DRONES IN THE MOUNTAINS: THE JASPER VISITOR SAFETY REMOTELY PILOTED AIRCRAFT SYSTEM (RPAS) PROGRAM

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ABSTRACT: Jasper Visitor Safety is responsible for avalanche forecasting, avalanche control, and search and rescue (SAR) across Jasper National Park, an approximately 11,000 km² park in the Canadian Rockies, Alberta. The park's remote character and limited seasonal access to rescue helicopters prompted Jasper Visitor Safety to develop an in house Remotely Piloted Aircraft System (RPAS, or drone) program with the aim of training staff as competent pilots and using drones for search and rescue and, ultimately, avalanche control. This paper describes the program's aims, current fleet and equipment, training pathway, and operational experience to date. Drones have proven their value in several search and rescue operations, including night searches with infrared imaging, initial assessment of possible avalanche burials, and delivery of survival equipment to subjects. In parallel, Jasper Visitor Safety has supported live testing of drone delivered avalanche control and sees the drone as a complement to, rather than a replacement for, avalanche control with helicopters. Current limitations include line of sight radio range, payload flight endurance, and reduced performance relative to helicopters in poor weather and long control missions. The paper concludes that RPAS meaningfully extends the reach, safety, and cost-efficiency of a remote mountain avalanche and rescue program.

KEYWORDS: RPAS, UAV, drone, avalanche control, search and rescue, Jasper National Park

1. INTRODUCTION

Jasper Visitor Safety is responsible for avalanche forecasting, avalanche control, and search and rescue (SAR) operations in Jasper National Park, Alberta, Canada. Because of the park's remote character and its limited seasonal access to helicopters, Jasper has begun developing its own RPAS program. The program aims to train staff to be competent drone pilots and to use drones for search and rescue operations and, eventually, avalanche control.

This paper outlines the current state of that program: the operating area it serves, the avalanche control and search and rescue tasks it supports, the drone fleet and supporting equipment, the training pathway for pilots, illustrative operational case studies, and the limitations the team has encountered. Interest in RPAS for mountain operations is growing across the avalanche community, from LiDAR snow-depth mapping for operational risk assessment (Sharp et al., 2024) to drone delivered avalanche control on avalanche-prone roads (Tveit and Bøckman, 2024).

2. OPERATING AREA

Jasper National Park covers approximately 11,000 km² (11,228 km²) and is the largest national park in the Canadian Rockies. In 2023 the park received 2.48 million visitors, including 520,700 front country campers and 15,100 backcountry campers, and it maintains roughly 1,070 km of trails and more than 80 backcountry campgrounds (Parks Canada, 2023). Together with Banff, Yoho, and Kootenay national parks and adjoining provincial parks, it forms part of the Canadian Rocky Mountain Parks UNESCO World Heritage Site (UNESCO, 2024).

Jasper Visitor Safety issues avalanche bulletins for the entire park and conducts avalanche control for Highway 93 North (the Icefields Parkway), north of Saskatchewan River Crossing, and for the Maligne Road, which leads to Maligne Lake. It currently manages 76 avalanche paths affecting these highways (Parks Canada, 2023).

3. AVALANCHE CONTROL

3.1 Current methods

Jasper Visitor Safety currently conducts avalanche control using helicopter bombing, an Avalauncher, and hand charging. Helicopter bombing is used primarily on the large paths on Mt. Cirrus, Mt. Coleman, Mt. Wilson, and Mt. Saskatchewan. The Avalauncher, a compressed gas launcher that can place roughly 1 kg of explosives up to about 2,000

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m and has served as a short range alternative to artillery for decades (Brennan, 2006), is used on Parkers Ridge, a medium-sized slope close to the highway (Fig. 1). Hand charging is used on Gravel Slopes, Viewpoint Bench, and other small slopes near the highway.

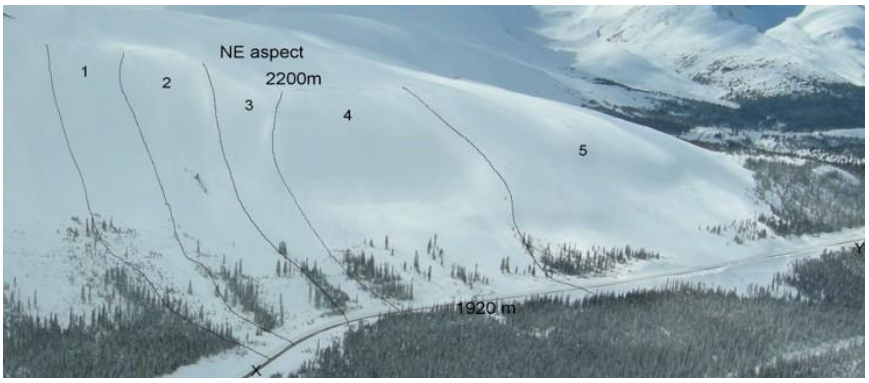

Figure 1: Parkers Ridge, an Avalauncher controlled path above Highway 93 North and a candidate for future drone-delivered control. Numbered lines indicate individual start zones on the northeast aspect, from about 2200 m down to the highway at roughly 1920 m.

3.2 Drone-delivered avalanche control

Jasper Visitor Safety sees the drone as a viable means to replace the Avalauncher and some hand charging, targeting start zones such as Parkers Ridge, Gravel Slopes, Viewpoint Bench, and Nigel Bench. Drone delivered control is unlikely to replace helicopter bombing on the larger paths in the foreseeable future. In collaboration with AVSS Aerial Vehicle Safety Solutions (AVSS) utilizing their Precision Avalanche Management System (PAMS) integrated on a DJI FlyCart 30 (FC30), tests were conducted that required the PAMS and RPAS to fly approximately 1,000 m of elevation gain to various start zones on the Medicine Lake slide paths to deliver 2 kg charges without technical or operational difficulty on numerous occasions. The principal benefits are precision and repeatability: routes can be pre-programmed, explosives can be placed on the same target coordinates on successive missions, and no personnel need to fly in a helicopter carrying explosives. Because control routes can be pre-programmed, drone-delivered control can also be carried out at night or in poor visibility, when helicopter bombing is not possible. The speed of deployment of helicopter bombing and the ability to fly the helicopter in high winds (e.g., the FC30 has a maximum wind speed of 43 km/h,[1] while most helicopters can fly in much higher winds) mean that helicopter bombing is unlikely to be fully replaced in the foreseeable future; Jasper Visitor Safety sees RPAS control as a complement to, rather than a replacement for, helicopter bombing, and plans to use it on paths such as Parkers Ridge that are close to the highway and require short flights.

AVSS, a Canadian company, has been developing drone-based avalanche control since 2020 through its PAMS and SnowDart delivery hardware. In August 2025, AVSS received a nationwide Special Flight Operations Certificate (SFOC) from Transport Canada for the technology, and in early 2026 it completed its first live, on mountain avalanche control testing on an existing control route in Jasper National Park, with support from Parks Canada, Transport Canada, Natural Resources Canada, and Innovation, Science and Economic Development Canada under the Innovative Solutions Canada program (AVSS, 2025). AVSS continues to test its system in Jasper National Park in conjunction with Jasper Visitor Safety.

3.3 Drone-based control elsewhere

Jasper is not alone in developing drone delivered avalanche control. In Norway, the Public Roads Administration and the contractor AF Decom have moved UAS-based control from field trials to operational use on avalanche prone highways, using DJI Matrice and FC30 platforms to either drop charges in the terrain or suspend them beneath the aircraft and detonate them remotely with electronic igniters (Tveit and Bøckman, 2024). Comparable programs and trials are underway at road authorities and ski areas in Austria and the United States. These efforts echo Jasper's experience that drones offer a mobile, lower cost complement to established tools such as the Avalauncher and helicopter bombing.

[1] https://www.dji.com/ca/flycart-30/specs

4. DRONE FLEET AND EQUIPMENT

4.1 Aircraft

Jasper Visitor Safety operates four aircraft (Fig. 3):

- DJI Mini: used to train pilots. Its controls mirror those of the larger aircraft, so staff can build flight skills without risking the more expensive drones.
- DJI Matrice 350 RTK: used for reconnaissance and search. It carries a high zoom camera (up to 400× hybrid zoom) with an infrared thermal sensor and is flown on initial assessments to locate a subject before the heavier FlyCart 30 is committed, conserving that aircraft's batteries. The Matrice 350 RTK offers up to 55 min of flight time with a maximum range of 20 km (DJI, 2024a).
- Two DJI FlyCart 30: heavy-lift aircraft used to carry payloads. The FlyCart 30 can lift 30 kg with dual batteries and can be fitted with either a cargo box or a winch (DJI, 2024b). It is the platform used in Jasper's avalanche-control trials with AVSS's PAMS. With a 30 kg payload it can fly up to 16 km or 18 min.

Figure 2: A DJI FlyCart 30 fitted with the AVSS Precision Avalanche Management System (PAMS) in flight.

Figure 3: The Jasper Visitor Safety fleet: the heavy-lift DJI FlyCart 30 (Centre), the DJI Matrice 350 RTK reconnaissance aircraft (left), and the DJI Mini training aircraft (right).

4.2 Payloads and accessories

- Spotlight: illuminates search areas at night and includes a strobe function.

- Zoom / thermal camera: the Matrice 350 RTK carries a high zoom, infrared camera (up to 400× hybrid zoom); recorded footage can be reviewed with pixel search software such as Loc8, which analyses images at the pixel level to flag the colours of a subject's clothing (Loc8, 2024).
- Speaker: records and transmits voice messages to subjects.
- Winch: fitted to the FlyCart 30; it raises and lowers a payload of up to 30 kg on a cable up to 20 m long at up to 0.8 m/s, so the aircraft need not land to deliver (DJI, 2024b). The load is released manually at the end of the line or when it touches the ground; it cannot be released in flight.
- Long-line: fitted to the Matrice 350 RTK; it can release items from the air but cannot raise or lower them.
- Cargo box: a foam box mounted between the FlyCart 30's support legs for carrying gear. The team defaults to the winch because flat, safe landing spots are difficult to find in the mountains and the aircraft risks punching through the snow in winter.

4.3 Portable command center

A portable command center supports drone missions in the field (Fig. 4). It comprises an ice-fishing tent, a table and chairs, an additional monitor, a Starlink satellite terminal, and an external battery. The tent shelters operators from the elements and has windows that can be closed to eliminate glare on the monitors. For searches, one operator flies the aircraft while a second watches the additional monitor; rotating the second observer roughly every 15 min reduces fatigue and the risk of missing critical detail. The Starlink terminal has been repackaged into a hard case with an integrated battery bank so that it can be used anywhere without a main power source. Jasper Visitor Safety uses the Starlink link to send daily snowpack observations back to the office for inclusion in the avalanche bulletin. A generator is also carried to recharge RPAS batteries.

Figure 4: The portable command center: an insulated ice-fishing tent, folding table and stools, an additional monitor, a repackaged Starlink terminal, and a battery box for off-grid operation.

5. TRAINING

Jasper Visitor Safety is training its entire team of eight to be capable drone pilots. Advanced operations require the Transport Canada Advanced RPAS Operations certificate, which involves a written examination and an in person flight review (Transport Canada, 2023). Team members first build basic flight skills on the DJI Mini before progressing to the Matrice 350 RTK and the FlyCart 30. Pilots then refine and assess their proficiency using the NIST Standard Test Methods for Response Robots (the "Open Test Lane"; NIST, 2024).

Advanced skills practiced by the team include grid and waypoint based searches, winch delivery with the FlyCart 30 including delivery of the team's titanium rescue stretcher, and the transfer of control of an aircraft from one controller to another.

6. SEARCH AND RESCUE

The Jasper Visitor Safety team is responsible for lost person searches, emergency backcountry medical care, and traumatic injury rescues; in 2023 it responded to 171 incidents (Parks Canada, 2023). Jasper

National Park has a dedicated rescue helicopter stationed in the park only during July and August; for the remainder of the year the nearest helicopters are in Hinton and Valemount, neither of which currently has a rescue pilot on staff. As a result, Jasper typically draws its rescue helicopter from Revelstoke, Golden, or Canmore, all more than 200 km from the town of Jasper. In this context an RPAS program is especially valuable: initial assessments can be made without a helicopter, low urgency calls can be investigated quickly and at minimal cost, and the drones' infrared cameras, pixel-search software such as Loc8, and night flight capability add search capacity in their own right. The Matrice 350 RTK is shared with the Parks Canada Human Wildlife Coexistence team and is also used frequently for wildlife work.

6.1 Case study: Bow Glacier Falls rockfall

On 19 June 2025, a large rockfall, an approximately 50 m wide slab, released above the Bow Glacier Falls trail in neighboring Banff National Park, killing two hikers and injuring three others (CBC News, 2025). Visitor Safety was able to search the debris with an RPAS to obtain imagery of an unrecovered subject while keeping a safe distance from the recent rockfall area (Fig. 5).

Figure 5: Bow Glacier Falls rockfall. The rockfall debris searched by RPAS is outlined in red; Bow Glacier Falls is visible at left.

6.2 Case study: Mushroom Peak

On 18 April 2026, a member of the public reported ski tracks entering an avalanche on Mushroom Peak with no tracks seen exiting, and a vehicle left at the trailhead overnight. An initial assessment was flown with a drone. Tracks were clearly visible, crossing over the avalanche debris and exiting below (Fig. 6), allowing Jasper Visitor Safety to stand down without calling for a helicopter.

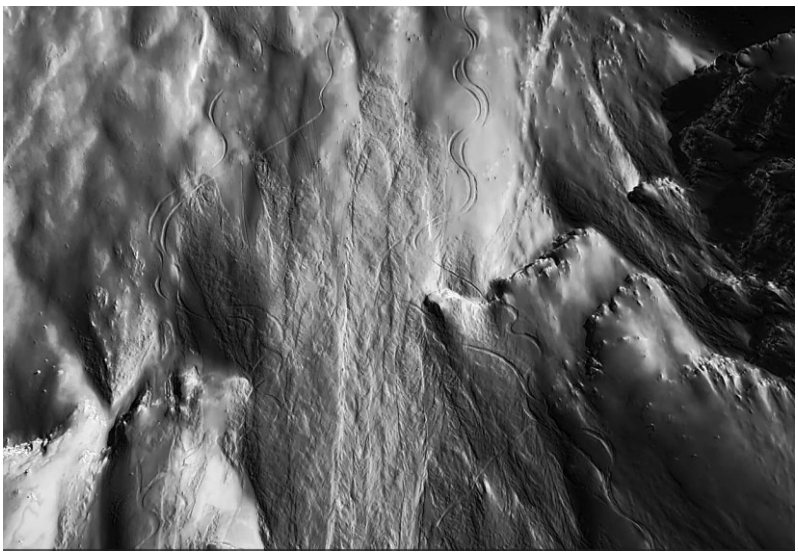

Figure 6: Mushroom Peak. Infrared drone imagery clearly shows ski tracks crossing over and exiting below the avalanche debris, confirming the party was not buried.

6.3 Case study: Whistlers Mountain night rescue

On 18 August 2025, a hiker became lost after dark on Whistlers Mountain. An infrared drone search located the subject (Fig. 7). The team flew a headlamp and a radio to the hiker using the Matrice 350 RTK long line, then followed the hiker down, using the radio to redirect them whenever they strayed from the trail.

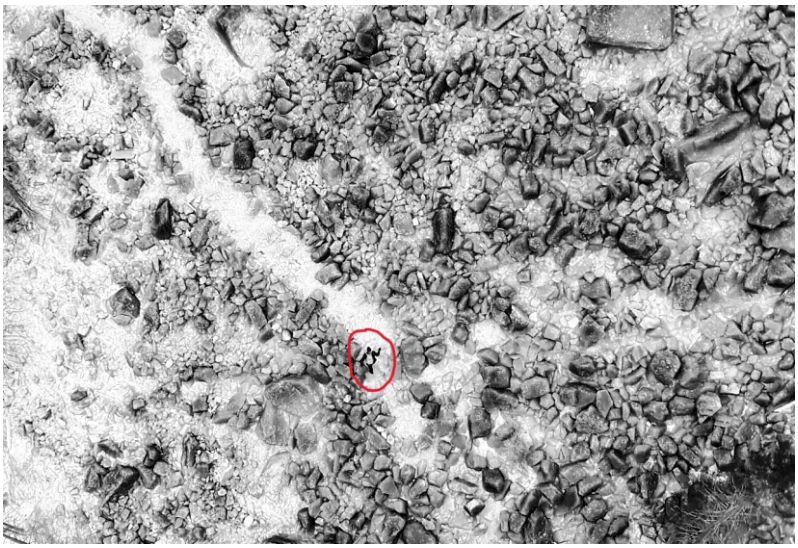

Figure 7**:** Whistlers Mountain night rescue. The lost hiker (circled in red) was located by infrared drone search; a headlamp and radio were then delivered by long line.

6.4 Other operations

Additional operations supported by the RPAS program include a multi-agency search for a missing hiker at Marvel Lake, conducted alongside ground teams and helicopters; a response to skiers reported 24 h overdue on the Charlton–Unwin route, where the drone was the initial resource before a rescue helicopter was called after no subjects were found; and a search for an overdue solo ice climber on Polar Circus on 11 February 2023, when, with hazardous avalanche conditions preventing access, a Parks Canada Visitor Safety drone flown over the route located the climber, who had died in a fall (RM Outlook, 2023). Jasper Visitor Safety has also used drones to locate Avalauncher duds (unexploded rounds) in avalanche terrain so that they can be detonated in place.

6.5 Drones in mountain rescue elsewhere

Mountain rescue teams worldwide report similar benefits. In December 2024, North Shore Rescue in British Columbia located a hypothermic missing hiker roughly two kilometers away using a thermal drone, reaching him on the aircraft's last battery (DroneXL, 2025). In the United States, county rescue teams routinely use thermal cameras and drone-mounted speakers to find lost hikers and have dropped lights and supplies to stranded subjects, operations that closely parallel Jasper's Whistlers Mountain rescue. In China, heavy lift delivery drones now fly scheduled cargo missions on roadless peaks such as Mount Huangshan and have been used to survey flood zones and extract stranded people (Yicai Global, 2025).

7. CURRENT LIMITATIONS

7.1 Line-of-sight radio range

The aircraft require a line of sight to the controller, which limits operations over long distances, ridges, and gullies. Control can be transferred between two ground stations: the team has done this successfully with one operator at staging and a second on a ridge top within line of sight, flying the aircraft up to the second operator, transferring control, and then continuing over the far side of the ridge. Although DJI advertises a transmission range of up to 20 km for these aircraft (DJI, 2024a, 2024b), the team's own testing shows usable connectivity beginning to degrade at much shorter distances in mountainous terrain.

7.2 Payload capacity and endurance

The FlyCart 30 can currently carry and release only one explosive charge per flight. After each delivery the aircraft is flown back to the staging area, where its batteries are usually replaced before the next charge is loaded and flown. This one charge per flight workflow, together with the reduced flight endurance that cold temperatures and mountainous terrain impose in practice, means that completing a full control route takes considerably longer than helicopter bombing, which can carry and place several charges in a single flight.

7.3 Comparison with helicopters

Helicopters still do many, if not most, tasks better than drones: they are more capable for avalanche control, have far greater range and payload, and can fly in windier conditions. Nonetheless, drones have shown that they add clear value to the program, and the team will continue to explore their use for avalanche control, rescue, and searches.

8. FUTURE WORK

Jasper Visitor Safety has begun training to fly rescue stretchers, climbing ropes, and camp gear to stranded or injured subjects, and plans to use these capabilities when operations must run at night or when a rescue helicopter is farther away. Following preliminary testing, the team also plans to begin using the AVSS SnowDart system for avalanche control on some of its paths close to the highway.

9. CONCLUSION

For a large, remote park with only seasonal access to a rescue helicopter, RPAS have proven to be a practical addition to Jasper Visitor Safety's toolkit. In their first seasons of use, the team's drones have carried out initial assessments that avoided unnecessary helicopter call outs, located subjects at night with infrared imaging, delivered light and communication to a lost hiker, searched terrain too hazardous for ground crews, and supported the first live tests of drone delivered avalanche control in the park. These gains come with real constraints, including line of sight range limits, single charge payloads, and reduced performance in wind and cold, which is why the team treats the drone as a complement to, not a replacement for, the helicopter, the Avalauncher, and hand charging. As airframes, payloads, and detection software continue to mature, RPAS are likely to take on a growing share of the program's search, rescue, and avalanche control work, extending the reach, safety, and cost efficiency of operations across a demanding mountain landscape.

ACKNOWLEDGEMENTS

The author thanks the Jasper Visitor Safety team and Parks Canada for their work in building the program, and AVSS – Aerial Vehicle Safety Solutions (AVSS) for their collaboration on drone-delivered avalanche control.

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