

AVALANCHE BURIALS IN THE UNITED STATES: 1967-1980

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Introduction

In 1976, Williams (1978) analyzed data from documented case histories of avalanche burials to determine chances of survival. With the addition of four more years of data, this paper updates many of the findings and examines data not looked at previously, drawing mainly from documented avalanche burials from 1967 to 1980. Survival rate according to type of rescue, body position when found, burial depth, and activity category were specifically examined. The analysis was restricted to victims totally buried, defined by Williams (1975) as those completely beneath the snow when the avalanche stops. This includes those with no more than an attached object or body part (i.e. hand, boot, or ski tip) protruding from the snow, as well as those in vehicles or buildings that are completely buried.

Survival Rate According to Type of Rescue

Table 1 shows that of 246 documented burials, 131 people (53%) survived. Among the survivors are 24 who were able to dig themselves out and 17 who were trapped inside vehicles and structures. Excluding these categories, the remainder were buried victims in direct contact with the snow who could not free themselves. Of 193 such burials, 90 people (47%) were found alive, and 103 (53%) were found dead. Of these 90 survivors, 49 were spotted and quickly rescued because of an attached object or body part protruding from the snow; 25 were rescued by members of their parties and 16 were rescued by an organized rescue group.

Among the 115 fatalities, 12 victims were inside vehicles or structures and 103 were in direct contact with the snow. Of these, 20 were found by members of their parties, 79 were found by organized rescue groups, and four were never found.

Table 2 shows that more than half of the survivors, 71 of 131 people, were quickly located and saved

because of a body part or attached object protruding from the snow. Of the 78 victims in this category, all but 7 either were rescued alive or were able to free themselves--a 91% survival rate.

The probe line continues to be effective in locating buried victims. Fourteen people were found alive by this method, and 46 were recovered dead. Of those found alive, three later died of their injuries.

Of those located by rescue beacons, more than half were found alive (five of eight), all by members of their parties. Perhaps significant is the fact that all five live rescues and two of the body recoveries have occurred from 1977 to 1980. Rescue beacon use also appears to be improving survival rates among deeply buried victims, as described later in this paper.

Of the five people found by means of their avalanche cords, four (three alive and one dead) were roped together--an unintentional, but successful use of an avalanche cord.

Despite the insulating properties of snow, a few victims who were shallowly buried were able to yell and be heard by their rescuers (acoustic contact). An unfortunate case was the man whose moans were heard and who was located, but who, by the time he was uncovered 20 minutes later, was dead.

To date in this country, no live rescues have been performed by avalanche dogs. Six body recoveries can be attributed to dogs since 1967, four of these since 1979. In one case, the victim's pet had dug down 0.3 m into the snow to uncover one of his owner's arms, and was waiting patiently near the body 32 hours later when the rescue party arrived. Burial depths of the victims located by dogs were: 4 cases, 0.6 m; 1 case, 1.0 m; and 1 case, 2.1 m.

For 19 victims, the rescue was called off after several days. The bodies were recovered from several months to one year after burial. Because many of the bodies were partially melted out, the burial depth could not be measured. But for seven victims, depths were estimated at between 6 to 10 m, deeper than the length of a standard avalanche probe.

In the "other" category, four victims were never found, presumably having been swept down glaciers and into crevasses. Four victims, one in Montana and three in California, were swept off a highway into a body of water and drowned.

#### Body Position of Buried Victims

It appears that the most common position for both live and dead victims is with head pointing downhill and in a prone (face down) position (Table 3). It would be difficult to draw any conclusions from these data other than that this is the position the victim was initially pushed into by the avalanche. A larger sample was used in Table 4, where body and face position data were separated, giving sample sizes of 102 and 85 respectively. However, among the 50 fatalities, 35 (70%) were found prone, compared with only 15 (30%) found on their backs. It is only speculation that of those caught in an avalanche, the victims that could not actively fight against the snow had a greater chance of being buried face down and a less likely chance of survival. These people could have been hampered by gear, skis, or pack, or have been struck by a tree or rock on their descent, rendering them immobile or unconscious. Much more data needs to be collected on body position before any conclusions can be drawn.

#### Percent Survival and Burial Depth

When percent survival among avalanche victims as a function of depth of burial was examined in 1976, Williams (1978) found that the deeper the burial, the less the chance for survival. Upon updating this data to September 1980, similar results were found (Figure 1). Survival rates for those buried at all depths show little change.

However, in the 1976-1980 sample, at shallower depths, survival rate decreases slightly, while at the deeper depths, the survival rate increases, until 2 m, when it reaches zero. Nothing in the 1976-1980 data readily explains the decrease at shallow depths but there might be an explanation for the survival rate increase at the depth of 1.1-1.5 m. Of the 10 victims buried at that depth, all four rescued alive were located with rescue beacons (as was one of the fatalities). The only other live recovery with a rescue beacon was at a depth of 0.6-1.0 m.

The increase in survival at a depth of 1.6-2 m, from 17% to 23%, is not statistically significant, because this only reflects the addition of one person rescued alive in a small sample of 13.

The updated data on survival as a function of burial time show no change from the 1910-1976 data (Williams, 1978), indicating that the 50% survival time remains at about 30 minutes.

### Activity Categories

Williams' (1978) compilation of avalanche fatalities by activity from 1950 to 1976 shows that those involved in recreation (74%) far exceeded those killed in work-related activities (26%). Data from the period 1976 to 1980 show similar results: 85% involved in recreation compared to 15% work-related (Figure 2). Climbers continue to suffer large numbers of fatalities; in the recent data, they share first place with ski tourers (which include cross-country skiers, ski mountaineers, helicopter skiers, and snowshoers). Lift skier fatalities decreased from 27% to 18% in the two samples. This decrease could be a result of improved avalanche control work, given the increases in numbers of skiers and their abilities.

There is an increase from 20% to 38% in the proportion of fatalities who were ski tourers, because during the 1970's, the numbers of ski tourers increased dramatically (Holman, 1980; Rosenthal, Driver, and Rauhauser, 1980). The increase in the number of tourers travelling in the back country increases the risk of people in this category being killed by avalanches.

When data from 1950 to 1976 are combined with the latest figures, the 1976-1980 data have a small effect on the total sample (Figure 3). Only an increase in ski touring fatalities and a decrease in lift skier fatalities is evident. Of interest is the "residents" category, which shows no fatalities in the past four winters (Figure 2). Although avalanches have damaged and destroyed homes since 1976, none has been occupied.

Figure 4 shows a more general picture of the past four winters: numbers of people caught, buried, and killed, by activity category. The recorded number of people caught is certain to be less than the actual total, reflecting

only those encounters that were reported. Leading the group are ski patrollers (and some snow rangers), with 250 caught, but only 14 buried, and none killed. The absence of fatalities and the large number caught reflect good training and the nature of the job, ski-checking. Patrollers routinely release frequent, shallow, slab avalanches on constantly controlled slopes. This probably accounts for the high number of patrollers getting caught but the relatively low number of burials. In contrast is the ski tourer, who often triggers slab avalanches on uncontrolled slopes; avalanches considerably larger than those within a ski area boundary. Of the tourers caught in the past four years, half were completely buried, with nearly one-third killed.

### Conclusion

Speed of recovery is still the critical factor in live rescues. Two-thirds of the live rescues were made by members of the victim's party. However, a victim's best chance for survival (55%) is if an attached object or body part protrudes from the snow. Of the 78 people who were found by this means only 7 were dead. This emphasizes the validity of the technique of actively fighting the avalanche, swimming to remain near the surface, and thrusting a hand or foot up when the avalanche begins to slow down.

An encouraging finding from these data is the recent success with avalanche beacons. Since November 1976, seven rescues using beacons have produced five live victims, all found by members of their parties. Four of the five groups were equipped with shovels. The fifth group did not have shovels and had to dig with hands and skis until shovels were brought in 15 minutes later. The fact that these beacon rescues were responsible for a slight increase in survival rate at 1.1-1.5 m gives some hope to deeply buried victims, provided their rescuers have both beacons and shovels.

These findings on avalanche burial and rescue methods are based on data from avalanche accident reports. From these data, rescue techniques are evaluated and determined. Therefore, accurate and complete reporting of all accidents is essential.

Finally, while it appears that the numbers of people getting caught, buried, and killed in avalanches have remained fairly stable over the last nine winters (Table 5), the numbers of people involved in winter recreation have increased dramatically, particularly ski tourers. However, increased use has not increased the number of avalanche encounters. How effective the public education programs, avalanche schools, clinics, avalanche warning programs, and availability of printed materials, are toward keeping the figures low should be an area for future research.

#### References

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Table 1 U.S. Avalanche Burials: January 1967-September  
1980  
(Total = 246)

	Found Alive		Found Dead	
	Number	%	Number	%
Direct contact with the snow				
Freed selves	24	10	--	--
Rescued by party	68	27	20	8
Rescued by organized rescue party	22	9	79	33
Inside vehicle	7	3	6	2
Inside structure	10	4	6	2
Body not recovered	--	--	4	2
Total	<u>131</u>	<u>53</u>	<u>115</u>	<u>47</u>

Table 2 Method of Rescue for Buried Avalanche Victims, January 1967-September 1980

	Freed Self	Found Alive			Sub Total	Found Dead			TOTAL
		Rescue by Party Members	Rescue by Organized Rescue Group			By Party Members	By Organized Rescue Group	Sub Total	
1 Object or body part protruding	22	43	6	71	3	4	7	78	
2 Hasty search	0	5	2	7	9	1	10	17	
3 Fine & coarse probe	0	2	12(3*)	14	4	42	46	60	
4 Rescue beacon	0	5	0	5	0	3	3	8	
5 Avalanche cord	0	4	0	4	1	0	1	5	
6 Inside vehicle	1	5	2	8	0	6	6	14	
7 Inside structure	1	0	10	11	0	6	6	17	
8 Acoustic contact	0	2	1	3	1	0	1	4	
9 Avalanche dog	0	0	0	0	0	6	6	6	
10 Found, but after considerable time span	0	0	0	0	0	19	19	19	
11 Not known	0	4	1	5	1	1	2	7	
12 Other (& not found)	0	3	0	3	1	7	8	11	
<b>TOTAL</b>	<b>24</b>	<b>73</b>	<b>34</b>	<b>131</b>	<b>20</b>	<b>95</b>	<b>115</b>	<b>246</b>	

\*Died later

Table 3 Body Positions of Buried Victims by Body and Face Positions Combined January 1967-September 1980

	Found Alive	Found Dead
Head uphill - face up	6	3
Head uphill - face down	0	3
Head downhill - face up	5	5
Head downhill - face down	10	15
Sideways - face up	3	6
Sideways - face down	0	7
Vertical - face up	2	0
Vertical - face down	0	1
Total cases	26	40

Table 4 Body Positions of Buried Victims (Not in Vehicle or Structure) - January 1967-September 1980

	Found Alive Number	%	Found Dead Number	%
<u>Body</u>				
Head uphill	10	17	6	13
Head downhill	20	35	23	51
Sideways	9	16	12	27
Vertical	18	32	4	9
TOTAL	57	100	45	100
<u>Face</u>				
Face up (supine)	20	57	15	30
Face down (prone)	15	43	35	70
TOTAL	35	100	50	100

Table 5 Numbers of People Caught, Buried, Injured, and Killed in Avalanches in the United States 1971-72 to 1979-80\*

	Caught	Buried	Injured	Killed
1971-72	168	63	17	5
1972-73	92	35	3	5
1973-74	169	102	13	13
1974-75	195	79	9	22
1975-76	177	81	15	17
1976-77	98	35	13	10
1977-78	155	71	16	17
1978-79	159	62	16	11
1979-80	136	44	9	6
TOTAL	1349	572	111	106
MEAN	149.9	63.6	12.3	11.8

\*From U.S. Forest Service Avalanche Notes (monthly newsletter compiled by Rocky Mountain Forest and Range Experiment Station, Alpine Snow and Avalanche Project, Fort Collins, Co., from Westwide Data Network).

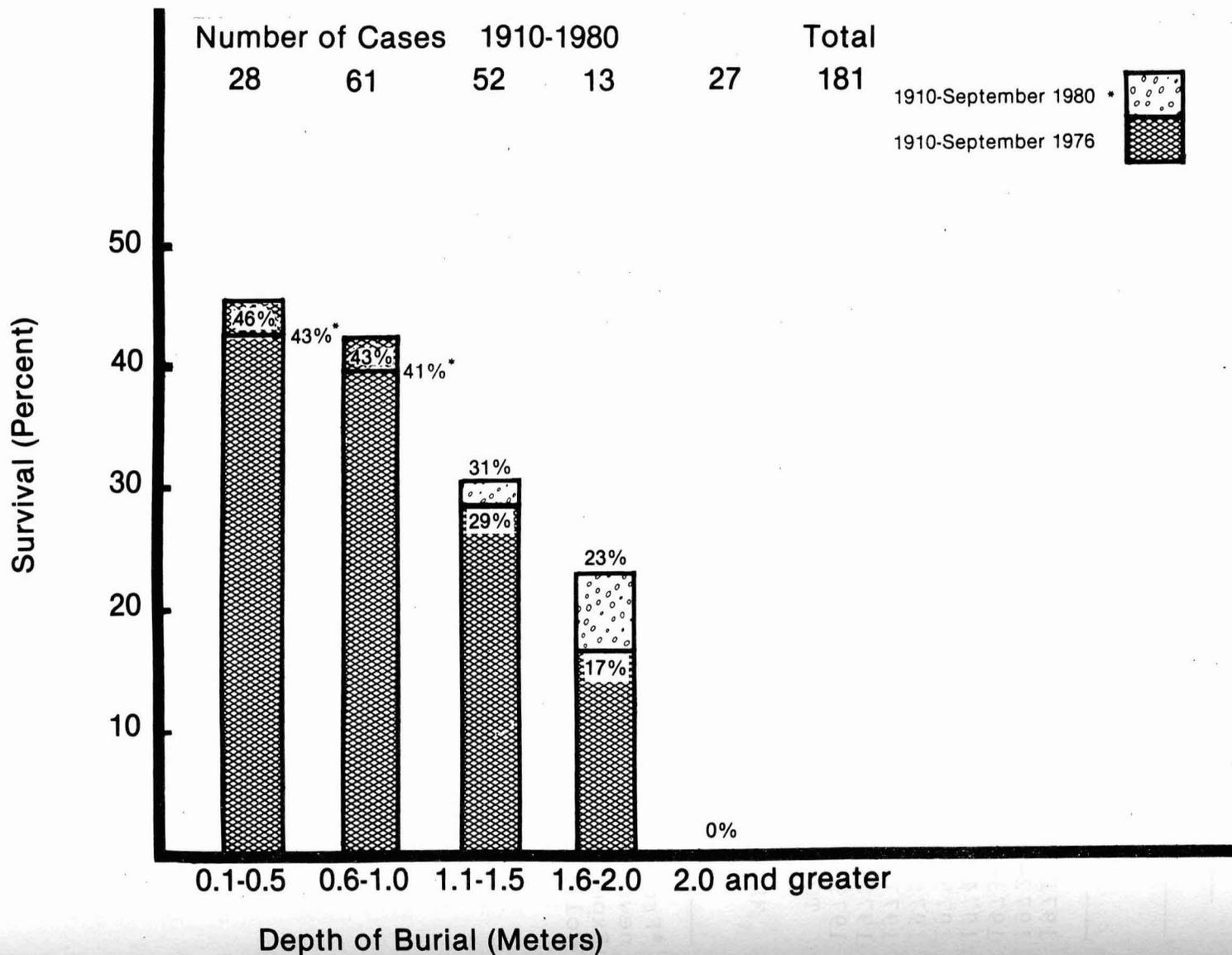


Figure 1. Percent survival among avalanche victims as a function of depth of burial (1910-1980).

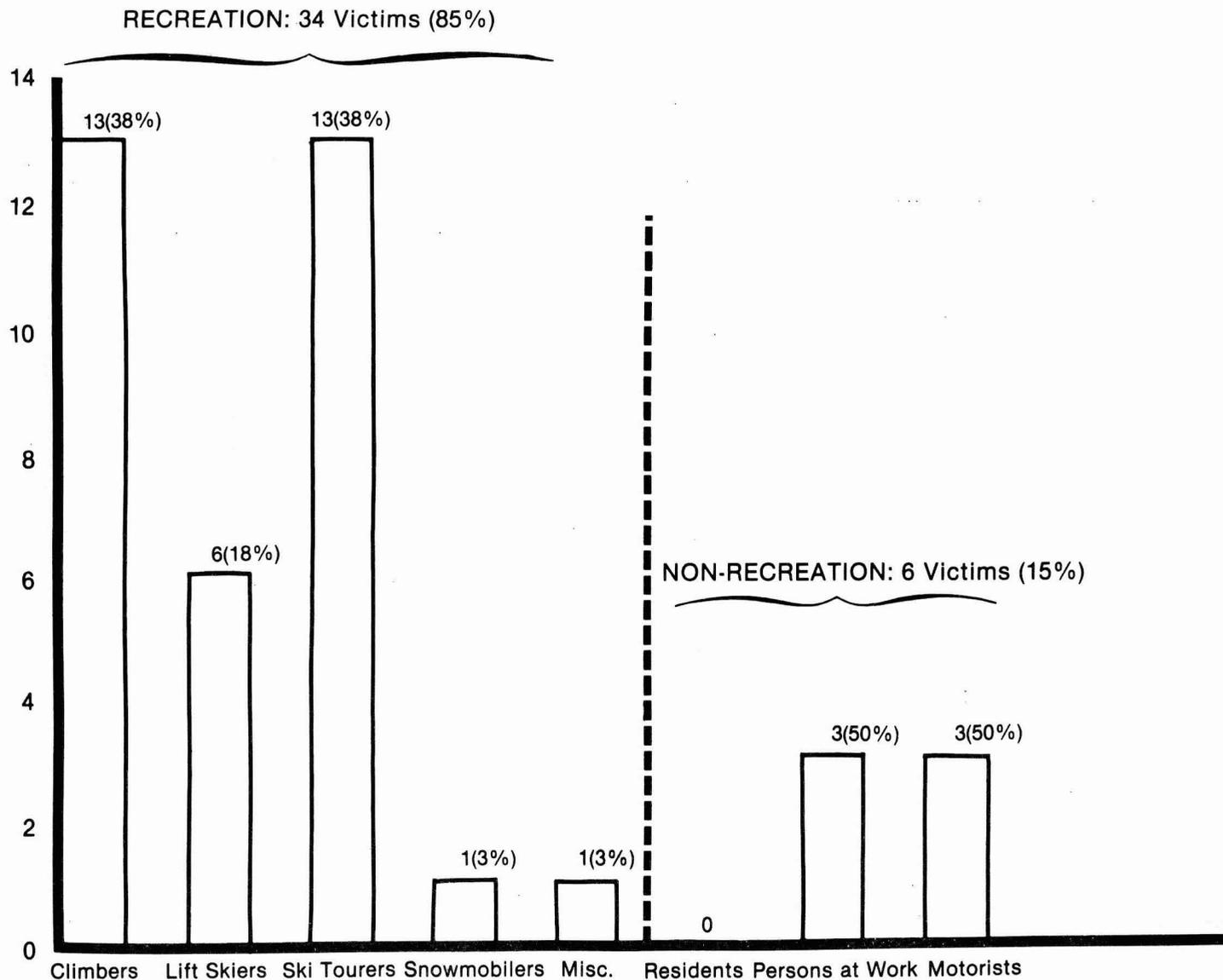


Figure 2. Number of avalanche fatalities by activity categories (Nov. 1975-Sept. 1980). Percentages at the top of each bar are percent of recreation fatalities and percent of non-recreation fatalities.

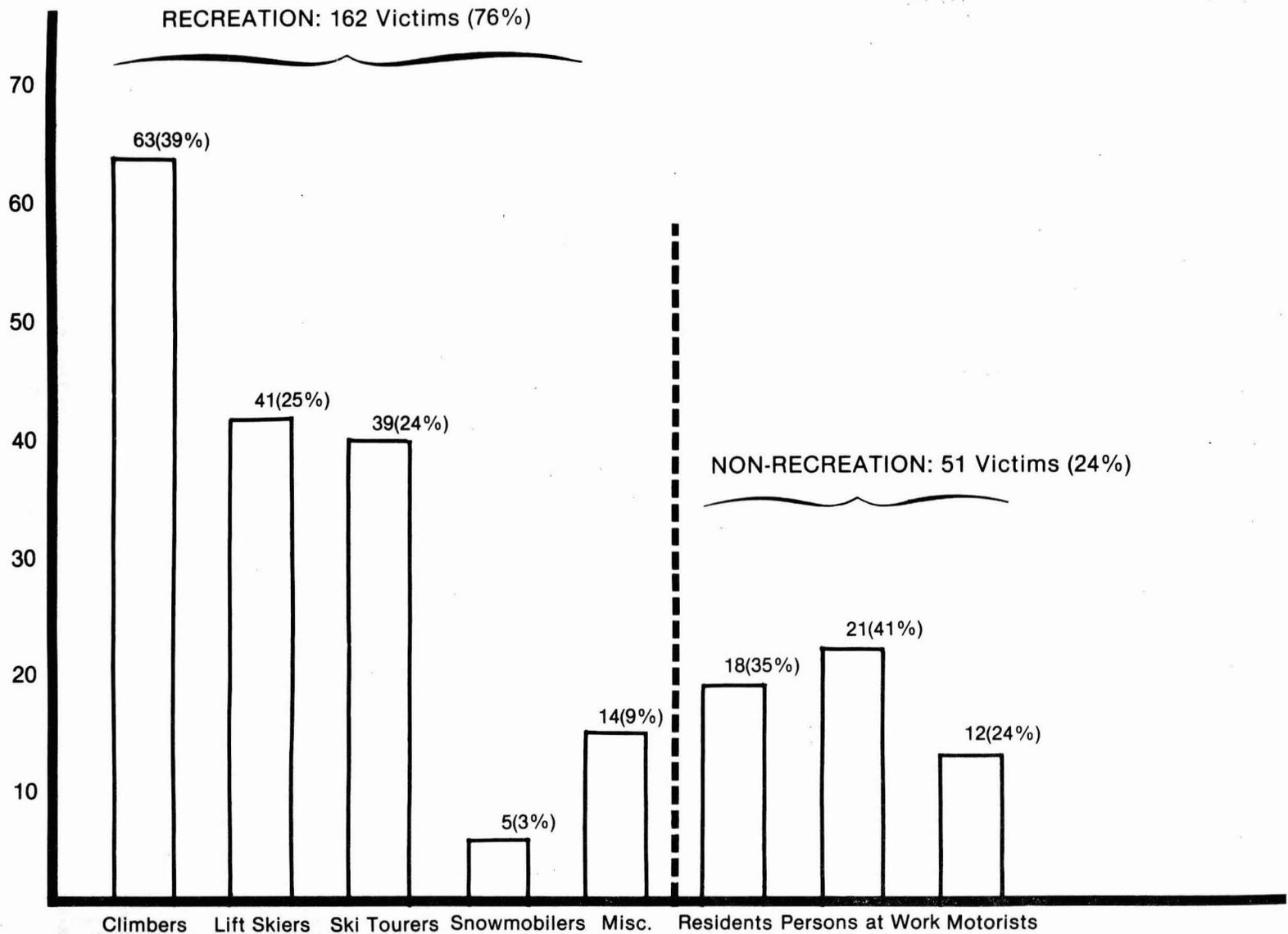


Figure 3. Avalanche fatalities by activity categories (1950-51 to 1979-80). Percentages at the top of each bar are percent of recreation fatalities and percent of non-recreation fatalities.

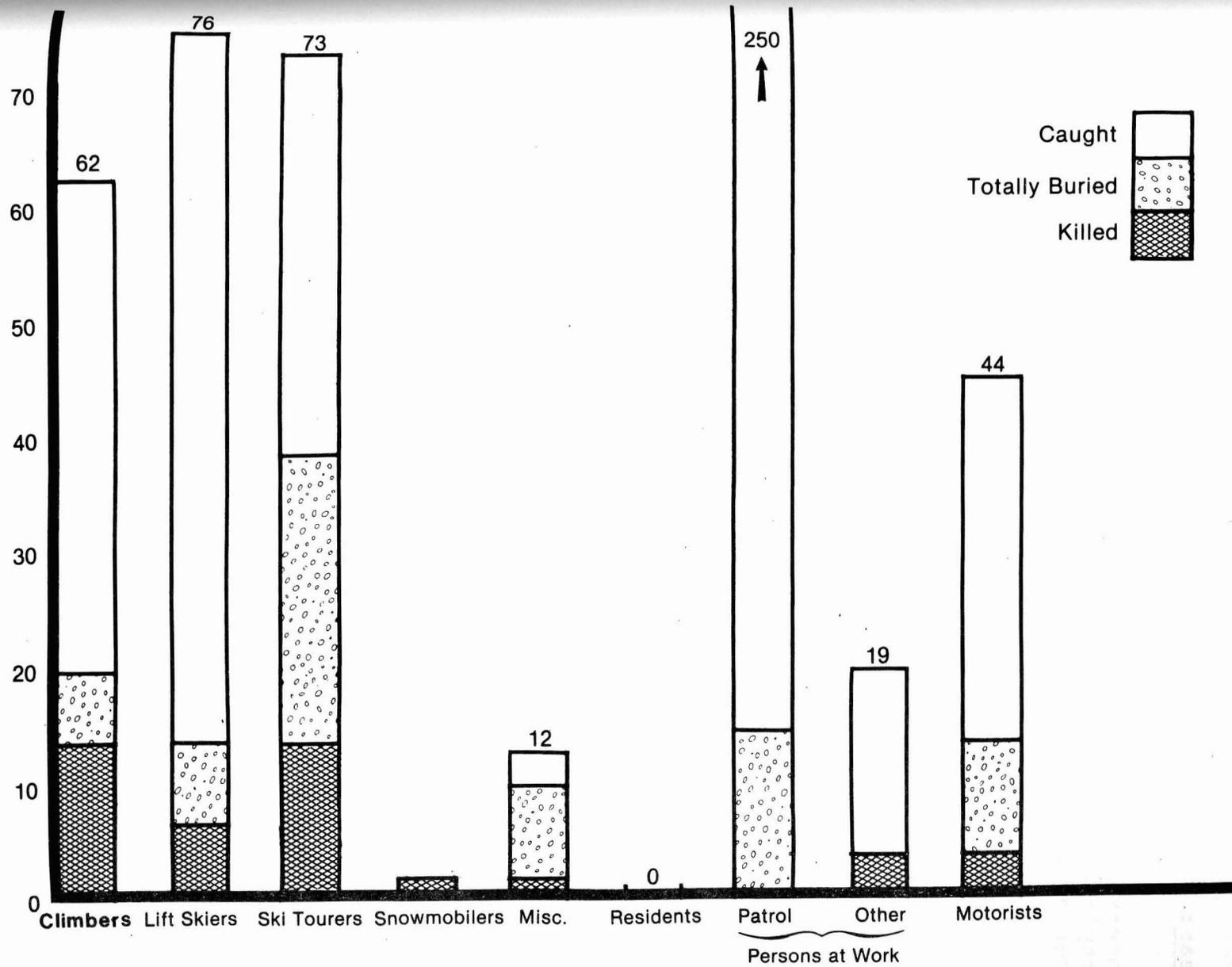


Figure 4. Avalanche accidents in U.S. (Nov. 1976-Sept. 1980).

DiscussionSpear:

I wish to suggest that avalanche accident reporting forms include a section on the victim's and/or the party's avalanche education (that is, courses, years of experience, etc.).

Armstrong:

Data from U.S. avalanche accident reports give us information about who the avalanche victims are, in terms of their activity when caught. To date, the U.S. Forest Service avalanche accident reporting forms do not include questions about the victim's background. In the future, data will be collected pertaining to (1) victim's experience (number of years, level of ability, and previous avalanche training, and (2) type of outing, organized group trip or casual.