NEW PUBLIC AVALANCHE AWARENESS OPPORTUNITIES - ARE YOU BEEPING?

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ABSTRACT

As members of Cascade Backcountry Ski Patrol (CBSP) and the Ski Patrol Rescue Team (SPART) of King Country Search and Rescue, we strive to increase avalanche awareness through extensive education of members in the rescue community as well as active participants in the avalanche awareness and education community. There has been an increase in media attention around local avalanche accidents in the Pacific Northwest in the 2011-2012 winter season. In combination with this media attention and the desire for more of the public engaging in winter backcountry recreation, we felt that a new public outreach campaign was needed in the Pacific Northwest.

In cooperation with King County Search and Rescue, Northwest Weather and Avalanche Center, the US Forest Service, Washington State Department of Transportation, and the Summit at Snoqualmie Ski Resort, and many others in the industry we were fortunate to launch our first pilot of new avalanche awareness signs around several of the common trailheads at Snoqualmie Pass. We secured a special use permit from the US Forest Service and worked in close partnership with many other public safety entities to develop a new trail sign. This was deployed to as many winter recreation entrance points in the surrounding Snoqualmie Pass Washington winter recreation area as possible.

In addition, we've also developed and launched the first proto-type of a beacon check station for the US Forest Service in the Alpental area. This new "Are You Beeping?" beacon check station includes simple public information, a solar powered BCA Beacon Checker™, trail beam and motion sensors, instrumentation for temperature/humidity, Zigbee wireless mesh capabilities, and a micro-controller for logging of all data. The first two months of data from the pilot was retrieved successfully from the logs showing the public entering a trailhead, triggering the beacon checker (if they were wearing a beacon), proceeding further up the trailhead, along with time, date, temperature, and humidity. Plans to deploy several more signs for the 2012-2013 winter season are already planned.

1. INTRODUCTION

Thousands of backcountry travellers entering the Mount Baker - Snoqualmie National Forest in Washington every winter may not be aware that they are traveling into known avalanche terrain. As they enter the trailhead, there is typically little or no warning, education, or signage displaying the warnings. The areas may be owned and operated by different agencies or entities further complicating the ability to unify an educational message. Now as they enter the trailhead in the Snoqualmie Pass recreation area they see a set of new public avalanche awareness signs. There were two different signs designed and tested in this project. Both signs are entirely an optional information opportunity for the public. They do not restrict access to the wilderness or suggest any managed hazard reduction of the terrain. It gives the traveller an opportunity to consider their understanding of the hazard and seek additional information if necessary.

1.1 New Avalanche Awareness Signs

This new standalone sign is approximately 45cm x 60cm and attached to a single post at as many trailheads as possible. It highlights the dangers of avalanche terrain, providing information on

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how to check for current conditions and information concerning avalanche travel. It also adds awareness of resources (Northwest Avalanche Center hotline and website QR code) to increase their understanding and gain additional skills of traveling in avalanche terrain.

1.2 New Beacon Check Station

This new beacon check station and avalanche awareness education station is visibly labelled "Are You Beeping?". As they approach within 30 feet of the station a PIR motion detector senses the movement and activates the station from energy-saving sleep mode. The beacon checker visibly begins to flash a RED "X" drawing their attention to the station. Should they be wearing a transmitting avalanche beacon and are within 10 feet of the Beacon Checker, it will change from a RED "X" to a Green "O" and an audible beep will notify that their beacon is transmitting. Receiving the Green "Go" and drawn closer to the sign they proceed to read the awareness tips and enter the trailhead. All of the interactive and passive events are time stamped and logged for further analysis in a micro-controller located at the station. Weather sensors and trail beam sensors are also included in the data logging for further weather-to-traffic pattern analysis.

2. METHODS

A group of three ski patrol, SAR, and avalanche education volunteers (the authors) assembled in 2011 to begin collaboration on this project. Recent local events involving fatalities in the local backcountry raised concern over the lack of public education at the vast winter recreation are in the Mount Baker-Snoqualmie National Forest, Snoqualmie Pass, and Stevens Pass ski areas.

Creating a set of signs at backcountry trailheads in public spaces in the past proved virtually impossible due to one of two inhibiting factors. 1) Lack of funding by public, private, and non-profit agencies. 2) Way too many agencies to navigate for right-of-way, jurisdiction, or permission to install the signs.

2.1 Funding Model

Funding for the entire project was provided by the Ski Patrol Rescue Team (SPART); a 501(c)(3) non-profit organization and a unit of King Country Search and Rescue. SPART provided a grant to the project team for the pilot sign deployment as well as the first beacon check station for the initial pilot deployment. Further funding for the 2012-2013 winter season to build and install two or three more beacon check stations will be a combination of non-profit grants as well as a possible federal grant. Having a 501(c)(3) centralize funding helps to navigate the public-private funding limitations

2.2 Navigating the Agencies

In the Mount Baker-Snoqualmie National Forest there are many agencies operating and controlling policies and procedures for placing signage in their jurisdictions. For example many of the private ski areas operate in the National Forest on leases however provide avalanche control and gate access to the public lands from within their boundaries. Avalanche control is done by several agencies like the Department of Transportation (DOT) and ski area patrollers. Avalanche forecasts in the area are a collaboration of many agencies and local resources like the DOT, local ski patrols, National Weather Service, and the Northwest Avalanche Center (NWAC). Don't forget the Sheriff's Department who has jurisdiction for search and rescue outside of the established ski areas.

One unique characteristic with the project members (authors) are their membership in SPART (funding source and King County SAR members), and Cascade Backcountry Ski Patrol (CBSP). Most ski patrols are members of the National Ski Patrol and cover a unique private ski area however CBSP, works with the US Forest Service. Its hours logged in the National Forest provide grants to the local USFS Ranger districts. One of the duties of CBSP is to provide awareness in frequently-used backcountry areas and to provide trip reports to the USFS on how many persons were seen, interacted with, snow conditions, weather, etc. This close interaction with the local USFS ranger districts provided a unique opportunity. Could a new avalanche awareness plan with a combination of signs and beacon check stations be used to educate the public as they enter the wilderness? Could a beacon check station also provide telemetry and additional data to support the limited ski patrol resources in such a large coverage area?

Working collaboratively with the USFS Snoqualmie Ranger District, a design for both a set of temporary signs and a beacon check station pilot were approved and a special use permit was issued. Also, since two of the project members were also ski patrollers in the local ski areas, arrangements were made to place signs and the first beacon check station in an area bordering the private ski area.

The key enabling factor was the special use permit by the USFS and extensive effort was placed in a set of design documents describing the overall design, graphics, verbiage, placement, maintenance, removal, funding, security, and environmental impacts.

2.3 Pilot Testing of the Awareness Sign

After months of design and development and the special use permit was issued by the USFS, the signage pilot was put into action. The first phase was to deploy eight of the 45cm x 60cm Avalanche Awareness Signs to the high-traffic backcountry access points in the Snoqualmie Pass area. Trailhead locations were selected for their known winter travel traffic patterns, access into hazardous avalanche terrain, and historical avalanche related incidents. These were placed at public and USFS entrance areas and not in an established ski area. For example signs were placed at snow park entrances as well as across the street from the Alpental ski area. Notably, this area does not require a snopark permit to park, and thus, in addition to the usual crowd, can attract atypical backcountry skiers accessing the vast Snow Lake and Snoqualmie Mountain areas.

Figure 1. The new trailhead avalanche awareness sign design.

The original sign design was based on previous work from Bruce Tremper and Craig Gordon (Utah Avalanche Center) and their successful use of the "Know before you go" programs at trailhead access points in winter backcountry terrain. Working closely with Tremper, we were able to benefit from his design work on the sign and then update the content to our local area. The intended audience is the day-use traveller either needing to be reminded or informed for the first time what precautions to consider and resources are available concerning avalanche conditions.

Figure 2. The highly visible sign was placed at trailhead entrances around Snoqualmie Pass

2.4 Pilot Testing of the Beacon Check Station

The second phase was the installation of a Beacon Check Station. The new station design had a few goals. The first was to be highly visible and retain the "Are You Beeping?" tagline as well as common content with the other awareness signs placed in this project.
The second included a fully functional and self-powered avalanche beacon checkpoint built into the sign for testing of avalanche transceivers. Finally the third was to provide additional telemetry and statistics on the frequency of visitors at a trailhead that would be logged and later analysed.

Figure 3. The new beacon check station

As shown in *Figure 3* above, the beacon check station graphics incorporated the three main avalanche awareness points, red flag warning signs, and instructions for using the beacon checkpoint. The BCA Beacon Checker™ was selected as the initial transceiver check device. To maintain focus on the sign's awareness guidelines and checkpoint instructions, the beacon checker was inlaid in the sign. This

provided a simple, clean, and secure placement for the sensitive electronics.

All of the microelectronics, solar charge controller, and batteries were protected inside a NEMA-3R enclosure and sandwiched between two sheets of plywood and two cedar fence posts. The NEMA-3R enclosure was also inlaid in the rear plywood to reduce exposure to the weather and for extra security as seen in *Figure 4*. In the construction phase it was decided to keep it simple, secure, weatherproof, and portable. The first USFS special use permit only allowed for temporary placement so weight and portability were also a factor in the selection of materials.

Figure 4. Rear of the Beacon Check Station. The solar panel is mounted to the top of the structure and the beam sensor to the side post.

One initial design requirement was the ability to log both active beacon checks as well as the total number of persons passing the sign and a set of beam and motion sensors. It was also decided in the design phase that having weather telemetry along with a timestamp would add value to the data being recorded. As seen in *Figure 5* below, the sensors include an outdoor-rated security beam sensor, passive infrared motion sensor, temperature, and humidity sensors. It also included a simple solar charge controller rated 7A@12VDC, GPS tracking device for security, and a Zigbee 2.4GHz wireless radio for RS-232 mesh communications. The Zigbee radio could be used in the future for communications to other check stations in the area or transmission of data files to a central station.

The heart of the electronics is an Atmel ATMega328 Open Source micro-controller used to log the beacon checker events as well as the beam and motion sensor events. The beacon checker events and beam or motion events are referred to beacon and trail events respectively. For every event, both time/date and temperature/humidity are logged in a single entry to the on-board micro SD flash card for further removal and analysis. The schematic in *Figure 5* below shows the individual components.

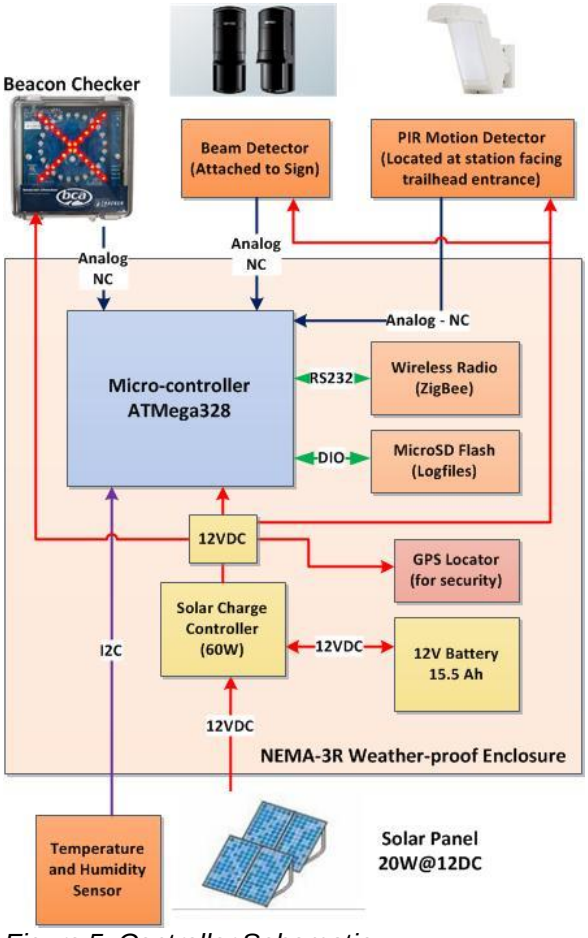

Figure 5. Controller Schematic

Each log entry for every event is appended to a single log file in tab-delimited format. Each entry indicated either a beacon check or trail sensor that was activated. *Figure 6* below shows two different test entries. The first as a skier approaches the sign and triggers the motion sensor. The second is the beacon checker detecting a transmitting avalanche beacon. Finally, the third entry shows the beam sensor being triggered as the skier continues up the trail.

2012/4/22	9:11:55	Trail	79.00%	7.30C
2012/4/22	9:12:35	Beacon	79.70%	7.40C
2012/4/22	9:13:32	Trail	79.00%	7.30C

Figure 6. Log entry format

3. RESULTS AND DISCUSSION

3.1 Overall Sign Feedback

The feedback from persons entering and exiting the trailheads as the individual awareness signs and beacon check station were being installed was very positive. The common response was a "Thank you" from the obvious experienced backcountry travellers to curiosity from the un-experienced to awareness of the dangers due to the recent press coverage of local avalanche fatalities. The beacon check station received immediate press coverage with TV news coverage within 48 hours; directly linking the installation as a response to the recent avalanche events.

3.2 Awareness Sign Performance

The new avalanche awareness signs performed well as a temporary sign. They were attached to 2 meter rough-cut cedar fence posts and placed in the snow. They could not be permanently attached due to the use-permit limitations. However they performed well. As they were installed late in the spring with a rapidly melting snowpack, it was made a priority for at least one patrol member from CBSP to check every sign at least once a week. Also, as the snowpack melted and trails or trail entrances changed, the signs were also moved so they were always in view of the entering backcountry recreationalists. It was also observed that some signs could be permanently affixed to a USFS sign board or trailhead information station should they not be normally covered by the snowpack. Additional considerations to the placement, maintenance, and permit requirements will be evaluated for the 2012-2013 winter season.

3.3 Beacon Check Station Performance

The beacon check station exceeded expectations of performance in several ways. All components in the system performed as expected and during the four week test no components failed or were damaged. The overall power draw from the electrical loads were well under the expected storage and solar generation calculations. The 20 watt solar panel kept the 15.5Ah 12VDC lead-acid batteries fully charged. The output voltage available to the components was also logged and never dropped below 11.5VDC and was well within the operating voltage of the loads. After the end of the pilot and when the sign was removed an inspection also found no water intrusion or weather damage to components.

Maintenance was performed at least once or twice a week by the authors. One key observation during the maintenance interval was the need to either move or realign the sign to an upright position. Due to the rapidly melting snowpack, the sign had to be adjusted every few days. It was also noticed that due to the amount of weight on the upper portion of the sign, it tended to lean quickly if not monitored. Considerations for both additional bracing and an adjustable permanent structure are being discussed. A design is being submitted to the USFS as an exception to the temporary placement requirement in the use-permit. The design will include a method to quickly raise and lower the structure to accommodate fluctuating snowpack depths during the winter season.

The beam sensor contained two components. The first was the receiver which was mounted on the side of the actual beacon check station post and connected to the micro-controller. The other side was the transmitter. It was mounted to a separate post at the other side of the trail entrance and powered by a battery and small solar panel on the remote post as seen in Figure 6. Due to the changing snowpack and the station constantly moving the beam sensors had to also be realigned. This might be resolved again by a permanent structure or bracing with trees or other fixed objects. This misalignment of the beam sensor also provided false readings as the sensors moved out of alignment or no readings at all. In *Figure 7* below is the beam transmitter. *Figure 8* shows the beacon check station placement with the beam sensor mounted directly to the left post.

Figure 7. Remote beam transmitter

Figure 8. Final check station placement in a snow bank.

3.4 Data Analysis

At the end of the pilot period the Micro SD flash memory card was removed from the controller for data analysis. Since the beam sensor constantly was out of alignment and was providing several false records, that data was rejected from our analysis. In the first few days of use or after the sign and the beams were realigned, some useful data did show a percentage of beam events were not correlated to a beacon event. Once the beam sensors can provide reliable data, we can then abstract the ratio of trail beam events with and without beacon check events. This may be very useful for calculating a percentage of trail users wearing an avalanche beacon.

Date	Time	Humidity	Temp C
Sunday, April 29, 2012	7:55:13 AM	99.90%	3.20
Sunday, April 29, 2012	8:42:52 AM	99.90%	4.00
Sunday, April 29, 2012	8:54:40 AM	94.60%	6.10
Sunday, April 29, 2012	8:55:04 AM	93.90%	6.00
Sunday, April 29, 2012	8:55:22 AM	93.50%	6.00
Sunday, April 29, 2012	9:32:57 AM	93.90%	6.30
Sunday, April 29, 2012	9:33:00 AM	93.90%	6.30
Sunday, April 29, 2012	9:33:08 AM	93.70%	6.20
Sunday, April 29, 2012	9:33:17 AM	93.90%	6.30
Sunday, April 29, 2012	9:33:57 AM	94.30%	6.30
Sunday, April 29, 2012	11:56:37 AM	81.40%	8.20
Sunday, April 29, 2012	12:01:16 PM	81.50%	7.80
Sunday, April 29, 2012	12:02:22 PM	81.70%	7.80
Sunday, April 29, 2012	12:02:32 PM	82.00%	7.80
Sunday, April 29, 2012	12:28:16 PM	82.90%	6.70
Sunday, April 29, 2012	2:31:51 PM	78.50%	9.30
Sunday, April 29, 2012	3:38:44 PM	76.60%	9.20
Sunday, April 29, 2012	4:20:14 PM	81.30%	7.30

Figure 9. Data for a sunny spring ski day. Some of the events could be grouped as they are within a few seconds of each other.

After removing the beam sensor events the following were the findings. *Figure 9* shows one of the busiest days in the record set. As seen by the temperature and the historical weather for that day it happened to be a very busy and sunny day for persons carrying beacons. The beacon events can be grouped as the records

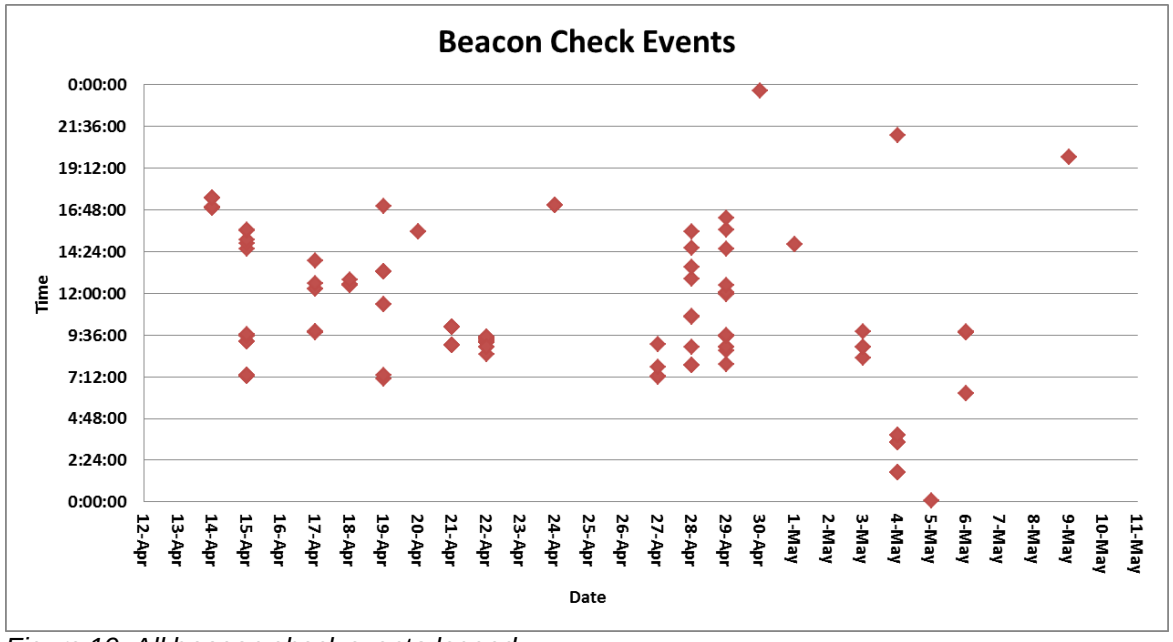

Figure 10. All beacon check events logged

show several beacon events in a span of one to three minutes. This could be a single beacon testing their transceiver or a group of several persons passing within a short distance of each other. It was observed during routine maintenance a person or group checking their gear while reading the sign and the beacon checker activating as the user transitioned their beacon from transmit to search as a test. This and many other behaviours could explain the multiple events in a short span of time. It was also observed the typical usage of 7am to 7pm as seen in *Figure 10* above.

Over the four week test, 172 beacon checks were captured and when grouped in three minute intervals there were over 70 different instances where a person or group passed in front of the station with a working avalanche beacon.

Total Beacon Events	172
Total Grouped Events < 3 min. apart	70
Average Temperature	7.26
Average Humidity	73.89%

Figure 11. Summary of records

4. CONCLUSIONS

A particular challenge in the central Washington Cascades is the easy of trailheads by interstate (e.g. I-90 and US Highway 2). Further, many winter trailheads double as popular summer recreation points, and allowing easy access to the members of the general public who may have little or no knowledge that they may be entering backcountry areas prone to avalanche danger. This is a particular challenge in late spring and early summer when the naïve hiker may not recognize the dangers of warm temperatures and a lingering snow pack (or even late-season storms).

The results of the pilot show that both a simple yet effective avalanche awareness signage system can be supported by multiple agencies in many locations. It also supports the notion that with a little technology, additional data and tools can be added to assist the limited patrol resources. With the increase in backcountry recreation and avalanche fatalities on the rise, providing additional statistics will help drive both public and private funding for additional resources. While the pilot was only the first phase, the project team is excited for the 2012-2013 winter season where additional signs and beacon check stations will be installed. Once the accuracy of the trail sensors can be resolved, an additional set of data can be analysed to calculate the ratio of those with and without an avalanche beacon.

5. ACKNOWLEDGEMENTS

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4 REFERENCES

Gordon, Craig, 2006, Know Before You Go Program, International Snow Science Workshop, 2006

Tremper, Bruce, 2000, Avalanche Preparations for the 2002 Olympic Games, International Snow Science Workshop, 2000: 587-591

Tremper, Bruce, 2006, Graphic Avalanche Information For The New Media, International Snow Science Workshop, 2006: 507

Clayton, Mary, 2008, Making the News, International Snow Science Workshop, 2008

BCA, 2010, Are you beeping? BCA Beacon Checkers popping up at backcountry trailheads, 2010, Retrieved from http://backcountryaccess.com

TGR, 2011, Avalanche Transceiver Checkpoints Gain Traction, 2010, Retrieved from http://tetongravity.com

TGR, 2011, Avy Beacon Checkpoint Program Launches In Tetons, 2010, Retrieved from http://tetongravity.com