DIVERSE CHALLENGES: AVALANCHE FORECASTING FOR THE DEPARTMENT OF CONSERVATION IN FIORDLAND, NEW ZEALAND

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ABSTRACT: The management of avalanche safety in Fiordland National Park poses diverse challenges. The avalanche forecasting team must closely manage avalanche hazards on three popular walking tracks, where users' risk tolerance is low. Concurrently, avalanche conditions across the entire 12,500 km^2 region are monitored in order to direct biodiversity workers. Extremes of weather cause avalanche conditions to change rapidly. Avalanche types range from size D1 glide slabs in unforgiving terrain to size D5 plunging avalanches, with substantial risk to National Park users across this spectrum. The programme's management strategies will be of interest to any operation forecasting for very large areas or in extreme maritime climates, or those managing avalanche risk exposure for recreationalists.

KEYWORDS: risk management, walking tracks, maritime, remote, vast area

1. INTRODUCTION

Fiordland National Park's 12,500 km^2 area includes some of the most steep-sided avalanche terrain in New Zealand. It has an extreme maritime climate, with an average annual rainfall of up to 13.4 m/year. Storms can bring 250 mm of precipitation in 24 hours. Strong to gale winds and fluctuating freezing levels are also common.

The Department of Conservation (DOC) Fiordland overhauled its avalanche safety management operations in spring 2013. Expert avalanche forecasting, facilities closures, travel restrictions, snowpack modification, rule-based decision-making and education programmes were implemented. The operation is challenged by the scale and seriousness of the weather and terrain, along with the diverse activities undertaken in the Park which require avalanche safety management.

Challenges include closely managing hikers on tracks while concurrently directing biodiversity workers spread remotely across the wider region. Maintaining communication with all affected parties and gaining adequate field data to support the programme are also key issues. Walkers' perception of risk is often mismatched with the reality of their exposure to avalanche hazard (Fig. 1).

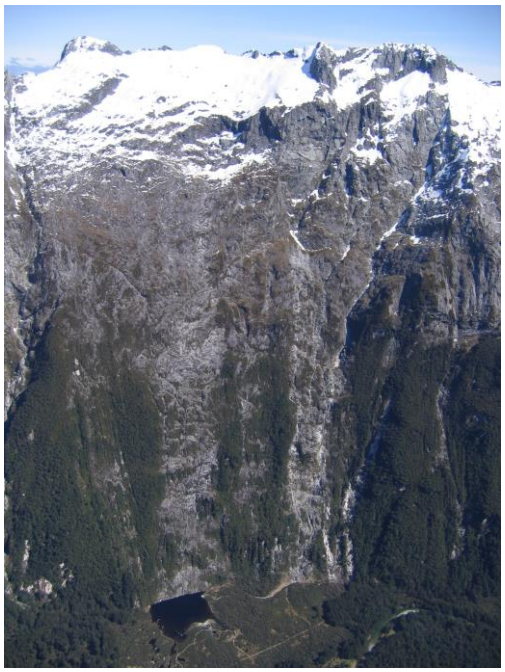

Fig. 1: The avalanche start zones are often not visible to walkers, who may be little aware of the risk from above. The Milford Track crosses in a straight line at the bottom of the image. The lake is an avalanche impact tarn.

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Fig. 2: Glide slabs on the McKinnon Pass section of the Milford Track.

Fig. 3: A plunging avalanche crosses the Milford Track.

2. THE *GREAT WALKS*: TOURISTS, BOOKINGS AND RISK PERCEPTIONS

New Zealand's *Great Walks* are a well maintained and extremely popular set of multi-day walking tracks managed by DOC. Fiordland hosts the Milford, Routeburn and Kepler *Great Walks* tracks.

During the winter months, bookings are not taken for these walks and users travel at their own risk. Deep snow and unfavorable weather keep user numbers low. During spring, the *Great Walks* booking season opens and crowds pour onto the tracks, which are usually fully booked well in advance. These walkers generally expect a high level of safety management and have a low risk tolerance. This may be partly due to marketing strategies and trends in the tourism sector.

However, a significant avalanche hazard usually affects the tracks at this time of year (figs. 2 and 3). Walkers seldom have the training or experience to recognize the avalanche risk they are exposed to. This is exacerbated by the fact that many avalanche start zones are not visible from the walking tracks. Because huts are booked to full capacity, there is a need for walkers to keep moving every day to avoid a backlog.

3. BIODIVERSITY WORKERS: IN THE DEEPEST REACHES

DOC runs ongoing conservation projects in Fiordland National Park, such as species monitoring. The remote and rugged nature of the terrain means teams are usually isolated, apart from radio contact, once flown into the field. During winter months, when the avalanche programme is unstaffed, a set of decision-making matrices is used to inform field workers where they can and cannot travel (fig. 4). These matrices, formulated in 2013 and still undergoing refinements, use Avalanche Terrain Exposure Scale (ATES) (Statham et al, 2006) mapping, Backcountry Avalanche Advisory (BAA) danger ratings (New Zealand Mountain Safety Council, 2013) and recent weather data to reach an outcome.

During spring months, DOC avalanche forecasters provide site-specific guidance to field teams. Due to the extended nature of field work, avalanche forecasts and travel plans are issued several days in advance.

4. AVALANCHE SAFETY MANAGEMENT

4.1 Weather observation network

Weather telemetry is installed at four sites. These stations measure snowpack depth, air temperature, snow temperatures, rainfall, wind speed and wind direction. Two river flow meters, used principally for flood monitoring, also aid in estimating through flow of water in the snowpack during rain-on-snow events. A planned expansion of the

Matrix A
For staff working in avalanche terrain
Above Bush line

ATES Rating	Danger Rating -Go or No go	No of people	Comms	PPE	Desired Qualifications (required after July 2015)
Complex: *Eliminate work during avalanche season*	Extreme: No go High: No go Cons: No go* Mod: No go* Low: No go*	Min 2	VHF radio contact	Transceiver, shovel, probe	Avalanche Stage 2 (at least one team member) Only for vital work e.g. assessing snow stability
Challenging: *Minimise work*	Extreme: No go High: No go* Cons: No go* Mod: Possible if overseen by Avo 2+ Low: Possible if overseen by Avo 2+ if wx forecast is steady or improving	Min 2	VHF radio contact	Transceiver, shovel, probe	MSC 4 day course or equivalent (at least one team member)
Simple	Extreme: No go High: Possible if overseen by Avo 2+ Cons: Possible if overseen by Avo 2+ if wx forecast is steady or improving	Min 2	VHF radio contact	Transceiver, shovel, probe	MSC Avalanche Awareness Course or equivalent (at least one team member)
	Mod: OK Low: *OK* if wx forecast is steady or improving	Min 2	Radio, sat phone or ELB	Transceiver, shovel, probe	MSC Avalanche Awareness Course or equivalent (at least one team member)
* An exception may be made for Avalanche team with minimum Avo 1 + 3 years experience (preferably Avo 2). Only for essential work e.g. assessing snow stability. + Approval must be granted by Avo 2 Avalanche team member prior to entering terrain.					

Fig. 4: An example terrain-use matrix for times when the avalanche programme is unstaffed.

telemetry network includes three new alpine stations.

During the *Great Walks* season, hut wardens also take daily manual weather observations of precipitation, temperature, wind and cloud cover. They relay these to the avalanche team by radio, along with avalanche and snowpack observations.

4.2 Field observations

The avalanche team makes regular field observations by helicopter and on foot. Snowpack studies are undertaken when practical, however the scale of the forecast area often lends itself to broad-scale aerial observations. Consequently, a local knowledge of normal seasonal snowpack cover is very helpful for assessing the likelihood of avalanches reaching the tracks. At critical times, an avalanche forecaster is stationed at Harris Saddle on the Routeburn Track and/or on the Milford Track to closely monitor weather and snowpack conditions.

4.3 Forecasting

Daily avalanche forecasts are generated for each section of the three *Great Walks* by Avalanche Safety Management Stage 2 qualified staff using remote weather data, recent snowpack and avalanche observations, weather forecasts, judgement and experience. These are distributed to relevant DOC visitor centres and adventure tourism operators.

4.4 Communicating

DOC staff members make visitors aware of current avalanche conditions and other environmental hazards when they make a booking, and again when they collect their hut tickets prior to starting their walk.

Avalanche safety brochures, signs and posters (Fig. 5) also help improve awareness of avalanche dangers amongst Park users.

Hut wardens receive avalanche awareness training each season and provide a key link in the chain of communication between avalanche forecasters and walkers through daily hut briefings and other interactions.

Fig. 5: Avalanche information poster.

4.5 Closures, restrictions and helicopter shuttles

During the booking season, a *HIGH* avalanche danger rating for any section of a *Great Walks* track prompts a closure of that section. As full bookings preclude the option of walkers spending an extra night in a hut, they are instead ferried by helicopter across the closed section, or sections, of track. During the spring avalanche season, walkers pre-pay for this service. On the Routeburn Track, a boat ferry across an alpine lake may replace the helicopter shuttle in future. Under *EXTREME* danger, tracks are closed and flying may be restricted.

A *MODERATE* avalanche danger prompts 'no stopping' restrictions, which are explained to walkers prior to their departure for the day by hut wardens. 'No stopping' areas are signposted. These restrictions are not enforced, therefore a conservative approach to the avalanche danger forecasting is taken.

Under *LOW* danger, tracks are open and avalanche areas are signposted.

A *CONSIDERABLE* danger rating is not used.

4.6 Glide slabs and snowpack modification

Glide slabs pose a threat on all three of Fiordland's *Great Walks* and are a common feature of the springtime snowpack in Fiordland. Often glide slabs are relatively small, but are poised above terrain traps (lakes, cliffs and steep gullies). The threat of a small avalanche in combination with a terrain trap presents an unacceptable risk during the *Great Walks* season.

If an isolated small section of glide slab is preventing a track from opening, occasionally the avalanche team will modify the snowpack into small chunks using shovels, chainsaws or explosives (fig. 6). Sometimes this labour-intensive tactic removes the hazard. At other times it only aids in speeding up the melt process.

Fig. 6: Snowpack modification to remove or break up problematic areas of snowpack (which may otherwise fail as glide slabs onto the track).

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