

## Developments in avalanche forecasting and other prevention measures and their potential effects on avalanche fatalities

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**ABSTRACT:** Despite the ever increasing attractions of backcountry and off-piste winter sports as well as ever more heavily frequented mountain routes in Switzerland, avalanche fatalities are slightly decreasing. In this empirical study, we present the developments in avalanche accident prevention methods throughout the last 40 years in Switzerland. In five-year steps, from 1968/69 until 2007/08, the developments in Swiss avalanche forecasting, the change and expansion of informational products, their frequency, presentation and distribution are presented. These are seen alongside the developments in further prevention measures such as education, rescue, equipment and human factors. This series of developments is compared to a total of 988 avalanche fatalities in backcountry and off-piste areas as well as on ski runs and on traffic routes. Catastrophic avalanche situations and victims thereof are not taken into consideration since the time frame of the analysis is too short. A mix of qualitative and quantitative analysis aims to depict the changes and trends over the 5-year steps. Positive and negative trends in avalanche fatalities are set against developments and reversals of trends in avalanche prevention. The mostly qualitative study hopes to offer a basis for discussion rather than conclusive scientific results on this complex topic. However, it can serve as a framework for individual forecasting services or for countries to draw up a comparison of trends in avalanche accident prevention methods and avalanche fatalities.

**Keywords:** prevention, avalanche forecasting, avalanche fatalities

### 1. INTRODUCTION

The diminishing numbers of avalanche victims and fatalities in recent years in Switzerland are an extremely encouraging development (figure 1). This significant trend (Harvey and Zweifel 2008), has been achieved in spite of increased off-piste sports activities and more heavily frequented mountain traffic routes.

What are the paramount factors and safety measures which lie behind this trend? We examine the following hypothesis: The chief reasons are improved avalanche warning communication and media presence, professional educational measures and high quality as well as easy-to-use emergency rescue devices."

Evidence from the last 40 years has been gathered to show the factors, which have contributed to the positive development in avalanche fatalities. The most important stages in the evolution of preventive measures and peer rescue are analyzed as objectively as possible.

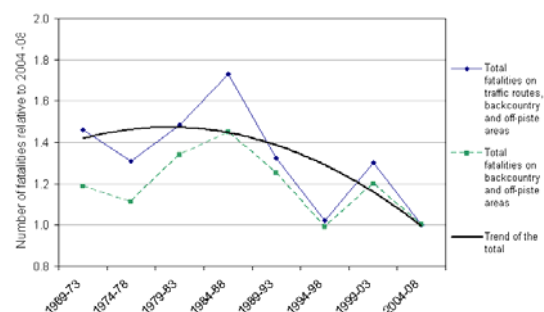


Figure 1: Avalanche fatalities in Switzerland from 1969 to 2008, subdivided into eight 5-year periods. Dashed line: development of avalanche victims group "Backcountry skiers and off-piste recreationists." Solid line: development of avalanche victims total of "Backcountry skiers and off-piste recreationists" and "on traffic routes". The thick line is the calculated trend of the total number of avalanche fatalities.

### 2. DATA AND METHODS

#### 2.1 Types of data and basic principles

The following list shows the analyzed data, data type and source. The list is based on all

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currently and/or previously existing and tangible preventive measures related to the decrease in avalanche fatalities.

#### Measured data

- Number of avalanche fatalities (SLF, 1969 - 2008)
- Number of avalanche warning and information products (SLF, 2007)
- Number of types of media (SLF, 2007)
- Number of ABS-airbag-backpacks (manufacturer information, 2008)
- Number of hotel overnights in winter (Federal Statistical Office, 1969 - 2008).

#### Estimated data

- Number of backcountry tours and off-piste recreationists, based on quantitative data from a small region (Rätz, 2006)
- Number of avalanche rescue search devices sold (manufacturer information, 2008)
- Number of avalanche course participants (course instructor information, 2008).

#### Qualitative Information:

- Type of course, educational topics and technical milestones (information from several professional instructors).

## 2.2 Methods

The 40 year period of analysis 1969 - 2008 was subdivided into eight five-year clusters. The studied factors were grouped into the five main topics: Avalanche bulletins and information product; media; number of organisations, courses and participants; course topics; milestones. For the number of course participants we used three subclasses:  $\leq 200$ ,  $\leq 500$  and  $> 500$  participants per five-year period. For the other quantitative data, the five-year mean was calculated.

The results of all main topics were compared to the last five-year period (2004 - 08). To compare the quantitative and qualitative data, we chose a binary evaluation for each factor in each five-year period. Each factor that is present in a given period is evaluated with a 1; each factor not present in a given period is evaluated with a 0. These values are added for each time period within a group or subgroup. The sum of the current time period (2004 - 2008) is taken as reference for a comparison over time. Each five-year period sum of a group or subgroup is normalized in respect to the sum of the last period. The following example illustrates the normalization for the group "Media" (Table 1, bottom):

The sum of all factors in the group entitled "Media" in the current five-year period 2004 - 08 is 7. The sum of the group entitled "Media" in the period 1969 - 1973 is 3. Normalizing the earlier period with respect to the current status 2004 - 2008 is  $3/7 = 0.43$ , which is the value plotted in figure 2 for the period 1969 - 1973.

The trend lines shown in Figures 1, 2, 4 and 8 are the calculated best fit trends.

Through the above described procedure, data of different types and magnitudes can be compared and visualized.

## 3. RESULTS

### 3.1 Avalanche bulletin and other information products and their media of distribution

Table 1: Overview of numbers of products and media of distribution at the end of each five-year period.

1969-73 1974-78 1979-83 1984-88 1989-93 1994-98 1999-03 2004-08	Avalanche bulletins and information products
0 0 0 0 1 1 1 1	Avalanche danger map for TV, inc. danger level and region
0 0 0 0 0 0 0 1	Avalanche danger map for media with icons, inc. danger level and region
0 0 0 0 0 1 1 1	Avalanche danger map for Internet, inc. danger level, region, aspect and altitude
0 0 0 0 0 0 0 1	Avalanche danger map for Internet, inc. wet/dry (springtime)
0 0 0 0 0 1 1 1	Regional Bulletin (1st region coverage)
0 0 0 0 0 0 1 1	Regional Bulletin (regions 2 to 7)
1 1 1 1 1 1 1 1	National Avalanche Bulletin nowcast, in German (d), whenever required
0 0 1 1 1 1 1 1	National Avalanche Bulletin nowcast, in French (f), whenever required
0 0 1 1 1 1 1 1	National Avalanche Bulletin nowcast, in Italian (i), whenever required
0 0 0 1 1 1 1 1	National Avalanche Bulletin nowcast, whenever required with nationally defined danger levels (d, f, i)
0 0 0 0 0 1 1 1	National Avalanche Bulletin nowcast, whenever required with European-defined danger levels and Interpretation guide (d, f, i)
0 0 0 0 0 0 1 1	National Avalanche Bulletin nowcast and forecast (d, f, i)
0 0 0 0 0 0 0 1	National Avalanche Bulletin nowcast, and forecast, in English
0 0 0 0 0 0 1 1	WinterAktuell in German
0 0 0 0 0 0 0 1	JournalBlanc in French
0 0 0 0 0 1 1 1	Infobox / Infomanager, Internet platform with special products for safety guardians, authorities
0 0 0 0 0 1 1 1	Snowpack and snow stability map, maps on overall snow depths, 1-day and 3-day amounts of new snow
	<b>Media</b>
1 1 1 1 1 1 1 1	Radio
1 1 1 1 1 1 1 1	Newspaper
1 1 1 1 1 1 1 1	Telex / Telegram / Fax
0 0 0 0 1 1 1 1	Television
0 0 0 0 0 1 1 1	Internet
0 0 0 0 0 0 1 1	Flat screen in ski areas
0 0 0 0 0 0 0 1	SMS, MMS

Based on Table 1, it is possible to graphically depict the trend (figure 2).

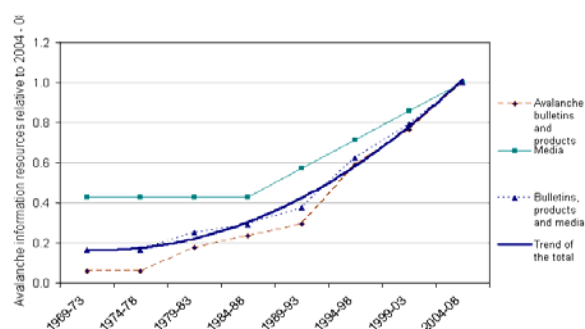


Figure 2: Avalanche bulletins and products and their distribution through the media in Switzerland from 1969 to 2008, subdivided into eight 5-year periods. Dashed lines: development of the group Avalanche Bulletins and Products. Thin solid line: development of the group Media. Dotted line: development of both groups combined. Thick curve: trend when both groups are combined.

Table 1 shows the time periods when avalanche bulletins and other information product were first introduced, together with its respective medium of distribution (SLF, 2007). It reveals for example that the National Avalanche Bulletin was not published in the national languages of French and Italian until 1979 - 1983. This was a very important step in a country with several officially spoken languages and many tourists. Enabled by the new electronic illustration possibilities, the Avalanche Danger Map was introduced in the period 1989 - 1993, namely in 1989. This map was initially made available only to the three national television stations of Switzerland. Subsequently, the development of products flattened out for about 10 years. As of 1998, the prevention products then suddenly increased in number (figure 2).

Until the early 90s, terms and definitions of danger levels were subjectively chosen by the bulletin authors. For that reason, the interpretation was somewhat difficult for readers and users. Then, in 1994, a uniform, precisely defined five-level "European Avalanche Danger Scale" was developed in collaboration with the neighboring countries and then introduced (SLF, 2007). It was followed by an avalanche danger map with danger levels and icon depiction of particularly critical altitudes and aspects. As of 1998, the products became accessible to a large group of users via the Internet. Throughout 1998 - 2003, the Regional Avalanche Bulletins were further developed. By 2003, all the mountain regions of Switzerland were covered by 7 Regional Avalanche Bulletins with a few exceptions. Only parts of the Prealps and Ticino, which are all

covered in the national bulletin, are not yet covered in the regional bulletins.

The increased frequency of publication and the improved publication times and contents, were additional points of significant development. By 1997, whenever required (e.g. heavy snowfall, strong wind, rising of avalanche danger etc.), a National Avalanche Bulletin with a written description of conditions was published between 9:00 and 10:00 am. As of 1998, the National and Regional Bulletins were published daily at 5:00 pm, and at 8:00 am with the latest information and a forecast of coming weather trends, snowpack development and the forecasted avalanche danger. The Regional Avalanche Bulletins are published at 8:00 am (SLF, 2007) and offer the latest data and a nowcast for the current day.

Besides the National and Regional Avalanche Bulletins and the danger maps, it also became increasingly important to avalanche specialists to obtain easy access to raw data from automatic snow and weather stations and observations. This need was recognized in connection with establishing and expanding an inter-cantonal measurement and information system known as IMIS (Egli, 2006). This access to the data, the "InfoBox", was later called "Infomanager". As of 1997, the "InfoBox" was operative and available to avalanche authorities via a dial-up modem connection, later on via the Internet.

The publication of avalanche bulletin information on the Internet was launched in the mid-nineties. In the beginning, however, it was used only sparingly. It has since grown to become one of the most important media sources of snow and avalanche information to the public. In the winter of 2007/08 there were more than 5 million hits on SLF internet pages with snow and avalanche danger information.

Two additional products are also important developments. First, the "WinterAktuell" Internet pages, providing a wintertime review of the past week's weather and avalanche conditions as well as avalanches triggered. In summertime, this product is published monthly. It is published in German and in French (SLF, 2007). As is the case with all the other products except the "InfoManager", "WinterAktuell" is made available free of charge to the public on the Internet.

Second, new in 2008 is an additional daily, highly simplified National Avalanche Danger Map placed into print and Internet media (figure 3). This map permits a quick and easy

overview of the current avalanche danger in Switzerland through easily grasped symbols, similar to weather maps using symbols in weather forecasts on television and in the newspapers. The symbols used can be utilized as single separate icons (SLF, 2007).

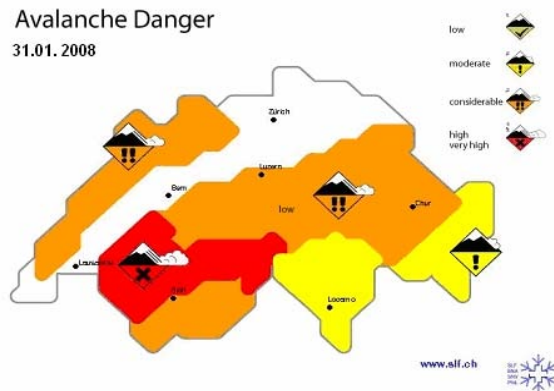


Figure 3: Easy-to-grasp Avalanche Danger Map of Switzerland with danger levels and the (roughly outlined) endangered regions. It is designed to draw the attention of all interested backcountry skiers and off-piste recreationists to the current avalanche danger. There is also a link leading to detailed information, namely to the National Avalanche Bulletin in written form.

A comparison of the numbers of avalanche fatalities shows that the numbers of victims began to decrease at the same time as the avalanche danger map was broadcast at prime TV time. It is also noteworthy that the numbers of victims had already begun to recede in the previous period (1994 - 1998), that is, before avalanche prevention measures had become so wide ranging and detailed. Next to avalanche warning products, education contributed significantly to the trend reversal in the number of avalanche fatalities during the five-year period from 1989 to 1993.

### 3.2 Education

Table 2 shows as of what time period specific courses were launched, by what organizations they were offered and what were the number of participants as well as the specific topics of each course. It also depicts the onset of educational milestones. The information stems from a poll organized by the SLF in the current year, 2008, which has not yet been made public. The poll was conducted by a variety of course instructors with long experience in giving the courses mentioned.

Table 2: Overview of the number of courses, the approximate numbers of participants in 5-year periods (added together), the topics of the courses and the notable

innovations (milestones) which were introduced in each five-year period. The milestones were intentionally evaluated once in the Education Topics and in the Milestones, in order to accord them the importance due to these notable innovations and positive influences.

1969-73	1974-78	1979-83	1984-88	1989-93	1994-98	1999-03	2004-08	Organization, course and no. of participants
1	1	1	1	1	1	1	1	Youth and Sport (J+S), course for touring guides I + II (winter)
0	1	1	1	1	1	1	1	<= 200 participants
0	1	1	1	1	1	1	1	<= 500 participants
0	0	1	1	1	1	1	1	> 500 participants
								Mountain guide courses, course for aspiring guides
1	1	1	1	1	1	1	1	"Winter part" or avalanche course
1	1	1	1	1	1	1	1	<= 200 participants
1	1	1	1	1	1	1	1	<= 500 participants
0	0	0	0	0	0	0	0	> 500 participants
								Swiss Alpine Club (SAC), winter training courses
1	1	1	1	1	1	1	1	<= 200 participants
0	0	0	0	0	1	1	1	<= 500 participants
0	0	0	0	0	0	1	1	> 500 participants
								Swiss Federal Institute for Snow and Avalanche Research (SLF), avalanche courses, especially for workers on transportation routes and those employed in community avalanche services
0	0	0	0	0	0	1	1	<= 200 participants
0	0	0	0	0	0	1	1	<= 500 participants
0	0	0	0	0	0	0	0	> 500 participants
								Swiss Cablecars (SBS), patrol team training courses A + B + C
1	1	1	1	1	1	1	1	<= 200 participants
0	0	1	1	1	1	1	1	<= 500 participants
0	0	0	0	0	1	1	1	> 500 participants
0	1	1	1	1	1	1	1	Swiss-Ski, avalanche courses
0	1	1	1	1	1	1	1	<= 200 participants
0	1	1	1	1	1	1	1	<= 500 participants
0	0	0	0	1	1	1	1	> 500 participants
								Naturfreunde Schweiz (NFS), avalanche course*
								Swiss Snowsports, ski teachers instruction course* (avalanche education)
								Mountain climbing schools*
								Short courses 2 days → various topics*
								Additional courses*
								*courses which were not evaluated, since no data was available
								<b>Topics of courses</b>
1	1	1	1	1	1	1	1	Avalanche science, snow profiles (flat surface)
1	1	1	1	1	1	1	1	Route selection
1	1	1	1	1	1	1	1	Avalanche beacons handling and searching / search procedure (analogue, later digital)
1	1	1	1	1	1	1	1	Rescue
0	0	1	1	1	1	1	1	Determining snow profiles on slopes (sliding block / -wedge)
0	0	1	1	1	1	1	1	Prevention
0	0	0	1	1	1	1	1	Avalanche bulletin interpretation, assessing dangers
0	0	0	1	1	1	1	1	Guide to planning 3X3
0	0	0	0	0	1	1	1	Reduction method (RM)
0	0	0	0	1	1	1	1	Risk management
0	0	0	0	0	1	1	1	Flyer "Beware of avalanches"
0	0	0	0	0	0	1	1	Elementary reduction method (ERM)
0	0	0	0	0	0	0	1	Education of road workers and community authorities in Switzerland, risk management for roads and communities
							1	V-shaped hole seeking buried victims (V-hole)

Table 2: (continued)

1969-73 1974-78 1979-83 1984-88 1989-93 1994-98 1999-03 2004-08	Milestones
1 1 1 1 1 1 0 0	Avalanche beacons analogue
0 0 1 1 1 1 1 1	Rules of conduct, alarm signs
0 0 1 1 1 1 1 1	Sliding block / -wedge
0 0 0 1 1 1 1 1	Guide to planning, 3 x 3
0 0 0 0 1 1 1 1	Exercises in decision making
0 0 0 0 1 1 1 0	Controversial reduction method (RM), later Elementary reduction method (ERM)
0 0 0 0 0 1 1 1	Reduction method (RM)
0 0 0 0 0 0 1 1	Elementary reduction method (ERM)
0 0 0 0 0 0 1 1	Avalanche beacons digital
0 0 0 0 0 0 1 1	Introductory IFKIS courses & squad courses, Swiss Federal Institute for Snow and Avalanche Research (SLF),
0 0 0 0 0 0 0 1	V-shaped hole seeking buried victims (V-hole)

Evident developments include the following: The numbers of participants at the various courses grew more in the first two five-year periods (1969 - 1978) than later on (figure 4). What specifically caused this trend cannot be precisely or finally determined by the course topics and the "milestones". It can be assumed that the advent of avalanche beacons had an influence on evolving new search strategies with the use of these devices, as well as on stirring discussions of new search strategies and the highly necessary practice with avalanche rescue beacons.

In the following five-year period, from 1979, particular efforts were made to focus on avalanche prevention, alongside ongoing efforts in the fields of general avalanche research, the training of rescue organizations and peer rescue. As examples of this, the recognition of alarm signs, decision making guidelines and decreasing the additional load by maintaining a safety distance between skiers can be cited. During 1984 - 1988, a further significant positive change was introduced which paved the way towards the future: new planning tools and factor checks for backcountry tours and freeriding, the so-called 3 x 3 (Nigg P., personal communication, 2008). The 3 x 3 (= planning a backcountry tour at home; just before getting underway; and during the tour) was described step by step by Munter (2003). This easy-to-understand procedure very probably made a great contribution to the decrease of avalanche fatalities in the subsequent 5-years.

The educational themes, including various planning tools and decision making based on established rules, e.g. the reduction method (RM) (Munter 2003), SnowCard (Engler and Mersch 2001) or the Avalanche Triangle (Durner and Römer 2005), which initially unleashed heated controversial disputes among experts, lent new impulses to avalanche science. That happened on the one hand, through the intense discussions and arguments

about their relevance, which was also pursued and published by the media in expert journals; and on the other hand, through their general acceptance ultimately by leading educational organizations, as in the case of the RM in 1997. These, as well as other interesting educational tools, e.g. the subsequently introduced "Elementary Reduction Method" (ERM) (Munter, 2003) and a new "V-shovel strategy" when digging for buried victims (Genswein, 2007), raised the level of education as well as the practical implementation continuously. The increased and improved expert training courses of the Swiss Federal Institute for Snow and Avalanche Research for the staff of local avalanche services may contribute to this as well.

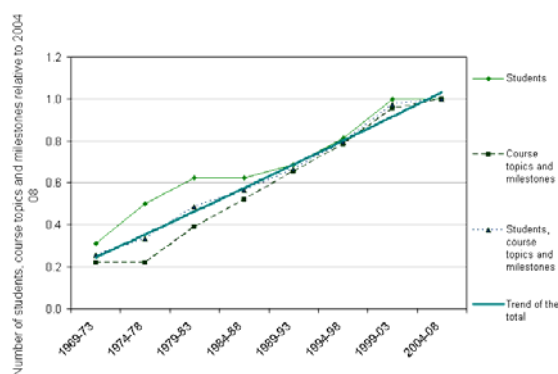


Figure 4: Number of course participants and so-called educational "milestones" in Switzerland from 1969 to 2008, subdivided into eight 5-year periods. Dashed lines: development in the group Course topics and educational milestones. Solid thin line: development of group Courses and number of participants. Dotted line: development, when both groups are viewed together. Thick curve: trend of the total.

Over the course of the last ten years, digital two-antenna and three-antenna avalanche beacons have also arrived in the Swiss market. These, through much easier handling and search procedure, have convinced many users of their benefits. In the time, the ABS-Airbag-Backpacks were sold and used much more (figure 6). Besides the improved education and the detailed avalanche warning system, it can be assumed that these new emergency systems also contributed as well to the decreasing number of fatalities. To keep in mind, that during the last years beside technical topics the "human factors" became more important in educational efforts.



### 3.3. Development of ascents and descents in outlying terrain

Estimates of the number of annual backcountry ski and freeriding tours well away from the secured ski runs in outlying terrain (= at least one terrain sector removed from supervised slopes) are based on a variety of recorded data from certain station points. At the same time, on days selected at random, manual measurements were conducted for purposes of comparison.

Based on a counting of people in the area of Davos (Zweifel et al. 2006), a total number of backcountry and off-piste recreationists for the Swiss Alps and a trend over the time (figure 5) was estimated by Zweifel and Wäger (2008).

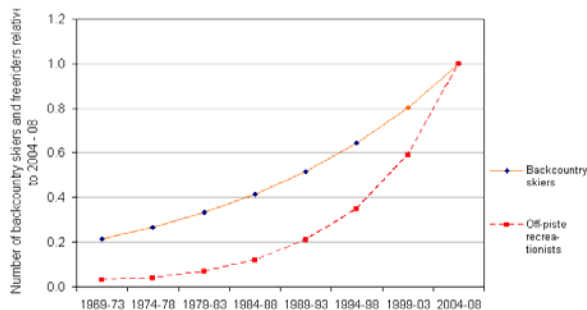


Figure 5: These values were extrapolated from the small region around Davos to ascertain the approximate development of backcountry and off-piste activities\* in Switzerland from 1996 to 2008, subdivided into eight 5-year periods. Dashed lines: development of off-piste recreationists\*. Solid line: development of backcountry skiers.

\* Number of off-piste recreationists far removed from ski runs in outlying terrain (= in different geographic sectors).

For the winter 2007/08 in Switzerland, the following orders of magnitude can be supposed: about 200,000 backcountry and about 70,000 off-piste recreationists were carried out. Off-piste in this context means far removed from the supervised ski runs. These projections are based on a small dataset from a small region. However, the numbers can be cross-checked and compared, at very least in the area of freeriding. This based on “first entries winter” for cablecars and lifts in Grisons (Zegg, 2002) and their extrapolation for the overall region of the Swiss Alps. “First entry Winter” means one visitor counted once daily per cablecar area. The following assumptions were made: a) about five times more “opportunity” off-piste recreationists (= “opportunity” off-piste recreationists in areas nearby supervised ski runs) travel in areas nearby supervised ski runs than registered in terrain far removed from such ski

runs (classic off-piste area); b) for each 1,000 “first entries” at the cablecars, about 10 “opportunity” off-piste recreationists leave the supervised ski runs several times a day into terrain near by. Based on these assumptions, an average of about 320,000 “opportunity” off-piste recreationists days (= more than one descent per person per day) could be supposed for the years 2001 and 2002, based on Zegg (2002).

Allowing due consideration to the trends and a near-perfect winter for off-piste recreationists in 2008, the calculated projections, about 70,000 “classic” off-piste recreationists”, multiplied with 5 times more “opportunity” off-piste recreationists results to about 350,000 “opportunity” off-piste recreationists in outlying, unsecured terrain. Thus, both assumptions can be given a high degree of credibility. In the areas cited nine fatalities occurred 2008 (0.0145 ‰ or 1 to 74,444 of the off-piste recreationists and backcountry skiers). On open traffic routes, the ratio is many times better.

To what extent backcountry users (backcountry skiers and off-piste recreationists) are aware of avalanche education or have access to it and pay heed to the evidence in avalanche bulletins and other information products, cannot be estimated with adequate accuracy at this point. The number of more than 5 million hits on SLF internet sites on snow and avalanche information, permits the assumption that even the warning products might have a positive influence on the prevention of avalanche fatalities.

### 3.4 Equipment development

The trend in avalanche search and rescue devices, including avalanche shovels and probes, are shown in Figure 6, based on data provided by a manufacturer. The trend is based on the assumption that since the onset of avalanche beacons sales at the end of the 1960s and beginning of the 1970s, the number of sold devices has increased by about 10% annually. In future, a slightly flattening curve in avalanche beacons sales is anticipated. In Switzerland, the number of backcountry skiers who have their own emergency avalanche equipment along with them (beacon, avalanche shovel and, occasionally, avalanche probes) is estimated at a relatively high percentage, compared to data from neighboring countries. According to estimates, more than 90% of backcountry sports participants are equipped on tour. For off-piste

recreationists, the percentage is probably somewhat lower.

However, it is interesting that a bevy of “insiders” have determined that for off-piste recreationists today, there is one indispensable “must”: namely, that at least one avalanche beacon and one small backpack with an avalanche shovel visibly affixed to it have to be taken along on the adventure. If that is not the case, the man or woman simply does not belong to the inner circle of genuine off-piste freaks.

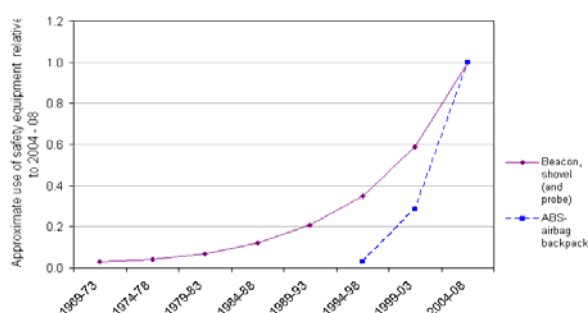


Figure 6: Estimate of the development of avalanche rescue beacons sold and confirmed data of the development of the number of ABS-Airbag-Backpacks sold in Switzerland from 1969 to 2008, subdivided into eight five-year periods. Dashed lines: development of ABS-Airbag-Backpacks. Solid line: development of sold avalanche beacons.

It might be added, almost secondarily, that today, a helmet also belongs to the required equipment of all those who are out in the snows of outlying terrain.

As Figure 6 clearly shows, carrying along ABS-Airbag-Backpacks has also undergone a very positive development. In this case, we were able to demonstrate the development on the basis of manufacturer sales in Switzerland. In the year 2008, the number of ABS-Airbag-Backpacks sold was about 1,700. This is still but a tiny percentage of the overall numbers of persons actively engaged in winter sports in outlying terrain. Nevertheless, the trend gives some cause for optimism. If more avalanche beacons and/or ABS-Airbag-Backpacks are carried along, it cannot be ruled out that there are also greater numbers of winter sports participants venturing into outlying terrain. The advantages of being able to quickly locate a buried victim or of not being buried to begin with or being buried to a far lesser depth in case of avalanches triggered far outweigh the negative aspect, namely, the dangers presented by these higher numbers of people in outlying terrain. That is proven by the relatively high numbers of people who have been

found and rescued thanks to avalanche beacons and/or ABS-Airbag-Backpacks. These people would probably not have survived without this equipment.

### 3.5 Hotel overnights development

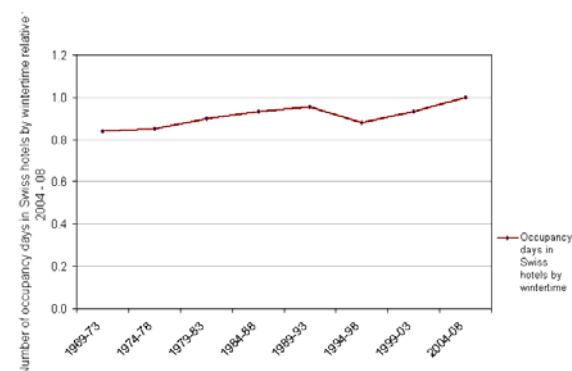


Figure 7: Development in the number of hotel overnights in winter in Switzerland from 1969 to 2008, subdivided into eight 5-year periods. The average number of overnights in the period from 2004 – 2008 was 15.36 million.

The trend in hotel overnights in wintertime (figure 7) was calculated and added to the study solely as a basis for comparison with the trend in the amount of avalanche bulletin information made accessible to the public, in avalanche science education and in the development of the number of persons who are skiing/freeriding in outlying terrain. It clearly demonstrates that the winter sporting developments analyzed and discussed above outreach the trend in the number of hotel overnights by far.

## 4. CONCLUSION

In Switzerland, a positive development in avalanche prevention (avalanche bulletin and other informational products, media distribution and avalanche education) can currently be determined. In spite of rising numbers of persons who venture into outlying terrain, far removed from the supervised ski slopes, i.e. off-piste recreationists and backcountry skiers, the number of avalanche victims did not increase, on the contrary, it decreased (figure 8). However, to conclude from these statistics that a sufficient amount is being done to drive down the number of avalanche fatalities would be backwards thinking and doubtless bring about a setback. Further good and innovative ideas must go on,

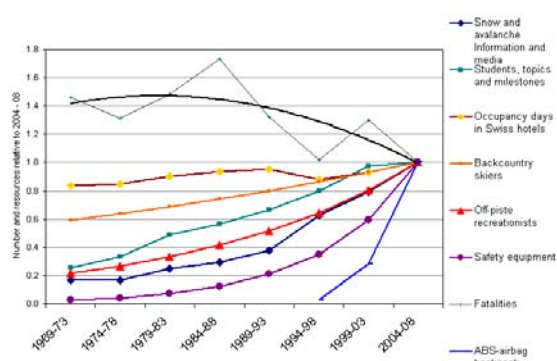


Figure 8: Total overview of the individual developments and trends in Switzerland from 1969 to 2008, subdivided into eight 5-year periods.

both in avalanche warning products, in distribution channels, in public relations efforts, in order to further raise awareness of the potential dangers through more widespread perception of them, and in the continued development and improvement of emergency systems and in the education of avalanche science.

## 5. ACKNOWLEDGEMENTS

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