HIGHLAND BOWL – A SKI AREA EXPANSION

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1. INTRODUCTION

The Highland Bowl is a large area which rises above the current lift structures south of the Aspen Highlands Ski Area and has recently been opened to resort skiers for the first time in history. This will be a simple article describing the history behind this opportunity and some of the techniques we have used to tackle some unique challenges.

2. THE AREA

Highland Bowl is an approximately 49 hectares (120 acre) bowl with aspects ranging from due south to due north. In our radiation climate, this causes widely varying snow conditions all within the same runout. The center axis of the bowl is easterly which generally puts it on the leeward side of our prevailing wind. It is has sustained, very steep pitches although virtually no cliffs with average pitches in the high 30 and low 40 degree range and maximum vertical fall of the starting zones around 366 meters (1200 feet) More than 98% of the bowl is skiable by 'average' expert skiers. There is little tree cover in the central portions of the bowl which, along with complicating control routes, makes skiing during low visibility very difficult. Most of the area is quite convex, not reaching its maximum steepness until the middle third of the pitch. The wind affect in this very exposed bowl is mitigated by the knife ridge that forms the rim of the bowl. Snow transported from the west side is launched far above the slope where there is ample room for sublimation. Wind deposition is mostly limited to very near ridgeline during blows from the west. Storms with very southern or very northerly wind components bypass the knife edge and create cross loaded pockets over the entire length of the slope. These storms are by far the worst for ski quality and the most difficult from an avalanche control perspective.

The snowpack in our region is classically continental. Generally cold temperatures, relatively small snowfalls and cold clear nights put us at the epicenter of Kinetic Metamorphism. Weaknesses formed in the early winter can persist through the entire winter. Addressing these persistent weak layers is the most important part of a snow safety program in this climate.

3. HISTORY

1970's and before ---

As far back as the mining days in Aspen, there are stories (and even 1 photo) of people skiing in Highland Bowl. After the development of the ski area in the 60's, it was technically closed. Of course, the counterculture ruled at that point and these rules were frequently flaunted. One classic description of avalanche experience occurred in Highland Bowl and was recorded by Flannigan in Snowy Torrents.

Early 80's

The Aspen Highlands Ski Corp (different than Aspen Skiing Company) began offering hiking tours into the bowl for powder skiing. These were moderately successful and involved trips to the generally less extreme north aspects where there is far more timber. The control plan was mostly timing and avoidance. In 83-84, a helicopter was used to remove the 'hiking' part of the experience. It was at the end of this season when three patrollers went on an explosive control route testing stability in a wide open area called G-8 which had not been skied as part of the tours. They were doing this to provide a venue for a powder 8 competition during the upcoming State Ski Patrol Convention. In hindsight of course, they used poor judgment selecting a 'safe' spot and all three were killed in a resulting explosive triggered slide. Details of the accident are also available in Snowy Torrents.

Late 80's and early 90's

After the accident, the Bowl was literally 'locked down'. Except for a few local skiers who would ski during good stability to avoid death and at dawn to avoid arrest and prosecution, nobody ventured into the bowl. The little control work performed was all by tray shots lowered from the safety of the ridge. The nature of the continental snowpack was that these missions were almost always successful and yielded some great video and still photos.

1994 – Present

In 1994, The Aspen Skiing Company purchased the Aspen Highlands Mountain and thus became the only ski area operator in the local area. Special interest was taken in the prospects of offering skiing in the Highland Bowl and so a team of ski patrollers were formed who were responsible for researching the area from a snow safety perspective. At the same time, an Environmental Impact Statement was ongoing with Liam Fitzgerald creating the Avalanche Hazard part of the report.

Action

In 1997, the report was complete and it was decided by the Forest Service that lifts would not be allowed in Highland Bowl ('at this time'). It was decided that beginning operations by opening only small chunks of the Bowl would allow for slowly proving control techniques. The south aspect closer to the ski area was the convenient place to begin. The first skiing opened in the 1997 – 1998 season.

Because Highland Bowl is a giant bowl with all slide paths eventually combining into 1 large runout, this solution presented some huge challenges. Mostly the worry was that persistent weaknesses, ever prevalent in the un-skied areas, could be enticed to bring avalanches running into the area of the bowl where skiing was being provided. Obviously, extensive explosive testing and an intimate knowledge of the snow structure were keys in operating this safely.

Over the following 5 years, a little bit more terrain was added each year. This technique gave us time to become institutionally familiar with the details of the terrain. Control teams did not get confronted with a first year challenge of control routes into the middle of the bowl. This also enabled us to more slowly develop the control plan through an evolutionary process rather than devising it all with little field knowledge of the area.

The Plan

The first part of the plan involves dealing with early season snows that normally progresses into depth hoar causing worry throughout the year. This is done through an aggressive compaction program. All areas of Highland Bowl are foot compacted during November and early December. In the 2003-2004 season, 2700 man hours were spent boot packing in Highland Bowl. 1500 of these hours were paid professional patrollers while 1200 were volunteers trading ski passes for hours.

Packing in an area with this vertical exposure has required us to devise some new techniques. After an incident in which several members of the packing squad took a group ride over 800 vertical feet in a microscopic avalanche, we were forced to look at the safety of packing operations. Out of that discussion, we developed a belay system which all packers use when descending in unpacked snow. A system of cables has been mounted into concrete foundations around the rim of the bowl. Ropes are clipped into these and laid out by 'advance teams'. Simple Petzl shunts provide protection against falls or avalanches. All packing in Highland Bowl is done vertically which means that packers descend in unpacked snow on the rope system and then return uphill on common trails broken in already packed areas.

Packing teams are continually reminded that we must always disturb all areas of snow to the ground, leaving no layers undisturbed. Those areas which cannot be penetrated are marked with chalk and we return later to Bigfoot.

"Bigfooting" is our vernacular for using explosives to disturb otherwise impenetrable areas. After a week of packing in clear weather, the Bowl can begin to take on the look of a war zone with pentolyte black marks scattered throughout. It seems the only way to ensure that all potential weak layers are disturbed, even if they are topped with hard wind slab.

We are obsessed with disturbing each and every layer of snow as it falls to reduce the chances of weak layers being buried. When storms pass through prior to the ski area being open, we institute a popular program called the Powder Posse. Local skiers with beacons are invited to ski those areas which have been boot packed and now have fresh snow. Careful co-ordination of the groups can force them to leave each area 'tracked out.' This means to us that it is no longer powder skiing but has progressed to 'crud' This is a subjective point where we feel the snow is disturbed enough that it will likely not be able to act as a weak layer. By continuing this process through every single weather event, we hope to build a snowpack which is free of undisturbed layers.

The ease of digital photography allows us to photograph the snow surface during all phases of the year and thus provide a primitive narrative of how each layer is disturbed. Throughout the year, continual disturbance of every storm layer results in what has thus far always appeared to be a snow pack with good stability. This is nothing new, every ski area has areas which were frequent performers until they were opened, and now they can't buy an avalanche. Because of the scale and scope of the Bowl, we continue to worry about deep slab possibilities and the affects of compaction.

4. DURING THE SEASON

Highlands opens later than the other mountains in the Aspen Snowmass complex, normally about 2 weeks before Christmas. Once we are open, the active control plan takes over. In one sentence, the control plan is this. Test the snow, and then get skiers on it.

During storm periods, an avalauncher is the first round explosive testing device. During large storms, up to 36 rounds per day can be sent into the various areas of Highland Bowl. The avalauncher is especially useful for testing those areas of maximum steepness below the convex rolls that make up the center portions of the bowl.

The next stage is to send out explosive carrying teams who hand charge from the ridgeline. These teams are mostly hunting for wind slab deposited near ridgeline and dealing with cornice removal.

The final stage, assuming good stability has been observed thus far is to send ski cutting teams out. Ski cutting begins on the lower elevation (and lower exposure) slopes and progress upwards. Good communication among the control teams lets each subsequent team know what to expect.

Avalanche control teams face lots of challenges in the sometimes harsh environment above timberline. When trail breaking is required, the teams will face hiking times of up to 1 hour to reach their zones.

The control routes in the center of the bowl are quite exposed. While ski triggered size 1 events are quite common during routes, we have yet to see ski triggered slides of a magnitude to endanger the teams.

The lack of tree cover is another real issue in the control team's work. Firstly, there is little good timber which can be regarded as 'safe.' Control teams have to make time specific decisions about the balance between their own safety and a good spotting location for their partners' safety. Sometimes, an appropriate spotting location may be threatened from above by a highly unlikely climax deep slab yet allow good visibility of a team member under real threat of getting caught in a size 2 new snow slide. Other times, spotting may happen all from a remote spotter with communication happening via radio.

Low visibility is another challenge presented by the lack of tree cover. Excellent terrain familiarity and frequent voice and radio communication can keep these situations manageable albeit nerve-racking.

5. SEQUENTIAL OPENINGS

After control work is complete in the Bowl, we rarely open the entire area at once. Instead, we maintain rope lines which segment the Bowl into 5 distinct areas. The areas closest to the lift structure are opened first. We ensure that each area is completely tracked up before we open the next area. The main reason for this is that in general, the best skiing is in the upper reaches of the bowl and the crowds would never ski the lower slopes, thus robbing them of important compaction. By extending a powder day over the course of a day and often into the next day, we ensure quality compaction in all areas. Our skiing community has understood this policy, even taking it upon themselves to enforce it with less knowledgeable visitors.

6. SNOW PROFILES AND TESTS

The efficacy of snow profiles and stability tests on skier compacted slopes is questionable. Snow profiles are difficult to interpret in areas where many storm layers are mixed together. Large weather periods are usually noticeable, but many smaller ones are destroyed by a multitude of ski tracks.

The large number of stability tests performed over the last several years has always yielded limited information. Generally results are CT above 20 with Q scores almost always 3. Rutschblock scores have generally been 6 or above. We have, over the past 5 years, rarely seen any snow profile data which leads to a conclusion of poor stability of a deep slab nature.

A few pits have indicated instability. These areas were tested with unusually large explosives to remove any doubt. These tests have always turned up producing no avalanching, making us long for more data about interpreting these tests in compacted areas.

Deep slab avalanching, involving more than fresh surface snow, is a primary concern. New snow avalanching can certainly present hazards to teams and the public but it is deep slab that has the potential kill or injure even skilled workers. This is why we continually focus on testing and trying to decipher what clues the snowpack holds that would allow us to forecast deep slab instability. Just to know that someday, a climactic deep slab will occur, is not enough. We need specific tools which would allow us to determine when and where. Is it possible that the primary predictor is recent weather? Certainly most incidents of compacted terrain avalanching have happened during very notable storm periods. Is that enough? Does that mean that deep slab avalanching will essentially be independent of snow stratigraphy? Or is it just that the overwhelming forces of large loads exploit weaknesses that cannot be detected with conventional stability tests? We don't

know but think that some more research into the predictive possibilities could certainly help our program. A much longer observation period will determine if the lack of indicators of instability via conventional stability tests are an indication of an especially stable 5 year period or if they are just not gleaning pertinent data.

The one similarity of almost every snow profile dug in Highland Bowl over the last 5 years has been unmistakable evidence of snow at the ground hardened by early fall boot tracks. The hardened snow is the shape and size of the original boot track and locating additional tracks only requires guessing at the spacing of the original tracks and expanding the hole. The snow in-between the tracks does not appear to be affected. (Without a 'control' area there is nothing to compare it to) This is quite interesting as it leads us to believe that the boot packing actually affects the metamorphic process in the depth hoar layer enough that 3 months later, the tracks are always recognizable. Density tests taken in the boot tracks compared with the surrounding snow are often denser on an average of 100 to 150 kg/m3. As spring approaches, this difference often begins to narrow as the surrounding depth hoar gains density.

Several times per season, especially as the depth of the snow cover gets large in the springtime, we put out very large explosive tests in areas that for some reason seem slightly suspect. Shots as large as 91kg ANFO (200 lbs), spread wide with det-cord have failed to cause any deep slab avalanching.

7. WET SLABS

In the spring of 2004, a ridiculously hot warm spell struck the state of Colorado. Temperatures stayed above freezing at night for something like 10 days. Anything that wasn't tied down slid. At the peak of the warm up, about 60% of our mountain was shut down. During this period, we saw our first widespread deep slab avalanching in Highland Bowl. The difference between wet and dry slab avalanching was very instructive here. Even though avalanches were triggering naturally and with explosives on the sunnier exposures, we still could not illicit avalanching on the more northern slopes of Highland Bowl. The northerly aspect stayed open for all but 2 days of the warm up. Wet conditions pillage the strength of the snowpack and result in vastly different conditions than there would be if the same snow were left cold. Wet slab avalanches have different predictive factors and should be discussed in different context than forecasting dry deep slab events.

8. RESULTS

Highland Bowl has been a very successful addition to our ski area. Before we opened it, even those of us pushing the project questioned how many people could or would ski this new 'extreme' terrain. The results showed my pessimistic nature because skiers of all shaped and sizes began to love the skiing. Due to the lack of cliffs, and with wide open slopes and fantastic snow conditions, it has become the most talked about area in the local area. More than a few advanced intermediates have somehow managed to get themselves down. The hiking access was, at the beginning, a very big negative. We wondered how many people would make the hike that is 25 minutes even for a very fit person. It turns out that the hike becomes the best part of the trip for some; it becomes their own personal Everest. The smiles and successful feelings at the summit are often even better than those on the traverse leaving the Bowl.

From a snow safety perspective, 5 years is nothing. We certainly cannot claim that anything is solved. We have, however evolved a program that has been able to deal with the things Mother Nature has thrown us over the last 5 winters. It is always possible (or even probable) that there will be a condition or series of conditions that could leave us having to close Highland Bowl for an entire season. The ski area management is well aware of that. In the years and winters ahead, it is my hope that this program can continue to confront whatever challenges get tossed our way and that we remain ever vigilant.