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A New View on Ski Maps

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Document Type

Masters Capstone Project

Degree Name

M.S. in Geographic Information Science

Department

Geography

Keywords

Ski area map, Traditional topographic map, Ski runs, Elevation contours, Shaded topography, Skiers, Snowborders navigation

Subject Categories

Geographic Information Sciences | Geography | Physical and Environmental Geography | Social and Behavioral Sciences

Comments

Publication Statement

A New View on Ski Maps

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for

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Abstract

Traditional ski area trail maps have remained mostly unchanged for many decades. Since the earliest maps were produced, they have shown picturesque panoramic views of the ski mountain nestled in with its the surrounding peaks. Trees individually painted on the slopes, pristine and snow-covered, the runs marked as a winter wonderland. These maps are each an individual work of art, painstakingly created by skilled artists but they are not quality maps. This project will present a new view on the ski area map, creating a more traditional topographic map depicting ski runs, elevation contours, and shaded topography. The project will also examine the potential for moving the new map into a mobile app to better help skiers and snowboarders navigate.

Table of Contents

List of Figures

Introduction

From the perspective of a vacationing skier or snowboarder, one who is not familiar with a particular ski area or the mountain on which it sits, the trail map available from the resort is likely your only way to get around the mountain. Having reached the top of a lift and beginning your day on the slopes, careful planning must be applied to ensure you end up not only where you want to (i.e. the base of another lift to get further up the mountain, or the mid-mountain lodge to meet family for lunch) but also via the path you'd like to take. Certain skiers would like to avoid terrain any steeper than "Easy", or green runs, while others would like to take the most direct route, regardless of difficulty, and preferably avoiding the pesky "Slow Zones". All this planning is normally accomplished with the use of the ski area-provided folding map, which after taking off a glove and removing it from your pocket presents a beautiful painting of the ski area mountain, nestled amongst the peaks of its particular mountain range, with a veritable beehive of activity in the form of trail routes, lodges, and chairlifts.

Finding where you are requires that you know where you came from (a particular lift or chair), or knowing what you're standing next to (a specific lodge or lift), and at some resorts knowing which side of the mountain you're on. Route planning requires knowing where you want to get, and being able to connect the wavy lines in between, and may entail several flips of the map since most ski area maps are now presented on both sides of the

paper, with detail for the backside of the mountain on a different page than the front of the mountain where you've assessed your present location to be.

Google added ski area trails to their GoogleMaps application in early February 2013. Google's new presentation left much to be desired though, in a void between the current printed maps and the electronic presentation found in their application. The Google presentation does a good job of presenting the trail routes as lines colored per the normal ski run convention of green, blue, and black though confusion can arise in the particular baselayer with which the Google map is viewed. As seen in Fig. 1, the satellite imagery baselayer is most often from summer months, when there's no snow on the mountains and it's difficult to discern specific trails from access roads. The satellite imagery also does not present topography, making it difficult for a visitor to assess the steepness of a trail before embarking on it. Switching to the terrain base layer in Fig. 2, the maps better present the topography, with the addition of a hillshade and contour lines, but the trail lines now become multi-colored "spaghetti" set on a shaded green background. Discerning the width of a trail and whether it is gladed or not is now difficult, requiring swapping between the different base layers to get a sense of what the trail in front of you would entail. If the user is trying to go from end to end on the mountain, zooming out enough to see the entire resort footprint removes the trail lines and even the lift routes from the map, leaving only the mountain roads (see Fig. 3). The

roads also contribute to the cluttered appearance at any zoom level, as many of them underlay a named ski run or catwalk.
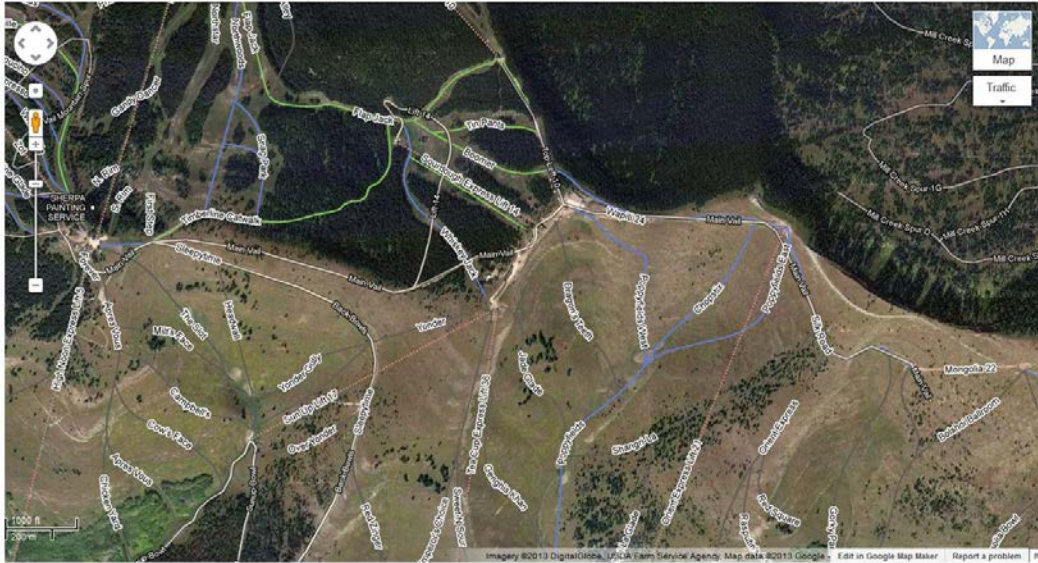

Figure 1.
GoogleMaps Summer Imagery

Figure 2.
GoogleMaps Terrain Baselayer

Figure 3.
GoogleMaps Zoomed to Entire Resort

In the void between the current panoramic printed maps and the cluttered mess of Google Maps, there's much opportunity for cartographic experimentation to create a user-friendly product. This project will create a user-friendly map, allowing the skier or snowboarder to see the entire mountain on one side of the paper, while still being useful for route planning and wayfinding. The project will initially create a new layout for printed paper maps, and will explore the potential for electronic applications for use on mobile smartphones while on the mountain.

Literature Review

Ski area maps dating back to the very first maps at almost every ski area depict the mountain in a panoramic view, usually from a viewpoint

across the valley (or fictionally across the valley) looking back towards the mountain on which the resort sits (skimap.org). Other peaks and valleys are seen in the background, presenting a picturesque view of the entire resort, from peak to village, as it sits amongst the pristine alpine surroundings. The trees often have a thick dusting of snow on them, the sky is always clear blue without a cloud in sight, and the lines representing trails and lifts make the mountain look like a beehive of activity concentrated along the openings in the forest.

Presumably the first ski maps were published and distributed in this format to aid in promoting a mountain vacation. A traditional map with lines and topography wouldn't have been enough to convince the family of the late sixties to pack up the car and drive to Colorado for a week of skiing, but a panoramic image of the mountain, from top to bottom, and the quaint village below, was plenty to encourage patronage. As skiing in North America has grown, so has the need to map the ever expanding resorts and present ever-greater marketing materials to attract customers. (Tait, 2008).

Maps have always had a variety of ways to present their information, but in the realm of ski maps three views have stood out as the common practice among large ski areas; Planimeteric, panoramic, and profile. Out of 428 surveyed resorts though, 86% use the panoramic viewpoint while profile and planimetric are used by 8% and 6% respectively. Further analyzing the survey of ski maps, almost three quarters, 72%, were painted, while 20%

were illustrated, 6% were annotated photos, and only 3% were computer rendered (Tait, 2008).

While many of the artists who create the trail maps were cartographers before becoming ski map artists, a cartographic critique of a modern trail map reveals several flaws. For example, take the 2012-2013 Winter Trail Map of Vail Resort. Using a list of "Elements Every Map Should Have" found in the Harvard University GIS Manual to assess the cartographic elements, several basic flaws appear that would fail a basic cartography class. The maps (both front and back page) have no title, no scale bar (due to the panoramic presentation distorting proportions), no projection information, no north indication (despite being a non-standard south-facing view), and no data sources. The legends accurately present the entities described on the map, and the graphical hierarchy helps delineate the village and the non-skiable forest from designated runs and area boundaries.

Because of the perspective used, only one face of the resort can fit on the front side of the map, while the opposite face and the back peak are depicted on the back side of the map. The perspective also hides terrain changes, especially in an area like the Game Creek Bowl, which on the map appears to be just adjacent to the Eagles Nest lodge, when in reality it is behind and far below the lodge. A textual warning is required to warn visitors not to attempt to ski from the bottom of Game Creek to Eagle's Nest. The scales vary from front to back page of the map and some areas on

the mountain become relatively congested by trees, lifts, and trail lines, especially in the vicinity of mountain lodges. The picture-like presentation of the mountain vaguely presents the vertical elevation and terrain changes as the various runs cascade down the mountain, and the technique of generalizing trail lines is utilized to smooth them or make them appear more direct (Monmonier, 60-61) to be visually pleasing while in reality the trail is not nearly as direct nor are the intersections quite so perfect.

While these artistic panoramas of the ski areas were popular and essential marketing tools in the early days of commercial ski resorts, the general public, and especially the outdoorsy types likely to be frequenting a ski area, are much more map savvy. Every car has a built-in GPS navigation system and every visitor has their own smartphone map app that they use to navigate. People are used to planimetric maps, and can easily interpret topographic elevation contours. Through various computer mapping techniques presented in papers published by the International Cartographic Association's Commission on Mountain Cartography, a topographic map incorporating cartographic techniques to enhance terrain, hill-shading, and rock face representation, as well as generalized vegetation areas and accurate lifts, runs, and structures on the resort that is still useful, visually pleasing, and cartographically accurate can be produced. This relatively small-scale map will present the entire resort with a north up reference point, elevation contours, and all resort amenities, lifts, and runs.

Design and Implementation

The primary goal of this project is to create a valuable alternative to the present maps produced and distributed at major ski areas in North America. As such, the maps produced by this project take on a more traditional nadir viewpoint, with a north-up orientation. The maps will be created as though they are replacing the current paper map, and will be formatted to match the extent of the current paper map at their respective resorts. Other considerations taken into the map creation include the need to present the entire resort on one side of the page, so that needless map flipping is not required to facilitate easy on-mountain navigation. For the purposes of this project, Vail and Taos ski areas will be used. Vail presents a large, multi-faced area with many trails, lifts, and lodges. Taos presents a smaller area with primarily a single aspect face, but many runs on very steep terrain and fewer lifts and lodges.

DEMs and orthoimagery for each ski area were downloaded from the USGS National Map Viewer. Hillshading was added to the maps to enhance the visual perception of terrain and to aid the user in navigation and route planning, though with different techniques. While the commonly accepted hillshade presents light from a northwesterly direction (Loisios, 2007), in areas such as ski resorts with multiple aspects used for skiing (back bowls or

easterly facing slopes), the standard northwesterly hillshade leaves much of the resort in the shadows and hides defining terrain features.

Using techniques presented by Kennelly, multiple hillshades were overlaid on the Vail map, taking into account the aspect with which the majority of the front side of the mountain faces to present the terrain more accurately. Multiple angles and combinations of hillshades were attempted, but due to the front/back/front aspects of Vail (Front Side, Back Bowls, Blue Sky Basin), a combination of the traditional northwesterly (315 heading) and a 90-degree difference from the northeast (heading 045) were used to best present the topography of the area. See Figure 4 for hillshade variations applied to determine the best. All were completed with a 45 degree elevation azimuth for the light source and equally transparent over the rest of the map.

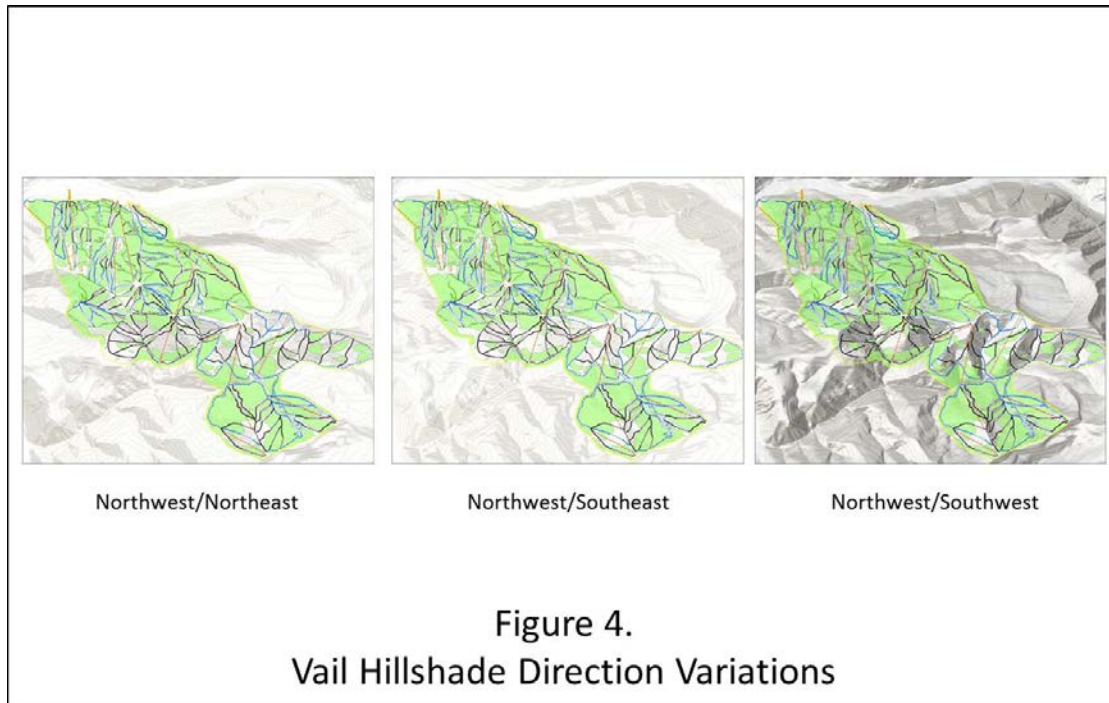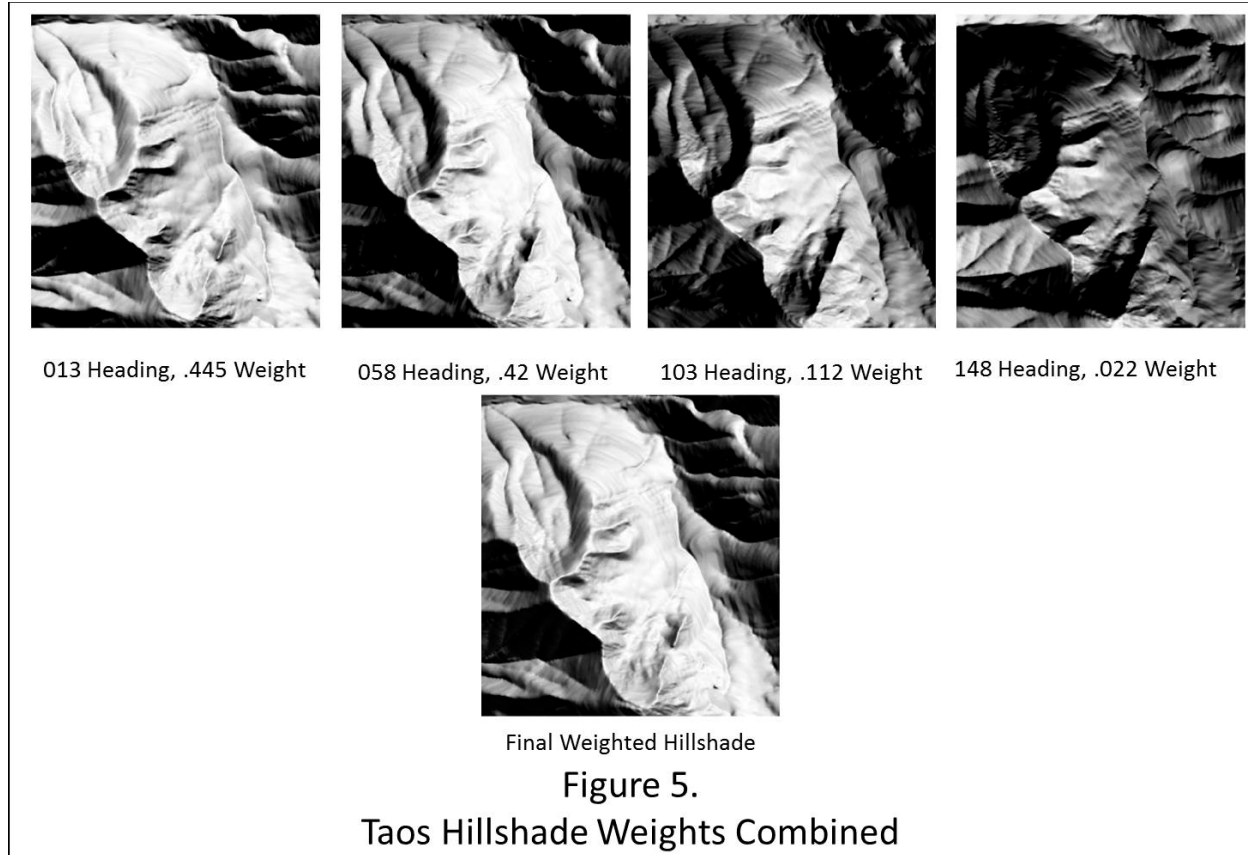Northwest/Northeast   Northwest/Southeast   Northwest/Southwest

Figure 4.
Vail Hillshade Direction Variations

For the Taos map, since the entire mountain faces primarily one direction, the weighting method presented by Loisios was applied to the hillshade. The aspects of the total map area were assessed and then split into four 45 degree increments on either side of the primary aspect (heading 058). The four increments were then weighted, by dividing the number of pixels in each increment by the sum of pixels in all four. Hillshades were created at each 45 degree increment, and then multiplied by their respective weights and summed using the map calculator. See Figure 5 for hillshade weights and combinations for Taos.

013 Heading, .445 Weight   058 Heading, .42 Weight   103 Heading, .112 Weight   148 Heading, .022 Weight

Final Weighted Hillshade

Figure 5.
Taos Hillshade Weights Combined

After creation, the hillshades were brightened and made slightly transparent to allow for topographic contour lines to show through beneath. The brightness and transparency levels applied to the hillshade would alone appear excessively light (See fig 6.) but when contours are added below, the lighting and transparency appear appropriate.

Figure 6.
Vail Hillshade Alone

Contours for the area were created and displayed at 50 foot intervals with 200 foot reference lines bolded. They were labeled to allow for vertical calculations, and in conjunction with the hillshades help depict the terrain a skier can expect to encounter on their planned route.

Ski runs were manually drawn onto the maps, using the source map from each resort and downloaded imagery from the USGS. Runs were smoothed using the Bezier Interpolation technique in ArcGIS's cartography toolkit. A challenge arose in attempting to label the runs not only with their names but also with the accepted conventional symbol for their difficulty (circle, square, diamond, or double diamond). This was overcome by applying the ASCI characters for the respective difficulty in front of the name in the attributes for each run. Runs now label with their name and difficulty

level present in the same place. Vegetation polygons were also created to help delineate areas that are gladed and to add perspective trail widths to the map to better inform the map user. The traditional panoramic paintings are better suited to present tree stand densities than are simple polygons (see fig. 7), but to the user trying to plan their ski route, their only practical concern is whether the run goes through trees or is wide open, and as such the mapped polygons of trees meets that need. Polygons representing ski area structures, such as lift houses and lodges, were also created based on imagery. Only structures pertinent to visitors on the mountain were added, leaving minor service facilities hidden in the trees off the map.

Trees Polygon   Trees Painting

Figure 7.
Trees Polygon vs Painting
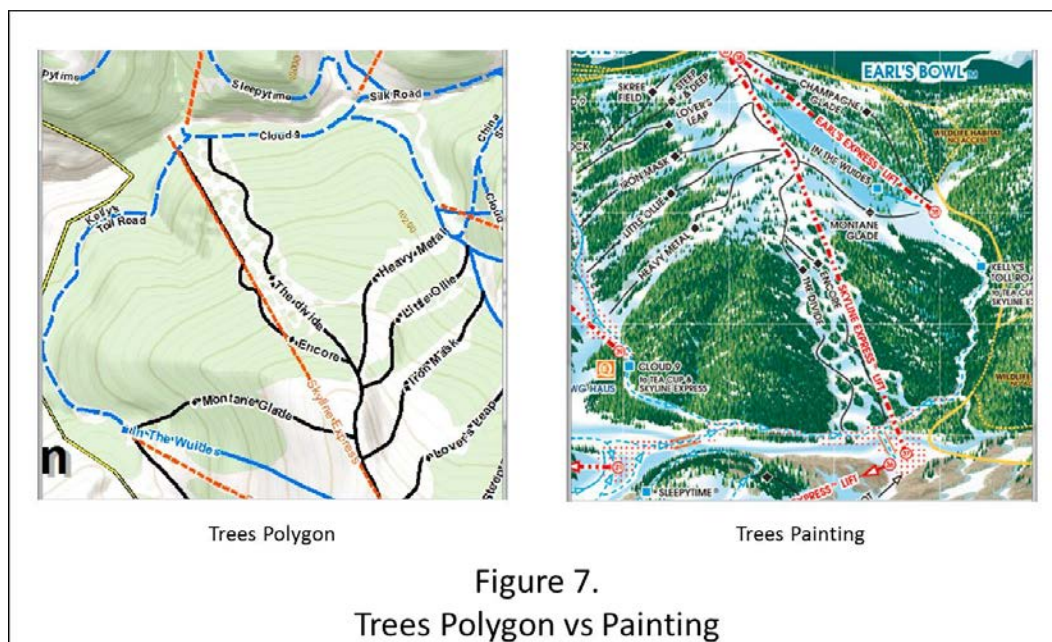
Ski area boundaries were drawn to enclose the ski area and delineate its border from the surrounding forest. All vegetation polygons were cut to show only inside the ski area boundary, to help show vegetation within the

ski area on runs, but also to better show topography for the visitors who enjoy departing the ski area boundaries (at their own risk of course). No readily available polygons existed to describe the actual ski area boundary, so the polygon is based on inferred boundaries from the published paper map and from backcountry gate locations.

Further cartographic refinement was applied, sizing the maps to fit within the current paper size used by the respective resorts, as well as adding a legend, scale bar, north arrow, and leaving excess room for the additional resort information that typically clutters the edges of a ski map. The topographic maps have also freed up the entire back side of the page, allowing more space for information or advertisements.

Results
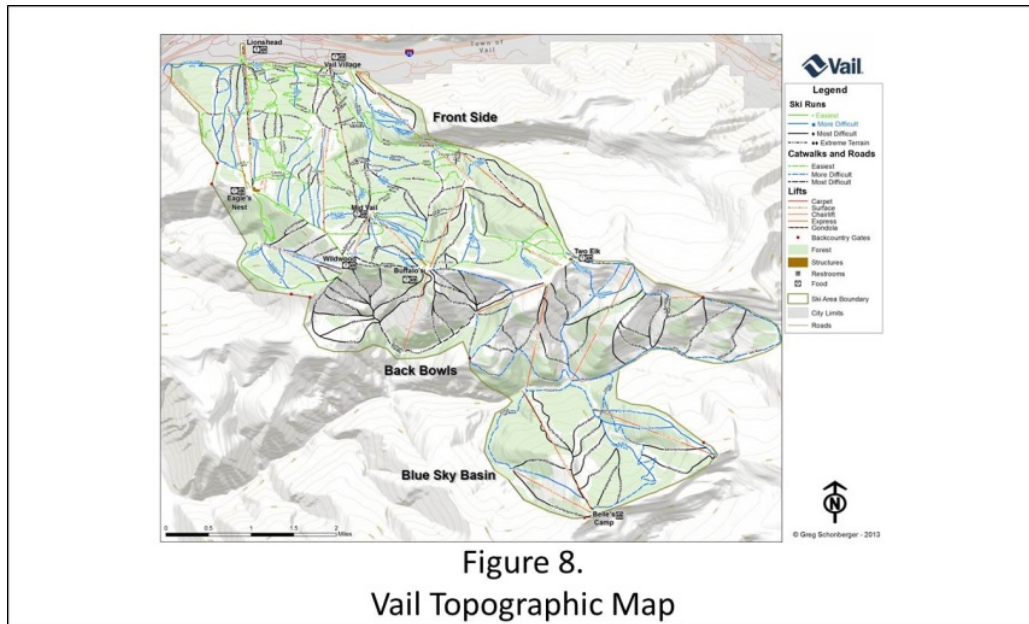
Initial comparison between the two maps for Vail is shown in figure 8 and for Taos in figure 10.

Figure 8.
Vail Frontside

Vail Back Bowls/Blue Sky

Figure 8.
Vail Topographic Map

 The topographic map of Vail generated from this project is able to present the entire ski resort on a single side of the page, while the printed map shows only the front side of the mountain on one page, and the Back Bowls and Blue Sky Basin on the back of the map. Also see in figure 7 an example of the problem created by using the panoramic presentation; certain areas such as Game Creek Bowl are not well presented on the panoramic map, whereas the steep walls and inability to ski/hike out of the bowl are made clearly evident on the topographic map (the panoramic map has to assert the warning with a large caption because it is so unapparent due to its perspective).
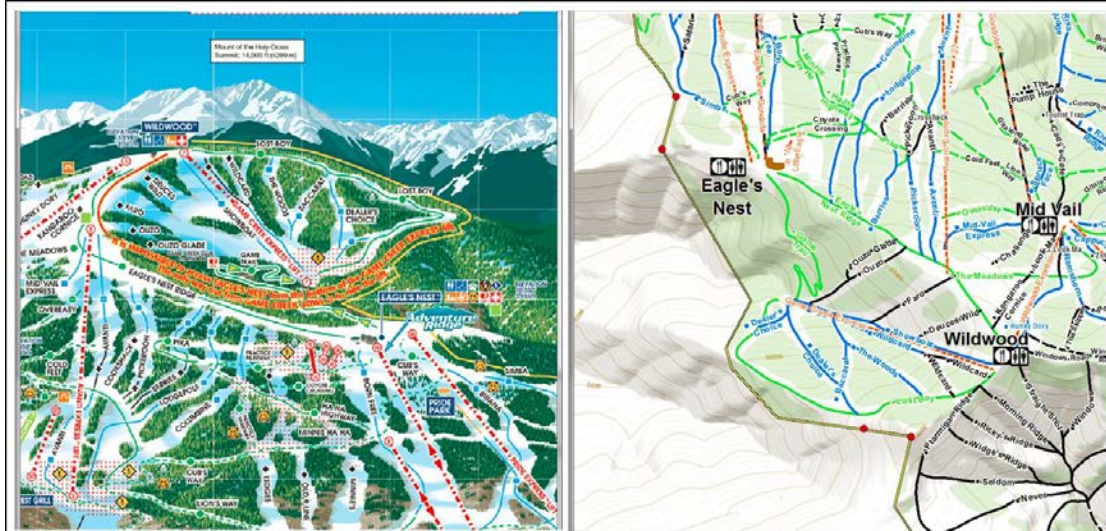
Figure 9.
Game Creek Painted vs Topographic

The scale of the map also played a factor in overall design. The resort's printed map is presented at a scale of approximately 1:22,500 for the front side, and approximately 1:24,000 for the back bowls and Blue Sky Basin. Due to the paper size requirement (20X14" for Vail), and the wide layout of the resort, the topographic map had to be presented at a scale of 1:27,000. Both are fairly similar in presentation size, though the topographic map allows the entire resort to be presented on one side of the page, leaving the back open for other objects or information.

The Taos resort map presents a smaller ski area with primarily a single aspect rather than multiple faces of a mountain. The printed map is presented at a scale of approximately 1:9,000, while the topographic map was able to fit onto the page at a scale of 1:10,000. The Taos panoramic map does not have separate front and back sides to the area, but does

feature two zoomed-in depictions of the Highline Ridge and Kachina Peak areas. These close-ups show a greater detail of all the runs that exist within the chutes of the mountain that aren't depicted on the primary front-side of the map. The topographic map is able to incorporate all these detailed runs on the primary map area and without the need for close-ups or multi-page maps. See Figure 10 for comparison of Taos panoramic and topographic maps.
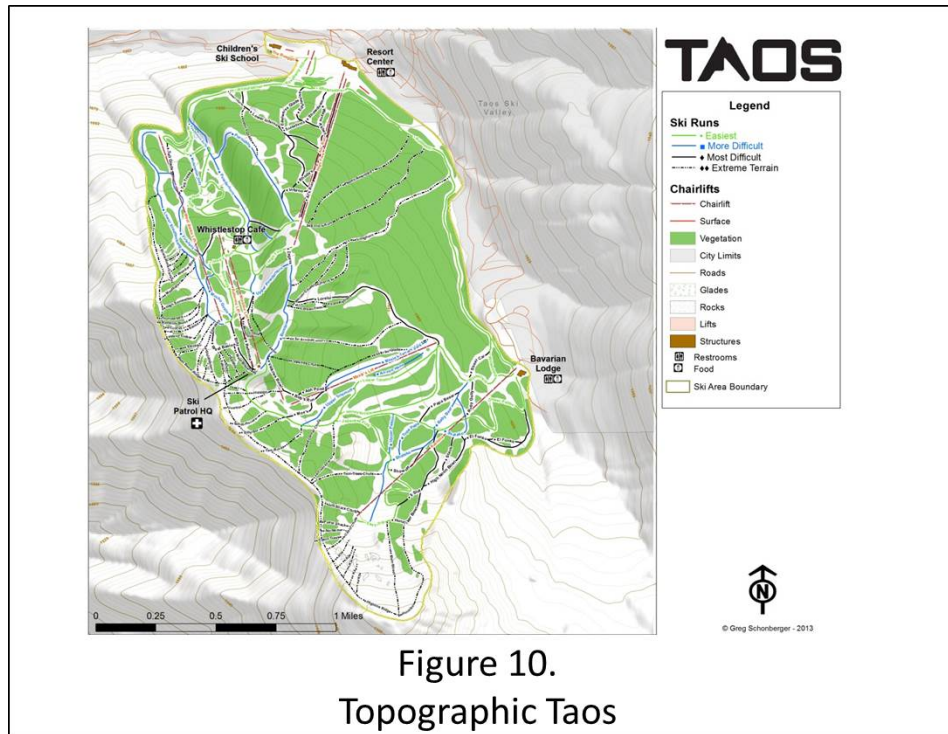

Figure 10.
Panoramic Taos

Figure 10.
Topographic Taos

The topographic maps created in this project were able to meet the original project intent. Within the confines of the current printed maps provided by the respective ski areas, the topographic maps were able to present the entire ski area, at very close to the same scale as the panoramic maps, on a single page, including all relevant data. Certain resort-specific details such as restaurant and attraction names were left off, as they added little to the value of the maps and are items that could be incorporated in greater detail either in the remaining sidebar area or the back side of the page.

Areas for Further Research

The initial test to assess if the project created useful maps would be to print and provide the maps to a focus group of skiers/snowboarders, of varying experience levels, for use during a day or weekend on the mountain. Feedback surveys conducted with the group would indicate areas potentially missed in the initial map creation, areas for improvement in design, or positive attributes of the new maps over the old panoramic ones.

Assuming acceptable topographic maps to replace the current panoramic maps were created, the useful intent of the project has been met. Paper maps are quickly becoming the way of the past though, especially for tech-savvy outdoor enthusiasts. Advances in mobile applications for smartphones and tablets have also accompanied progress in mobile mapping apps. Using open source programming tools for custom mapping applications, the maps created by this project can be incorporated as ~~baeslayers~~ base layers to a mobile map application, tailored with ski area-specific add-ins for resort visitors.

Such potential add-ins to the mobile application would include position tracking (past runs), total vertical elevation change, friend-finder options, and would provide resorts the ability to track data on where visitors ski/snowboard on the mountain. Such a program would be useful not only

to the resort visitor, but also to the resorts for marketing and improvement

planning.

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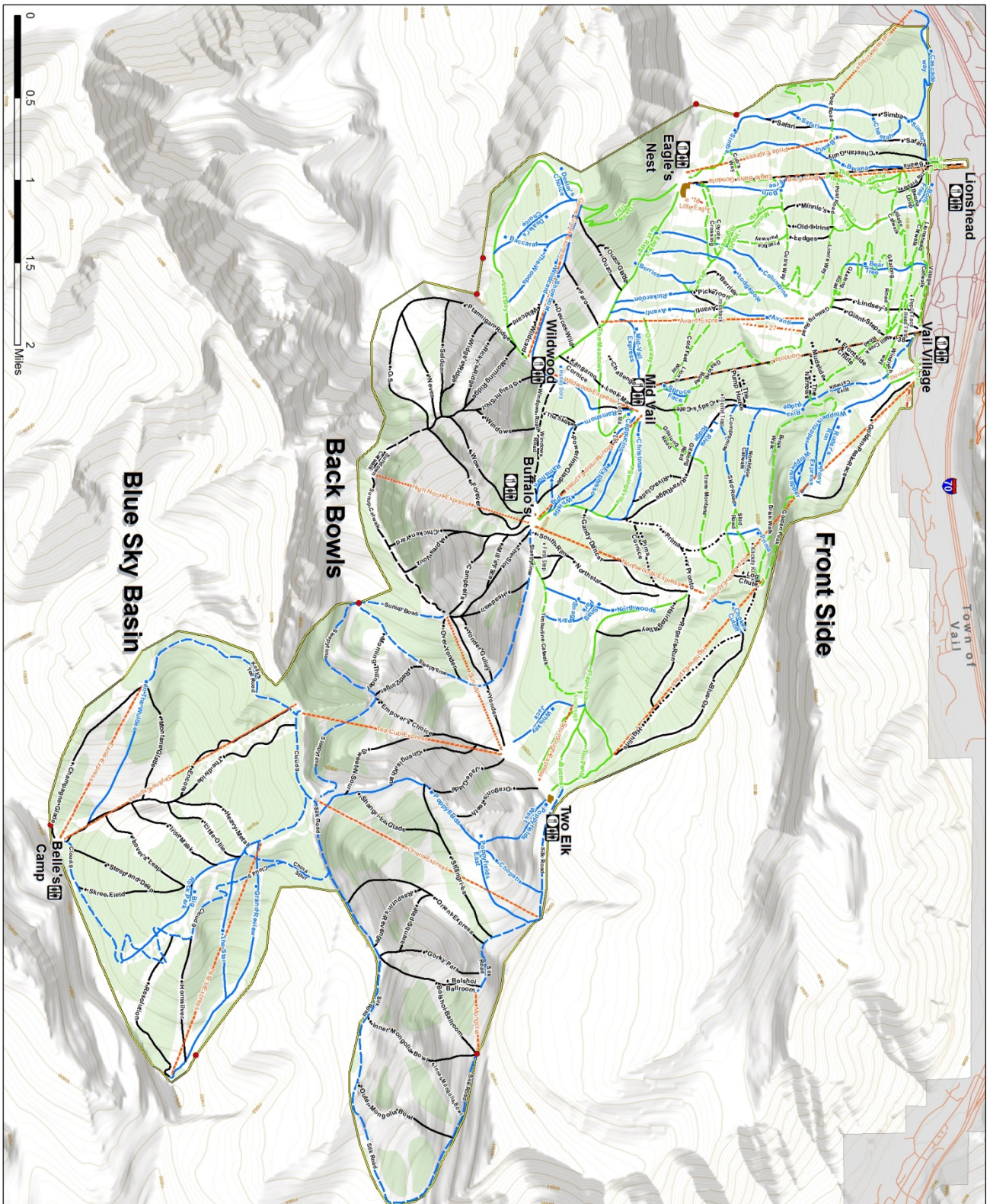"Skimap.org." Skimap.org. http://www.skimap.org (accessed April 9, 2013).

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Appendix A – Full-Size Vail Topographic Map

Blue Sky Basin

Back Bowls

Front Side

Eagle's Nest

Wildwood

Mid Vail

Buffalo's

Two Elk

Belle's Camp

Lionshead

Vail Village

Legend

Ski Runs
- Easiest
- More Difficult
- Most Difficult
- ◆ Extreme Terrain

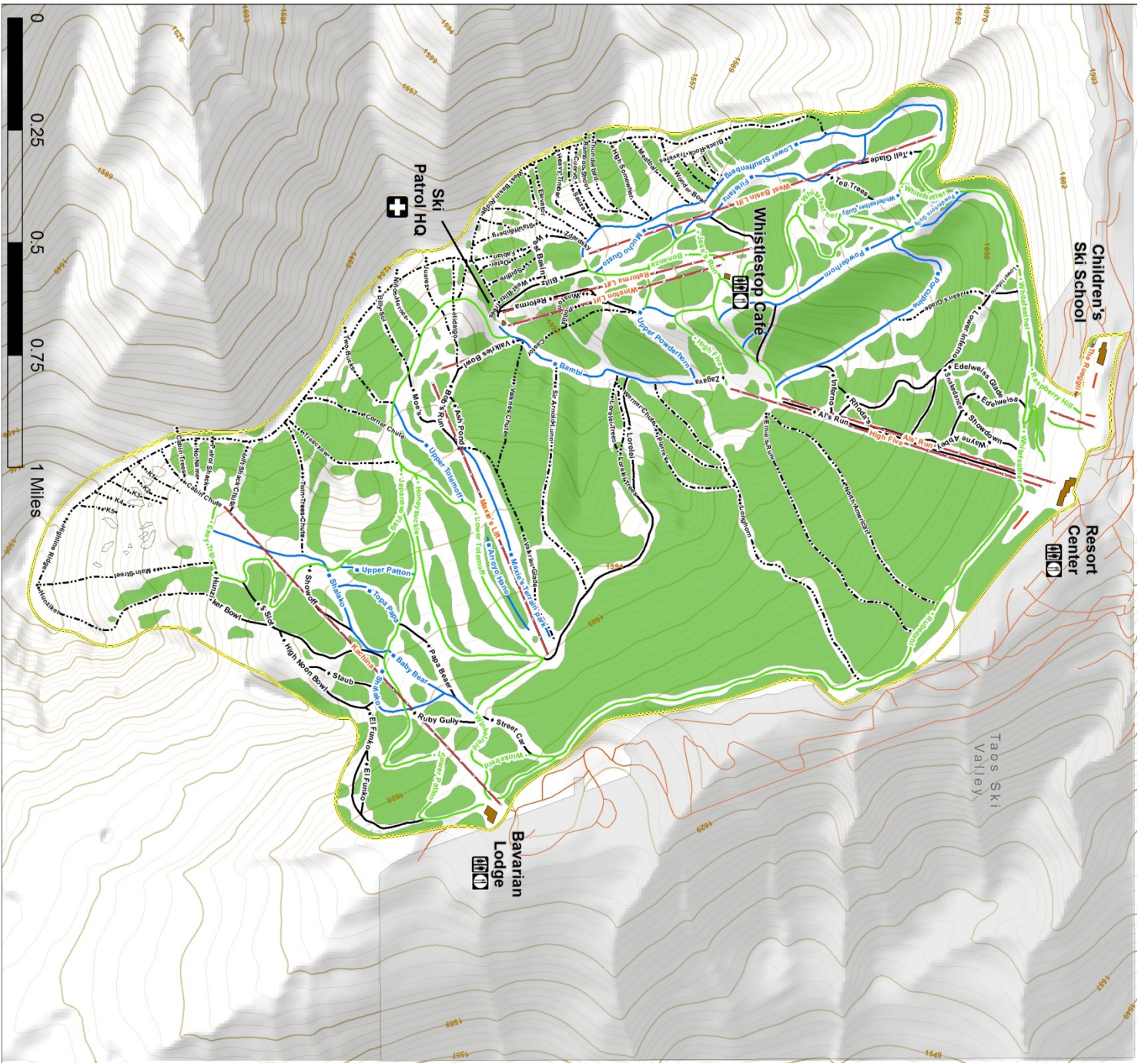**Catwalks and Roads**
- Easiest
- More Difficult
- Most Difficult

Lifts
- Carpet
- Surface
- Chairlift
- Express
- Gondola
- Backcountry Gates
- Forest
- Food
- Restrooms
- Structures
- Ski Area Boundary
- City Limits
- Roads

Town of Vail

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Appendix B – Full-Size Taos Topographic Map

Legend

Ski Runs
- · Easiest
- ■ More Difficult
- ◆ Most Difficult
- ◆◆ Extreme Terrain

Chairlifts
- Chairlift
- Surface

Vegetation
City Limits
Roads
Glades
Rocks
Lifts
Structures
Food
Restrooms
Ski Area Boundary