

FUNDING THE FORECAST: COMPARING APPROACHES TO AVALANCHE RISK MANAGEMENT

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ABSTRACT: Winter backcountry recreation has grown dramatically in recent years. Despite this surge, annual avalanche fatalities in the US have remained stable for the last three decades. This juxtaposing trend is largely attributed to avalanche safety programs. The structure and stability of these programs directly shape their performance and effectiveness; structure encompasses operational architecture (staffing, governance, partner networks, and service dissemination), while stability refers to the financial mechanisms sustaining operations. When funding is unreliable, operations follow: staff positions go unfilled, forecast coverage shrinks, and public risk communication erodes, undermining a program's ability to reduce avalanche fatalities. Understanding how US avalanche programs are structured and funded, and how those models compare with peer countries, helps identify which models best support durable, effective public safety services.

This study is a comparative policy analysis examining avalanche programs in the US and peer countries across North America, Europe, and New Zealand. Using a literature review, expert informant surveys, semi-formal interviews, and comparative analysis of 12 programs across seven countries, the study evaluates differing organizational approaches to identify policy recommendations that could improve the long-term efficacy and stability of US avalanche programs.

Findings indicate that organizational structure explains how a program is funded and staffed, but does not reliably predict its effectiveness or funding stability. Instead, whether funding is legally protected—through legislated mandates or multi-year contracts—is the stronger predictor of program durability. Based on these and additional findings, this research recommends standardizing multi-year funding mechanisms, strengthening cohesion among US avalanche centers, preserving existing nonprofit partnerships, and adopting reach-based metrics alongside fatality data to more fully capture and translate program impact.

KEYWORDS: avalanche forecasting operations, organizational structure, funding, program analysis

1. INTRODUCTION

The February 2026 California avalanche that killed nine backcountry skiers was the deadliest avalanche in the country since the 1980s (Fuller & Cowan, 2026) and a stark reminder of the fatal risk avalanches pose. This tragic accident brought to light the importance of avalanche safety and warning efforts across the United States (US), placing US avalanche forecasting centers in the public eye at a time when nationwide winter backcountry recreation is at its peak (Valle et al., 2022; SIA, 2025). Despite significant growth in backcountry recreation, annual avalanche fatalities in the US have remained relatively stable over the last three decades, indicating that individual avalanche risks have been reduced (Birkeland et al., 2017). These juxtaposing trends do not exist in a vacuum; they span countries and continents (Dahl et al., 2026; Berlin et al., 2019; Neweduk & Haegeli, 2025), and this global pattern of avalanche risk reduction can be attributed to avalanche safety programs.

These programs reduce the risk of fatalities primarily through two mechanisms: forecasting services and educational programming (Greene et al., 2022; Fisher et al., 2021; McNeil et al., 2023). Because avalanche programs operate across a broad spectrum—from community-based nonprofits to national agencies—and each has developed in response to distinct geographic, institutional, and funding contexts, their structures and outputs vary considerably.

Most existing avalanche safety-focused studies concentrate on reducing public risk through improvements in forecasting techniques or educational programs (Greene et al., 2022; Hill et al., 2004). However, one can surmise that the structure and stability of avalanche programs directly affect their performance and effectiveness

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in reducing risk. Structure encompasses a program's operational architecture, including staffing, governance, partner networks, and the dissemination of safety services. Stability refers to the financial mechanisms sustaining these operations. When funding is unreliable, operations follow: staff positions go unfilled, forecast coverage shrinks, and public risk communication erodes, ultimately undermining a program's ability to reduce the risk of avalanche fatalities.

The US has 29 distinct avalanche forecasting programs, which are largely decentralized and have a range of funding structures, including state-funded, fully nonprofit, and public-private partnerships supported in part by the US Forest Service and in part by a 'friends of' nonprofit group (NAC, 2025). In other countries, such as Canada and Switzerland, avalanche programs are much more centralized, clustered around one or two organizations, and predominantly funded by federal governments (Avalanche Canada, n.d.; Parks Canada, 2026; SLF, n.d.). Considering recent US Forest Service (USFS) budget cuts (USDA, 2025) and major organizational restructuring (USDA, 2026), US avalanche programs—half of which receive some funding from the USFS—are in a precarious position. Would further centralization of the 29 programs under an entity such as the USFS provide increased funding, stability, and effectiveness, or does the current model allow greater freedom in funding streams and operational flexibility?

Understanding the structure and funding of US avalanche programs and how these designs compare with those of peer countries therefore helps identify which models best support durable, effective safety services. Thus, this study's comparative analysis examines avalanche programs across North America, Europe, and New Zealand to understand how program funding and organizational models differ among and within countries. What organizational traits relate to the financial stability, forecast consistency, and long-term durability of avalanche safety programs? Exploring these countries' differing organizational approaches will identify novel policy options that could improve the long-term efficacy and resilience of US avalanche forecasting services.

2. METHODOLOGY

This is a cross-sectional, comparative case study that integrates qualitative social science data with select quantitative elements to identify trends in how structural and funding models shape the stability and efficacy of avalanche safety programs. A case study approach allows for in-depth, multifaceted exploration of highly complex phenomena, which fits well for avalanche programs, as they vary widely in operational contexts and are inherently complex.

I collected data from 12 expert informants representing seven different countries' avalanche programs through in-depth surveys and semi-formal interviews. The study was led by surveys designed to elicit rich program descriptions through a combination of quantitative and open-ended qualitative questions. Interviews strengthened the design by providing data triangulation. Avalanche safety programs and affiliated expert informants from those programs were selected through purposive sampling to identify information-rich cases.

To represent each organizational type of avalanche center in the US, I selected one of each main type of center: the USFS-run national agency (NAC); a larger-scale public-private partnership with a closely integrated nonprofit arm and a USFS arm (NWAC); a smaller-scale public-private partnership with a distinct nonprofit 'friends of' group and USFS team (SAC); a fully state-run organization (CAIC); and a fully nonprofit-run organization (HPAC). In Canada, I studied the two primary existing programs—Avalanche Canada and Parks Canada—as these organizations represent a highly centralized model. Outside North America, I looked at a range of newly formed programs, such as NVE's Varsom program in Norway (established in 2013), and well-established programs, such as Switzerland's SLF program (responsible for avalanche warnings since 1945) (Varsom, n.d.; SLF, n.d.). I also selected this set of programs because they vary widely in structure and funding: Austria's program focuses on regional services; France's program operates as part of the country's national weather service; New Zealand's program has an advisory branch and a national nonprofit branch.

3. OVERVIEW OF FINDINGS

Six major themes were prominent in participants' responses: four related to program funding, one related to trade-offs in organizational structure, and another related to useful metrics to reflect program efficacy.

3.1 *Themes*

Theme 1: Organizational structure predicts trade-offs, not outcomes (Table 1)

Theme 2: Avalanche risk is funded as ‘voluntary’ recreational risk

Theme 3: Funding certainty, not amount, drives program stability (Table 2)

Theme 4: Funding concentration predicts funding concerns (Table 3, Figure 1)

Theme 5: There are 3 key improvements programs would make if resources allowed

Improvement 1: Guaranteed, Multi-Year Funding Consistent Across Longer Time Spans

Improvement 2: Dedicated Non-Forecasting Staff

Improvement 3: Investment in Technical Improvements to Keep Up with Demand

Sub-Theme: Programs Stress the Importance of Collaboration with Other Countries

Theme 6: Reach is a compelling metric for measuring program efficacy

Across the 12 programs, organizational structure (federal, state, nonprofit, or hybrid public-private) explains how a program is funded and staffed but does not reliably predict its effectiveness or the stability of its funding. Program structure is not black and white; even more centralized national systems have multiple forecasting programs, varied funding across the country, and some operations housed within a broader agency. Annual budgets range from \$220,000 to over \$4 million, a spread that relates more closely with a country’s size and population than with its organizational structure.

What does predict stability is whether funding is legally protected. Programs with a legislated mandate or multi-year funding contract reported more confidence in their financial futures than those relying on annual fundraising. Federal and state program types are funded almost entirely (80-100%) by government appropriations and endowments, giving them a consistent but sometimes politically exposed base. Nonprofit and hybrid programs procure funding from a fragmented mix of sources, including individual donations, corporate sponsorships, and foundation grants, which diversifies revenue but makes any given year harder to predict.

Effectiveness is more difficult to tie to any funding pattern, largely because avalanche fatality counts—a widely used efficacy metric—scale with population and terrain exposure rather than program quality. A program reporting lower fatalities may simply serve a user base that is less exposed to avalanche terrain and dangers. Reach-based metrics, such as a program’s education course participants or a program’s unique website users, emerged as a compelling proxy for program effort and public impact; one that is underused in funding conversations and advocacy efforts.

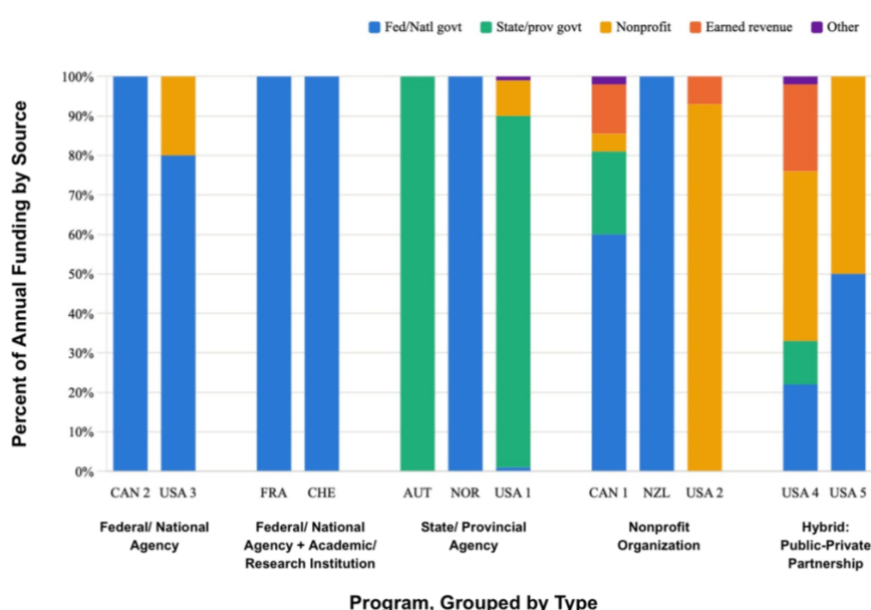


Figure 1: Funding Sources by Program. Stacked bar graph illustrating the percentage of funding each avalanche program receives from various sources, including federal/ national government, state/ provincial government, nonprofit, earned revenue, and other. Programs are grouped by organizational structure type.

Table 1: Trade-Offs for Each Avalanche Program

<i>Program</i>	<i>Country</i>	<i>Label</i>	<i>Pros</i>	<i>Cons</i>
<i>Federal/ national agency</i>				
Parks Canada	Canada	CAN 2	Legislated authority to manage land; stable, protected funding	Bureaucracy/ red tape; inability to be nimble; subject to changing federal politics/ priorities
National Avalanche Center	United States	USA 3	Tripod of experts; hub supporting regional centers	Bureaucracy; overburdened staff; interagency resource competition
<i>Federal/ national agency + academic/ research institution</i>				
Météo-France	France	FRA	Strong weather forecasting; dense data foundation	Coordinating 7 regions is hard; isolation effects; long staff shifts
WSL Institute for Snow & Avalanche Research	Switzerland	CHE	National consistency; strong regional/local network; proximity to research institute	Development resources compete with operational needs
<i>State/ provincial agency</i>				
Avalanche Warning Service Tyrol	Austria	AUT	Clear, legally defined mandate from provinces	Budget cuts (mismanagement during COVID-19 crisis)
Norwegian Water Resources & Energy Directorate	Norway	NOR	High quality/efficiency; full national coverage	Uncertain about having sufficient future funding, observations, and IT support
Colorado Avalanche Information Center	United States	USA 1	Efficient resource use; single govt group covers large area	Insufficient resources for forecast area's size and threat variability
<i>Nonprofit organization</i>				
Avalanche Canada	Canada	CAN 1	Centralization = cost savings, unified tech, easier govt relations, clear recognition as major avy program in country	Public perceives as govt entity (hurts donations); users recreate outside forecast zones; hard to be competitive with wages
Mountain Safety Council	New Zealand	NZL	Flexibility, adaptability, agility; evidence-based institution	Lack of qualified forecasters in rural regions; lack of data
Hatcher Pass Avalanche Center	United States	USA 2	Agile/ adaptable; sets own forecasting schedule/ staffing structure to meet local needs	100% dependent on charitable giving/ grants; hurts wages, retention, and growth
<i>Hybrid: public-private partnership</i>				
Northwest Avalanche Center	United States	USA 4	50-year USFS history; umbrella protection of federal workers issuing forecasts	USFS restructuring and funding shortfalls; federal govt chaos
Sawtooth Avalanche Center	United States	USA 5	Friends group offers flexibility; advocacy; more nimbleness in tech and purchasing than govt	Chaotic govt leadership; low awareness/ understanding of program structure; staff turnover

Table 2: Comparison of Efficacy, Staffing, and Funding Stability Among Programs

					<i>Spread of Annual Revenue Sources</i>				
<i>Label</i>	<i>How effective is your org in reducing avalanche risk</i>	<i>Are staffing level sufficient</i>	<i>How stable does funding feel over next 5-10 years</i>	<i>Total Annual Budget (USD)</i>	<i>Fed/ Natl Govt</i>	<i>State/ Prov Govt</i>	<i>Non-profit</i>	<i>Earned Rev</i>	<i>Other</i>
Federal/ national agency									
CAN 2	Very effective	Yes	Very stable	Not available ^{3*}	100%				
USA 3	Very effective	No	At risk	\$450,000	80%		20%		
Federal/ national agency + academic/ research institution									
FRA	Somewhat ineffective	Yes	Very stable	\$3,421,000	100%				
CHE	Unanswered	Somewhat	Very stable	Not available ^{4*}	100%				
State/ provincial agency									
AUT	Very effective	No	Somewhat stable	\$912,000		100%			
NOR	Very effective	No	Somewhat stable	\$3,060,000	100%				
USA 1	Very effective	No	Somewhat stable	\$3,700,000	1%	89%	9%		1%
Nonprofit organization									
CAN 1	Very effective	No	Uncertain	\$4,095,000	60%	21%	4.5%	12.5%	2%
NZL	Very effective	Yes	Somewhat stable	\$461,000	100%				
USA 2	Very effective	Yes	Somewhat stable	\$220,000			93%	7%	
Hybrid: public-private partnership									
USA 4	Somewhat effective	No	Uncertain	\$2,500,000	22%	11%	43%	22%	2%
USA 5	Somewhat effective	Somewhat	Somewhat stable	\$640,000	50%		50%		

³ The budget for the avalanche program within Parks Canada was not available due to the complexity of the organization's large, multi-jurisdictional operations.

⁴ The budget for the avalanche program at SLF was not disclosed by the participant.

Table 3: Primary Funding Concerns by Organizations' Primary Funding Source

<i>Primary Funding Source</i>	<i>Program</i>	<i>Primary Funding Concern</i>
Federal/ national government	CAN 1	No guarantee of large government grants being renewed
	CAN 2	Not well financed for capital projects or growth; difficult to innovate
	USA 3	Erratic government environment
	FRA	None besides possible budget cuts to training, comms tools
	CHE	Federal cost-cutting measures
	NOR	Global military, political, and economic situation/ uncertainty; being prioritized in government budget will become harder
	NZL	None at this time; funding recently increased, locked in for 3 years
State/ provincial government	AUT	Keeping forecasters on staff; budget cuts to digital tools
	USA 1	Severance Tax and Colorado Department of Transportation funding based on state budget fluctuations
Nonprofit	USA 2	Effect of increasing cost of living on charitable giving; state/ local government deficits affect grant availability
	USA 4	USFS budget and staffing cuts/ lack of support; macroeconomic headwinds impacting individual/ foundation giving
50/50 Split: Federal/ national government and nonprofit	USA 5	Uncertainty with federal appropriations/ budgets; nonprofit fundraising program vulnerable to economic downturn

4. RECOMMENDATIONS

The recommendations detailed below aim to improve US avalanche safety programs. Through this research project, I sought to compare the structure and funding of US avalanche programs with those of peer countries, with the aim of identifying policy options to improve the long-term efficacy and resilience of US avalanche forecasting services. These options are outlined in the recommendations below.

4.1 Recommendation 1 – Standardize Multi-Year Funding Across the US

US avalanche safety programs should band together to pursue a three- to five- year legislated or contractually guaranteed funding stream (modeled on France/ Switzerland/ Parks Canada counterparts). They should do so through a reliable mechanism, but it is unclear whether that should be through a government entity such as the US Forest Service (USFS) or National Weather Service (NWS), or whether some form of private sector funding should facilitate this. A large percentage of funding should come from government sources due to 1) the high percentage of government ownership of backcountry lands in the US; 2) overlap in equipment, technology infrastructure, and staff that contribute to avalanche forecasts; 3) the usually greater stability that government funding represents in other countries; and 4) such forecasting and education centers should be seen as part of a general public good that governments should provide.

State governments could contribute funding through Departments of Transportation and/or Natural Resources, state park passes or other outdoor recreation pass revenue, or extraction or resource taxes. The federal government could contribute legislatively mandated funding through mechanisms such as the SHRED (Ski Hill Resources for Economic Development) Act, a proposed Bill with bipartisan support that could invest in public safety by enabling avalanche centers to retain a portion of the annual fees paid by ski areas operating within National Forest boundaries. As proposed in H.R. 1084, the SHRED Act would establish a Ski Area Free Retention Account to retain fees that ski areas pay to the Forest Service, using those fees to support a variety of recreation management and community needs, including avalanche information and education.

This recommendation is complex and requires additional research to understand which funding mechanisms and sources are most feasible and sustainable. The exact mix of funding is variable across US avalanche centers. Still, a coordinated effort to gain clarity and commitment to fund these centers over multi-year cycles is an important next step.

4.2 Recommendation 2 – Create Cohesion Among All US Avalanche Centers

In addition to the first recommendation, the National Avalanche Center (NAC) should continue as the central hub for the 14 US Forest Service-funded avalanche programs, but should also endeavor to encompass and lead all 29 US avalanche programs. While the NAC does not have an official mandate to serve avalanche centers not on Forest Service lands (as the organization is housed under the USFS), it does provide support—particularly through the management of its centralized software system, the Avalanche Forecasting Platform (AFP), and its collaboration with the American Avalanche Association (A3)—to centralize the dissemination of avalanche information across all types of US avalanche centers. Due to limited funding, limited staffing, and chaos caused by recent USFS restructuring, the NAC is currently limited in its ability to support all 29 centers. The NAC should serve as a body that consolidates resources, facilitates collaboration, and advances US avalanche forecasting and safety services. However, further research is required to determine whether the NAC would be better suited as a federal entity under the USDA/ USFS (where the program currently resides), affiliated with a different governmental agency (such as the NWS), or operating as a nonprofit (501c3) entity funded by federal appropriations.

4.3 Recommendation 3 - Do Not Dissolve Existing Nonprofit Organizations

Existing nonprofit arms of avalanche programs in the US should remain intact to enable flexible advocacy efforts, community outreach, and additional fundraising to support technological and forecasting advancements. That said, avalanche programs should not have to rely on these nonprofits to remain operational (refer to Recommendation 1). To mitigate the sheer number of avalanche programs and affiliated nonprofits in the country, I do not recommend that centers currently without a nonprofit arm spend time and effort creating one.

4.4 Recommendation 4 - Adopt Reach-Based Metrics to Showcase Efficacy

US programs should adopt reach-based metrics (education participants, unique website users) alongside—not instead of—fatality data in program evaluations and advocacy efforts, given the consensus that fatalities alone underrepresent program effectiveness. Reach is a distinct metric that programs should utilize more frequently to explain the breadth of public safety work they conduct. Because it is difficult to support any single metric as a clear proxy for program effectiveness, there is a need to expand these metrics and demonstrate program effectiveness through a robust government review (similar to reviews conducted in Canada and New Zealand). Programs should also adopt reach-based metrics to showcase the amount of public infrastructure they help safeguard. Providing avalanche forecasts and other crucial weather data for transportation corridors, such as highways and mountain passes, reaches vast numbers of people and goes far beyond protecting backcountry recreationists.

4.5 Recommendation 5 - Collaborate on Public Communication & Advocacy

US programs should combine Recommendations 2 and 4 to strengthen inter-country collaboration when it comes to providing a compelling story to funders. By pooling resources and speaking with one voice, rather than many disparate ones, avalanche centers can maintain funding streams essential to their mission.

5. CONCLUSION

The study's main findings translate directly into the five recommendations above. Because guaranteed funding, not structure, drives stability, Recommendation 1 targets legislated or contractually guaranteed funding streams. Since centralization alone did not predict greater stability and durability among the participants surveyed, Recommendation 2 treats consolidation under the NAC as a coordination and consensus-building block, not the guaranteed solution to the US' instability problems. Recommendation 3 preserves the flexibility that nonprofit programs offer, but acts as a supplement rather than a foundation for US avalanche programs. Recommendation 4 provides examples of metrics that programs can lean into when securing guaranteed, multi-year funding, and offers an additional suggestion to expand such metrics through an official government review of nationwide avalanche programs. Finally, because comparative data showed that funding concerns map to whichever revenue source a program depends on most, Recommendation 5 focuses on pooling the resources of the existing 29 US programs into one coordinated effort to attract long-term, reliable funding. These recommendations are meant to complement one another and work in tandem to create a stronger, more effective ecosystem of avalanche safety organizations in the US.

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