$60,000
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State

Colorado Department of Highways	\$20,000
Colorado Division of Parks, Snowmobile Fund	\$ 2,000

Local Government

Eagle County	\$ 3,000
Pitkin County	\$ 3,000
Summit County	\$ 2,000
Town of Breckenridge	\$ 1,200
Town of Frisco	\$ 1,000
Town of Silverthorne	\$ 500

Ski Industry

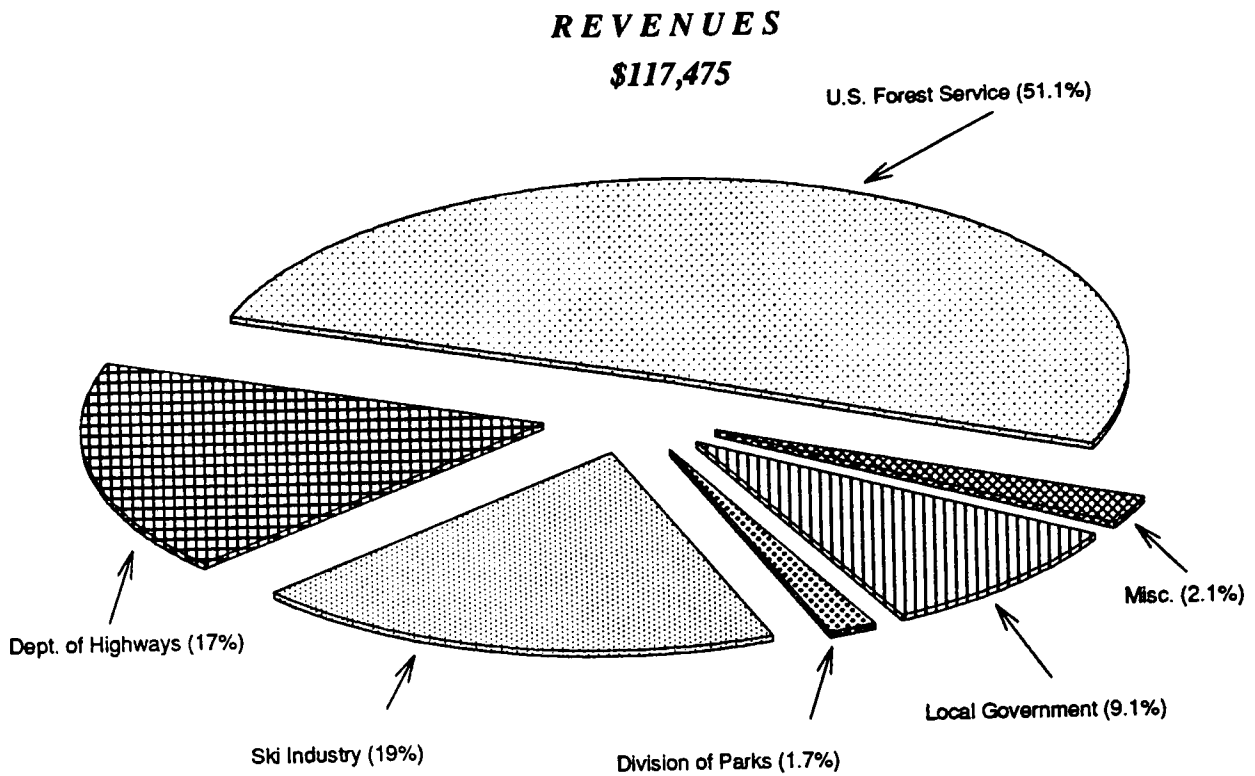
Colorado Ski Country USA	\$15,000
Winter Park Recreational Association	\$ 1,000
Breckenridge Ski Area	\$ 1,000
Vail Associates	\$ 1,000
Steamboat Ski Area	\$ 1,000
Copper Mountain Resort	\$ 1,000
Crested Butte Mountain Resort	\$ 600
Arapahoe Basin	\$ 500
Telluride Ski Corp	\$ 500
Loveland Ski Areas	\$ 500
Snowmass Resort	\$ 250

Miscellaneous

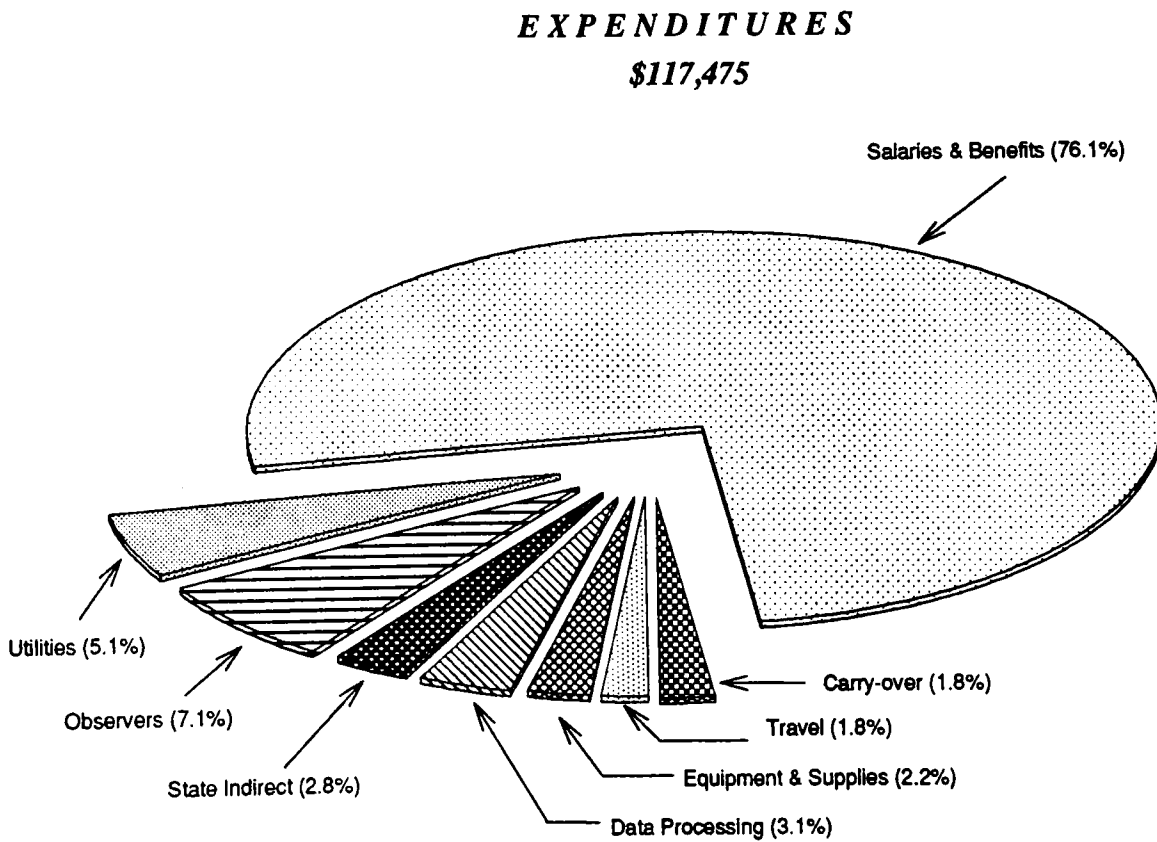
Colorado Search & Rescue Board	\$ 500
Mountain Rescue - Aspen	\$ 500
Alfred Braun Hut System	\$ 300
Tenth Mountain Trail Association	\$ 300
Henderson Mine and Mill	\$ 300
NCAR	\$ 275
Neptune Mountaineering	\$ 200
REI	<u>\$ 50</u>

Total	\$117,475
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WHERE THE MONEY CAME FROM



HOW THE MONEY WAS SPENT



OPERATIONS

Administration: The Avalanche Center is managed by the Colorado Geological Survey under the directorship of State Geologist John W. Rold. Founded in 1983, the Center was administered for four years by the Executive Director's Office of the Department of Natural Resources before moving to the Geological Survey in April 1987. The Center is totally funded by grants and donations.

Housing: The Center has its main office at the National Weather Service Forecast Office in Denver (at 10230 Smith Road.) The space provided is shared with NWS Fire Weather operations. Secondary office space is provided by the U.S. Forest Service in Fort Collins.

Season: The Center operates on a full-time basis seven days a week from November through April. During the summer months, the Center is closed and the staff works on a part-time basis.

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 twice-daily information to the public, via recorded telephone messages (hotlines) (see Section VII);
- warn of dangerous avalanche conditions by issuing avalanche warning bulletins via the NOAA Colorado Weatherwire and the news media (see Section VII);
- present educational avalanche awareness talks, seminars, and public service announcements (see Section VIII);
- investigate all significant avalanche incidents (see Section VI);
- be a focal point of avalanche information for sponsors, news media, government or private agencies, researchers, writers, etc.
- provide specialized information to sponsoring agencies; and
- maintain a computer data set of mountain weather and avalanche events, from Colorado and other mountain states (see Section VI).

Staffing and Duties: Personnel for the 1990-'91 winter were: Knox Williams (Director), Nick Logan (Associate Director), Dale Atkins, and Gordy Reese. One of the four forecasters was on duty daily from 6:30 am to 4:30 pm, from opening day on November 13, until closing on April 22.

The forecaster was 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 recorded telephone messages (hotlines) twice daily;
- issuing and terminating avalanche warnings when warranted;
- handling special requests from sponsoring agencies; and
- initiating or responding to calls from the news media.

Data Sites: The Center maintains a network of mountain observation sites for providing weather, snowpack, and avalanche data to the forecast office. Altogether there are approximately 32 manned sites: 20 are ski areas, and the remainder are highway and backcountry locations. The Center supports contract observers at Berthoud Pass, Gothic, and Red Mountain Pass; it also has access to data from remote weather stations maintained by the Soil Conservation Service.

Education: Forecasters present avalanche awareness talks and field seminars to many groups, providing education opportunities to citizens, tourists, and avalanche practitioners. In addition, forecasters maintain frequent contact with news media personnel to give broad (and accurate) coverage of current avalanche conditions. Such news stories not only inform but also enhance avalanche education among the public. Section VIII details our efforts in the areas of public education and safety.

WEATHER and AVALANCHE SYNOPSIS

The winter of 1990-'91 produced three distinctive snowfall personalities, resulting in a record number of avalanches. The winter got off to an early start with deep snows in the Central and Southern Mountains¹ in October and November. The months of December to February were progressively drier, allowing what was once a generally stable pack to become shallow and weak so that even light snowfalls produced avalanches. Winter returned with a vengeance in March with heavy snows for all sites, causing wide-spread avalanching.

Monthly temperatures (obtained from the Colorado Climate Center) in the mountains were: November, about 2 degrees F above normal; December, about 4 F below normal; January, 1 to 2 F below normal; February, 3 to 5 F above normal; March, 1 to 3 F above normal; and April, 1 to 2 F below normal. These fluctuations very nearly canceled each other out, so that the average winter temperature was about 1 degree F above normal.

Snowfall

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

In a reversal of last year's dry start, early season snowfalls favored the Central and Southern Mountains. A steady flow of moisture at the beginning of November favored the Southern and Central Mountains, and snowfall wound up 107-120% of normal. The Northern Mountains were not so lucky and were only 56-66% of normal.

December brought below normal snowfall for all areas except Wolf Creek: Amounts in the Northern Mountains ranged from 43-91%; in the Central Mountains, 50-84%; and in the Southern Mountains, 42-95%, though Wolf Creek got 120% for the second month in a row. All sites saw most of the snow fall in a 10-day period from the 13th-22nd.

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 this line from Denver-Hoosier Pass-Glenwood Springs to a southern boundary line from Pueblo to Montrose. The Southern Mountains lie between this Pueblo-Montrose line and the New Mexico border.

Table 1. 1990-'91 snowfall totals in inches (percents of normal are for sites with 10 or more years of record)

	Nov	Dec	Jan	Feb	Mar	Apr	<i>Total</i> Dec-Mar	<i>% of</i> Norm	<i>Total</i> Nov-Apr	<i>% of</i> Norm
<u>Northern Mountains</u>										
Arapahoe Basin		41	38	24	82	86	185	89%		
Bear Lake	25	29	29	17	55	36	130		191	
Beaver Creek		55	53	29	100		237	112%		
Berthoud Pass	30	39	45	39	88	73	211	104%	314	104%
Breckenridge	28	25	31	32	57		145	68%		
Copper Mountain		33	37	35	85	50	190	109%		
Eldora		20	21	20	28	54	123			
Loveland		32	42	40	94	84	208	91%		
Steamboat		55	74	38	72		239	97%		
Vail		45	65	48	111		269	102%		
Winter Park s.a.		51	47	37	100		235	92%		
Winter Park town	19	35	28	19	67	51	149	97%	219	98%
<u>Central Mountains</u>										
Aspen Highlands		32	22	23	73		150	88%		
Aspen Mountain		27	29	38	79		173	106%		
Cooper		25	14	19	60		118			
Crested Butte		23	24	21	80		148	90%		
Gothic	54	45	44	44	138	59	271	116%	384	118%
Monarch	48	32	32	23	85		172	91%		
Snowmass		33	23	28	79		163			
Sunlight		38	31	19	77		165	92%		
<u>Southern Mountains</u>										
Purgatory		50	27	14	87		178	97%		
Red Mtn. Pass		20	36	22	88		166	78%		
Telluride		26	34	19	80		159	86%		
Wolf Creek	71	76	33	16	141		266	98%		

January was without significant storms, so snowfall was on the light side for the month; only Vail and Beaver Creek were above normal. In the Northern Mountains amounts ranged from 72-120%; in the Central Mountains, 58-85%; and in the Southern Mountains, 49-85%.

February was another dry month with no major storms, and snowfall for all areas was below normal. For the month in the Northern Mountains amounts ranged from 62-88%, but Vail and Copper Mountain got 93% and 98% respectively; in the Central Mountains, the range was 49-72%, though somehow Aspen Mountain got 99%; in the Southern Mountains the range was a dismal 26-44%.

March brought generous and welcome snowfall for all mountain areas. Seven sites reported record March snowfall. Amounts in the Northern Mountains ranged from 100-170%; in the Central Mountains, 140-230%; and in the Southern Mountains, 130-175%.

April brought above-normal snows to the Northern and Central Mountains (no sites remained open in the Southern Mountains). Gothic recorded 140% of normal, while Berthoud Pass and Winter both had 136%. The last 10 days of the month were particularly snowy: Arapahoe Basin received 46" during this time.

For the seasonal trend, note in Table 1 the percent-of-normal totals for December-March. Two points stand out: First, while the Northern and Central Mountains got near- to above-normal snows (89-112% and 88-116%, respectively), Breckenridge was far below normal at only 68%. The second point is that the Southern Mountains were below normal. Lastly, Table 1 shows that only three sites have entries for percent-of-normal for the six months of November-April and that these percentages were almost identical to the December-March figures.

Avalanches

A total of 2,242 avalanches was reported to the Avalanche Center from November through April. This number is 21% above the average of 1,850 avalanches. Table 2 shows the monthly distribution of the avalanche total.

November produced very few avalanches (67, as shown in Table 2), mainly because of a shallow snow cover. December was very active (304) because of the stormy period between the 13th-23rd. Though no significant storms struck in January, the very weak snow cover produced many avalanches (536) with only light snowfall. February continued to produce avalanches. Heavy snows overloading the weak snow cover during the month of March produced extensive avalanching. A total of 838 avalanches was reported. Few days in April were without clouds, so no significant cycle of wet-snow avalanches occurred. Avalanche activity was confined to the stormy periods.

Avalanche Hazard and Warnings

Tables 2, 3, and 4 present several looks at the avalanche hazard and warning days this season. Table 2 shows the daily hazard ratings (low, moderate, high, and extreme) for the Northern, Central, and Southern Mountains on a monthly basis. During an average winter, the number of days with a widespread "high" hazard is greatest in December, January, and February. These are the months that most often threaten backcountry travelers with deep-slab, delayed instability. This winter in the Northern Mountains deep-slab instability extended into March, when 13 days carried a "high" hazard. In the Central and Southern Mountains, deep-slab instability occurred in December and then returned in March. Below-normal snowfall in January and February added little load to a weakening snowcover, but the heavy snows of March made for deep-slab instability and 13-19 days of "high" hazard (see Table 2.) An "extreme" hazard occurred on two days in March in the Central Mountains, and on one day in the Southern Mountains during a period of heavy snow and wind.

Table 3 shows a monthly summary of warning days for the 1990-'91 season, plus the previous 16 seasons. (A warning day is one on which the hazard was rated high and an Avalanche Warning was issued.) Warnings were issued on 30 days, about four below average. No warnings were issued for November or April.

Table 4 breaks the warning days this season into regional statistics for the Northern, Central, and Southern Mountains.

Table 5 shows the impact of avalanches this season on Colorado Mountain highways. It lists the number of events and dates on which both natural and artificially triggered avalanches reached highways. The total of 32 natural avalanches is well above the 14 of last winter. We have not kept accurate records of triggered events long enough to establish a meaningful average.

Avalanche Accidents

The last part of Table 2 lists a monthly breakdown of avalanches involving people and property in 1990-'91, while Table 6 compares these same statistics with long-term annual averages. The winter of 1990-'91 was worse than normal in the number of people caught, totally buried, injured, and killed. The number killed -- five -- was one above the long-term average. Only one category, partly buried, was below the long-term average. Finally, for the fourth winter in a row, there were no property sites damaged.

Table 7 lists all accidents reported to the Avalanche Center this winter. Note the five fatalities occurred on November 7, December 2, February 17, and March 6 and 17. Avalanche Center personnel try to investigate all fatal accidents (see Section VI).

Figure 1, below, portrays the number of avalanche accidents (defined as an incident in which at least one person was caught) compared to the posted hazard rating in the area at the time of the incident. Statistics from both 1990-'91 and the average over the last five years are included. By a narrow margin, most avalanche accidents occur when the avalanche hazard is rated high to extreme. However, many accidents happen during times of moderate hazard, most likely because more people are in the backcountry and in steeper terrain during these times. (We are working hard in our hotline and seminar messages to dispell the misconception that *moderate* means safe.)

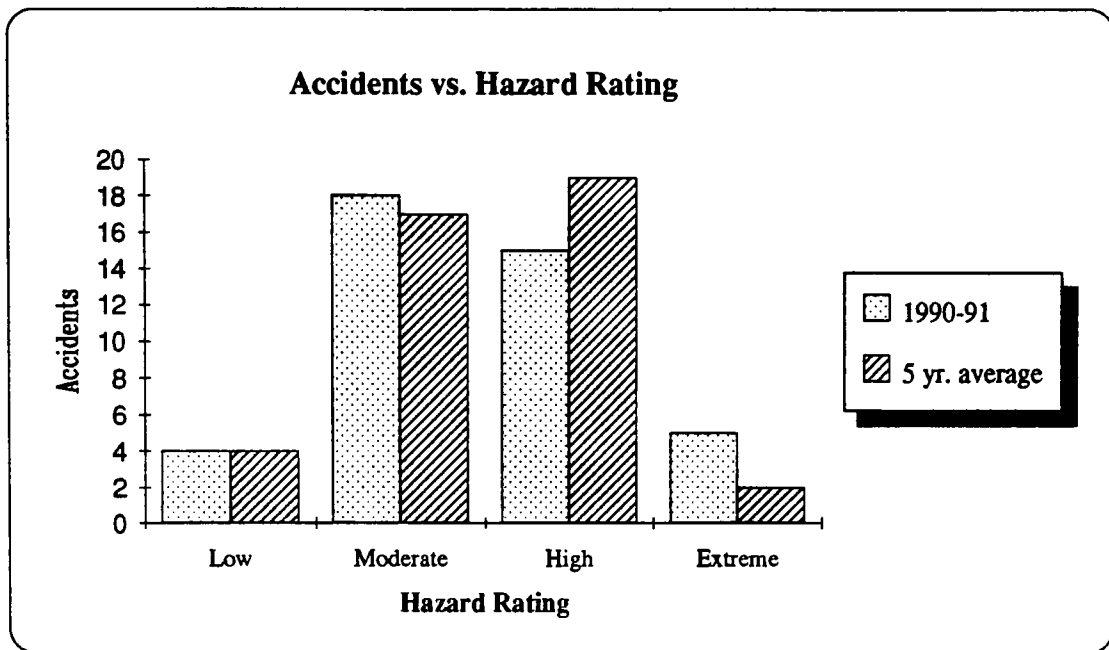


Figure 1.

This synopsis has presented a general and statistical overview of the 1990-'91 winter season, with tables 1-7 showing different aspects of the season. For a more detailed description of events, the reader should continue to the next section, the Detailed Winter Summary.

Table 2. 1990-'91 winter summary of avalanches, hazard days, and accidents

Topic	Nov	Dec	Jan	Feb	Mar	Apr	Total
No. of avalanche warning periods	0	2	2	2	1	0	7
No. of days with warning in effect	0	9	6	6	9	0	30
No. of observed avalanches	67	304	536	355	838	142	2,242
No. of days with 1 or more slides	16	25	29	17	27	20	134
<u>Northern Mountains</u>							
No. of days with:							
low hazard	13	3	0	11	0	10	37
moderate hazard	4	16	19	8	18	20	85
high hazard	1	12	12	9	13	0	47
extreme hazard	0	0	0	0	0	0	0
<u>Central Mountains</u>							
No. of days with:							
low hazard	13	3	0	12	0	10	38
moderate hazard	4	12	28	12	15	20	91
high hazard	1	16	3	4	14	0	38
extreme hazard	0	0	0	0	2	0	2
<u>Southern Mountains</u>							
No. of days with:							
low hazard	13	3	0	15	0	13	44
moderate hazard	4	12	23	9	11	13	72
high hazard	1	16	8	4	19	0	48
extreme hazard	0	0	0	0	1	0	1
<u>Avalanche accidents</u>							
people caught	5	8	14	4	15	7	53
people partly buried	1	2	3	0	2	1	9
people buried	1	2	0	2	4	0	9
people injured	0	2	1	0	2	0	5
people killed	1	1	0	1	2	0	5
vehicles caught	0	0	1	0	1	0	2
property sites damaged	0	0	0	0	0	0	0

Table 3. A 17-year summary of avalanche warning days

Winter	Nov	Dec	Jan	Feb	Mar	Apr	Total
1974-75	0	9	16	10	15	2	25
1975-76	3	4	6	12	4	0	29
1976-77	0	4	7	5	5	2	23
1977-78	2	5	7	8	15	0	37
1978-79	0	13	12	0	9	5	39
1979-80	6	5	20	9	5	4	49
1980-81	0	6	2	6	16	5	35
1981-82	4	8	3	3	4	0	22
1982-83	1	7	3	14	16	5	46
1983-84	8	15	3	3	12	9	50
1984-85	2	10	4	6	12	3	37
1985-86	12	3	0	12	0	0	27
1986-87	0	0	15	6	5	0	26
1987-88	0	8	17	4	3	0	32
1988-89	3	11	0	13	0	3	30
1989-90	0	6	0	4	10	0	20
1990-91	0	9	6	6	9	0	30
Total	41	123	121	121	140	38	584
<i>Average</i>	2.4	7.2	7.1	7.1	8.2	2.2	34.3

Table 4. Avalanche warning days by region, 1990-'91 (dates in parentheses)

Region	Nov	Dec	Jan	Feb	Mar	Apr	Total
Northern Mountains		(18-22)	(27-28)	(14-15)	(6-10)		
Days:	0	5	2	2	5	0	14
Central Mountains		(14-16) (18-22)		(17-20)	(2-9)		
Days:	0	8	0	4	8	0	20
Southern Mountains		(14-17) (19-22)	(4-7)		(2-9)		
Days:	0	8	4	0	8	0	20
Total	0	21	6	6	21	0	54

Table 5. Avalanches reaching Colorado highways, 1990-'91

Highway	Location	Natural avalanches		Triggered avalanches	
U.S. 6	Loveland Pass	4	Feb. 14 Mar. 17, 22	23	Dec. 15 Jan. 15, 28 Feb. 15, 20 Mar. 4, 6, 18 Apr. 13
U.S. 40	Berthoud Pass	1	Feb. 7	4	Dec. 21 Jan. 19 Feb. 15 Mar. 7
I-70	Vail Pass			1	Mar. 7
U.S. 50	Monarch Pass	2	Mar. 5 Apr. 6		
U.S. 550	Red Mountain, Molas, & Coal Bank Passes	18	Dec. 14 Jan. 5 Feb. 17 Mar. 5, 6	3	Mar. 3
U.S. 160	Wolf Creek Pass	1	Mar. 1		
Colo. 361	Camp Bird Mine	2	Jan. 5 Mar. 23		
Colo. 110	Howardsville	2	Mar. 5		
mine road	near Marble	1	Dec. 20		
local road	near Ophir	1	Mar. 1		
Total: 63 avalanches; 32 natural and 31 triggered					

Table 6. Summary statistics of Colorado avalanche victims

	<i>Total</i> 1970-'90	<i>Average</i> (20 winters)	<i>Total</i> 1990-'91
People caught	737	37	51
People partly buried	200	10	9
People totally buried	137	7	10
People injured	66	3	5
People killed	79	4	5

Table 7. Colorado avalanche accidents grouped by month, 1990-'91 (italics indicate fatal accident)

Date	Location	Details
<i>11/7</i>	<i>Storm King Peak (La Plata mountains)</i>	<i>1 ski tourer caught, buried, killed</i>
11/11	Berthoud Pass	1 ski tourer caught
11/27	Aspen Mountain	1 patroller caught & partly buried
11/28	Aspen Mountain	1 patroller caught
11/28	Wolf Creek	1 patroller caught & buried
<i>12/2</i>	<i>Fletcher Mountain (near Fremont Pass)</i>	<i>2 climbers caught & buried, 1 injured & 1 killed</i>
12/6	Aspen, (McFarlane's Bowl)	1 ski tourer caught & injured
12/16	Shrine Pass	1 ski tourer caught & partly buried
12/17	Aspen Mountain.	1 o.b. ski tourer caught
12/24	Irwin	1 snowcat ski-guide caught
12/28	Carter Bowl (near Breckenridge)	2 o.b. lift skiers caught, 1 partly buried
12/30	Monarch	1 patroller caught
1/6	Snowmass	1 lift skier caught
1/6	Telluride	1 patroller caught & partly buried
1/9	Breckenridge	1 o.b. ski tourer caught
1/12	Ski Cooper	1 o.b. snowboarder caught
1/12	Washington Gulch	2 ski tourers caught
1/14	Steamboat (Toots)	1 o.b. skier caught & partly buried
1/14	Breckenridge	1 patroller caught
1/15	Steamboat (Toots)	1 patroller caught
1/15	Camp Bird Mine road	1 motorist and vehicle caught,
1/16	Copper Mountain	1 patroller caught
1/20	Little Professor	1 ski tourer caught
1/21	Berthoud Pass	1 o.b. snowboarder caught, partly buried, injured
1/21	Breckenridge	1 patroller caught
2/15	Aspen Highlands	1 patroller caught
<i>2/17</i>	<i>Cottonwood Pass (near Buena Vista)</i>	<i>1 snowmobiler caught, buried & killed</i>
2/19	Crested Butte	1 o.b. skier caught & buried, dug self out
2/19	Monarch	1 patroller caught
2/27	Chalk Mountain (Fremont Pass.)	1 avalanche instructor & 2 students caught
3/5	Maroon Creek (near Aspen)	3 snowmobiles caught & partly buried

Continued on next page...

Table 7. Continued...

Date	Location	Details
3/6	Aspen Mountain	1 lift skier caught, lost a ski
3/6	<i>Castle Creek (near Ashcroft)</i>	<i>1 ski tourer caught, buried, killed</i>
3/6	Snowmass	4 patrollers caught (two incidents), 2 injured
3/6	Rico	1 ski tourer caught, buried; 1 dog caught & buried (dug self out)
3/6	Loveland Ski Area	1 worker caught, 1 snowcat caught with slight damage
3/9	Peak 10 Ridge (near Breckenridge)	2 o.b. lift skiers caught, 1 partly buried, 1 buried, both injured lost equipment
<i>3/17</i>	<i>Loveland Pass (west side)</i>	<i>2 sledders caught, 1 partly buried, 1 buried & killed</i>
3/22	Breckenridge	1 patroller caught
4/5	Telluride	1 heli-ski guide caught & partly buried
4/5	Sunshine Peak (near Aspen)	2 ski tourers caught
4/7	Aspen Highlands	1 lift skier caught
4/14	Loveland Pass	1 snowboarder caught
4/24	Loveland Ski Area	1 o.b. lift skier caught
4/24	Rocky Mountain National Park	2 searchers caught

DETAILED WINTER SUMMARY

The following narrative is a detailed, month-by-month description of weather and avalanche events and trends of the 1990-'91 winter season. If you are into details, this is the section for you.

November

November began with a big storm that struck the Southern and Central Mountains. From the 2nd-7th, Wolf Creek got 43" and Gothic, 30". Only light snow fell in the Northern Mountains. By the 8th, mild weather returned to the Colorado mountains.

On November 7th, an avalanche in the La Plata Mountains, northwest of Durango, claimed the winter's first victim. The wind and recent snows had left an inviting snowfield for a backcountry tourist. While the snowpack was generally shallow, an extremely unstable windslab had formed. The victim was hiking alone when he triggered a slide, and was buried by the avalanche. He was only shallowly buried with his pack sticking out of the snow, and a companion could have easily saved his life. Rescuers recovered his body two days later.

Fair weather was the rule from the 8th-13th. On November 13, the Avalanche Center opened for the season. Fair weather continued until the 20th. Daytime high temperatures ranged from the upper 30's to the 50's. Lows were well below freezing. This led to an overall thinning or disappearance of snowcover on southern aspects, while north through northeastern aspects continued to remain shaded and cold. This established a depth hoar situation that would plague forecasters, avalanche technicians, and backcountry travellers well into the winter season.

On November 20, winds picked up, clouds moved in, and snow began. The storm lasted until the 22nd, and left significant snowfall. Amounts ranged from 1-10" statewide. Avalanche activity was reported in association with the low-density new snow and strong winds. There were 11 avalanches in the Central and Southern Mountains on the 21st. This cycle quickly subsided as the weather returned to bluebird status.

On November 26th, a system moved into the state from the southwest. This changed the weather dramatically as substantial snows were received through the 29th. Snowfall amounts were 3-21" in the Northern, 4-15" in the Central and 17-21" in the Southern Mountains. This storm generated an avalanche cycle as weak, early-season snow could not uphold the newly deposited snowfall. There were 12 slides in the Northern, 10 in the Central, and nine in the Southern Mountains. This cycle was

not widespread enough to entirely eliminate the early season depth hoar buildup. Opportunities and factors for future avalanches remained.

November ended on a mild note, but as we have seen in the past, November weather and snows establish the foundation for the winter's avalanche problem. In this case, depth hoar was widespread, guaranteeing a weak base for much of the winter.

For the month, snowfall was about average in the Southern and Central Mountains, and below average in the Northern Mountains. Wolf Creek recorded 120% of normal; Monarch, 118%; Gothic, 107%; Berthoud Pass, 66%; and Winter Park, 56%.

December

A strong ridge of high pressure over the western U.S. dominated the mountain weather for the first 11 days of December. The slow start made the ski area operators a little nervous. During this time skies were often sunny and temperatures were seasonal to above normal. By the 11th, afternoon high temperatures seemed more like spring than winter. High temperatures reached into the upper 30's to middle 40's. Only twice, on the 2nd and the 6th, was the mild weather interrupted as upper-level short waves slipped through the ridge. On the morning of the 3rd, a trace (T)-3" was reported in the Northern and Central Mountains, but the Southern Mountains were dry. Then again on the 6th, the Northern and Central Mountains reported a T-6" while the Southern Mountains remained dry.

The snowpack was shallow in early December, ranging from 6-30", though Wolf Creek reported 42". Observers reported that kinetic metamorphism (the new nomenclature for *temperature gradient*) dominated, especially on the cold, north aspects. In early December the snowpack posed little danger to the backcountry traveller because of the absence of a slab, except in isolated pockets above treeline. On December 2nd, two mountain climbers discovered one such pocket high on the north side of Fletcher Mountain, south of the Copper Mountain ski area. The two triggered a slide, that buried both after a 600' vertical ride. One received minor injuries and was able to free himself, but the other one died of suffocation, or trauma to his head. This was the second avalanche death of the season.

The mild weather ended on the 12th as a storm approached the mountains from the West Coast, heralding the beginning of a long and snowy period. By the end of the day, light snow had spread across all the mountains. On the morning of the 13th the Northern Mountains reported 2-9" of new snow, the Central, 4-10", while the Southern Mountains received 3-8".

Light snow continued to fall overnight accompanied by moderate to strong southwest to west winds. On the morning of the 14th, observers in the Northern Mountains reported 1-4", but Beaver Creek reported 7"; in the Central Mountains, 1-6"; and the Southern Mountains reported 4-8". Winds

gusting 60-70 mph were common. Even Vail reported a peak gust of 65 mph. The winds loaded steep slopes necessitating the season's first Avalanche Warning to be issued for the Central and Southern Mountains at midday.

The skies cleared briefly on the 15th as a weak ridge of high pressure moved over the mountains. But it would not last long, as subtropical moisture was aimed at the Southern Mountains. Wolf Creek, favored by the southwesterly flow, reported 8" new snow on the morning of the 16th, while other sites in the Central and Southern Mountains reported a T-3", though Gothic got 5". Virtually no moisture reached the Northern Mountains.

Light snow continued to fall, and by the morning of the 17th most mountain sites reported 1-3". Steamboat was favored and received 7", and Wolf Creek was blessed with 13". Decreasing winds and moderating temperatures allowed the backcountry avalanche hazard to ease, so the warning for the Central and Southern Mountains was dropped at 4:15 pm.

During the warning episode, daily amounts of snow slowly added stress to an already weak snowpack that was prone to triggered releases. Two ski tourers discovered this fact. One triggered a slide on the 16th near Shrine Pass and was partly buried. And on the 17th, another was caught near Aspen Mountain.

Light snow continued to fall, and on the 18th, observers reported 1-4" of new snow, but Steamboat excelled with 10". Westerly winds increased to 30-40 mph, and by late afternoon gusts to 60 mph were being reported in the Northern and Central Mountains. This required the month's second Avalanche Warning to be posted late that afternoon for the Central and Northern Mountains. The strong winds had not yet reached the Southern Mountains. In the Central Mountains a natural release left debris 18 feet deep on the road to the quarry outside of Marble, keeping the day shift at work longer than expected.

The winds continued to increase as the jet stream moved over the mountains. On the 19th, for the second time this month, observers in all mountain areas were reporting gusts of 50-60 mph. Though no new snow fell this day, the strong winds continued to load steep slopes, and the warning area was expanded to include the Southern Mountains late that afternoon.

The 20th was a brutal day in the Southern Mountains with the jet stream right over the region. Winds gusting to 90 mph raked the Saint Paul Lodge on Red Mountain Pass. Orographic snowfall produced 4-13" of new snow by morning. At Wolf Creek, though, skiers could not enjoy the fresh powder because the pass was closed all day due to poor visibility caused by the strong winds and blowing snow.

Lighter winds in the Central and Northern Mountains made for more enjoyable conditions. Observers in the Central Mountains reported 5-8", but Irwin got 11", and Sunlight, 12". In the Northern Mountains 2-7" was reported. But as the jet stream sagged southward it pulled in arctic air that would soon put the mountains into a dry deep freeze.

The coldest period of the month (and for the winter) was heralded by a -32 F reading at Lake Eldora on the morning of the 21st. For the next four days cold air was trapped in the mountains: High temperatures were in the single digits, and overnight lows dropped far below zero (-35 F at Winter Park on the morning of the 23rd). The coldest temperature occurred at Taylor Park, near Gunnison, on the morning of the 24th when the thermometer bottomed out at -49 F. The cold temperatures inhibited snow stabilization and kept the avalanche hazard high for the higher elevations, but when the threat of natural releases eased the Avalanche Warning was terminated on the morning of the 22nd.

There was only one avalanche incident during this cold spell. A snowcat ski-guide was caught at Irwin on the 21st. On the 22nd, explosive control work at Snowmass yielded impressive results in the cold brittle snow, triggering two hard slabs ranging from 12-18' deep!

Between Christmas day and the 27th, the temperatures warmed--a welcome break--as three very weak short waves brushed the mountains. Each morning observers reported only a dusting of snow as the systems had too little energy and lacked moisture for significant snowfall. By the 28th a deep upper-level low over Washington pushed the jet stream over the mountains with several fast-moving systems in the southwesterly flow. By afternoon moderate snow was being reported in the Southern Mountains.

On the morning of the 29th the first fast-moving short wave had dropped in the Southern Mountains 2-7" of new snow. The Central and Northern Mountains, not favored by the southwesterly flow, reported only 0-1", though Powderhorn and Steamboat both got 4". A second system left 1-5" on the morning of the 30th for all mountains, though Sunlight received 8". The last avalanche incident of the month occurred on the 30th when a patroller at Monarch was caught in a small slide while doing routine control work. December ended with sunny skies as a ridge of high pressure over the West Coast pushed the storm track to the north.

Snowfall for the month was generally light, as most of the snow fell during a 10-day period between the 13th and 23rd. Only Sunlight and Wolf Creek were above normal. Wolf Creek recorded 122% of normal, and Sunlight, 110%. The Northern Mountains were below normal: Beaver Creek, 91%; Berthoud Pass, 79%; Mary Jane/Winter Park, 78%; Arapahoe Basin, 67%; Vail, 59%; and Breckenridge, 43%. In the Central Mountains, Gothic received 79%; Monarch, 78%; Aspen Mountain, 68%; and Crested Butte, 50%. In the Southern Mountains, Purgatory received 95%; Telluride, 64%; and Red Mountain Pass, only 42% of normal.

The month was not very active for avalanche releases--only 304 slides were reported to the Center. Avalanche Warnings were issued for nine days during the month. Seven avalanche incidents occurred during December: Eight people were caught, two were partly buried, two were buried, two were injured, and one was killed.

January

The mild weather inherited from the last day of December continued for the first three days of January. Not until the night of the 3rd did the first snows fall in the Southern and Central Mountains as moisture moved into the region from southern California.

On the morning of the 4th only a dusting of new snow was reported in the Northern and Central Mountains. The sites in the Southern Mountains, favored by the southwesterly flow, reported 4-9". Moderate snowfall continued during the day in the Southern Mountains, and the first Avalanche Warning of the month was issued for the Southern Mountains at 12:45 pm. On the 5th, observers in the Northern Mountains reported 1-6" of new snow. In the Central Mountains 4-7" fell, but sites that were favored by the southwesterly flow did better. Crested Butte got 12", and both Gothic and Irwin reported 15" of new snow. In the Southern Mountains 9-13" was reported. Red Mountain Pass was closed by seven natural releases that left debris 6 feet deep on the roadway.

Skies began clearing on the 5th, but a fast moving short wave left a dusting of new snow on the 6th before skies turned sunny. When the Avalanche Warning for the Southern Mountains was dropped on the 7th, a total of 96 avalanches had been reported to the Center. One ski patroller was caught and buried to his waist at Telluride on the 6th. During this same time at Snowmass, a skier released a slide in an open area on the 5th, bringing out the ski patrol to probe the debris. Then on the 6th a second skier was caught in a slide in a closed area.

Between the 8th and 13th a series of weak short waves, about a day apart, moved over the mountains. These systems favored the Northern Mountains, but only with very light snow. During this period in the Northern Mountains snowfall ranged from 4-13", but Steamboat got 21". The Central and Southern Mountains were less fortunate with only scattered very light snow.

Though the snowfall was light, the new snow enticed people into the backcountry, and three avalanche incidents occurred. On the 9th, a backcountry skier was caught near Breckenridge. On the 12th, at Ski Cooper, an out-of-bounds snowboarder was caught in a hardslab slide he triggered. Also on the 12th, near Crested Butte, two backcountry skiers were caught in a large slide they triggered. Fortunately all escaped their brush with the "white death."

Two stronger impulses moved over the mountains on the nights of the 13th-14th. Observers on the morning of the 14th in the Northern Mountains reported 2-10"; in the Central Mountains, 2-5"; and in the Southern Mountains only a dusting fell at Wolf Creek and Purgatory, but Telluride and Red Mountain Pass excelled with 9". On the 15th in the Northern Mountains observers reported 1-7", but Beaver Creek got 9". In the Central Mountains a T-4" fell, while the Southern Mountains only got a dusting. Light snow continued to fall, and by the morning of the 16th Red Mountain Pass and Telluride, favored by the northwesterly flow, reported 6" and 7", respectively. There was no snow at Wolf Creek, and only a dusting at Purgatory.

Four avalanche incidents occurred on the 14th-16th. Two occurred on the 14th: At Breckenridge a ski patroller was caught and carried for a short ride while doing control work; and a backcountry skier was caught and buried to his waist outside of the Steamboat Ski Area in an area called the "Toots." On the 15th, again in the Toots, failing to heed nature's warning of recent avalanche releases, another backcountry skier was caught. The fourth incident on the 16th involved a ski patroller who was caught and taken on a short ride while ski cutting at Copper Mountain.

After the reports to the Center of the triggered avalanches, and a few natural releases, a special Avalanche Advisory was issued for the Northern and Southern Mountains at 6:15 pm on the 15th. While there was no natural avalanche cycle, the snow pack was fragile and prone to triggered releases. The advisory was an extra effort to alert backcountry travellers to the high avalanche hazard.

A closed low formed over the Four Corners area and slipped to the south of Colorado on the 17th creating a northerly flow over the mountains. The cool, dry air, could only produce a dusting of new snow in the Northern Mountains on 17th, 18th, and 19th.

A stronger, more moist system raced through the mountains during the night of the 19th. On the morning of the 20th observers in the Northern Mountains reported 2-10" of new snow; in the Central Mountains, 2-7"; and in the Southern Mountains, only another dusting. With the new snow came the 11th avalanche incident of the month. A backcountry skier was caught near Loveland Pass. Also on the 20th, at nearby Jones Pass, ski tracks were observed entering a recent avalanche. However, all backcountry skiers were accounted for and the impending search was called off.

The avalanche danger was rated high in the North and Central Mountains, and triggered releases were deemed likely by backcountry travellers. The minor incidents on the 20th verified the rating due to the weak snowcover in the Northern Mountains. Doing control work early in the morning of the 21st a patroller was caught at Breckenridge by a very small slide. It was just a matter of time before a serious incident occurred. It did not take long: At 11:30 am a snowboarder cut into a permanently closed area at the Berthoud Pass Ski Area and triggered an avalanche. This wave was not to be ridden,

and the luckless snow-surfer wound up buried to his chest with a fractured pelvis. He was quickly dug out, evacuated by helicopter, and charged by the local sheriff for violating the Skier Safety Act.

Light snow fell again in the Northern Mountains on the night of the 22nd and during the day of the 23rd as a weak storm passed to the north of Colorado. Observers on the 24th in the Northern Mountains reported 1-7". In the Central Mountains only a dusting was reported. The Southern Mountains went dry. Another fast-moving short wave on the 25th brought 3-7" of new snow to the Northern, a dusting in the Central, and no new snow in the Southern Mountains.

The jet edged over the Northern Mountains on the 26th causing heavy snow transport and producing a natural avalanche cycle in the Summit County area. Northwest winds, gusting to 40-60 mph, stripped fetch areas and loaded starting zones with blowing snow. By mid-afternoon 29 slides had been reported to the Center. Strong wind gusts continued in the Northern Mountains on the 27th. Breckenridge had a peak gust of 92 mph. A Special Avalanche Advisory was issued for the Northern Mountains that morning. By 3:00 pm the continued winds necessitated upgrading to an Avalanche Warning, the second of the month. On the 28th the winds decreased and the warning was dropped as little natural activity occurred.

Northwesterly flow aloft continued, and a short wave raced through the mountains on the night of the 28th. On the 29th observers reported what would be the last snow in January: 1-5" in the Northern and Central Mountains, and 1-2" in the Southern Mountains. A ridge of high pressure pushed the storm track north of Colorado and the month ended mild and dry.

Major storms were few and far between in January, and snowfall was on the light side; only two sites were above normal. In the Northern Mountains Beaver Creek received 120%; Vail, 103%; Copper Mountain, 93%; Berthoud Pass, 88%; Winter Park/Mary Jane, 72%. In the Central Mountains, Aspen Mountain received 85%; Gothic, 77%; Monarch, 71%; and Crested Butte, 58%. In the Southern Mountains, Telluride received 85%; Purgatory, 78%; Red Mountain Pass, 73%; and Wolf Creek, only 49%.

Although snowfall was less than normal, it was an active avalanche month. The shallow snowpack (except in the Wolf Creek Pass area) was weak, and composed primarily of kinetic metamorphism (temperature-gradient) grains topped by brittle slabs. Even light amounts of new snow caused avalanching in the fragile snowpack, and by month's end 536 avalanches had been reported to the Center. Avalanche Warnings were issued for six days during the month. Thirteen avalanche incidents were reported during January, and 14 people were caught, 3 were partly buried, 1 was injured, and 1 vehicle was caught.

February

Despite two storms near the middle of the month, February was dry. Without a good storm to fuel the fires of avalanches, the 1st-12th saw few events. During this time the snowpack stabilized enough to lower the avalanche hazard rating to an overall low.

While fresh snow was conspicuously absent early in the month, the weather was delightful for backcountry outings. There were a few cloudy periods, and parts of the Northern Mountains saw 2" of snow on the 4th. After that, though, a strong ridge of high pressure dominated the western United States. Temperatures climbed into the 30's and 40's with only light wind.

This all came to an abrupt end on the 12th as a fast-moving storm bore down on Colorado. Several snow-hungry ski areas were relieved to see precipitation once again. Avalanche forecasters, on the other hand, were aware of what a major storm could do to the weak snowpack. On the morning of the 13th, Berthoud Pass reported 11" while 10" fell at Loveland. About 5 inches were logged in the Central Mountains. Snowpack stability was endangered, and the avalanche hazard jumped to high. With continued wind and more snow likely, the fifth Avalanche Warning of the season was issued at 9:00 am on the 14th. It encompassed all of the Northern Mountains and would remain in effect through the 15th.

Snow continued to fall well into the 14th. On this morning, Copper Mountain had 13" of fresh powder, Loveland and Berthoud Pass reported 1-foot each. Irwin Lodge, about 10 miles west of Crested Butte in the Central Mountains, rallied with 25" while a few miles away Gothic got only 3". Such are the vagaries of mountain weather. By now it was apparent the Northern and Central Mountains were going to get substantial accumulations as upstream moisture stretched back to the Pacific.

This first wave of back-to-back storms was all but over in the early hours of the 15th. It left several more inches of snow in the Northern Mountains before escaping to the plains. New snow amounts so far were 25" each at Berthoud and Loveland passes; 24" at Copper Mountain; and about 20" at Winter Park/Mary Jane and Vail.

If abundant snow was not enough to increase the avalanche hazard, another element intensified the situation even more. Wind velocities up to 65 mph caused much blowing and drifting snow, and a gust to 72 mph roared through Berthoud Pass during the night. At Arapahoe Basin, fresh piles of slab-like snow reached 6-8' deep in lee areas, and a small natural avalanche reached U.S. Highway 6 on the east side of Loveland Pass.

We were lucky so far. Avalanche tallies numbered only 38 in the warning area. The underlying snowpack held up pretty well to the additional weight of the new snow, but how much could it take? There was more snow on the horizon, so it wouldn't take long to find out.

Another deep trough of low pressure provided additional snow for selected sites on the 16th-19th. It was selective. Accumulations on the morning of the 17th ranged from 1-12" in the north, and 1-26" in the Central Mountains (26" at Gothic). Another Avalanche Warning was issued on the 17th, this time for the Central Mountains.

This storm, the second and last for February, embraced the Southern Mountains as well. By the morning of the 20th, storm totals at Steamboat reached 36"; Vail, 25"; Gothic, 35"; Irwin Lodge, 30"; Telluride, 20"; and 15" and 13" respectively at Wolf Creek and Red Mountain Passes.

The Avalanche Warning was dropped on the 20th, but not until after the storm's fury prompted over 200 reported avalanches (in just three days) and several accidents. Two ski patrollers were caught while doing avalanche control work on the 15th and 19th, and an out-of-bounds skier at Crested Butte was buried in a slide. He dug himself out, but was cited by the sheriff for violation of the Skier Safety Act.

The third fatality of the season also came during this time. On the 17th, a tragic accident claimed the life of a snowmobiler travelling on a well-packed road just above timberline near the summit of Cottonwood Pass west of Buena Vista. A collapsing cornice apparently triggered the slide that buried the trailing rider in a party of three. He was dug out from under 3' of debris in about an hour, but was most likely killed instantly from chest and other internal injuries.

February's period for moisture, from the 12th-19th, was now over. Snow accumulations during this time were impressive! Irwin Lodge led with 55", followed closely by Steamboat at 54". Vail collected 44" while Gothic ended with 35" of new snow.

A few more avalanches ran in the days shortly after the 20th, but warm weather soon promoted bonding in the new snow layers. On the 22nd, temperatures reached into the 40's at some sites. Another weak cold front edged in on the 24th and brought 1-4" to the mountains. Overall, the end of the month was mild except for light accumulations from scattered snow showers. However, on the 28th a strong storm system had broken through the ridge of high pressure and was poised to roll through Colorado. It would not be long until winter returned in force.

As already mentioned, February was dry. Snowfall amounts in the Northern Mountains ranged generally from 62-88% of normal, though Vail got 93% and Copper Mountain, 98%. In the Central

Mountains, the range was 49-72%; however, Aspen Mountain got 99%. The Southern Mountains fared the worst with a mere 26-44%.

There were 355 avalanches reported to the Center during the month. This brought the seasonal total to 1,262 events which is near normal. These numbers were shattered in March.

March

In many ways, March '91 was similar to March of the previous winter. The common link is that of abundant snow, many avalanches and serious accidents. March more than made up for the preceding dry periods. This was made possible by the breakdown of the high pressure ridge that so stubbornly attached itself to the West Coast in February. It was conveniently replaced by a storm-producing trough that conveyed Pacific weather systems directly to Colorado. Let us continue with the transition from February to March.

As expected, the storm rolled into our mountains from the southwest on the first night. It was a true San Juan Special. By morning, fresh snow was reported from all sites: up to 13" already on the ground in the Southern Mountains; 10" in the Central Mountains. With the southwest flow, most areas north of I-70 had little more than an inch -- so far.

Weather forecast data supported the potential of continued snowfall and wind. Combined with the historically weak substratum onto which it would fall, forecasters knew what it could do for the avalanche danger.

On the 2nd, the seventh Avalanche Warning of the season was issued. It covered the San Juan Mountains and also the West Elk Mountains to the northeast. During its span, the warning period saw a full compliment of danger and avalanche action as we'll see.

By the 7th, substantial amounts of snow had fallen. Here are some examples. Vail led the Northern Mountains with 44", but Steamboat got 41" and Winter Park/Mary Jane about the same with 40". Winds had not been excessive except on the 5th. Many sites recorded velocities near 50 mph, and ridgetop gusts between 60-80 mph were also noted.

The Central and Southern Mountains did even better. Irwin Lodge and Gothic, both surrounded by the Elk and West Elk Mountains, got 63" and 64" respectively, while Wolf Creek received 58"! New snow of 30-40 inches was common among the other sites as well.

By now the hazard rating in the Central and Southern Mountains had been upgraded to extreme, and the Warning had expanded to include all regions. Here are some incidents that had occurred during

this storm: On the 5th, a party of snowmobilers travelling in Maroon Creek near Aspen had a near-miss when two avalanches rumbled across their path. On the 7th, Berthoud Pass was closed after the Floral Park avalanche, a popular area for skiing, slid across the highway. The road was closed for about 4 hours while rescue workers searched the debris for victims. None were found.

Elsewhere, several people were caught in separate incidents, including four ski patrollers, one lift skier, and two ski tourers. It was on the 6th that one of these tourers near Rico was buried 3' deep for five minutes. Her dog was also buried. The woman was luckily found alive by random digging in the area where the dog was seen digging himself out. On the same day in Castle Creek, near Ashcroft (and Aspen), the story had a sadder note. A local woman who was cross-country skiing along the valley floor was struck by a half-mile-wide avalanche that released naturally from more than 2,000' above her. Her body was found two days later by a probe line. She became the fourth avalanche fatality of the season.

Roads and highways were also affected by avalanches. More than 25 slides forced closures from several minutes to several hours. These were on Wolf Creek, Red Mountain, Monarch, Vail, Berthoud, and Loveland passes. Also, Colorado Highway 110 to Howardsville was struck, along with the road to Ophir near Telluride. One of the avalanches hitting U.S. Highway 550 on the south side of Red Mountain Pass had not run this far since 1941. It even carried trees in its destructive debris.

From the 7th-9th there was little snowfall. Cold temperatures, however, prevented rapid stabilization within the new snow. There was also some lingering deep instability. Evidence of this came when two lift skiers left the ski area boundary (through a Forest Service access gate) at Breckenridge. They proceeded to the next ridge south where they triggered a 1,400-foot-wide avalanche just above timberline. One was partially buried and injured, the other totally buried under 2-3' of snow for about 15 minutes.

This buried victim had two things going for him: First, even though he couldn't move, there was a small air pocket around his head. Secondly, his companion had the perseverance to continue searching. He did so until he saw the barely-visible, red tip of a boot sole at the snow surface--just in time to prevent imminent suffocation. They lost equipment, but not their lives.

With warming temperatures and little new snow for a couple of days, the Warning was dropped on the 9th for the Central and Southern Mountains. It was ultimately terminated on the 10th in the Northern Mountains. During this nine-day period there were 665 reported avalanches, eight people were caught in slides with two injured, two buried and one killed.

The end of precipitation was not in sight. Light to moderate snow fell periodically through the 16th. The fifth and last avalanche fatality of the winter occurred the next day. After spending the night

camped near the summit of Loveland Pass, three men descended a ridge of Grizzly Peak on hard-plastic sleds. As they neared the bottom, they triggered a slide from the compression zone in a narrow gully. Two were caught, and one was buried 5-6' deep. He was found by random probing with avalanche-probe/ski poles, and dug out in 20 minutes. But it was too late. He had perished from suffocation.

Three days of clear, warm weather passed between the 17th-19th before yet another weather system moved in. It formed a slow-moving, closed low pressure center over Colorado. By the 20th, some 5-10" had fallen in the Southern Mountains with lesser amounts to the north. The persistence of the storm brought much-needed moisture to the mountains. Some totals by the 23rd were Wolf Creek with 33", Telluride with 28", and Gothic with 20". In the Northern Mountains, Steamboat and Vail led the pack with 20" and 23" respectively, while 12-15" fell in the Berthoud and Loveland Pass areas.

After little more than a two day break of blue sky overhead, a deep trough of low pressure marched across the Great Basin. Strong southwest winds heralded even more snow as March waned toward its latter days. Fresh snow fell on the 25th-29th. In the Northern and Central Mountains, 10-27" of snow fell. The Southern Mountains did well too with 17" at Red Mountain Pass and 26" at Wolf Creek. Warm temperatures allowed the new snow to settle and bond well. There were few reports of avalanches.

While temperatures remained cool on the heels of the storm, March finally broke into intense spring sunshine for its last two days.

To gain a perspective of the contrast between February and March, compare these percent-of-average snowfall amounts with that of February. For the month, Gothic got 230% of normal; Crested Butte, 200%; Wolf Creek 175%; Aspen Mountain and Copper Mountain, 170%; Purgatory, Monarch, Beaver Creek, and Winter Park, all 160%; Berthoud Pass and Vail, 155%; Aspen Highlands, Sunlight, and Winter Park/Mary Jane, 140%; Red Mountain Pass and Telluride, 130%; and Breckenridge, 100%. The following sites received their heaviest March snows of record: Gothic, Crested Butte, Wolf Creek, Aspen Mountain, Beaver Creek, Vail, Sunlight, Winter Park/Mary Jane. This generated 838 confirmed avalanches during the month, far more than in previous years.

April

Just when most folks wanted to ease out of winter and into spring, along came April. A series of quick-moving, wet, and warm storm systems from the Pacific dampened the mountain weather with wind, snow, showers, and the occasional thunderstorm. This provided a nice icing for the winter's snowpack totals and thus insured enough water in most areas for the summer months. In other words, a fairly normal wet weather pattern existed for this last month of the winter season. The combination of winter-like conditions and warm temperatures associated with spring also created an eclectic avalanche

situation, as the compass, clock, thermometer, and altimeter became keys to forecasting and evaluating the avalanche hazard.

April 1st began on a benign note. All mountain ranges reported bluebird skies and high temperatures ranging from the mid-30's to near 60 degrees. This wasn't to last, though, as the first April storm moved through the mountains on the 2nd, leaving behind 2-8" of wet, heavy snow. This snowfall fueled the first of April's avalanche cycles. On the 2nd, 24 avalanches were reported to the Center, primarily wet-loose and soft-slabs involving the newly fallen snow only. Also, snowpack temperatures began to warm up, reflecting a general springtime warming trend.

By April 4th, high pressure took over, leaving the Colorado mountains basking in gloriously sunny weather for the next two days. Daytime temperatures began to creep upwards as most observers were reporting highs in the 40's to mid-50's. This resulted in a wet avalanche cycle that lasted until April 8th, when another short wave moved in and clamped down on the thaw instability. During this period, April 5th-8th, 61 slides were reported. Most of these occurred in the Central Mountains, particularly in the Aspen area. The observed wet-loose and wet-slab slides occurred below 10,000' and in the afternoon as the sun warmed the more southerly aspects, while hard-slab releases were occurring above 11,000' on northerly aspects. This wide range of variables accounted for three avalanche incidents that caught four skiers, three while in the backcountry including a heli-ski guide.

The winter's accumulation of complexities made the current avalanche situation difficult to evaluate. Hazard ratings at the Avalanche Center were primarily concerned with a wet slide cycle that revolved around temperatures, aspect and elevation. It was difficult to forecast the hard-slab releases that occurred in specific locales. One theory on the deepslab instability involves warm temperatures accelerating the creep rate of the top half of the snowpack and thereby increasing the stress on the lower pack as well.

As previously noted, a short wave moved into the state on April 8th, effectively ending the wet avalanche cycle as colder temperatures tightened the bonds between crystals. This system affected mountain weather for only two days, but it served notice that winter was not yet about to relinquish its grasp on the mountains. Snowfall amounts were generally 2-10", although Beaver Creek received 16" over the 8th and 9th. Minimal avalanche activity occurred.

On the 11th, winter returned. A low pressure trough closed off and meandered around the state for several days. The result was cold temperatures, shifting, gusty winds, and significant snowfall, particularly in the Northern Mountains. Beaver Creek recorded 17"; Vail, 20"; and Loveland Basin, Berthoud Pass, and Mary Jane, all 24" for the four-day period ending April 14th. The Central and Southern Mountains received only 7-14" over the same period. The new snow bonded well to the previous snow surface. Eleven avalanches were observed in the Northern Mountains during this storm

period. One snowboarder was caught in a slide on April 14 with no apparent injuries. The Central and Southern Mountains reported only one slide at this time.

After April 14th, the Avalanche Center saw a decline in the amount of information it received on a daily basis, as many of our observers closed up shop and headed for warmer climes. The season was winding down for some and so, it seemed, was the weather. There were no reports of measurable precipitation from the 15th through the 20th. Daily temperatures were in the upper 30s to mid 40s, and winds were light to moderate. Despite the mild temperatures, only seven avalanches were reported during this period. Afternoon convection produced cloudiness and a number of thunderstorms in all mountain regions. Thus, local conditions changed rapidly, with clouds and cooler temperatures effectively inhibiting an afternoon thaw cycle. Nighttime lows were cold enough to refreeze any melting that was taking place within the snowpack.

By April 20th, high level clouds began to move into Colorado, preceding another storm off the California coast. This system spun off a series of short waves that affected mountain weather before the main punch arrived on the 26th. From April 20th-30th, there was measurable snowfall every day, except for the 24th. Our observer in Gothic received snow every day, much to his chagrin. Accumulations were: Gothic, 34"; Winter Park (town), 23"; Berthoud Pass, 35"; Loveland Basin, 44"; and Arapahoe Basin, 46".

There was an obvious increase in reported avalanche activity due to the continual snow and blowing snow conditions. Twenty-five avalanches were reported to the Center. Although there were no deepslab releases, new-snow softslab fracture lines reached up to 4' deep. While there were several close calls, only three people were involved in avalanche incidents during this storm cycle. One was an out-of-bounds skier near Loveland. The other two were part of a search and rescue effort taking place on Long's Peak in Rocky Mountain National Park. Their search and climbing routes necessarily exposed them to this kind of hazard. Fortunately, no injuries resulted from these incidents.

Snowfall totals for April were above normal for the few sites for which we have long-term records. Here are some figures for those who stayed in touch through the end of the month and reported consistently: Arapahoe Basin, 86"; Loveland Basin, 84" (140% of normal); Berthoud Pass, 73" (136% of normal); Winter Park (town), 51" (136% of normal); and Gothic, 59" (140% of normal).

Avalanche totals for the month of April: Northern Mountains - 56, Central Mountains - 61, Southern Mountains - 25, for a total of 142. These reported slides resulted in seven people being caught and one of these being partially buried, with no reported injuries.

The Avalanche Center closed its full-time operations on April 22nd, but continued to forecast and gather data on a part-time basis through May 1st.

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 two main sources of these data--the Colorado observer network and the National Weather Service.

Colorado observer network: The Center has established a network of some 32 manned observation sites in the Colorado mountains. Twenty of the 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.

A toll-free WATS line, linked to a Code-a-phone, is available for observers' convenience. This gives quasi-24-hour reporting capabilities. Observers make mandatory morning calls, plus timely updates during changeable conditions. All data are logged by the forecaster at the Center.

National Weather Service: Avalanche Center personnel have access to all the products and expertise of the NWS staff. Computerized weather maps from the new DARE-II work stations, satellite photos, radar data, radiosonde data, information from manned and remote weather stations, and written analyses and forecasts are available. Additionally, discussions with NWS forecasters in interpreting data and products are an immense help.

Westwide Data Network

The Colorado Avalanche Information Center is responsible for the administration of the U.S. Forest Service Westwide Data Network. A portion of funding received from the Forest Service is earmarked for managing this computer data base. In this capacity, the Center serves as a repository for mountain weather, avalanche events, and avalanche accident data for avalanche-prone areas of the United States. The weather and avalanche data from some 60 sites in the mountain West are computerized and stored on magnetic tape at the Colorado State University Computer Center in Fort Collins. Information on avalanche accidents in the United States is stored in a data base at the Center, on an IBM-compatible PC.

The Center also compiles Avalanche Notes, a monthly newsletter which contains summaries of the computerized weather and avalanche data, as well as avalanche accident information. The newsletter is distributed monthly from November-April to 300 contributors and other interested people and agencies.

These data are used by Center personnel on a real-time basis and also for later analysis. Trends in avalanche accidents, relationships between survival and burial times and depths, and types of rescues are essential information to be passed on to snow scientists and the public. Lectures, field seminars, media contacts, and publications by Center personnel are some of the methods for disseminating this information. Additionally, the Center responds to 10-20 requests a year for raw or tabulated data. These requests come from the ski industry, Forest Service offices, universities, snow researchers, and lawyers.

Accident Investigation

Avalanche Center personnel try to investigate all significant avalanche incidents and fatal accidents. This winter the Center staff was able to visit four of the five fatal accident sites during or shortly after the rescue operation. Information obtained from field data, witnesses, survivors, and rescuers is used for current stability evaluation and for future educational purposes.

DISSEMINATION of HAZARD FORECASTS

The Colorado Avalanche Information Center continues to provide vital information to the public, specialized audiences, and sponsors. The following are means by which the Center disperses data pertaining to mountain weather, along with avalanche and snowpack conditions.

Public Hotlines

Incoming data from 30 field-observation sites are continually assimilated to prepare forecasts for seven recorded message systems located 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. The public made good use of this service as some 55,841 calls were placed to the hotlines this season. While usage fluctuates from winter to winter, we affirmed yet another raise in the overall call count. This represents an increase of almost 13% above last year. (See figure 2.) The following are specifics for the various hotlines.

Denver: Telephone messages are recorded twice daily on the U.S. Forest Service telephone in Lakewood. A total of 26,063 calls from the Denver and Boulder areas were made to the phone (236-9435) this winter. Following a slight decrease last year, the count rebounded by over 9% this season.

Fort Collins: This message phone, sponsored by The Mountain Shop, was back in full operation last November. The recording system, which is owned by the Avalanche Center, is housed and administered by the Larimer County Sheriff's Office. There were 2,770 calls made to the 482-0457 number this winter. That was a drop of 13% from last year.

Colorado Springs: In its sixth year of operation, this phone saw another increase in usage. While last winter call counts were up by a whopping 72%, they increased by 32% this season. There were 6,490 calls placed to the 520-0020 number. As with the Denver and Fort Collins telephones, updates were made on a twice daily schedule, seven days a week. This system is jointly sponsored by the Avalanche Center and the Mountain Chalet, a local mountaineering shop where the phone is housed.

Summit County: Once again, this area has shown remarkable support for the Center's services through the local hotline (668-0600). Summit County is comprised of much avalanche terrain, and precise information is vital. Over the course of the winter, 9,971 calls were made to the 668-0600 phone number. This represented another increase, this time of 27%. The 24 hour message phone is housed and sponsored by the county through the Summit County Rescue Group.

Eagle County: The public message phone here is housed and maintained by the U.S. Forest Service in Minturn. The phone (827-5687) saw 1,614 calls. In addition to this hotline, the Vail and

Beaver Creek Ski Patrols use daily information from the Avalanche Center to update their own recorded message phone. This is a service available to skiers leaving the ski area boundary; the phones are provided at gates of departure.

Pitkin County: The Forest Service in Aspen maintains a public message phone for local residents and tourists. Forest personnel get daily information from the Center and, after combining it with other local data, transfer an appropriate message to their recording. An estimated 1,200-1,600 calls were made to this phone during the winter.

Durango: We have been very pleased with the public's response in the Durango area. This hotline, in place for the fourth season, provides mountain weather and avalanche information for residents of southwest Colorado. Phone call counts have risen steadily for the last four years. The 7,733 calls people made to get our message represents an increase of 16% over last winter.

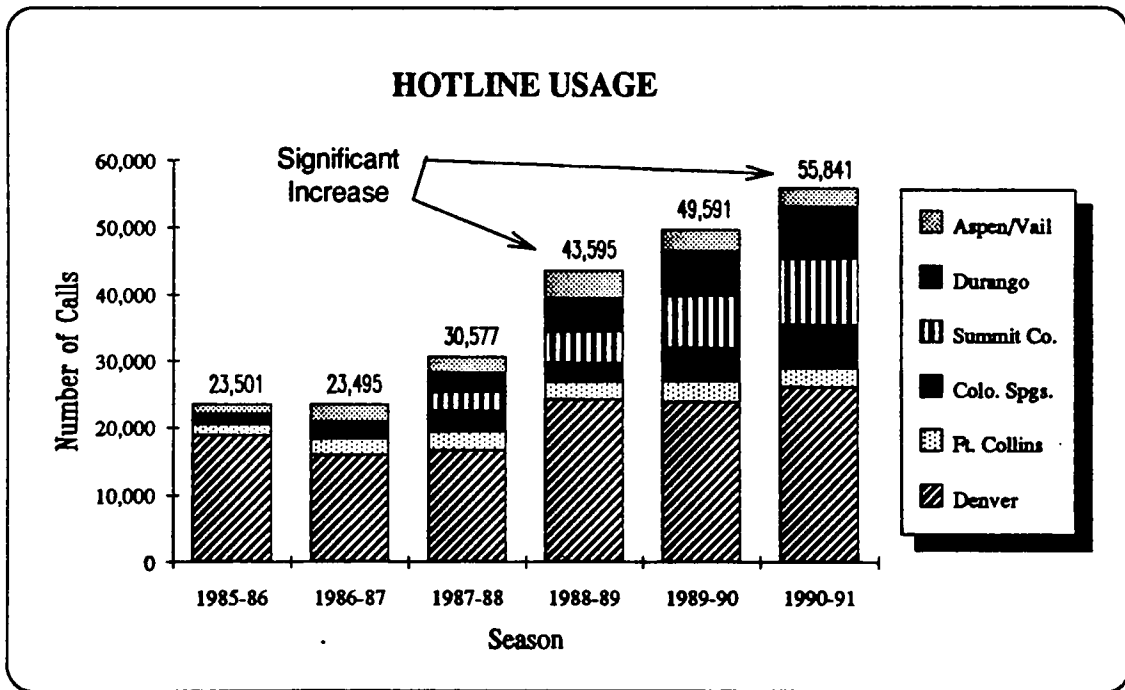


Figure 2.

Radio Broadcasts

The Avalanche Center enjoys a large listening audience through radio stations located in the mountain communities. This is especially beneficial to regions where a long distance telephone call to one of the hotlines would be inconvenient and costly. While some stations broadcast our message daily, others have been most helpful by transmitting Avalanche Warnings or Special Avalanche Advisories when necessary. Listed here are some of the stations conveying our bulletins.

This was the first winter that KOA in Denver talked with the Center every Sunday morning. We were asked to take part in a live radio show, "Colorado Outdoors," which informed the public of ski and snow conditions. It provided yet another outlet to underscore avalanche safety in the backcountry.

Public radio station KVNF-FM in Paonia has been calling the Center on a daily basis for six years to record and broadcast our messages. This is made possible by a memorial fund established for an avalanche victim killed near Ridgway in 1984. This station serves the towns of Paonia, Montrose, Delta, Ouray, Ridgway, and other rural communities in southwestern Colorado.

Throughout the winter, radio station KOTO in Telluride continued to broadcast our messages to residents in that region. This was done by recording the daily message from the Durango hotline. The area has proven to be a high risk for avalanche accidents in the past. KOTO sees to it that backcountry enthusiasts, comprised of residents and tourists alike, are kept well informed of avalanche conditions.

In Summit County, KYSL-FM in Frisco provided surrounding communities with vital updates from the Avalanche Center. People were able to keep abreast of current conditions, plus learn about timely avalanche seminars--all in an area that is no stranger to dangerous avalanche situations.

NOAA Colorado Weatherwire

During times when the avalanche hazard is rated high or extreme, CAIC forecasters issue Avalanche Warning bulletins twice daily until the hazard subsides. At that time an Avalanche Warning Termination bulletin is dispensed. Special Avalanche Advisories are sent out as well during transition periods when the avalanche danger is increasing. These bulletins are transmitted to the news media via the National Oceanic and Atmospheric Administration (NOAA) Weatherwire. Sample warning and advisory bulletins are shown in Appendix A. Tables 3 & 4 also contain related information.

News Media

Throughout the winter, highlights related to avalanches occur that draw the public's, and therefore the media's, attention. These are usually avalanche incidents involving people, property, or highways, or abnormal mountain weather conditions. When these occur, CAIC forecasters are obligated to respond to, and sometimes initiate, contacts with television, radio, newspaper, and magazine

reporters. This is done to provide as accurate information as possible for broad news coverage and high visibility. There were 163 of these contacts in 1990-'91.

Media personnel frequently called for information on current avalanche warnings, public interest stories, avalanche accidents, and current avalanche and mountain weather conditions. In addition, many live and taped interviews were conducted for radio and television broadcasts.

Seven inquiries came from outside Colorado including calls from "USA Today" in Washington D.C., "Outside" magazine in Chicago, the "Boston Globe" in Boston, the "Chicago Tribune," NBC News in Washington, and KOBF in Farmington, New Mexico. The "Associated Press" was also a frequent caller.

Colorado TravelBank

For the second winter, the Avalanche Center utilized another means to get our messages to the public. Through the "Colorado TravelBank" we can make our reports available to users directly through their own personal computers. Located in Denver, this computer network system is accessed from anywhere in the United States.

The service provides information in 11 different categories on more than 90 topics. This was the second winter they offered mountain weather and backcountry avalanche forecasts dispensed by the Avalanche Center on a daily basis. Our written forecast transfers, via modem, directly into the TravelBank system. It is then available any time to users wanting to call the product up on their home monitor.

In addition to individual users, the service is utilized by travel agents, travel and recreation organizations and other agencies. Our forecasts were also available on 500 cable television systems throughout the country.

Response to this special service still carries full momentum. There were 25,421 contacts documented between December and April. We are looking forward to using the TravelBank again next season to maintain such a high profile among computer/backcountry enthusiasts.

PUBLIC EDUCATION

A prime responsibility of the Avalanche Center is to provide education about the avalanche phenomenon. If people understand the basic concepts of snow and avalanche safety, and apply this knowledge in the field, accidents can be kept to a minimum. With this in mind, the staff is eager to participate in seminars and field courses throughout the state. Our training is accomplished through the following means:

Avalanche Awareness Talks and Field Seminars

This season, avalanche education began as early as October 10th. By the time the last talk was given on May 7th, the Center staff had spoken on 54 different occasions (three more than last winter), to a total of 2,211 persons attending 1-hour seminars to multi-day field sessions. While this is a substantial number, attendance was down by 17% from last season. These relationships are displayed on a yearly basis in Figure 3 below.

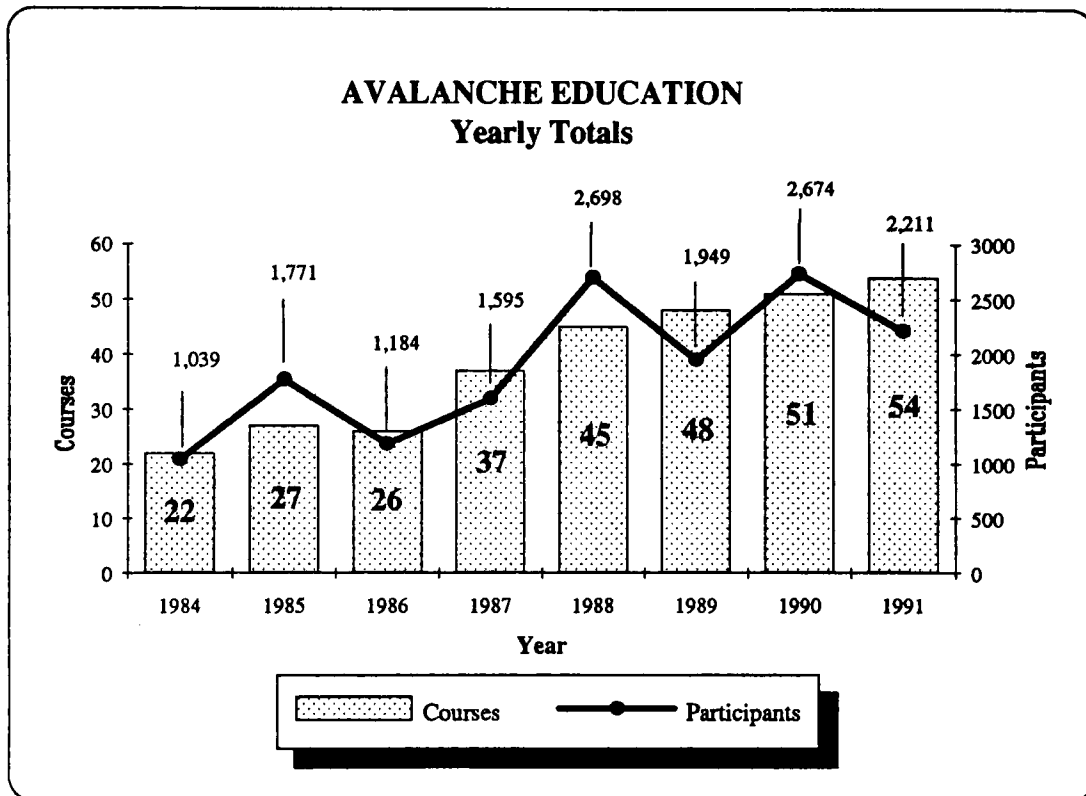


Figure 3.

To sharpen their skills, course participants had the opportunity to learn about such topics as mountain meteorology, avalanche terrain recognition, the Colorado snowpack, methods of safe winter travel, and survival and rescue techniques. The students' backgrounds ranged from professional ski patrollers, search & rescue volunteers, Colorado Mountain Club members, ski and snowmobile clubs,

and members of the general public. Table 8 shows more details about the courses. Betsy Armstrong, formerly a full-time Avalanche Center staff member, remains an associate of the CAIC and continues to educate the public about avalanches. Her classes are also listed in table 8.

In order to monitor our efforts in providing avalanche awareness, Center personnel logged the time spent in course preparation, driving time and presentation length. The outcome for 1990-'91 was: preparation - 101 hours, driving time - 144 hours, and 253 hours spent teaching the various courses. This represents about 80% more time spent on education than last season.

Avalanche Cards and Brochures

The Colorado Avalanche Information Center maintains a supply of printed material in the form of wallet-size avalanche cards, and brochures with simplified text and illustrations explaining the "what's," "where's," and "why's" about avalanches. These are distributed at all lectures and seminars, and are included in return letters of correspondence with the public. The handouts contain all of the public hotline phone numbers and definitions of the four avalanche hazard ratings. This literature is also disbursed at popular backcountry trailheads.

In Summit County, a generally high-risk avalanche region, the Summit County Rescue Group has printed special cards designed specifically for the Summit County area. This is in conjunction with their sponsoring of the local hotline. Rescue group members distributed and maintained avalanche poster/card holders in the area, which helped generate local hotline usage.

Avalanche Information Packets

For the second season, the Avalanche Center provided a free information packet to anyone requesting one. Public hotline messages conveyed the announcement that callers had only to provide a self-addressed stamped envelope to receive their own copy. The packet contained a CAIC brochure and wallet-size card, plus information about the Center's mountain weather and avalanche forecasts. To help the reader better understand our products, a glossary of terminology commonly used in hotline recordings and avalanche courses was also included. There were 31 packets mailed, the same as last year.

Table 8. Scheduled contacts with organized groups by Avalanche Center personnel, 1990-'91

Date	Personnel	Group	Participants
10/12	N. Logan	ISSW, Bigfork, Montana	40
10/27	D. Atkins	NSPS instructors clinic, Lakewood	12
10/28	D. Atkins	American Mountain Guides Assn., Estes Park	21
11/6	D. Atkins	Colorado Outdoor Sports, Denver	28
11/8	K. Williams	US West, Denver	22
11/13	B. Armstrong	EMS, Lakewood	4
11/14	D. Atkins	EMS, Boulder	12
11/15	D. Atkins	EMS, Lakewood	18
11/15	K. Williams	EMS, Boulder	33
11/25	N. Logan	Summit Co. awareness, Breckenridge	64
11/26	K. Williams	Boltz Jr. High School, Fort Collins	55
11/28	D. Atkins	Alpine Rescue Team, Evergreen	43
12/4	K. Williams	Mountain Shop, Fort Collins	60
12/8-9	NL, DA	CSRB seminar, Breckenridge/Webster Pass	115
12/10	N. Logan	Minturn Middle School, Minturn	16
12/18	N. Logan	Colorado Department of Highways, Silverthorne	14
12/18	N. Logan	Summit High School, Frisco	95
12/19	N. Logan	Breckenridge Elementary School, Breckenridge	42
12/23	N. Logan	Summit Co. awareness, Frisco	12
12/30-31	N. Logan	Colo. Heli-ski guides, Dillon/Vail Pass	18
1/6	N. Logan	Colo. Heli-ski guides, Dillon	10
1/8	K. Williams	CMC awareness, Vail	75
1/8-9	NL, DA	SCPAC Level III Symposium	100
1/9-11	K. Williams	Paragon Guides, TMTA hut tour	13
1/12	N. Logan	Keystone Science School instructors, Loveland Pass	8
1/14	D. Atkins	ABC'S Week, Golden	58
1/16	G. Reese, DA	Neptune Mountaineering, Boulder	53
1/16	B. Armstrong	Mountain Sports, Boulder	50
1/16-17	K. Williams	REI, Denver	55
1/17	N. Logan	CMC avalanche course, Vail	17

Continued on next page...

Table 8. Continued...

Date	Personnel	Group	Participants
1/18-19	D. Atkins	Silverton Avalanche School, Silverton	112
1/24	G. Reese	Cherry Creek High School, Denver	35
1/24-26	D. Atkins	NSPS, Sunlight	56
1/25-26	K. Williams	Mountain Rescue, Aspen	70
1/30	N. Logan	American Avalanche Institute, Berthoud Pass	17
1/31	D. Atkins	St. Anthony's, Denver	51
2/4	K. Williams	USFS, Fort Collins	14
2/4	G. Reese	Civil Air Patrol, Longmont	20
2/5	N. Logan	Mountain Chalet, Colorado Springs	35
2/10	D. Atkins	American Avalanche Institute, Monarch	13
2/12	D. Atkins	NSP Patch Course, Lakewood	14
2/12-13, 21	N. Logan	Breckenridge Ski Patrol, Breckenridge	11
2/12-16	K. Williams	Wilderness Medical Society, Crested Butte	250
2/17	D. Atkins	NSP Patch Course, Loveland	14
2/20	N. Logan	Snowcraft Industries, Frisco/Eisenhower Tunnel	35
2/27	N. Logan	Colorado Department of Highways, Silverthorne	39
2/28	K. Williams	Larkspur Junior High School, Denver, National Weather Service	10
3/2, 23- 24	DA, NL	American Avalanche Institute, Colorado Springs/Hoosier Pass	16
3/5	G. Reese	Mile High Snowmobile Club, Littleton	65
3/8	N. Logan	Minturn Middle School, Vail Pass	18
3/12	N. Logan	Buena Vista Snowdrifters, Buena Vista	38
3/14	D. Atkins	Logan School, Denver	9
4/9	N. Logan	Breckenridge Elementary School, Breckenridge	38
5/7	D. Atkins	Evergreen Junior High School, Evergreen	68
Total			2,211

HAZARD GRADING

For the seventh year, the Avalanche Center has used a grading system for evaluating its performance of avalanche forecasting. This forecast, based on incoming weather and current snowpack conditions, focuses on the avalanche potential. To arrive at a prediction, the forecaster on duty makes an evaluation for the next 24-hour period. This is done for each of the Northern, Central, and Southern Mountain regions. The forecast is logged every afternoon in the "Daily Hazard Information and Decision Chart" by using one of the four hazard categories. On the following day, the actual hazard rating--based in part on the field observers' estimates--is compared to the previous day's forecast. A grade of "correct forecast," "under forecast," or "over forecast" is then recorded.

Avalanche hazard forecasts are phrased using the terms "low," "moderate," "high," or "extreme" to depict the hazard in a given area. The forecaster can choose only one of the four terms used to describe the hazard. If he feels a more complex description is warranted for a given area, he states this by using specifics for each rating as to elevation, aspect, etc.

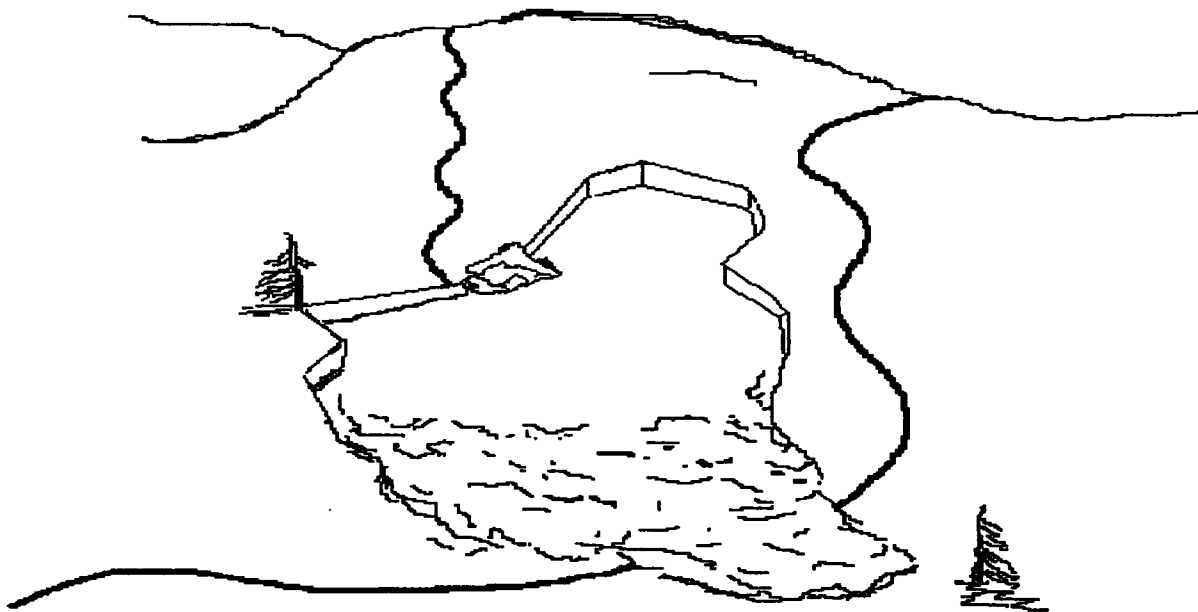
The scores for this season and previous years are shown below:

	<u>1990-91</u>	<u>1989-90</u>	<u>1988-89</u>	<u>1987-88</u>	<u>1986-87</u>	<u>1985-86</u>
Correct forecast:	91%	91%	90%	86%	95%	92%
Over forecast:	4%	6%	5%	8%	2%	5%
Under forecast:	5%	3%	5%	6%	3%	3%

Our "correct" forecasts continue to be at an acceptably high level, and are thus quite satisfying. The "correct" forecast remains well above 80% in a field that is as much art as science. The "under" forecast rate only slightly exceeds "over" forecasts.

Sample Avalanche Warnings & Advisories

This appendix contains examples of products that Avalanche Center forecasters issued to the media via the NOAA Colorado Weatherwire. These include a Special Avalanche Advisory and selected Avalanche Warning Bulletins disseminated during the winter. Pages 44-47 show some events from a warning period in February. Pages 48-52 take you through the steps of development, expansion, and termination of the longest-running Avalanche Warning of the winter. It was the only formal warning issued in March, but it blanketed nine days. On page 53 you will find a Special Avalanche Advisory. These illustrate the general content and format incorporated in the Center's announcements.



AVALANCHE WARNING ... BULLETIN NO. 1
COLORADO AVALANCHE INFORMATION CENTER
NATIONAL WEATHER SERVICE DENVER, CO
1015 AM MST SUNDAY FEBRUARY 17, 1991

... AVALANCHE WARNING IS ISSUED FOR CENTRAL MOUNTAINS ...
GOTHIC COLORADO REPORTS 26 INCHES OF SNOW

AN AVALANCHE WARNING IS IN EFFECT IMMEDIATELY FOR THE ELK MOUNTAINS
WITHIN A FIVE MILE RADIUS OF THE OLD MINING TOWN OF GOTHIC..JUST NORTH
OF CRESTED BUTTE. 26 INCHES OF SNOW HAS FALLEN THERE IN THE LAST 24
HOURS.

THIS WARNING WILL REMAIN IN EFFECT THROUGH TODAY..WHEN IT WILL BE RE
EVALUATED LATER THIS AFTERNOON.

IN THE REST OF THE CENTRAL MOUNTAINS THE AVALANCHE HAZARD IS RATED
HIGH.

WHILE VISIBILITY IS POOR AROUND GOTHIC THIS MORNING..AVALANCHES HAVE
BEEN HEARD RUNNING IN THE DISTANCE.

BACKCOUNTRY TRAVELLERS IN THE GOTHIC AND CRESTED BUTTE AREA ARE URGED
TO AVOID ANY SNOW LOADED SLOPE STEEPER THAN 30 DEGREES AND STAY WELL
AWAY FROM STEEP SLOPES ABOVE YOU.

IN THE NORTHERN MOUNTAINS THE AVALANCHE HAZARD IS HIGH..AND IN THE
SOUTHERN MOUNTAINS THE HAZARD IS MODERATE TO HIGH. BACKCOUNTRY
TRAVELLERS SHOULD USE EXTREME CAUTION NEAR AND ABOVE TIMBERLINE IN ALL
MOUNTAIN REGIONS.

THIS MESSAGE IS OF PARTICULAR INTEREST TO PERSONS USING THE
BACKCOUNTRY OUTSIDE OF DEVELOPED SKI AREA BOUNDARIES. WHERE NECESSARY
SKI AREAS USE AVALANCHE CONTROL METHODS WITHIN THEIR BOUNDARIES.

FOR ADDITIONAL AVALANCHE INFORMATION CALL ... 236-9435 IN DENVER AND
BOULDER ... 482-0457 IN FT. COLLINS ... 520-0020 IN COLORADO SPRINGS
...668-0600 IN SUMMIT COUNTY ... AND 247-8187 IN DURANGO.

THE NEXT SCHEDULED AVALANCHE BULLETIN IS FOR 4 00 PM SUNDAY.

LOGAN
COLORADO AVALANCHE INFORMATION CENTER
9091 6-1

AVALANCHE WARNING ... BULLETIN NO. 4
COLORADO AVALANCHE INFORMATION CENTER
NATIONAL WEATHER SERVICE DENVER, CO
4 00 PM MST MONDAY FEBRUARY 18, 1991

... CENTRAL MOUNTAINS RETAIN AVALANCHE WARNING ...

THE AVALANCHE HAZARD REMAINS HIGH AND AN AVALANCHE WARNING HAS BEEN EXTENDED THROUGH TUESDAY MORNING. THE WARNING AREA COVERS THE ELK MOUNTAINS AND THE WEST ELK MOUNTAINS BETWEEN CRESTED BUTTE AND ASPEN.

SOME 2 TO 3 FEET OF SNOW HAS FALLEN AT MOUNTAIN SITES IN THE LAST TWO DAYS THUS KEEPING THE AVALANCHE DANGER HIGH. COLD TEMPERATURES WILL INHIBIT STABILIZATION OF THE NEW SNOW. MODERATE WIND ABOVE TIMBERLINE IS CREATING SLAB CONDITIONS.

MORE THAN 140 AVALANCHES HAVE BEEN REPORTED TO THE CENTER IN THE LAST 48 HOURS. ONE SNOWMOBILER WAS CAUGHT AND KILLED IN AN AVALANCHE ON COTTONWOOD PASS SUNDAY AFTERNOON.

IN ALL MOUNTAINS THE AVALANCHE HAZARD IS RATED HIGH AT THIS TIME. BACKCOUNTRY TRAVELLERS ARE URGED TO AVOID ANY SNOW LOADED SLOPE STEEPER THAN 30 DEGREES AND STAY WELL AWAY FROM STEEP SLOPES ABOVE YOU.

THIS MESSAGE IS OF PARTICULAR INTEREST TO PERSONS USING THE BACKCOUNTRY OUTSIDE OF DEVELOPED SKI AREA BOUNDARIES. WHERE NECESSARY SKI AREAS USE AVALANCHE CONTROL METHODS WITHIN THEIR BOUNDARIES.

FOR ADDITIONAL AVALANCHE INFORMATION CALL ... 236-9435 IN DENVER AND BOULDER ... 482-0457 IN FT. COLLINS ... 520-0020 IN COLORADO SPRINGS ... 668-0600 IN SUMMIT COUNTY ... AND 247-8187 IN DURANGO.

THE NEXT SCHEDULED AVALANCHE BULLETIN IS FOR 11 AM TUESDAY.

LOGAN
COLORADO AVALANCHE INFORMATION CENTER
9091 6-4

AVALANCHE WARNING ... BULLETIN NO. 6
COLORADO AVALANCHE INFORMATION CENTER
NATIONAL WEATHER SERVICE DENVER, CO
4 15 PM MST TUESDAY FEBRUARY 19, 1991

... CENTRAL MOUNTAINS ... AVALANCHE WARNING CONTINUES ...

THE AVALANCHE HAZARD REMAINS HIGH AND AN AVALANCHE WARNING REMAINS IN EFFECT FOR THE ELK MOUNTAINS AND THE WEST ELK MOUNTAINS SURROUNDING CRESTED BUTTE AND ASPEN IN CENTRAL COLORADO. THIS WARNING IS VALID UNTIL WEDNESDAY MORNING ... AT WHICH TIME WE WILL PROBABLY TERMINATE THE WARNING.

SNOWFALL HAS NOW STOPPED BUT 2 TO 3 FEET OF SNOW THAT FELL IN THE LAST THREE DAYS IS THE CAUSE OF THE HIGH AVALANCHE DANGER IN THE BACKCOUNTRY. MODERATE WINDS HAVE CREATED WIDESPREAD SOFTSLAB AVALANCHE CONDITIONS IN THE BACKCOUNTRY SNOW COVER.

200 AVALANCHES HAVE BEEN REPORTED TO THE CENTER IN THE LAST 3 DAYS. ONE SNOWMOBILER WAS CAUGHT AND KILLED IN AN AVALANCHE IN COTTONWOOD PASS SUNDAY AFTERNOON. NO OTHER PERSONS HAVE BEEN CAUGHT NOR HAS ANY PROPERTY BEEN REPORTED DAMAGED.

THIS WARNING COVERS AN AREA OF THE MOUNTAINS OF CENTRAL COLORADO WHERE THE HAZARD HAS BEEN GREATEST AND THE LARGEST NUMBER OF AVALANCHES HAS OCCURRED. IN FACT ... THE BACKCOUNTRY AVALANCHE HAZARD IS RATED HIGH FOR ALL MOUNTAIN AREAS AT THIS TIME.

BACKCOUNTRY SKIERS AND SNOWMOBILERS ARE URGED TO AVOID ANY SNOW LOADED SLOPE STEEPER THAN 30 DEGREES. TRIGGERED AVALANCHE RELEASES ARE LIKELY ON THESE SLOPES. SAFE TOURING CAN BE FOUND ON ROADS AND SLOPES LESS THAN 30 DEGREES.

THIS MESSAGE IS OF PARTICULAR INTEREST TO PERSONS USING THE BACKCOUNTRY OUTSIDE OF DEVELOPED SKI AREA BOUNDARIES. WHERE NECESSARY SKI AREAS USE AVALANCHE CONTROL METHODS WITHIN THEIR BOUNDARIES.

FOR ADDITIONAL AVALANCHE INFORMATION CALL ... 236-9435 IN DENVER AND BOULDER ... 482-0457 IN FT. COLLINS ... 520-0020 IN COLORADO SPRINGS ... 668-0600 IN SUMMIT COUNTY ... AND 247-8187 IN DURANGO.

THE NEXT SCHEDULED AVALANCHE BULLETIN IS FOR 11 AM WEDNESDAY.

WILLIAMS
COLORADO AVALANCHE INFORMATION CENTER
9091 6-6

AVALANCHE WARNING TERMINATION ... BULLETIN NO. 7
COLORADO AVALANCHE INFORMATION CENTER
NATIONAL WEATHER SERVICE DENVER, CO
11 AM MST WEDNESDAY FEBRUARY 20, 1991

... CENTRAL MOUNTAINS ... AVALANCHE WARNING DROPPED ...

THE AVALANCHE WARNING FOR THE ELK MOUNTAINS AND THE WEST ELK MOUNTAINS SURROUNDING CRESTED BUTTE AND ASPEN IN CENTRAL COLORADO HAS BEEN TERMINATED ... THOUGH THE BACKCOUNTRY AVALANCHE HAZARD REMAINS HIGH ... ESPECIALLY ABOVE TIMBERLINE.

SNOWFALL ENDED TUESDAY MORNING ... TEMPERATURES ARE WARMING ... AND ALL NATURAL AVALANCHES RELEASES ENDED ON MONDAY. THUS WE FEEL THE HAZARD HAS MODERATED ENOUGH THAT WE CAN DROP THE WARNING. HOWEVER ... A HIGH AVALANCHE DANGER AND A THREAT OF SKIER OR SNOWMOBILER TRIGGERED AVALANCHES REMAINS FOR ALL MOUNTAIN AREAS OF COLORADO. THIS THREAT IS LIMITED TO SLOPES OF 35 DEGREES AND STEEPER ... AND THE DANGER IS SLIGHTLY GREATER NEAR AND ABOVE TIMBERLINE BECAUSE OF MORE BLOWING SNOW AND SLAB FORMATION DURING THE STORM PERIOD SEVERAL DAYS AGO.

ABOUT 205 AVALANCHES WERE REPORTED TO THE CENTER SINCE THE WARNING WAS FIRST POSTED ON SUNDAY FEBRUARY 17.

BACKCOUNTRY SKIERS AND SNOWMOBILERS ARE URGED TO AVOID SNOW LOADED SLOPES STEEPER THAN 35 DEGREES. TRIGGERED AVALANCHE RELEASES ARE LIKELY ON THESE SLOPES. SAFE TOURING CAN BE FOUND ON ROADS AND SLOPES LESS THAN 30 DEGREES.

THIS MESSAGE IS OF PARTICULAR INTEREST TO PERSONS USING THE BACKCOUNTRY OUTSIDE OF DEVELOPED SKI AREA BOUNDARIES. WHERE NECESSARY SKI AREAS USE AVALANCHE CONTROL METHODS WITHIN THEIR BOUNDARIES.

FOR ADDITIONAL AVALANCHE INFORMATION CALL ... 236-9435 IN DENVER AND BOULDER ... 482-0457 IN FT. COLLINS ... 520-0020 IN COLORADO SPRINGS ... 668-0600 IN SUMMIT COUNTY ... AND 247-8187 IN DURANGO.

THIS IS THE LAST BULLETIN ON THIS AVALANCHE SITUATION.

WILLIAMS
COLORADO AVALANCHE INFORMATION CENTER
9091 6-7

AVALANCHE WARNING ... BULLETIN NO. 1
COLORADO AVALANCHE INFORMATION CENTER
NATIONAL WEATHER SERVICE DENVER, CO
9 30 AM MST SATURDAY MARCH 2, 1991

... AVALANCHE WARNING IS ISSUED FOR SOUTHERN AND CENTRAL MOUNTAINS ...

AN AVALANCHE WARNING IS BEING ISSUED FOR THE SOUTHERN MOUNTAINS AND FOR THE ELK MOUNTAINS. THE AREA AFFECTED IS SOUTH OF A LINE FROM SALIDA TO GUNNISON TO MONTROSE. ALSO AFFECTED IS THE AREA NEAR AND AROUND CRESTED BUTTE.

THIS WARNING IS VALID THROUGH SUNDAY MARCH 3.

THE AVALANCHE HAZARD IN THESE AREAS IS RATED AS HIGH DUE TO SUBSTANTIAL SNOWFALL AND MODERATE BUT GUSTY WINDS...

NATURAL AND TRIGGERED AVALANCHES ARE LIKELY ON ALL ASPECTS AND AT ALL ELEVATIONS...

STORM TOTALS RANGE FROM 22" AT TELLURIDE TO 24" AT IRWIN LODGE AND 33" AT WOLF CREEK...

BACKCOUNTRY TRAVELLERS ARE URGED TO AVOID ANY SNOW LOADED SLOPES...

THIS MESSAGE IS OF PARTICULAR INTEREST TO PERSONS USING THE BACKCOUNTRY OUTSIDE OF DEVELOPED SKI AREA BOUNDARIES. WHERE NECESSARY SKI AREAS USE AVALANCHE CONTROL METHODS WITHIN THEIR BOUNDARIES.

FOR ADDITIONAL AVALANCHE INFORMATION CALL ... 236-9435 IN DENVER AND BOULDER ... 482-0457 IN FT. COLLINS ... 520-0020 IN COLORADO SPRINGS ... 668-0600 IN SUMMIT COUNTY ... AND 247-8187 IN DURANGO.

THE NEXT SCHEDULED AVALANCHE BULLETIN IS FOR 4 00 PM SATURDAY...

REESE
COLORADO AVALANCHE INFORMATION CENTER
9091 7-1

AVALANCHE WARNING ... BULLETIN NO. 8
COLORADO AVALANCHE INFORMATION CENTER
NATIONAL WEATHER SERVICE DENVER, CO
4 00 PM MST TUESDAY MARCH 5, 1991

..AVALANCHE WARNING EXPANDED TO INCLUDE ALL COLORADO MOUNTAINS..

THE AVALANCHE WARNING WHICH BEGAN SATURDAY MORNING MARCH 2 HAS BEEN EXPANDED TO INCLUDE ALL COLORADO MOUNTAINS. THE HAZARD IN THE SOUTHERN MOUNTAINS IS RATED EXTREME..AND HIGH IN THE NORTHERN AND CENTRAL MOUNTAINS.

THIS WARNING IS VALID THROUGH WEDNESDAY AFTERNOON WHEN IT WILL BE RE-EVALUATED.

ADDITIONAL HEAVY WET SNOW AND STRONG WINDS IS KEEPING THE AVALANCHE DANGER HIGH. CONTINUED SNOW AND WIND WILL NOT LET THE HAZARD ABATE IN THE NEXT 24 HOURS.

SINCE THE AVALANCHE WARNING WENT INTO EFFECT MORE THAN 250 AVALANCHES HAVE BEEN REPORTED TO THE CENTER. MORE NATURAL AND TRIGGERED AVALANCHES ARE CERTAIN TO OCCUR ON ALL ASPECTS AND ELEVATIONS.

BACKCOUNTRY TRAVELLERS ARE URGED TO AVOID ANY SNOWCOVERED SLOPES STEEPER THAN 30 DEGREES. SAFER BACKCOUNTRY SKIING AND SNOWMOBILING CAN BE FOUND ON SLOPES LESS THAN 30 DEGREES...BUT STAY WELL AWAY FROM STEEP SLOPES ABOVE YOU..AND AVOID NARROW VALLEYS.

THIS MESSAGE IS OF PARTICULAR INTEREST TO PERSONS USING THE BACKCOUNTRY OUTSIDE OF DEVELOPED SKI AREA BOUNDARIES. WHERE NECESSARY SKI AREAS USE AVALANCHE CONTROL METHODS WITHIN THEIR BOUNDARIES.

FOR ADDITIONAL AVALANCHE INFORMATION CALL ... 236-9435 IN DENVER AND BOULDER ... 482-0457 IN FT. COLLINS ... 520-0020 IN COLORADO SPRINGS ...668-0600 IN SUMMIT COUNTY ... AND 247-8187 IN DURANGO.

THE NEXT SCHEDULED AVALANCHE BULLETIN IS FOR 1100 AM WEDNESDAY....

LOGAN
COLORADO AVALANCHE INFORMATION CENTER
9091 7-8

AVALANCHE WARNING ... BULLETIN NO. 14
COLORADO AVALANCHE INFORMATION CENTER
NATIONAL WEATHER SERVICE DENVER, CO
4 30 PM MST FRIDAY MARCH 8, 1991

...AVALANCHE WARNING REMAINS IN EFFECT FOR ALL BACKCOUNTRY AREAS OF
THE COLORADO MOUNTAINS...

THE AVALANCHE WARNING ...FIRST ISSUED SATURDAY ... REMAINS IN EFFECT
FOR ALL BACKCOUNTRY AREAS OF THE COLORADO MOUNTAINS. THIS WARNING HAS
BEEN EXTENDED AND IS VALID THROUGH SATURDAY MARCH 9.

MORE THAN 600 AVALANCHES ... 611 TO BE EXACT ... HAVE BEEN REPORTED TO
THE CENTER SINCE WARNINGS WERE FIRST POSTED ON SATURDAY. NATURAL
AVALANCHE RELEASES HAVE ENDED IN THE CENTRAL AND SOUTHERN MOUNTAINS OF
COLORADO ... WHERE THE WEATHER HAS BEEN BENIGN. BUT IN THE NORTHERN
MOUNTAINS THREE NATURAL RELEASES HAVE BEEN REPORTED TODAY ... BECAUSE
WINDS ARE KEEPING UP BLOWING SNOW NEAR AND ABOVE TIMBERLINE.

RESCUE EFFORTS HAVE RECOVERED THE BODY OF A CROSS COUNTRY SKIER BURIED
IN A LARGE AVALANCHE WHICH RAN ON WEDNESDAY AFTERNOON SEVEN MILES
SOUTH OF ASPEN. THIS WAS THE FOURTH PERSON TO DIE BY AVALANCHE THIS
WINTER IN COLORADO.

SKI OR SNOWMOBILE TRIGGERED AVALANCHES REMAIN A SERIOUS THREAT TO
BACKCOUNTRY TRAVELLERS THIS WEEKEND. WE URGE PERSONS HEADING INTO THE
BACKCOUNTRY TO AVOID ANY SNOWCOVERED SLOPE STEEPER THAN 30 DEGREES ...
FOR TRIGGERED RELEASES REMAIN LIKELY ON THESE SLOPES. SAFER
BACKCOUNTRY SKIING AND SNOWMOBILING CAN BE FOUND IN SHALLOW TERRAIN
FAR AWAY FROM STEEP SLOPES ABOVE YOU.

THIS MESSAGE IS OF PARTICULAR INTEREST TO PERSONS USING THE
BACKCOUNTRY OUTSIDE OF DEVELOPED SKI AREA BOUNDARIES. WHERE NECESSARY
SKI AREAS USE AVALANCHE CONTROL METHODS WITHIN THEIR BOUNDARIES.

FOR ADDITIONAL AVALANCHE INFORMATION CALL ... 236-9435 IN DENVER AND
BOULDER ... 482-0457 IN FT. COLLINS ... 520-0020 IN COLORADO SPRINGS
...668-0600 IN SUMMIT COUNTY ... AND 247-8187 IN DURANGO.

THE NEXT SCHEDULED AVALANCHE BULLETIN IS FOR 1100 AM SATURDAY....

WILLIAMS
COLORADO AVALANCHE INFORMATION CENTER
9091 7-14

AVALANCHE WARNING ... AND TERMINATION ... BULLETIN NO. 15
COLORADO AVALANCHE INFORMATION CENTER
NATIONAL WEATHER SERVICE DENVER, CO
1115 AM MST SATURDAY MARCH 9, 1991

...AVALANCHE WARNING REMAINS IN EFFECT FOR NORTHERN MOUNTAINS...

...WARNING TERMINATED FOR CENTRAL AND SOUTHERN MOUNTAINS...

A HIGH AVALANCHE DANGER AND AN AVALANCHE WARNING REMAIN IN EFFECT FOR BACKCOUNTRY AREAS OF THE NORTHERN COLORADO MOUNTAINS ... NORTH OF A LINE FROM DENVER TO BRECKENRIDGE TO GLENWOOD SPRINGS.

THIS WARNING IS BEING EXTENDED ONE MORE DAY AND IS VALID UNTIL SUNDAY MORNING MARCH 10.

A HIGH AVALANCHE HAZARD CONTINUES IN THE CENTRAL AND SOUTHERN MOUNTAINS OF COLORADO FOR BACKCOUNTRY AREAS THAT ARE NEAR AND ABOVE TIMBERLINE. HOWEVER ... THE AVALANCHE WARNING COVERING THE CENTRAL AND SOUTHERN MOUNTAINS IS BEING TERMINATED.

THE LAST 2 DAYS ... TEMPERATURES HAVE BEEN SLIGHTLY WARMER AND THERE WAS LESS WIND AND BLOWING SNOW IN THE CENTRAL AND SOUTHERN MOUNTAINS THAN IN THE NORTHERN MOUNTAINS. THUS THE STABILIZING EFFECTS ON THE SNOW COVER HAVE PROCEEDED A LITTLE FASTER IN THE SOUTHERN AND CENTRAL MOUNTAINS AND WE FEEL THAT TERMINATING THE WARNING IN THIS AREA IS WARRANTED.

THIS MORNING 17 FRESH AVALANCHES HAVE BEEN REPORTED IN THE NORTHERN ... 3 IN THE CENTRAL ... AND NONE IN THE SOUTHERN MOUNTAINS. THIS BRINGS THE TOTAL TO 640 AVALANCHES REPORTED TO THE CENTER SINCE WARNINGS WERE FIRST POSTED LAST SATURDAY. SKI OR SNOWMOBILE TRIGGERED AVALANCHE REMAIN A SERIOUS THREAT TO BACKCOUNTRY TRAVELLERS THIS WEEKEND. WE URGE PERSONS HEADING INTO THE BACKCOUNTRY TO AVOID ANY SNOWCOVERED SLOPE STEEPER THAN 35 DEGREES ... FOR TRIGGERED RELEASES REMAIN LIKELY ON THESE SLOPES. SAFER BACKCOUNTRY SKIING AND SNOWMOBILING CAN BE FOUND IN SHALLOW TERRAIN FAR AWAY FROM STEEP SLOPES ABOVE YOU.

THIS MESSAGE IS OF PARTICULAR INTEREST TO PERSONS USING THE BACKCOUNTRY OUTSIDE OF DEVELOPED SKI AREA BOUNDARIES. WHERE NECESSARY SKI AREAS USE AVALANCHE CONTROL METHODS WITHIN THEIR BOUNDARIES.

FOR ADDITIONAL AVALANCHE INFORMATION CALL ... 236-9435 IN DENVER AND BOULDER ... 482-0457 IN FT. COLLINS ... 520-0020 IN COLORADO SPRINGS ... 668-0600 IN SUMMIT COUNTY ... AND 247-8187 IN DURANGO.

THE NEXT SCHEDULED AVALANCHE BULLETIN IS FOR 1100 AM SUNDAY....

WILLIAMS
COLORADO AVALANCHE INFORMATION CENTER
9091 7-15

AVALANCHE WARNING ... BULLETIN NO. 17
COLORADO AVALANCHE INFORMATION CENTER
NATIONAL WEATHER SERVICE DENVER, CO
2 30 PM MST SUNDAY MARCH 10, 1991

... NORTHERN MOUNTAINS ... AVALANCHE WARNING DROPPED ...

THE AVALANCHE WARNING FOR THE NORTHERN MOUNTAINS HAS BEEN TERMINATED ... THOUGH THE BACKCOUNTRY AVALANCHE HAZARD REMAINS HIGH ESPECIALLY ABOVE TREELINE.

WARM AFTERNOON HIGH TEMPERATURES THE PAST TWO DAYS HAS ALLOWED THE SNOWPACK TO SETTLE AND GAIN STRENGTH. WE DO NOT EXPECT ANY NEW REPORTS OF NATURAL AVALANCHE RELEASES ... SO WE FEEL THAT TERMINATING THE AVALANCHE WARNING IN THIS AREA IS WARRANTED.

THOUGH WE DO NOT EXPECT NATURAL AVALANCHE RELEASES THE BACKCOUNTRY AVALANCHE DANGER STILL REMAINS HIGH NEAR AND ABOVE TREELINE FOR ALL MOUNTAIN AREAS AS TRIGGERED RELEASES BY BACKCOUNTRY TRAVELLERS ARE LIKELY ON SLOPES 35 DEGREES OR STEEPER.

SINCE THE WARNING WAS FIRST POSTED LAST SATURDAY 665 AVALANCHES HAVE BEEN REPORTED TO THE CENTER FROM ALL MOUNTAIN AREAS. ALSO 8 PEOPLE HAVE BEEN CAUGHT IN AVALANCHES ... 2 PEOPLE INJURED ... 2 BURIED ... AND 1 PERSON KILLED ... NEAR ASPEN LAST WEDNESDAY.

SKI OR SNOWMOBILE TRIGGERED AVALANCHES REMAIN A SERIOUS THREAT TO BACKCOUNTRY TRAVELLERS THIS WEEKEND. WE URGE PERSONS HEADING INTO THE BACKCOUNTRY TO AVOID ANY SNOW COVERED SLOPE STEEPER THAN 35 DEGREES ... FOR TRIGGERED RELEASES REMAIN LIKELY ON THESE SLOPES. SAFER BACKCOUNTRY SKIING AND SNOWMOBILING CAN BE FOUND IN SHALLOW TERRAIN FAR AWAY FROM STEEP SLOPES ABOVE YOU.

THIS MESSAGE IS OF PARTICULAR INTEREST TO PERSONS USING THE BACKCOUNTRY OUTSIDE OF DEVELOPED SKI AREA BOUNDARIES. WHERE NECESSARY SKI AREAS USE AVALANCHE CONTROL METHODS WITHIN THEIR BOUNDARIES.

FOR ADDITIONAL AVALANCHE INFORMATION CALL ... 236-9435 IN DENVER AND BOULDER ... 482-0457 IN FT. COLLINS ... 520-0020 IN COLORADO SPRINGS ... 668-0600 IN SUMMIT COUNTY ... AND 247-8187 IN DURANGO.

THIS IS THE LAST BULLETIN ON THIS AVALANCHE SITUATION....

ATKINS
COLORADO AVALANCHE INFORMATION CENTER
9091 7-17

SPECIAL AVALANCHE ADVISORY
COLORADO AVALANCHE INFORMATION CENTER
NATIONAL WEATHER SERVICE DENVER CO
6 00 PM MST MONDAY MARCH 11, 1991

...SPECIAL AVALANCHE ADVISORY FOR ALL MOUNTAIN AREAS...

A SPECIAL AVALANCHE ADVISORY IS BEING ISSUED FOR ALL OF THE COLORADO MOUNTAINS TONIGHT AND FOR TUESDAY MORNING. THIS IS THE RESULT OF STRONG WINDS THIS AFTERNOON ... GUSTS TO 90-100 MPH IN THE SOUTHERN MOUNTAINS ... THAT WERE ACCOMPANIED WITH LIGHT TO MODERATE SNOWFALL.

WE ARE NOT EXPECTING A WIDESPREAD NATURAL AVALANCHE CYCLE ... BUT THE AVALANCHE DANGER IS RATED HIGH NEAR AND ABOVE TREELINE. WELL BELOW TREELINE THE HAZARD IS RATED MODERATE. THE MOST DANGEROUS SLOPES ARE ONES 30 DEGREES AND STEEPER.

BACKCOUNTRY TRAVELLERS ARE ADVISED TO STAY ON GENTLE SLOPES AND AWAY FROM STEEP ... SNOW COVERED SLOPES AND GULLIES ... KEEP ABREAST OF CHANGING MOUNTAIN WEATHER AND SNOW CONDITIONS THAT MAY INCREASE THE AVALANCHE DANGER IN THE NEXT 12 TO 24 HOURS.

THIS MESSAGE IS OF PARTICULAR INTEREST TO PERSONS USING THE BACKCOUNTRY OUTSIDE OF DEVELOPED SKI AREA BOUNDARIES. WHERE NECESSARY SKI AREAS USE AVALANCHE CONTROL METHODS WITHIN THEIR BOUNDARIES.

FOR ADDITIONAL AVALANCHE INFORMATION CALL ... 236-9435 IN DENVER AND BOULDER ... 482-0457 IN FT. COLLINS ... 520-0020 IN COLORADO SPRINGS ... 668-0600 IN SUMMIT COUNTY ... AND 247-8187 IN DURANGO.

ATKINS
COLORADO AVALANCHE INFORMATION CENTER
9091

LETTERS and NEWSPAPER ARTICLES

This appendix includes a collage of letters and cards commenting on the service provided by the Avalanche Center and a sampling of newspaper stories which helped the Center get its information to the public.

PO Box 737
Breckenridge, CO

Jan. 7, 1991
Crazy Oliver
Box 4434
Breckenridge
Co. 804

Dear Nick Logan,
Thank you for showing
us other things about avalanches
I liked watching the slides.

From,
Richard Norton

January 7, 1991

Dear Nick,

I am really happy you
came in to talk with us about
avalanche safety. I learned a lot!
Like when you get caught in one
you could do swimming strokes
and make a breathing hole with
your hands. I also learned that
you could never go out of bounds.
Thank you again!

Love,
Bellamy

Dear Mr. Logan,
I liked your seminar on
avalanches. I learned a lot. I liked
about the snow pits.

From,
Crazy Oliver

January 7, 1991
Breckenridge CO

Dear Nick Logan,
I thank you for coming
to tell us about avalanches.
I learned a lot.

If I ever go out in
the backcountry I'll know
how to avoid avalanches.
I'll also know how to
prepare for the backcountry
and how to rescue someone
if there is an avalanche.

I think my chances
of being in an avalanche
are much less now.

From,
Matthew Price

January 7, 1991
Breckenridge CO
80424

Dear Mr. Logan,
I think that the more
we saw with the people stay
out of sight that look like
an avalanche is going to
happen. I sure learned
to stay in bounds and
not go avalanche sight.
Well I learned a lot!

From,
Michael
Bunchman

January 7, 1991

Dear Nick,
Thank you for coming in. I enjoyed the
movie and slides. I learned a lot about
avalanches. Just because a hill looks safe
it might not be safe. I also learned how
to do the shovel test.

Thanks,
Bellamy

January 7, 1991

Dear Nick Logan,
I don't ski but I
learned a lot about avalan-
che safety. I also learned
how to see if there is
going to be an avalanche
soon. A thing I should
tell other people who ski
not to ski out of bounds.

From,
Missy
Moore

January 7, 1991

Dear Nick Logan,
Thank you for taking
your time to talk to us about
avalanches. I learned how to
choose a good route to go on.
I will be careful around
steep hills.

From,
Kim
Schardt

P.S. Thank you again!!!!

January 7, 1990

Dear Nick Logan,
I really appreciated you coming to our school and explaining how avalanches start. Now I know what to look for and where to ski. Thankyou very much for doing that.

Sincerely,
Wade Albert

Dear Mr. Logan,

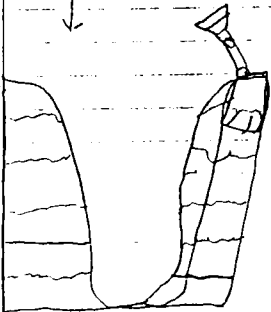
Thank you for taking the time to come in and talk to the 5th grade about avalanches. I learned a lot I learned that you should ski to the side of a run and not the middle.

Your friend,
Dodd Perkins.

January 7, 19

Dear Nick Logan,

Thank you for the presentation you put on for us at Breckenridge Elementary. I learned a lot about avalanches and how they could be triggered off. I also learned how to make a snow pit. A snow pit helps you know if the run is safe. Here is a picture of a snow pit.



From,
Piotti
Thompson
5th Grade

Dear Nick Logan, January 7, 1991

Thank you for coming and talking to us about avalanches. I really enjoyed it. Now I know how they start and I also know what to do if an avalanche is coming. And I now have a number to call and see if it's a good day to go skiing.

From
Nicki
Neuman

January 7, 1990

Dear Nick Logan,

Thank you for coming in and talking to me about avalanches. Safety. I can use this information when I go in the back country if I do.

Thanks alot,
Jason Brown

January 7, 1991

Dear Nick Logan,

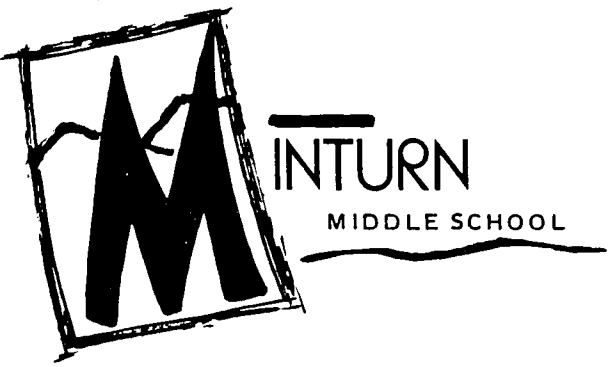
Thank you for using your time to come in and show us all about avalanches and how bad they can really be.

I learned how to know if the run is safe or not. I know how to test the run by digging a hole and seeing how stable the levels of snow are.

Thank you very much for showing and teaching us how bad avalanches are.

Thanks.

From,
Brianna
Edwards



MINTURN

MIDDLE SCHOOL

1951 S. HWY. 24
P.O. BOX 280
MINTURN, COLORADO 81645
303-827-5721
BEVERLY J. VOIGT, PRINCIPAL

March 12, 1991

Dear Nick,

You were great! I can't tell you how much my class (and their parents) enjoyed your presentation and instruction. Your informal technique proved to be both popular and very effective. The students were impressed by your work, and came away with a much greater sense of awareness about avalanche hazards. Any time we can provide hands on experience for young outdoorsmen, will be a very positive learning opportunity. They all came back very appreciative and excited about the trip.

You have been a wonderful addition to our environmental education program Nick, and I thank you for your time and help. I look forward to working together again. Let me know if I can be of help as well. Take care.

Sincerely

John Bredt





lynn d carlisle, dds, pc

drake professional building
373 west drake road
fort collins, colorado 80526
303-223-1420

April 20, 1991

Thomas Bank
350 Arapahoe, # 23
Boulder, CO 80302

The Folks at the Avalanche Center,

You guys are doing great work. I have been calling your service at least a couple times a week for the last two or three winters. Your mountain weather reports are excellent--to my knowledge, the very best in the state. Your avalanche forecasts are accurate and useful when planning a winter trip to the hills. And, making a good thing even better, there is no charge for the information.

Here are a few comments from one of your fans:

Keep the line free. As soon as there is a charge (a 900 phone number for instance), folks will hesitate to call as frequently.

You often give reasons for why you're making the forecasts you do. This is helpful and informative. Just reporting the avalanche danger is high is good, but reporting the avalanche danger is high *and* that over one hundred avalanches were reported in the last 48 hours *and* some idea of what kind of snow to expect is better.

You often report on conditions in the southern, central, and northern mountains separately. These regions are a little too ambiguous for my taste. Forecasting according to mountain ranges or groups of mountain ranges would be more precise.

Most of the time when I call, I get a reasonably clear message. Once in a while, the audio quality of the message makes it difficult to understand. Sometimes I get no answer at all, and this is very frustrating. If you can afford to get some better equipment, I would recommend getting it.

If you decided to provide mountain weather service all year round, I for one, would take advantage of it. But, the avalanche forecasting is much more important, don't cut into avalanche forecasting funds to provide summer weather reports.

All in all, I say keep up the good work. The ski season is about over, but there are still spring mountaineering adventures to be had. I'll be listening next year.

A Hardy Thanks

Tom Bank

Thomas Bank

I have been a regular user of the Avalanche line. I am an avid skier & use it several times during the week when I am planning to go skiing.
Thanks for a great service

Hi.
I depend on your avalanche reports for skiing on weekends but the weather report is useful every day. The Avalanche Report is a necessity to me. Thanks.

Paul Murrell
Box 131

Pacoma 81428

PRINTED IN U.S.A.

James A. FitzPatrick, Chairman
Friends - Please continue Avalanche Report - it's a very important service in Western Colorado. Listen on KVNF, Pacoma. Thank you.

Avalanche Center
10320 Smith Rd.
Denver, Co.
80239

Excellent!
You also do a fantastic job in your avalanche hot line. I call it religiously to give insight into the weather conditions ahead for the local skiers - snow, winds etc. Thanking in a couple of ski areas outdoor markets - if you could do that.
All in all - a great job.
D. Murrell
I will be in the area
40 Denver 858921

Apr. 21, 1991

I want you folks to know how much
your daily avalanche report
means to me. I live on the
Western Slope, have no TV,
and am pretty dependent on
your report as a weather
forecast. It is a boon to me.
I listen to KUNF, broadcast
out of Paonia. I will miss
you this summer.

Diane Hammond
4177 E 50 Drive
Chawfod CO 81415

Avalanche Center
10230 Smith Rd.
Denver, CO 80239

Dear Sirs:

Keep up the excellent, succinct & more
accurate weather info than anyone else for us
folks who travel in the mountains all through
the winter — on skis + snowshoes, that is.

Your service is reliable + very much
helps us with decision-making on where we
can safely venture on any given day. Thanks
for your conscientious efforts — it takes
out a lot of the risk + potential disappointment.

Sincerely,

Cecelyn Kercheak
& S. Ogden
Denver, CO 80209

4-23-91

Dear everyone at Avalanche
Center,

Thank you so much for
providing the excellent
snow report to the North
Fork Valley via KUNF radio
station. We skied the
backcountry alot and
who knows..... you may
have kept us out of
danger this winter! We
wish we could get your
weather report all year!

Thanks again,
Kim Roberts +
Chris Dourley
box 603
Hotchkiss, CO 81419

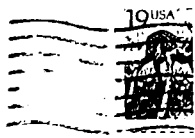
4/19/1991

Dear Avalanche Center,

Thank you for your fine reporting
of avalanche conditions through out
the winter. We depend on your
current information. Keep up the good
work. We hear your report on
KVNF radio.

Claire Moore
P.O. Box 131
Paonia, CO 81428

Dear Avalanche Crew,
Thank you for bringing
us the Avalanche Report
Every morning. We really
appreciate it and have
learned a lot about snow
patterns. Please continue
next winter. We listen
on KVNF out of
Paonia. and ski mostly in
the Red Mt. Pass area.
Thanks again, Leif & Liza Juell



POST CARD

Avalanche Center
10320 Smith Rd.
Denver CO 80239

DOGWOOD TIME IN THE OZARKS
The hill country in late April and early May attracts visitors from
many states to see the beautiful displays of dogwood and redbud.
There are still many rustic old rail fences and other reminders of the
early settlers in the rugged region.



35426681

Dear Nick Logan,

I really appreciate you taking time off to teach us about avalanches. I really enjoyed the trip. I feel I could recognize an unsafe slope to a safe slope. I know how to dig several kinds of snow pits and could locate a transceiver if I had to. I basically had an all around good time.

Sincerely,

Matt Lavery

Dear Mr. Logan,

Thank you for coming on our class trip. I enjoyed having you teach us about snow structure, and the other tests you taught us. I especially enjoyed the search for the missing SKADI boxes. Thank you again!

Sincerely,

Steve Merritt
MMS

Dear Nick Logan,

Thank you very much for coming with us last Friday. I learned a lot that will be important to my future. I really enjoyed the searching for the Skadis and the rock discussion. Thank you very much, and I would like to go again!

Sincerely,
Bryce Stewart
Karl Kuchel

Dear Nick Logan,

Thank you very much for taking the time to teach our class about avalanche safety. We appreciate it very much, and many of us hope to be able to take part in another activity like this one. This trip succeeded in teaching us many things that will help us in the future. I'd like to thank you once again for making this trip possible.

Sincerely,

Cassandra Hoevelmann

Dear Nick Logan,

We all really appreciate what you did for our class. The entire trip was very educational and exciting. I had never seen the snow pits before. And it was really cool to see the snow layers. I hope you take another group on the trip sometime.

Sincerely,

Termy Bacon
Brad Fenwick

Dear Nick,
The MMS Environmental Education class thanks you for taking time to inform us about avalanche safety. I think we all learned a lot by you going on this trip. Thanks Again.

Sincerely,

Robert Oramillo

Rocky Mt News Nov 27, 1990

Success snowballs for state's avalanche forecasters

There is nothing more terrifying in the back country this time of year than hearing a *whoomp*, like dynamite going off far below the surface, followed by a rattling of the ground like a minor earthquake.

It's the sound and feel of an avalanche in which thousands of tons of snow have slumped off a slope and are cascading down a chute, tearing out full-grown trees.

Each year, from mid-November through April, the Colorado Avalanche Information Center gears up to identify areas where avalanches are likely.

Center director Knox Williams says 20,000 avalanches occur each season in Colorado, and an average



Gary Gerhardt

Nature Watch

of 50 people get caught in them. Of that number, only an average of four die.

"So, your chances of surviving an avalanche is about 9 in 10," Williams said.

The center, administered by the Geological Survey Division of the Colorado Department of Natural Resources, evolved from a National Forest Service pilot project in 1973, Williams said.

"While Art Judson and I worked for the Forest Service in Fort Collins, we felt we had the knowledge, if good weather information and avalanche data were coming in, to make forecasts for the back country," Williams said.

Because more than 90% of the avalanches in Colorado occur on federal land, the Forest Service saw the program as a way to warn back-country users of potential problems and funded the project at \$70,000 a year.

"The problem was we didn't

have any way to measure success," Williams said. "We had a hotline, but didn't keep records of how many people called."

At that time, "spotters" were employees of 10 ski areas who would call if they detected avalanche conditions, he said.

With federal cutbacks in the early 1980s, Williams resigned from the Forest Service and went to work for the state, setting up the information center in the National Weather Service building near Stapleton International Airport.

The annual budget now is \$110,000, but he's quick to point out none of it comes from the state legislature.

"We are funded by 20 or 25 individual sponsors, and ironically, our largest sponsor is the national Forest Service," he said.

Other sponsors include Ski Country USA, individual ski areas and the Colorado Department of Highways.

Williams now has an associate director, Nick Logan, and forecaster, Dale Atkins, who continually monitor data fed to them by 35 field stations including ski patrols at 20 resorts, six individuals in highway department locations and nine backcountry residents trained to spot potential avalanches.

There are similar centers in Utah, Washington and Montana, but, surprisingly, none in California, Wyoming or New Mexico.

Internationally, only Switzerland has an avalanche forecasting system.

The center's hotlines, updated twice daily, receive 50,000 calls a year. Anyone going to the high country in winter might check one first. They are: Denver-Boulder, 236-9435; Fort Collins, 482-0457; Colorado Springs, 520-0020; Summit County, 668-0600; Durango, 247-8187; Vail, 827-5687; Aspen, 920-1664.

Monday, April 8, 1991 Times Daily 11

Avalanche experts urge spring caution

By SCOTT CONDON

Times Daily Staff Writer

Avalanche experts are warning backcountry adventurers not to let spring fever rush them into skiing slopes that are still ripe for slides.

There have been numerous avalanches in the Aspen area over the last week and prospects remain for more, according to the Colorado Avalanche Information Center.

Good strategy and a little luck helped four skiers avoid being buried by a slide they triggered Friday morning on a peak just east of Aspen (see story, page 1 and below.)

"There is a false sense of security out there at this time of year as we're just starting into springtime," said Dale Atkins, an avalanche forecaster with the Colorado Avalanche Information Center.

"The southerly facing slopes have springtime conditions which are easier to forecast avalanches, whereas the colder, north-facing slopes are still winterlike and need to be treated with the same concerns as one would in January or February," Atkins said.

Finish by late morning

Typically, south-facing slopes are fairly stable for skiers in the early morning, but Atkins warned they should be avoided starting late morning.

"It's a good time now — backcountry skiers could start getting out in the morning onto some of the south-facing slopes, but they'll want to get off those by afternoon," Atkins said.

Phil Weir, a rescue leader with Mountain Rescue Aspen, said Friday's avalanche proved it is still too early to be on some of the north- and west-facing slopes around Aspen. He urged people to give it a little more time.

Atkins agreed.

"I think it's still too early to be on any of the high elevation northerly aspects," Atkins said. "I think backcountry skiers ought to give it another week or two so we can get warm weather, and wait until the north-facing slopes start getting some sunshine and freezing and thawing."

Local conditions

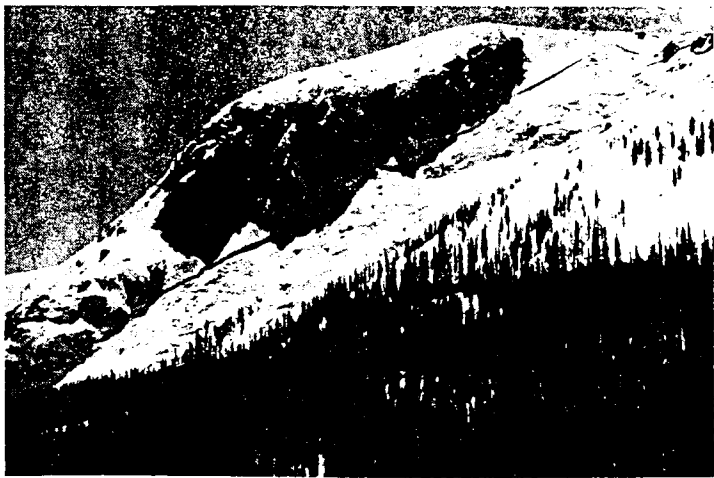
A recorded avalanche conditions message offered by the US Forest Service's Aspen office urged skiers Sunday to practice "continued caution pretty much all over."

The conditions are reported at 920-1664. The message is brought up to date each day.

Atkins said that at this time of year wet and slab avalanches are common. A wet slide occurs because water from melting snow or rain acts as a lubricant for remaining snow.

"One way to think of it is the wet snow — once there's water in the snow — there's no internal strength, there's no internal bonding," Atkins said. "It's just basically like slush or kind of like a slurry."

In slab avalanches, the entire portion of snow sticks together in big blocks even after the ride down a mountainside.



The break line of Friday's avalanche on Sunshine Peak spans most the mountain. According to skiers on the mountain when the slide occurred, the break line was more than 10 feet deep. Roy Willey photo.

Easy to be fooled

It can be hard at this time of year for even seasoned veterans to assess the avalanche danger, Atkins said.

Just before Friday morning's avalanche near Aspen, a man was partly buried by an avalanche in the San Juans. The man, who survived, had found a stable top layer of snow but the slope gave away because of a layer of water

underneath, according to Atkins.

"He was fooled, and I think any number of very experienced avalanche people would have been fooled as well, and that's why I'm advising people to dig hasty pits — even if there's a hard crust — to look for wet snow," Atkins said.

The pits are needed on all slopes, north and south aspects, to look for weak bonds and water, he said.

ROCKY MOUNTAIN SKIING

Avalanche seminar helps skiers improve the odds in backcountry

By Price Colman

Rocky Mountain News Staff Writer

Picture yourself in the backcountry on a bluebird day, skiing perfect powder in a bowl that seems pitched just for you.

Now picture yourself spinning the cylinder on a six-shot revolver, not knowing where the one live shell will stop, knowing only that it's your turn to put the pistol to your head and pull the trigger.

Head into snowfields — be it to ski, climb or snowshoe — ill supplied with knowledge and you'll be playing such a high-stakes game.

Knox Williams, head of the Colorado Avalanche Information Center, puts the situation more mildly: "As we say . . . it's like being caught between the dog and the fire hydrant."

Williams' aphorism sums up the predicament backcountry enthusiasts face: The delicate balance between risk and reward.

Via a prototype class put on through Recreational Equipment Inc. (REI), the sports equipment supplier and outdoor outfitter, Williams takes students past the catchy-saying phase, teaching them how to cut the odds well below the Russian Roulette level.

"It's a prototype program for the entire company," says Bruce Ward, outreach coordinator for the store. "It really is critical for our customers to know what they're doing."

Fortunately for the adventure addict, avalanche study has moved from the realm of lore into science during the past three decades.

The REI class hits on key basics: how to analyze snowpack, types of avalanches, what triggers them, and how weather and terrain contribute to the danger.

You'll learn to listen to and feel the snow — a hollow sound or sudden settling should trip alarms. You'll find that 95% of slides occur on slopes of 30 to 45 degrees and that wind and fresh snow can increase the danger.

Enough statistics have piled up that you can learn not only how to predict avalanches, but also how to avoid them, even what to do if you're caught in one.

Clearly, interest in such an education is growing. Williams, a transplanted Texan who has studied avalanches since 1970, has taught the REI-sponsored class for three years. This year, REI was forced to add extra sessions because of overflow.



Price Colman/Rocky Mountain News

Two skiers, participants in an avalanche awareness seminar, head up Second Creek trail north of Berthoud Pass.

AVALANCHE NUMBERS

Here are telephone numbers for the Colorado Avalanche Information Center:

Denver/Boulder.....	236-9435
Fort Collins	482-0457
Summit County	668-0600
Vail	827-5687
Aspen	920-1664

Recently, after completing a two-night session in the civilized confines of a classroom, Williams' students headed into the backcountry to put theory to practice.

First stop was at the parking area at the base of the Second Creek trail, roughly 1.5 miles north of Berthoud Pass. There, group leader Dan Erfurdt, who just happens to be an expert mountain climber and backcountry skier, handed out trail mix, avalanche beacons and mounds of advice.

Lesson No. 1: Always wear your beacon when you venture into slide territory.

Lesson No. 2: Always turn on the beacons and test them before you leave the parking lot.

There is an even more basic lesson: Call the state's various avalanche hotlines for current conditions before you hit the road.

Once at the campsite REI guides had established the night before, the class broke into four groups. Group one headed off with Brad Craig for an exercise in bea-

con use. Groups two and three dug snowpits under the expert tutelage of Doug Johnson and John Gallo and analyzed the snowpack. Meanwhile, Erfurdt gave group four a seminar in safe route finding.

The groups rotated through each station so that all had an opportunity to test knowledge gleaned in the classroom.

Eventually, though, you'll find yourself having to make judgment calls. Williams and the REI crew employ a simple tool called a data triad. Draw a triangle and put yourself or your group, a key variable, in the middle. Label each side of the triangle with one of the following: weather, snowpack and terrain.

Now analyze the data from each. Based on your calculations, give each one a green, yellow or red light. Two red lights and you can figure it's a good day to stick to safe terrain in the flatter valleys or thick trees. A red and two yellows — that's a tougher call, one to mull thoroughly, adding the variable of your group's expertise and experience.

"For every one person who dies, 15-20 are caught in an avalanche and survive," Williams says.

It's an encouraging statistic. On the other hand, who wants to swap a potentially terminal trip for slicing S's in knee-deep fluff on a safer slope?

Think about it.

Tuesday Jan. 22, 1991

Dear Nick,

I thought you might be interested in a copy of this article. This article was in the Jan. 22 issue of The Steamboat Review. I was wondering where the writer found some good snow to dig a pit, as of Jan. 3rd I hadn't found much of anything other than big TG. I noticed that that the writer also gave out your hot line number, how about that.

heyseeyalaterbye

Jeff

Avalanche awareness

We don't think much about getting caught in an avalanche up here in our neck of the woods. For the most part, the backcountry terrain near Steamboat Springs is fairly gentle and not usually prone to avalanching. And, since few people can actually remember an avalanche accident in our area, there seems to be a prevailing attitude among local backcountry skiers which dismisses

every day of the winter. Only under extraordinarily high avalanche conditions should one be concerned.

But more serious backcountry skiers heading for places like Hahn's Peak, Sand Mountain, Walton Creek Canyon, Little Snowbird or Baker Mtn. need to be far more cautious. All of these areas hold the potential for serious avalanche danger under the right conditions.

On January 3rd, one of my ski guides and I dug snow pits to examine our current snowpack conditions. On both south and north facing aspects, we found a snow depth of approximately four feet, with well-bonded layers all the way to the ground. From our snow pits we were able to conclude that, generally, snowpack conditions were stable and that skiing on steep, backcountry slopes was safe.

When we returned from digging our pits, we talked with Nick Logan at the Avalanche Information Center (AIC) in Denver. Logan confirmed our snowpit information with data AIC had gathered in NW Colorado. Logan also said, however, that there was still a large temperature gradient in the snowpack, meaning conditions were changing toward a weaker pack. New snow will, of course, always change current information.

If you are after steep, backcountry terrain but are unable to analyze snowpack conditions, then go with someone who can. If you wish to get information about area snowpack conditions, call the Avalanche Information Center at 1-371-1080.



the possibility of these frightening snowslides altogether.

As a backcountry ski guide, I spend over 100 days every winter skiing beyond the ski area boundary, from Hahn's Peak to Baker Mountain, and every winter I see avalanches or evidence of avalanches in our region. No need to be alarmed, but by the same token, we shouldn't be lulled into a false sense of security, either. But in any case, don't let anyone tell you that we don't get avalanches around here, because we do.

However, recreational cross-country skiers on trails near Rabbit Ears Pass can rest easy knowing that all of the marked trails can be skied safely practically

AVALANCHE

By Knox Williams, Director
Colorado Avalanche Information Center

I have been in the avalanche business for 20 years, and I have read far too many avalanche articles that seem to have one purpose: to scare the reader. This article is different. I plan on teaching you a few things about avalanches so that you will respect them, not fear them. There's a big difference here. Fear of avalanches — because you don't understand them — is a terrible thing, because it means you will have less fun and adventure than your friend who knows what to look for and how to travel safely. Learning respect should be your goal, because you then have the knowledge and confidence to travel where you like with a good idea of what the real risks are.

"All the avalanche experts are dead," I was told 20 years ago when I didn't know an avalanche from a snowball. That's bunk! I didn't believe that then, and I certainly don't now. You don't have to die in an avalanche, or be scared bad enough to wish you were dead, to be avalanche savvy. But you will have to work at learning about snow and avalanches before you gain the confidence to judge the risk and make a "go or no go" decision.

Most snowmobilers never come close to avalanche danger, preferring to zip over snowy meadows or maintained trails, their pleasure coming from exhilarating speed with a solid (and level) footing underneath. A few may briefly venture into avalanche terrain and not even know it, and another few may go there on purpose. That doesn't mean they are being unsafe, for they may have a thorough understanding of the conditions and know that avalanches are not possible today.

Avalanches triggered by snowmobilers are pretty rare, because so few of you are putting yourself in the danger zone. In the U.S., the first snowmobiler to die by avalanche was near Leadville in February 1968, and the most recent was near West Yellowstone, Montana in January 1990. The national total is now up to 15 deaths. That's not a lot, but what is disturbing is the upward trend: in the 1960's, there was one death; in the 1970's, four; in the 1980's, nine; and one year into the 1990's, one.

Avalanche safety is mostly probability. Now what do I mean by that? Well, we know that the odds against rolling "snake eyes" with one roll of the dice are precisely 35 to 1. Avalanche odds can never be expressed with such precision, but you know that if you always ride on the flats, your odds of causing an avalanche are zero. The odds go up a little if you occasionally cut steep slopes, and they go up a lot if you hang it out in the steeps. Do you hear this, highmarkers?

Avalanche education, like life, is "hard by the

10 Ways To Cut Your Risk



Avalanche on Loveland Pass. Coors Beer truck on left narrowly misses the slide.

C.A.I.C. photo

yard, but a cinch by the inch." What I mean by this is don't try to swallow the whole avalanche pill of knowledge at once: it will choke you. Rather, take your education in small doses: it will eventually develop into a clear picture.

With this in mind, here then are my "10 ways to cut your avalanche risk." Some involve work on your part (Drat! you say), and others are offered as simple tips. But taken altogether, these are guaranteed to improve your odds when snowmobiling in risky terrain.

1. Get smart! This is the tough one, for it requires a commitment of time and effort on your part. Let's divide the task into three parts. First, do some reading. There are

several good (and entertaining) books available. Two of the best are *The Avalanche Book* by Betsy Armstrong and Knox Williams, published by Fulcrum, Inc in Golden, Colorado (\$14.95); and *Snow Sense: A Guide to Evaluating Snow Avalanche Hazard*, by Jill Fredston and Doug Fesler, published by the Alaska Mountain Safety Center, Inc in Anchorage, Alaska (\$3.95). These are carried by all good outdoor recreation stores, large bookstores, the publishers, the Colorado Avalanche Information Center, and many libraries in Colorado.

Second, get a copy of the 30-minute video entitled *Avalanche Awareness: A Question of Balance*. It's excellent and is available

at many of the same outlets as the books.

Third, attend some avalanche lectures. If you

get a good speaker (such as from the Avalanche Center), you are guaranteed to be informed and entertained. Also, try to get someone to speak at your club meetings.

2. Call the Avalanche Center hotlines. There are seven hotlines in Colorado (see box) for you to call to get the latest information on mountain weather, snow and avalanche conditions. We update these messages twice daily, seven days a week, from November through April. People made 50,000 calls to these lines last winter. Also, if you have a computer, you can get the same information by tapping into the Colorado TravelBank bulletin board; 25,000 people did just that last winter.

3. Learn to identify avalanche terrain. Avalanches run repeatedly year after year in the same areas, on slopes we call avalanche paths. Avalanches most often start on slopes of 30-45 degrees, but sometimes start on slopes as shallow as 25 degrees and as steep as 50 degrees. Knowing the slope angle is "rule number one" in recognizing avalanche terrain, for once slope angles reach 30 degrees, you are in potential avalanche terrain regardless of all other factors.

Although many avalanches start on large open slopes near or above timberline, they can also start on smaller, low-elevation slopes such as gullies, road cuts, and small openings in the trees. Avalanches seldom start in dense trees, but once started they can flow through moderately dense forest.

Finally, avalanches are more likely on slopes that face away from the prevailing wind. We call these "leeward" slopes, and they collect snow that blows over the ridge. This snow piles up in deep pillows and is more dangerous than the shallow, harder snow on the windward side of the ridge.

4. Stay on shallow slopes. You can always travel avalanche-free on slopes up to 25 degrees, and more than 95% of the time you are safe on slopes up to 30 degrees. To measure angles exactly, you should buy an inexpensive slope meter (about \$10 in mountain recreation shops) to use on your excursions away from the flats. This way your avalanche worries are gone with the wind.

One caution, however: be extra cautious wherever steeper slopes lie above shallow ones. Though avalanches won't start on shallow slopes, it is possible that you could trigger an avalanche far above you, placing you in harm's way.

5. Look for danger signs. Sometimes the snow shows clear and present danger signs of avalanche. The best clue is fresh avalanches,

Please see **AVALANCHE** on page B-8

Colorado Avalanche Information Center	
for current information on mountain weather, snow, and avalanche conditions	
DENVER/BOULDER	236-9435
FORT COLLINS	482-0457
COLORADO SPRINGS	520-0020
DURANGO	247-8187
SUMMIT COUNTY	668-0600
U.S.F.S. - MINTURN	827-5687
U.S.F.S. - ASPEN	920-1664

SNOW SCOOP

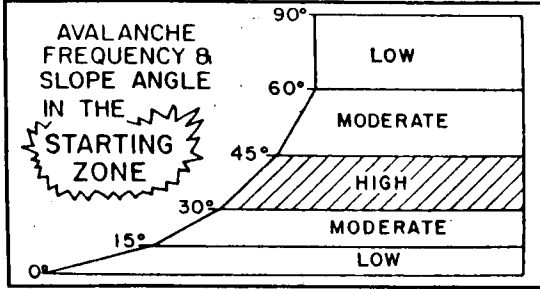
Section
December, 1990

B

Highmarkers ! - Be Prepared and Lower your Avalanche Risk

AVALANCHE continued from page B-1

which tells you that some slopes have already stressed out and that others may be near the breaking point. Also watch for snow that collapses beneath your machine or sends cracks shooting ahead. These are signs that the snow cannot hold you up. The snow is warning you with a shake of its rattlesnake tail, saying, "Today, stay flat, stay safe."



Some weather signs that the hazard could be worsening fast are heavy snowfall — more than 1 inch per hour — or strong winds creating blowing snow and snow plumes off the ridges.

6. Test the snow. Here is something you can do that's both fun and helpful for learning how strong the snow is. In the little book *Snow Sense*, this is illustrated and described as the Banzai Jump Test. Do this on a small slope — preferably 30 degrees or steeper — where you will not be in danger of causing an avalanche.

Use your shovel (Don't tell me you went into avalanche country without a shovel! See tip #10 below.) to dig a snowpit 4-5 feet deep and 6 feet wide. (That's moving a lot of snow, but you have friends to help, don't you?) Now your group climbs around and above the snow pit, so as not to disturb the snow uphill from the pit. Next, about six feet above the pit wall, stand in a line with arms tightly linked. Step forward together and flex your knees. See if you can make the exposed snow layer uphill from the excavated pit slide into the pit. If nothing happens, jump in unison, harder and harder until the snow finally breaks and you all fall into the pit. The more effort it took to break the snow, the stronger it is.

You don't have to go to such lengths as this to test the snow. You can dig a small, quick pit and try to make the snow break by prying on it with your shovel or by standing and jumping above the pit. Also, you can drive your machine across a small, moderately steep slope to try to make it break. But be careful: you don't want your machine to roll over on you if it does break! Your purpose in any test is to see how strong the snow is, and that will help you decide how steep a slope

you should be on. Finally, do your tests as near as possible to the slope you want to cross.

7. One at a time. If your group comes to a slope that you feel nervous about, only one person at a time should go onto the slope. Whether crossing or going up or down, do so one at a time while all others act as spotters from a safe location. This way, should an avalanche occur, there will be only one victim

and lots of rescuers.

8. Avoid the center. The greatest danger on any steep slope comes when you are in the middle of it. Should an avalanche break, you have no escape route. So avoid the center of open slopes. Cross it at the very top or bottom. Go up it or down along the edges. These positions give you a much better chance to escape.

9. Learn how to save yourself. Thousands of skiers, climbers, and snowmobilers have triggered avalanches and lived to tell about it. After all, statistics show that for every 15 people caught, one will die while 14 will live. Some people were just lucky: the avalanche spit them out at the last moment. Others lived because they did things that helped.

For example, many victims survived because

they were able to escape to the side. As long as your snowmobile is maneuverable, you have a good chance to accelerate to the side, or if caught near the bottom of the slope, to outrun the avalanche. (A skier who is caught can never outrun an avalanche.)

If knocked off your machine, try to grab a tree. If swept downhill, try to swim with the moving snow, similar to bodysurfing in the ocean. This may let you end up on top. If you can't make it to the surface, try to make (before the avalanche stops) an airspace in front of your face which will give you breathing space.

The bottom line is that you must fight the avalanche to live. A most instructive incident happened near Hailey, Idaho back in 1976. A 17-year-old snowmobiler disappeared beneath the snow of an avalanche that he had triggered. Three hours later rescuers found him alive beneath 3 feet of snow. He attributed his survival, first, to making an airspace with his hands which kept the snow from packing tightly around his face, and second, to swimming which didn't get him to the top but kept him from being hopelessly deeply buried. His snowmobile, which didn't swim, was found days later under 9 feet of snow!

10. Carry rescue gear. A small shovel and an avalanche rescue beacon are two items that anyone who even thinks he might go into steep terrain should not be without. The beacon makes for a quick find of a buried victim, and the shovel is absolutely necessary for digging in avalanche debris. Most avalanche victims cannot survive a burial of 30 minutes or longer, and beacons and shovels are the best way for a quick recovery.

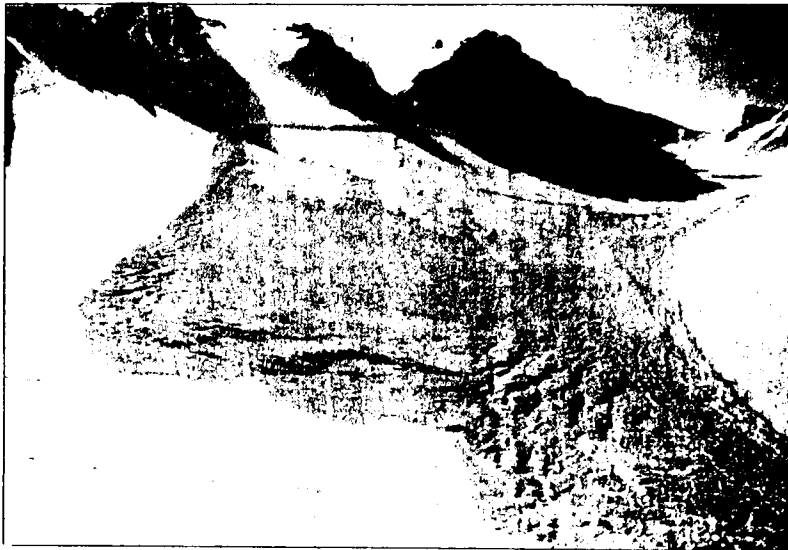
Avalanche beacons are expensive, more than



\$100 each, and it takes at least two to make the system work. After you buy them, you'll need to practice with them to become a good rescuer. Don't worry, this kind of practice is a lot of fun. We in the Avalanche Center can help you decide which beacon to buy and can get you started on some good practice exercises.

So there they are, my 10 tips for avalanche safety. To summarize, let's see how a highmarker can still play the game but lower his avalanche risk. First, he should be prepared before he ever leaves home. Armed with avalanche knowledge (#1) and the day's forecast (#2), and equipped for rescue and survival (#10), he has taken the first steps to avoid disaster. Next the highmark playing field is probably an avalanche slope (#3), so he might want to warm up on a shallower slope (#4), look for clues of unstable snow (#6). If there are obvious danger signs, don't go. Without any clear and present danger, still proceed with caution. He should insist that only one player be on the slope at a time (#7), and that the group use the edge, not the center, of the slope (#8). Finally, each player must be watchful for the first sign of trouble, such as cracking snow which signals the start of an avalanche, and be prepared to take immediate evasive action (#9). A highmarker is especially vulnerable if his machine becomes stuck, for he is a sitting duck while digging out his snowmobile.

So good luck and good sledding this winter. Use my rules to banish fear and gain respect for avalanches.



.....

Avalanche research deserves support

Statistics say the kind of accident that claimed Fort Lewis College student Tim Sheldon could be repeated as much as 12 to 15 times in the U.S. this year.

The 22-year-old FLC student from Malvern, Pa., was found dead last week buried under an avalanche on the north side of Snowstorm Peak in the La Plata mountains.

Deaths from avalanches have increased over the past decade coinciding with the boom in backcountry skiing. In Colorado not a winter has gone by since the 1950s without an avalanche death, according to the Colorado Avalanche Information Center. About 20,000 avalanches strike in the state every year.

In our area, Highway 550 is crossed by 93 avalanche paths. During an average winter, more than 100 avalanches reach the roadway, according to a recent report by the National Research Council.

The report predicts that avalanche-related deaths are certain to increase because financial support for avalanche research and prevention has been decreasing at the same time that backcountry recreation is increasing.

Although control work in Colorado is fairly extensive — the highway department, for example, spends more than \$100,000

along Interstate 70 and in Berthoud and Loveland passes bombing slides — forecasters aren't getting any better at predicting avalanches.

In 1985 the only national center for avalanche research, based in Fort Collins, was closed for lack of money from the U.S. Forest Service.

Could a more aggressive public education program have prevented Tim Sheldon's death? The answer would be sheer speculation at this point. But one thing's for sure, although the number of fatalities are small in comparison to other natural disasters, avalanches diminish the attractiveness of wintertime recreation in communities like Durango.

As Richard Armstrong, a researcher at the University of Colorado's Cooperative Institute for Research in Environmental Sciences, told the *Denver Post* Sunday, "If we expect to continue to reduce the numbers of accidents and fatalities, we can't do it without research.

Avalanches are a danger to life and property in Western Colorado. In our view, finding more money for research is a subject that deserves the attention of the state Legislature.