Comments on the Draft Environmental Impact Statement for Grand Targhee Resort's Master Development Plan Projects

June 20, 2025

Mike Merigliano

Dear Jay Pence and Kim Pierson,

My comments on the draft Environmental Impact statement for the Grand Targhee projects master plan focus on scenery, vegetation, bighorn sheep habitat, water quantity and quality, and skiing opportunities.

The DEIS includes a reasonable range of alternatives, and my preference among them is best described as an "enhanced no-action", or a much scaled-down alternative 3. The main reasons for this are largely environmental. The alternative I prefer is:

No expansions beyond the current ski area boundary, no summit restaurant on Fred's Mountain, and minimization of vegetation and soil disturbance. I don't have a specific list of projects that are acceptable and unacceptable. I am more concerned with minimizing ecological and scenic impacts, so some individual projects may be okay, depending on how they are implemented. My extended explanations cover this in more detail.

My choice is informed by experience in natural resources as well as skiing culture. Within the Robinson family era and early Bergmeyer management, I worked at Grand Targhee Resort as a lift operator and ski instructor. Near the end of my time with the Targhee National Forest, I inventoried, classified, mapped, and described the vegetation within the ski resort boundary for the 1994 Environmental Impact statement for Grand Targhee Resort. Most of my skiing experience is in the backcountry, in the Teton Range, the northern Rockies, Canada, and Alaska.

For years, Grand Targhee had a gentle footprint on the landscape. It fit-in visually, and infrastructure was enough to provide a simple skiing experience on high quality snow. The recent lift installations on Peaked Mountain have opened up a considerable amount of terrain, and the proposed expansion into Mono Trees and the South Bowl are not justified on a skier density basis. The South Bowl provides a backcountry experience that is relatively easy and provides a good introduction to this kind of skiing experience. Some call it "Geezer Bowl". This may not be the best marketing term for the "bro skiers" out there, but it captures the essence of the experience.

Over 40 years ago, before Peaked Mountain was part of the permit area, my friends and I would ski there. With the primitive equipment we had it was an adventure — especially the South Bowl. On our little skis, the trip down into Teton canyon was big. Expanding Grand Targhee will make the mountain feel even smaller and tamer than it is now. A lift-served, groomed South Bowl will be more of the same, and an unusual skiing experience will be lost.

The same goes for the Mono Trees area. This has been a "hidey-hole" place to ski on bad weather days, or when the snow is really good and skiing the tight trees is so much fun. Some skiers catch it from the resort, but it is quite accessible from the ski hill road. The small parking lot is big enough for the number of skiers that typically ski there. There is a nice mountain biking or hiking trail through Mono Trees, and the substantial proposed development there would change the woodsy experience traveling through there. It still has some wildness to it, and one day I crossed a fresh set of wolverine tracks (documented in the DEIS). This was not surprising and I have encountered them or their tracks in the Tetons for several years, as have others. As I understand it, Mono Trees is attractive to the Resort for its low-elevation and less-foggy weather. Some of this situation can be gained with a mid-way station along the Dreamcatcher lift. The old Bannock lift had a mid-way station, and the resort would require skiers to leave the lift at this station during especially bad weather. Skiers always had the choice of getting off the lift there. The accessible terrain is probably less than at Mono Trees (I estimate it to be 140 acres), but it would be a cost-effective way to gain some lower terrain when Dream Catcher is replaced. The Sacajawea lift also provides lower-elevation terrain as well.

The issue I struggled with the most was the potential impacts on bighorn sheep. Others have struggled too, and I was involved to some extent with the beginnings of the domestic sheep allotment issue while a US Forest Service employee, up to the recent Teton Range Bighorn Sheep and Winter Recreation Strategy. The strategy meetings were contentious, partly due to the difficulty in explaining the rationale for the closures. Many skiers were opposed, and one could think that they were "just a bunch of bros rolling joints with un-paid bills", but many had astute observations and questions. The skiers knew the snow, the biologists knew the sheep, but their knowledge never quite coalesced. I knew many of the skiers and climbers, as well as he biologists, and could see both sides, I think.

The herd is small and could become even smaller if we are not careful. Using a pre-cautionary principle is prudent, especially when causes are unclear. With just this in mind, the clear choice is to limit all skiing use in the South Bowl, including backcountry skiing. The Teton Bighorn Sheep Working Group's strategy allowed a compromise for South Bowl, and identified a designated route down the middle of the Bowl.

Although I present more background on it later, a conundrum is obvious: If there is truly forty five thousand acres of high-quality habitat, how would losing 200 of it affect a population of about 100? Of course there are other routes that can add-up, but for a long time, the conventional wisdom for winter habitat was that it was very limited, but all of a sudden, there was a tremendous amount. Perhaps I missed it, but I never heard a cogent explanation for it.

Although I criticize some of the bighorn sheep research, I have a lot of respect for the people that did it and their work is very conscientious and admirable. But the management approach tends to be one skirmish at a time, without a wholistic view of the habitat's capacity for sheep, increasing genetic diversity via natural migration, and a potential restoration of a source population in the Snake River Range. In over 40 years, despite considerable attention and management actions, the observed herd count has fluctuated around 75 animals.

Thinking about the DEIS as a whole, I realize that it is very comprehensive, detailed, and written with a development purpose and need in mind. Although I am familiar with the area and have a natural resources background, I knew it would difficult to consider everything in the detail that I wanted to. I suspect that others faced the same problem. Some of the projects are small and reasonably understood, and probably not controversial. Larger, controversial projects will take a lot of time to work out. A phased- decision could allow Grand Targhee to go forward with the easier projects, while further analysis and negotiations with the public and the resort could be delayed until the US Forest Service can make acceptable decisions.

To avoid writing a long, detailed response to the DEIS, I purposely waited some weeks to compress the time line. I am not sure this really worked.

Thanks to the US Forest Service, SE Group, and all of the other consultants for pulling together so much information for such a complex, controversial project, I wish you all the best.

My details comments follow.

Scenery

The DEIS recognizes the potential impacts to scenery (e.g., page 7 and 8) and the conflict with the 1997 Targhee National Forest plan. As the DEIS mentions. the expansion into the South Bowl and Mono Trees will change how Grand Targhee Resort looks from various places.

In the Targhee National Forest Plan, the visual quality objective for the nearby Jedediah Wilderness (JSW) is "preservation" (page III-72). Even if the expansion areas (South Bowl and Mono Trees) are converted to a "Special Use Permit Recreation Site", the infrastructure and tree-cutting within these areas would impact that objective. This objective is a forest plan standard.

The forest plan standard for the JSW requires visual quality preservation. Whether or not such preservation applies to areas within the wilderness boundary or beyond it not clear in the plan. The Wyoming Wilderness Act of 1984 includes language about buffers, and although the DEIS quotes it accurately, I repeat it here for convenience:

> **PROHIBITION ON BUFFER ZONES**
>
> **SEC. 504. Congress does not intend that the designation of wilderness areas in the State of Wyoming lead to the creation of protective perimeters or buffer zones around each wilderness area. The fact that nonwilderness activities or uses can be seen or heard from within any wilderness area shall not, of itself, preclude such activities or uses up to the boundary of the wilderness area.**

A key phrase is "of itself". Without it, the prohibition is clearly encompassing. The forest plan does not bring up the buffer prohibition in the visual quality objective, and doing that would have clarified whether it applies only to lands within the wilderness boundary, and that absence seems to open up an exception to the prohibition.

As pointed out in the DEIS, the scenery analysis relies on the Visual Management System (USDA Forest Service 1974) because the 1997 Forest Plan relied on that, as directed by the 1982 planning rule. In 1995, the US Forest Service published the Scenery Management System (USDA Forest Service 1995), and the 2012 planning rule requires that for forest plan revisions (Brunswick 2018). However, the 2012 planning rule in the Federal Register includes plan development, revisions, and amendments, so the SMS should be used to be consistent with that rule.

A fundamental difference between the Visual Management System and the Scenery Management System (SMS) is the former was conducted by experts such as landscape architects and it (partially) relied on a degree of change, while the latter incorporates the perceptions and aesthetic judgements by people who view and value the landscape. The DEIS further invites the SMS approach. The Built Environment Guide is from 2001 and has nothing to do with the 1997 forest plan, yet it is used in the DEIS. Why not formally use the SMS system too, as required by the 2012 planning rule?

So, what follows is my perceptions and aesthetic judgments on the landscape within the GTR expansion areas, as seen from various vantage points.

Fred's and Peaked Mountains have mostly subalpine vegetation, where natural tree density is generally low, so cut slopes are not as necessary and generally blend in with the natural vegetation. Much of the natural vegetation within the ski area boundary has not changed much since the establishment of Grand Targhee in late 1969; this is covered in more detail later. The South Bowl has few trees, but it is a prominent feature from many places, and the access road and ski lift will stand out as linear features. Already, the top of the Colter lift is noticeable from some vantage points, especially when it reflects the sun. Mono Trees is mostly closed-canopy forest, and the proposed ski-run clearing will be very noticeable due to their linear shapes. The cut-slopes on the west slope of Peaked Mountain are noticeable, and Mono Trees will add to it. Simulation 2 in the DEIS (pages 393 and 394) shows these effects very well.

The following viewshed maps (Figures 1 and 2) and associated photos (Figures 3 to 6) concentrate on the South Bowl and Mono Trees expansion areas. I used digital elevation models from the US Geological Survey (24 by 30-meter horizontal resolution, vertical precision of 1.55 meters RMS) and the viewshed algorithms in QGIS to extract the viewshed rasters and convert them to a vectors. Area and linear calculations are from the polygons in ArcGIS 10.6, using North American datum 1927, UTM zone 12 north. My approach is similar what SE used in the DEIS.

Along the trails in the viewshed, trees block some of the view, but the South Bowl is visible along much of the South Teton Trail and along the upper part of the Beards Wheatfield trail. Some example views are included after the viewshed maps.

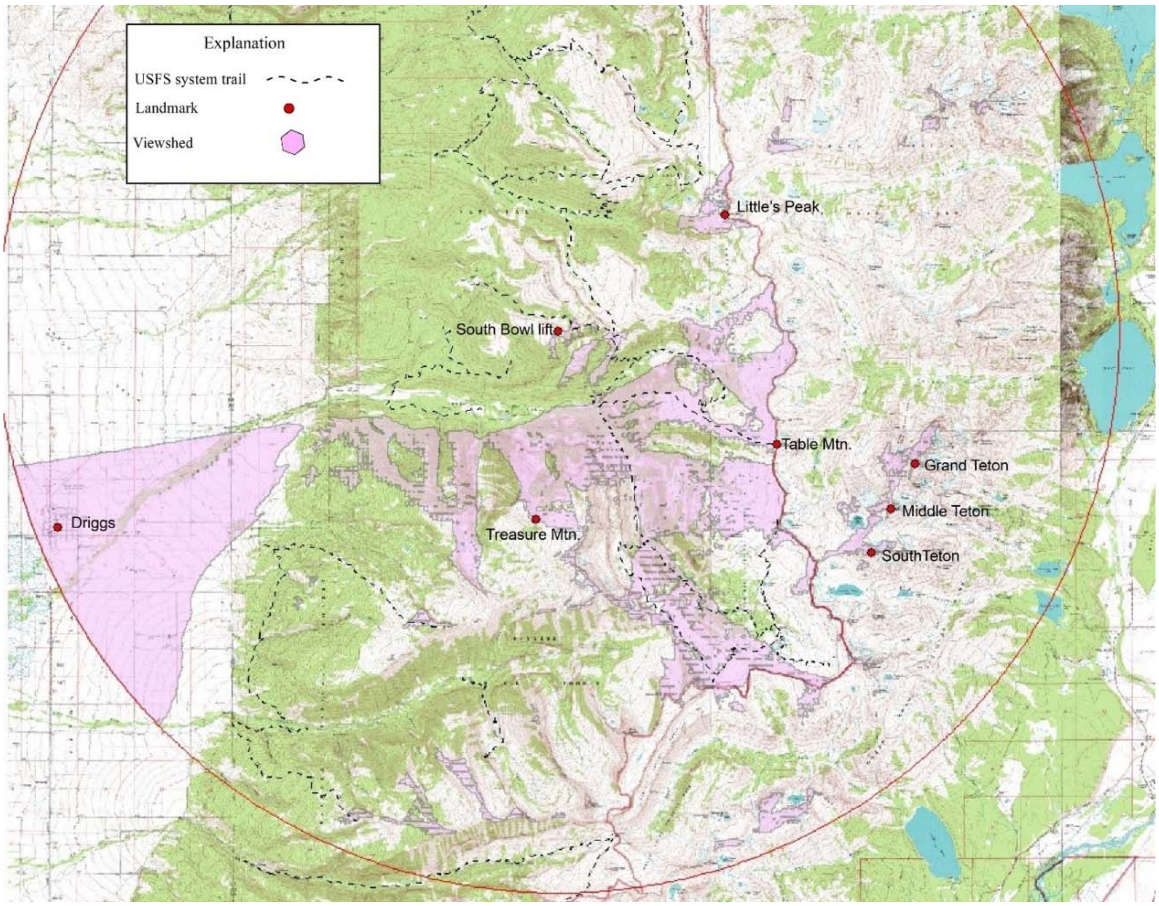

Figure 1. Viewshed (in lavender) from the proposed location for the South Bowl lift near the summit. Circle radius is 10 miles. Total area within circle is 201,062 acres, and viewshed acreage is 21,643. Viewshed area within the Targhee National Forest is 11,965 acres, and within the Jedediah Smith wilderness it is 9,807.

Table 1. Sight distances from the South Bowl lift to various landmarks, and trail miles within its viewshed.

Landmark	Miles	Trail	Trail miles
Grand Teton	6.8	South Teton	4.5
Middle Teton	6.7	North Teton	1.0
South Teton	6.9	Face Trail to Table Mountain	3.5
Table Mountain	4.4	Teton Shelf	3.7
Treasure Mountain	3.4	Beard’s Wheatfield (in N. Teton Canyon)	0.8
Little’s Peak	6.4		
Beard’s Wheatfield trail (average distance)	1.0		
Driggs, Idaho	9.6		

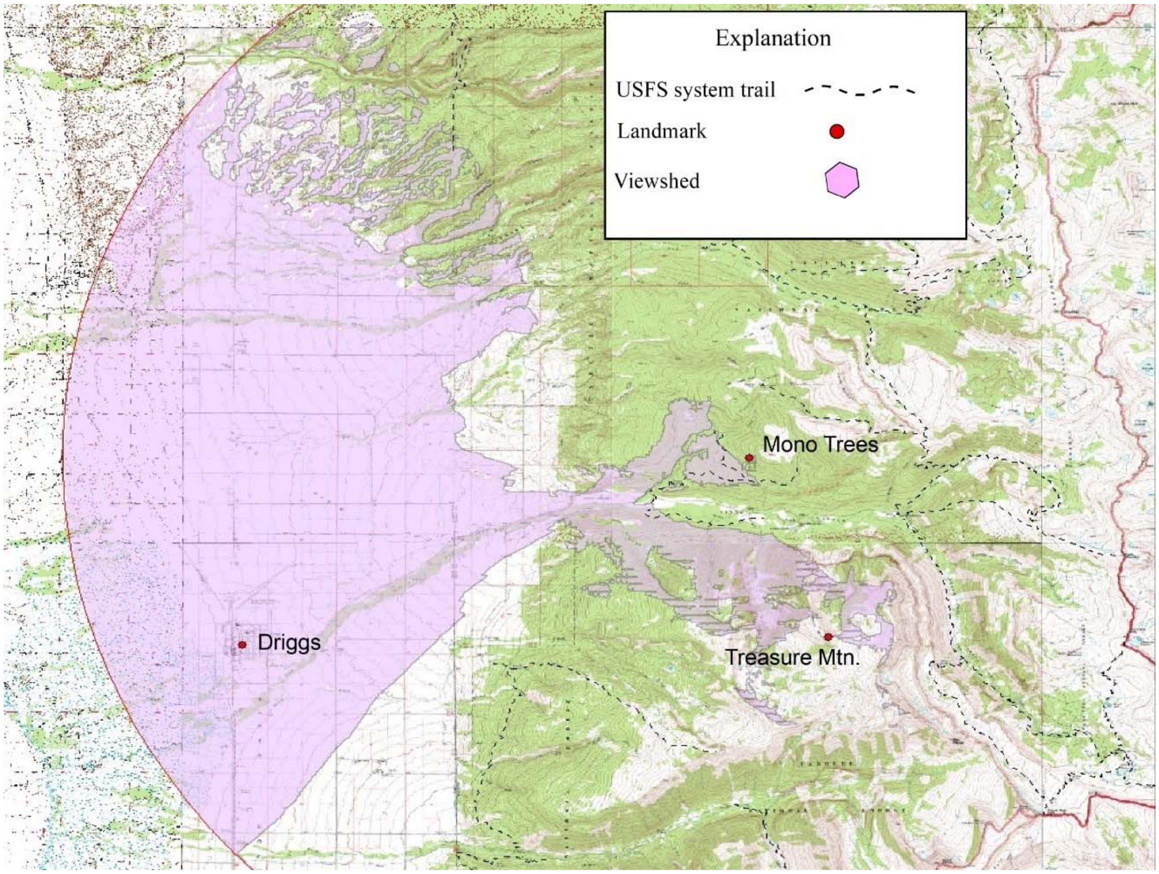

Figure 2. Viewshed (in lavender) from the mid-slope position within the proposed Mono Trees expansion area. Total area within the 10-mile radius circle is 201,062 acres, and viewshed acreage is 39,461. Viewshed area within the Targhee National Forest is 4,172 acres. The sight distance from Driggs to Mono Trees is 8 miles.

Figure 3. Peaked Mountain from the upper part of the Beard's Wheatfield trail. June 8, 2025. The tree-lined ridge extending down from near the summit is “Noodle Ridge”, which splits the South Bowl. The access road would cross the slope at far-left (see Figure 5). Photo by Mike Merigliano.

Figure 4. The east ridge of Peaked Mountain with the South Bowl beyond. March 5, 2021. Noodle Ridge forms the upper-right skyline, and the south ridge of Peaked Mountain is the furthest ridge at lower-left. The upper South Bowl shows a blast scar from recent avalanche control to allow ski patrol access to control slopes on the north side of Peaked Mountain. The summit is about 0.2 miles away from the viewer. Photo by Mike Merigliano.

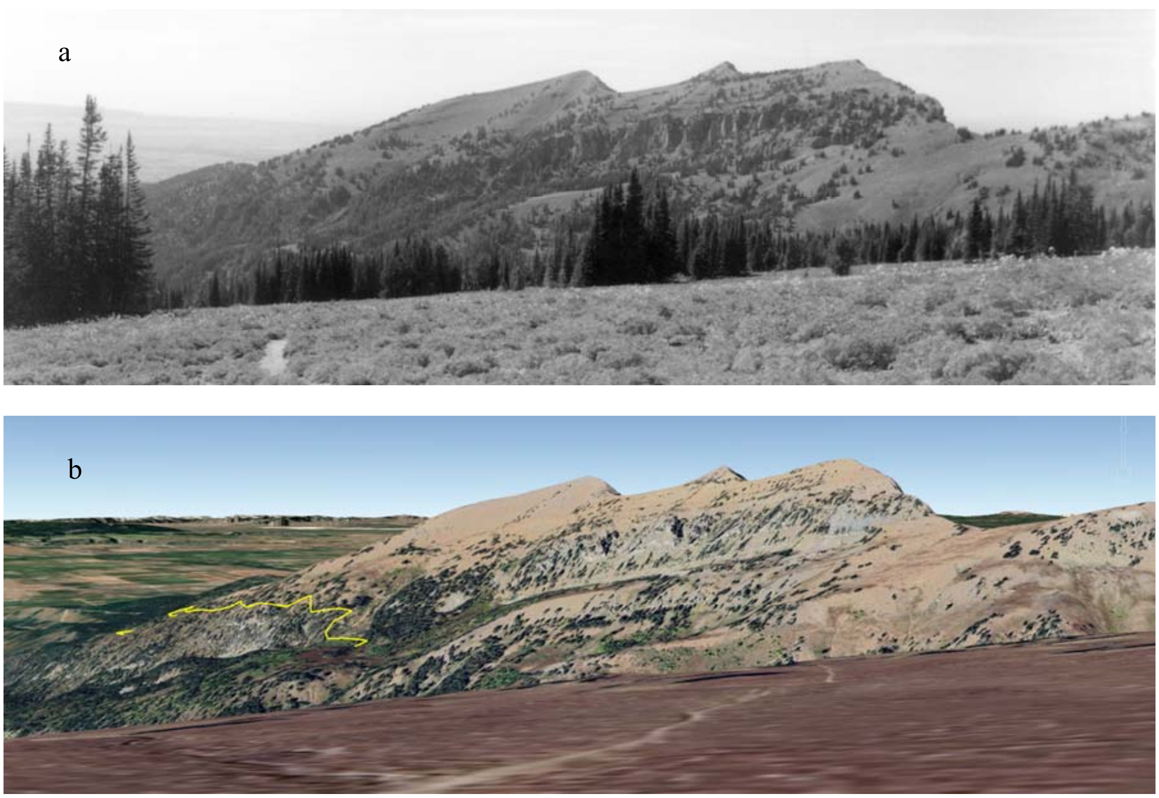

Figure 5. a) Peaked Mountain from along the Face trail on the west ridge of Table Mountain. July 11, 2023. The summit of Peaked Mt. is at upper-center-scene. The Patio shows as a crescent meadow just above the foreground trees in-line with the visible trail path. The prominent cliffs are Bighorn dolomite. b) Google Earth image showing the South Bowl access road in yellow at left. Photo by Mike Merigliano.

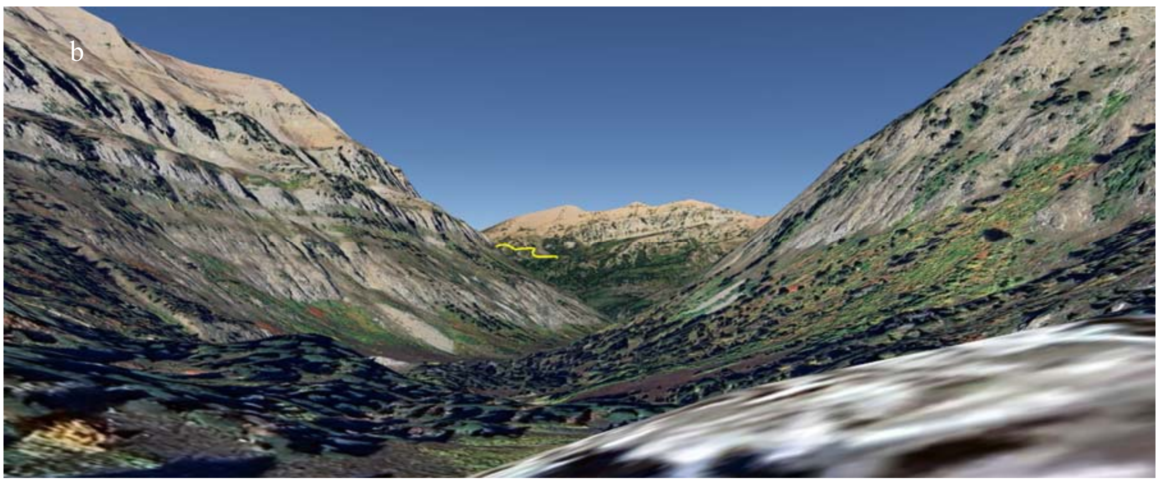

Figure 6. a) Northerly view down the South Fork of Teton Canyon. September 16, 2023. Peaked Mountain is near center-scene. b) Google Earth image showing the South Bowl access road in yellow. Photo by Mike Merigliano.

The South Bowl access road crosses the south side of Peaked Mountain's west and south ridges at around the 8000 to 8400-foot elevation, and ends at the Patio (spot elevation 8252 feet). As drawn on the map in the DEIS (page 388), the alignment appears approximate and has excessive variance in grade and does not fit the terrain contours very well. I used the road path as shown in the DEIS, and assume that the proposed road would be built at or near the mapped alignment. Of course, the actual road would not be a "wide yellow line" as in the Google Earth simulations, but cut-and-fill slopes will be prominent along the steep terrain, especially towards the Patio where it crosses the Bighorn dolomite.

The South Bowl development involves blasting and grading, as well as lift towers and terminals. The top terminal will require a large excavation (like the one for the Colter lift), and this could be quite an eyesore, especially from Table Mountain.

The DEIS assumes that project components would not be visible beyond 6.9 miles. Nearly all of the landmarks in Table 1 are less than this distance. Driggs is further (e.g. 8 miles to Mono Trees), yet the simulation in the DEIS shows differences that are easy to see.

The DEIS states that the South Bowl and Mary's Nipple are visible from the Teewinot Mountain viewpoint location, which is its summit. From there, the east side of Fred's Mountain is visible, but the north ridge of Mount Owen blocks the view beyond it to the west. The upper South Bowl and all of Mary's east and south sides are visible from the Crooked Thumb, a gendarme north of Teewinot that is not readily accessible from Teewinot's summit. Was there an error in viewshed analysis?

The DEIS analysis assumes brief viewing times for several viewpoints that depend on hiking speed. But many of them are common rest stops or scenery viewing areas, and viewers could spend several minutes or even an hour from these locations. This is especially true for the Lower Saddle (many people camp there), Hurricane Pass, Table Mountain, and the three Tetons.

The scenery analysis in the DEIS is okay for a first approximation, but true impacts on the scenery are hard to visualize, and many viewers will be non-local visitors to the Jedediah Smith Wilderness and Grand Teton National Park that won't be aware of the changes at Grand Targhee Resort until it is too late. Granted that the DEIS can be evaluated and commented on by anyone, but it is good practice to anticipate the reactions of all visitor types that are likely to be impacted before going forward, using the Scenery Management System.

<u>Vegetation</u>

The GTR projects involve a substantial amount of vegetation removal — particularly trees — for all of the alternatives except the No Action. For alternative 3, the least active of the action alternatives, the amount of tree clearing alone is 28.4 acres, while it is 107.4 acres for grading and tree clearing. Glading is 294.9 acres, and but the amount of tree clearing involved is unclear. In the DEIS, Figure 2 on page 388 shows glading areas that seem to add-up to 295 acres, but the "grading and tree clearing" is not explicitly shown. I assume that the "proposed ski trails" areas are where the grading and tree clearing will occur.

Today's vegetation at Grand Targhee Resort is very similar to what was there before resort development (Figure 7), and it is difficult to understand why so much glading, grading, and clearing is necessary now. Most of, if not all of the time, there is not a shortage of skiable acres, and skiing in the existing forested areas is not excessively challenging under the usual snow conditions.

Two stone pine species exist in the project areas: limber pine (*Pinus flexilis*) and whitebark pine (*Pinus albicaulis*). Limber pine is probably more common in the existing ski area boundary, and there are negligible amounts, if any, of either species in the Mono Trees area. The upper parts of the South Bowl could have a higher percentage of whitebark pine than limber pine, but crown shadows in recent aerial photography indicate most trees are subalpine fir.

The Environmental Impact Statement for the previous Grand Targhee Resort Master Development Plan (USDA Forest Service 1994) included a vegetation description and rare plant survey. The 1994 EIS relied on two reports that covered the vegetation in some detail (Merigliano 1990, 1991). These two reports are sequential, with some overlap in text. Further surveys were done in 1992 and 1993 by other US Forest Service people (see the EIS, page III-16), and wetlands were investigated separately by Barry Dutton of Land and Water Consulting, Missoula, Montana.

The 1990 and 1991 surveys were conducted before extensive mortality in the stone pines occurred and while cones were maturing or mature on the trees, so identifying the two stone pines was relatively straightforward. Nearly all vegetation patches were visited at least once. For convenience, the methods are inserted here:

<u>Methods</u>

The various vegetation types are based on distinct differences in structure, stage of successional development, and species composition. Type names are based on 2 or 3 species with the highest coverage and most consistent distribution throughout the type. Types were delineated on 1:12000 color aerial photos taken on 9/13/84. Almost every stand was walked through at least once, or examined from adjacent stands if this allowed adequate classification. Some areas were typed by photo signature only and these are: the rock cliffs on Peaked Mountain, the lower portion of "Sitting Bull Ridge" and the area north of the Blackfoot ridge typed as 342 AR 105. Not every portion of the larger stands were closely inspected, but photo signatures were consistent enough to allow reasonable typing for these stands. Stand boundaries were usually distinct on the photos. Some boundaries were indistinct both on the ground and on the photos where there was a continuum across an elevational gradient. Boundaries drawn in this situation are somewhat arbitrary.

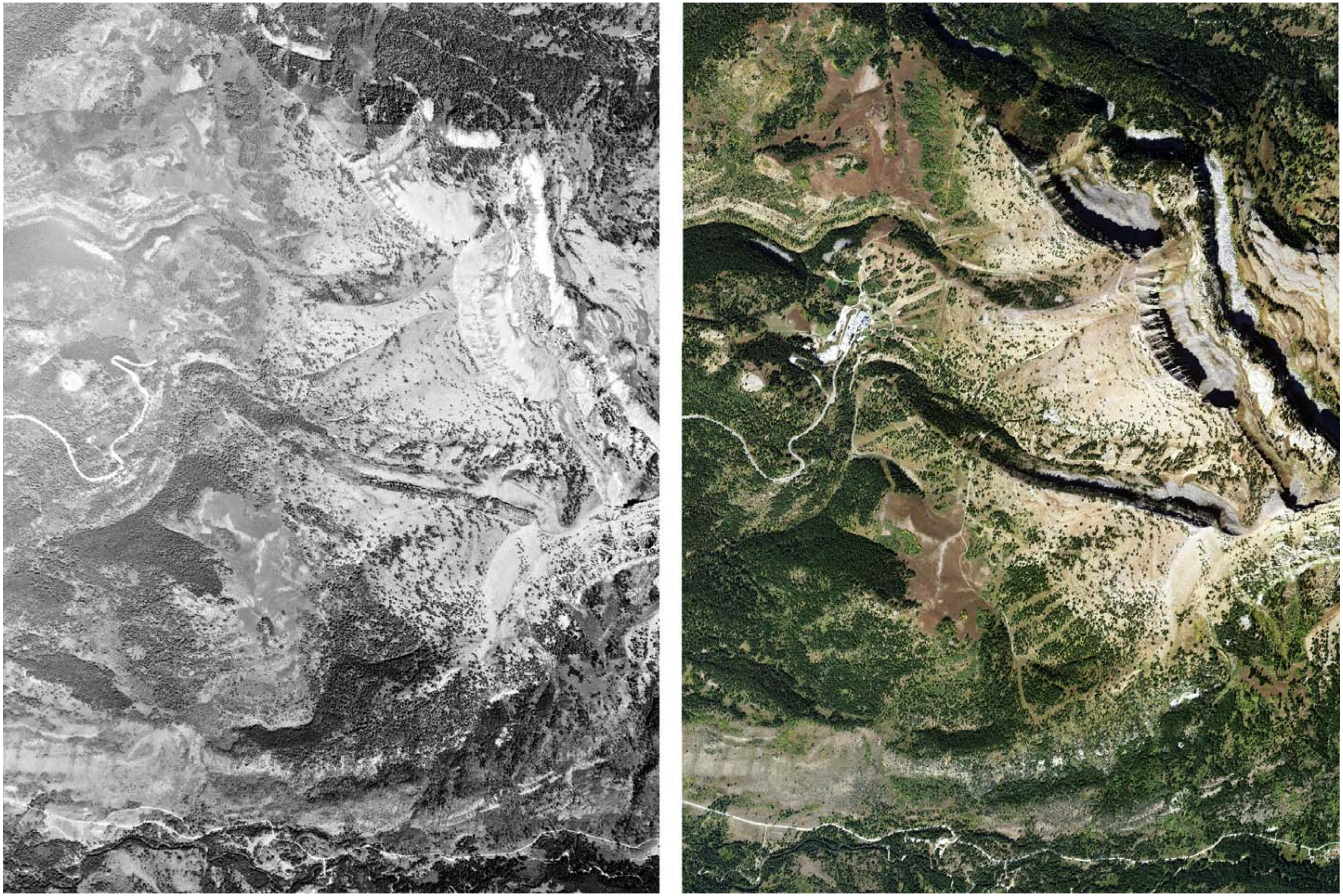

Figure 7. Orthophotos of Grand Targhee Resort and vicinity, August 9, 1967 (left) and September 12, 2015. Teton Creek and road are along the bottom. Most of the changes in vegetation are at the base area, the lower slopes of Chief Joseph Bowl near the Blackfoot lift, the slopes served by the Shoshone lift, and the lower part of Peaked Mountain.

The 1990-1991 survey highlighted the stone pines in a few vegetation types:

34* Subalpine fir (named Alpine fir in photo key)

Subalpine fir has the highest coverage, with minor inclusions of spruce and scattered relic Douglas-fir in some stands. The overstory canopy is continuous at lower elevation areas (7800 to 8600 feet), especially on northerly aspects. Above about 8600 feet, stands consist of small scattered clumps, usually less than an acre, surrounded by open meadows. Limber pine (Pinus flexilis) and whitebark pine (Pinus albicaulis) occur in and amongst the clumps of fir and spruce in some locales. Many of these higher elevation stands pre-date fire suppression history. Invasion of conifers in the higher meadows is very slow due to the episodic nature of seedling establishment. The clumps of conifers tend to expand in the leeward direction by the process of layering.

35* Douglas-fir

Douglas-fir (Pseudotsuga menziesii) dominates this type, but small amounts of aspen, subalpine fir, spruce, and limber pine are present in some stands. No stands of seedling or sapling Douglas-fir were found, although some uneven-aged stands included these age classes.

36* DF-AF Douglas-fir-subalpine fir

This type is composed mainly of the above species along with a very minor amount of limber pine in some areas. Douglas-fir ranging in age from about 150 to 250 years are mixed with subalpine fir of all age classes, including regeneration. Conifer overstory canopy coverage ranges from 50 to 100%. No young stands were found.

37* WB. Pine-Fir whitebark pine-subalpine fir

The only location with appreciable amounts of whitebark pine is on the ridge south east of the summit of Fred's mountain. There are scattered individuals or clumps of whitebark pine on the upper portion of Fred's and Peaked Mountains, but they were not extensive enough to delineate. (see type #34 description)

Note: The asterisks are place-holders for forest stand age classes. Most were mature or old.

The 1990-91 survey had 50 types, excluding the age-class separation. A modern reproduction of the map is in Figure 8, and the original is Figure 9. I made the original map by transferring type boundaries from aerial photos onto orthophoto maps (a topographic map with rectified vegetation patches overlayed on it). I drew the new map on aerial photography that I rectified in ArcGIS 10.6.

In general, limber pine is associated with Douglas fir on warmer sites (southerly aspect, lower elevation) while whitebark pine is associated with subalpine fir is at higher elevations. On soils derived from carbonate rock, limber pine tends to predominate, while whitebark is common on soils derived from felsic rock (more acidic). At higher elevations (say 9500 feet+), whitebark pine becomes common even on carbonate rock. This pattern does not hold range-wide for these trees, but has been noted in various publications since at least the 1970's for the northern Rocky Mountains (Weaver and Dale 1974, Hansen-Bristow, Montagne, and Schmid 1990). The elevational transition on predominately carbonate rock was apparent at Grand Targhee in 1990 and 1991, and I see it in other places in NW Wyoming.

Although whitebark pine is listed as Threatened under the ESA, limber pine has similar ecological traits and should have similar attention. Both have large nutritious seeds that are primarily animal-dispersed (Hutchins 1990). Clark's nutcracker disperses both species (Schuster and Mitton 1991, Schoettle and. Rochelle 2000). The nutcracker and other seed-eating birds depend on other conifers besides whitebark pine (Douglas fir, limber and lodgepole pine, Engelmann spruce, and subalpine fir at GTR), so protecting the entire seed resource is important to protecting the nutcracker and in turn whitebark pine. A good example of this synergy is the grizzly bear's dependence on squirrel caches to

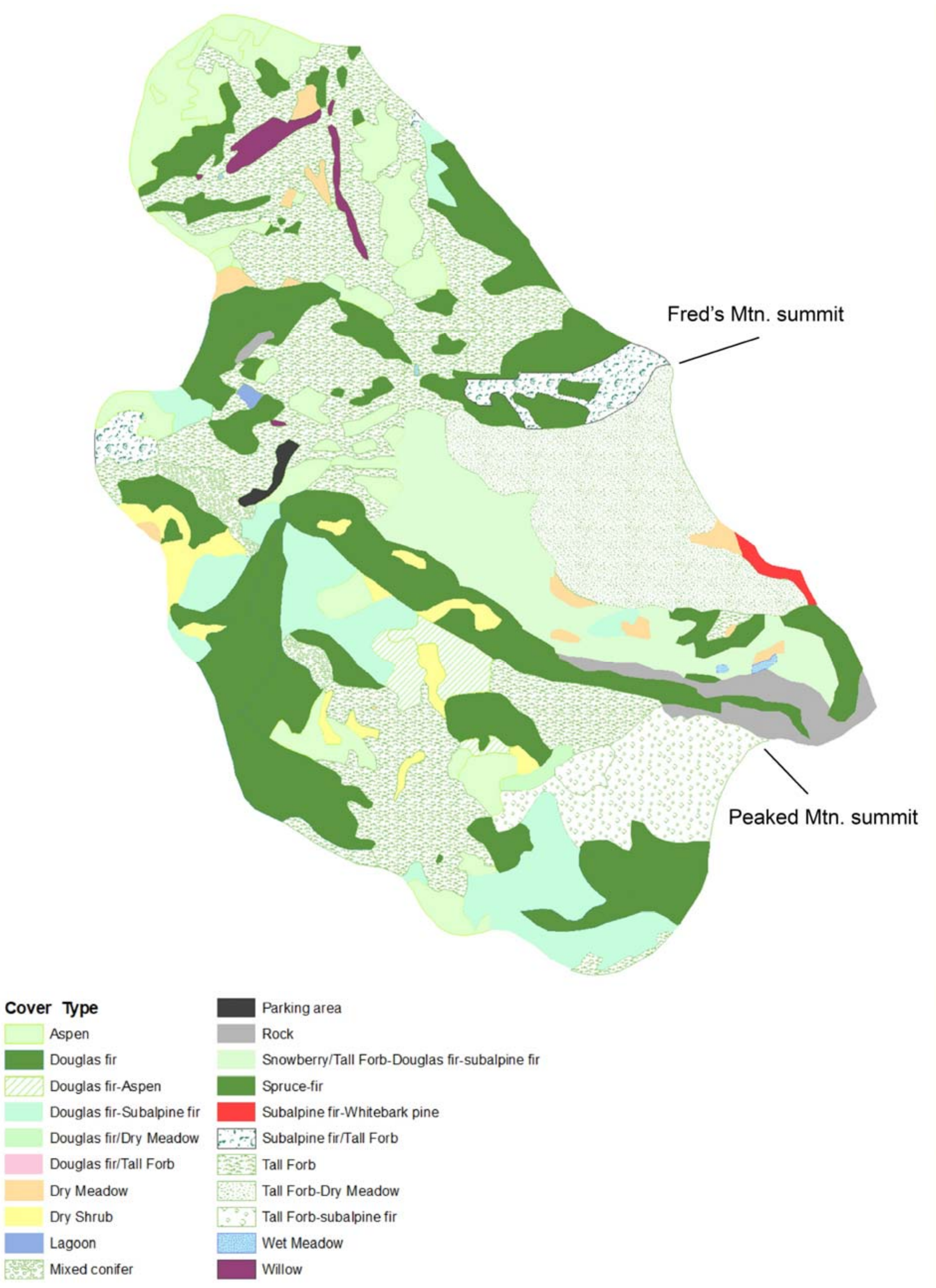

Figure 8. Simplified 1990-1991 vegetation map of the permit area at that time.

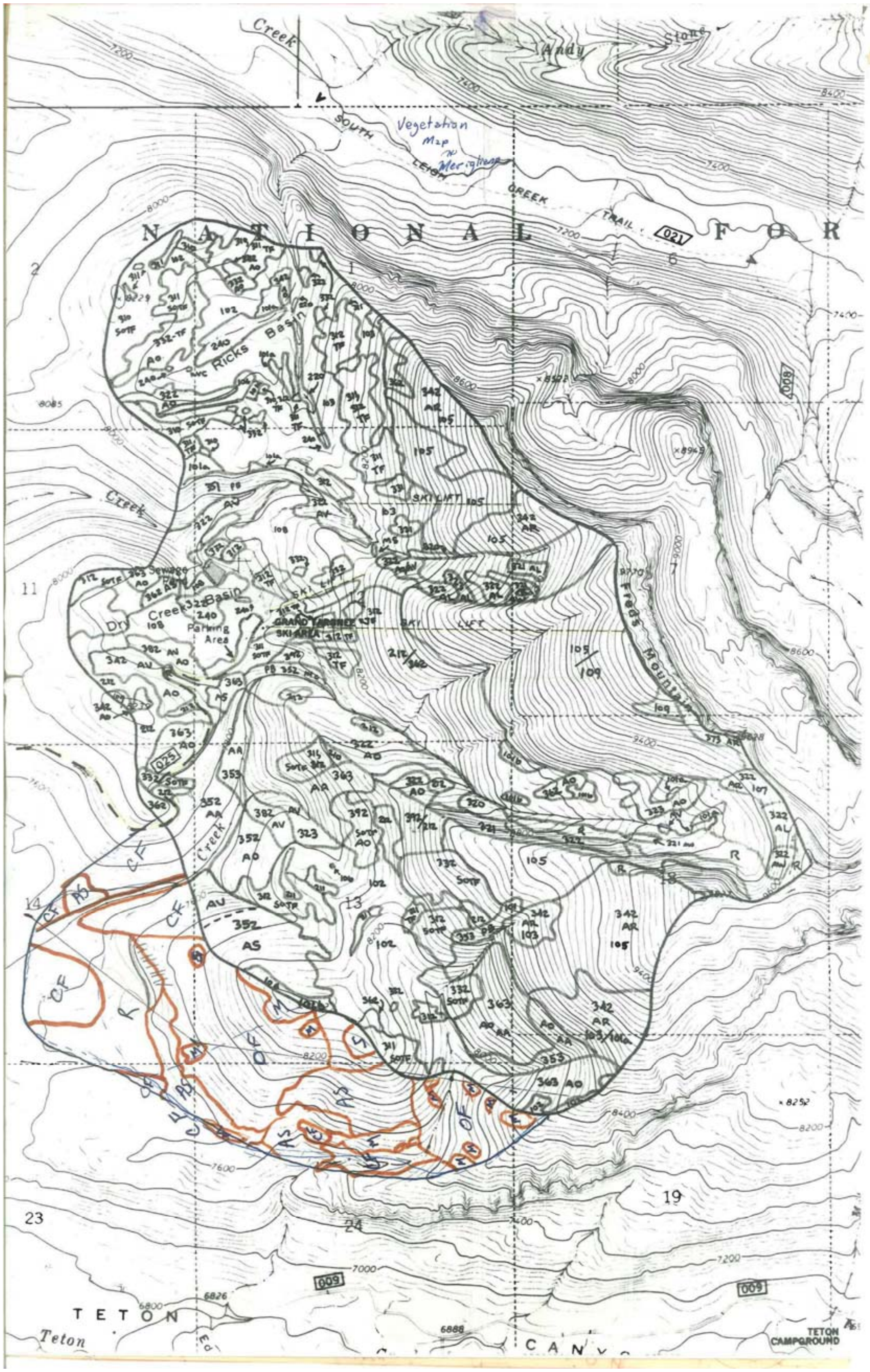

Figure 9. Vegetation map from the 1990-1991 survey. Black lines with black numbers and letters correspond to the report's type descriptions. The orange lines were drawn in later, when the permit area was adjusted.

easily obtain whitebark pine seeds. Squirrels and their caches are much more common in mixed-conifer forests because of the variety of seeds they offer, and the less harsh environment and more-reliable seed abundance found in mixed stands compared to pure whitebark pine stands at higher elevations (Reinhart and Mattson 1990).

Grading could impact the ground vegetation, and this is important for various wildlife species. Even though they are common, ski areas use and animal habitat can co-exist better if native vegetation is protected as much as possible. The design criteria for grading seems to handle this, but there is a lot of proposed grading (mentioned previously here) that appears excessive, and recent glading (I guess, not sure what glading really is) near the base area and around the Shoshone lift appear excessive to me. The rectified aerial photography in Figure 10 shows the impacts

My age estimates for trees in 1990-1991 were educated guesses. Since then, more information has confirmed the ages. Repeat photography of scenes from late July 1872 showing Fred's and Peaked Mountain show stable vegetation types over the century, and many trees and shrubs extent then are still there today (Figures 11 to 15). In 2020, a wind-thrown whitebark pine along the south ridge of Fred's Mountain that was cut leaving a stump, provides a convenient, precise age for a typical sized tree (Figures 15 to 17). Ring counts at the stump were 249 years, so the likely establishment year was around 1770. This is not an unusual age for mature-looking whitebark pine. Near Holly Lake in Grand Teton National Park, several living whitebark pines were cored and their establishment years ranged from 1324 to 1919; most established between 1600 and 1800. (Kelly 2014). In the Gros Ventre Valley on the Bridger-Teton National Forest, establishment years for sampled limber pine started in 1322 (Wise 2010).

Given all of the above, the vegetation patches at Grand Targhee Resort are quite stable due to plant longevity and slow reproductive rates, so, impacts from tree cutting and grading will be long-lasting. Yet, most soil surfaces are frequently disturbed by pocket gophers. The herbaceous vegetation is adapted to this (as well as the underground herbivory), and established trees, especially conifers, are resistant to it. The stone pines are aptly named: they tend to establish on rocky sites that limit pocket gopher activity, and have limited reproductive success in meadow sites where soils disturbance is so high. This situation has implications for stone pine restoration. Meadow sites are easy to plant trees in, but most if not all of the trees will likely succumb to pocket gopher disturbance. Rocky sites are more protected, but harder to plant trees in. Natural regeneration from bird-dispersed seeds is slow and apparently sporadic.

With a warmer climate likely ahead, sites will probably favor limber pine over whitebark pine. There are some young trees here and there, and they can be identified with a quick and relatively cheap genetic test (Alongi et al. 2019) to infer trends.

The DEIS's high count of thousands of whitebark pines in the Grand Targhee Resort area is surprisingly high, and the estimated removal of 350 to 450 trees, depending on alternative is excessive. The methods probably led to over-estimates. For example, there are about 25 "Whitebark pine-not-cone bearing" trees marked along the west ridge of Peaked Mountain, plus a few "Mixed cone-bearing and not-cone bearing" (Figure 14 in Biological Assessment). On a recent trip along this ridge, I counted three live five-needle pines. But fortunately, the design criteria (page 46 in DEIS) are not sensitive to existing density (areas to be impacted are surveyed and trees protected as much as possible). This should be extended to limber pine and old-growth Douglas fit too. A main point is that there are probably not many whitebark pine remaining so we should be especially careful.

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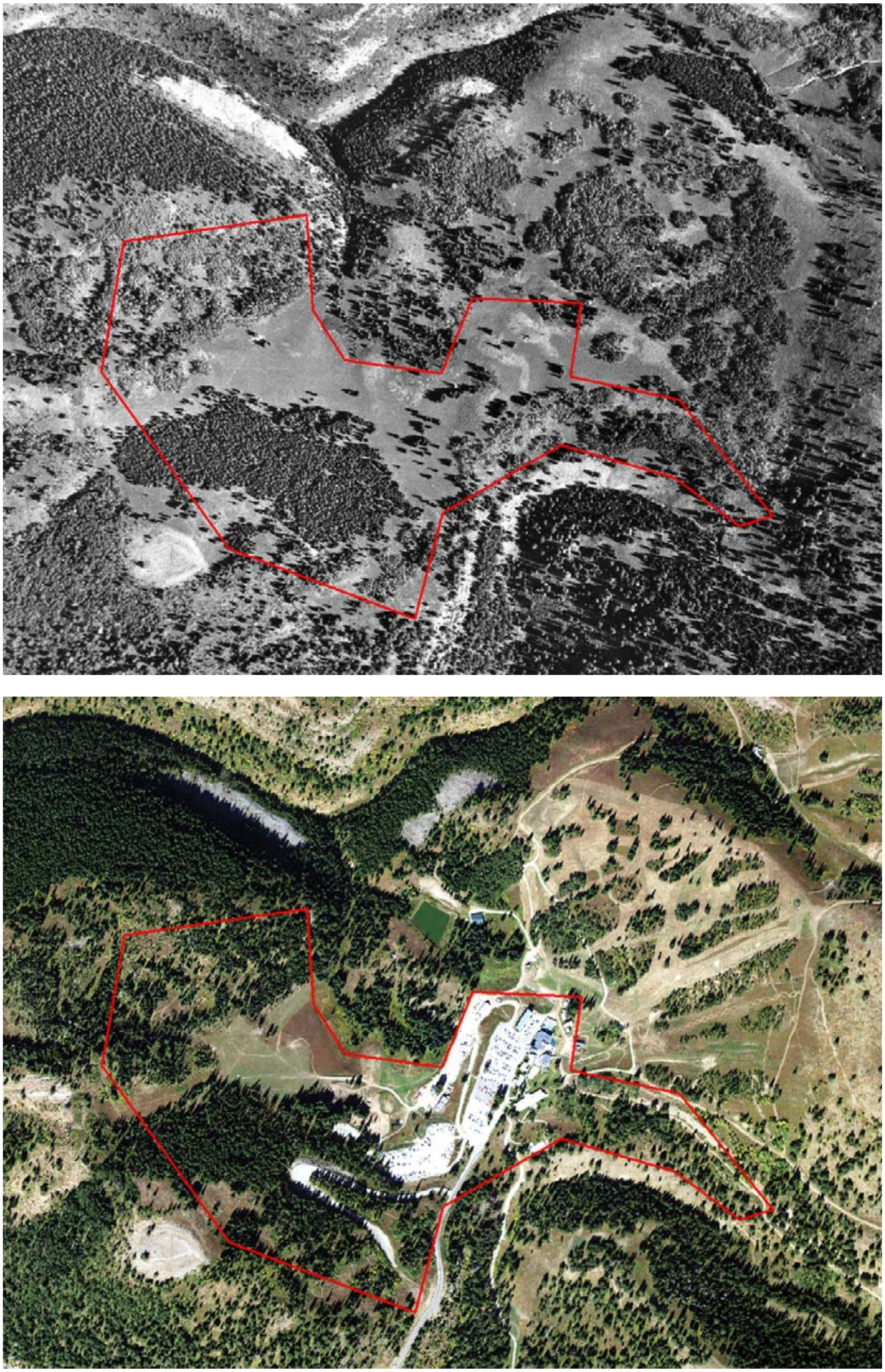

Figure 10. Grand Targhee base area and environs, August 13, 1963 (top) and September 12, 2015 (bottom). Private land boundary, (via Teton County WY GIS) shown in red.

Figure 11. Fred's Mountain from Peak 9930 (Mary's Nipple), July 30, 1872. The upper-third of Fred’s, starting above the large snowfield at right and dipping down to the west (left), is the Madison limestone formation, while the prominent cliffs below the snow is the Bighorn dolomite formation. The Darby formation is between the Madison and Bighorn, and generally forms gentler slopes and has a more deeply-weathered surface with more soil development. The small oval patches among the scattered trees are mostly alpine prickly current (*Ribes montigenum*). These patches persist for decades (see Figure 12). Photo by William H. Jackson, US Geological Survey.

Figure 12. Fred's Mountain from Peak 9930 (Mary's Nipple), August 4, 2020. The general pattern of vegetation has not changed much over the last 148 years. Photo by Mike Merigliano

Figure 13. Peaked Mountain from Peak 9930, July 30, 1872. The geology is similar to Fred's Mountain. The contact between the Darby and Madison formations is near the saddle. The South Bowl and Noodle Ridge slope down to the left from the summit. There are more round-topped trees on the ridges, and many of them are probably five-needle pine. Photo by William H. Jackson, US Geological Survey.

Figure 14. Peaked Mountain from Peak 9930, August 4, 2020. Dead five-needle pine are obvious, but a substantial proportion are still alive. Some of the round-topped trees are likely old-growth Douglas fir. Photo by Mike Merigliano.

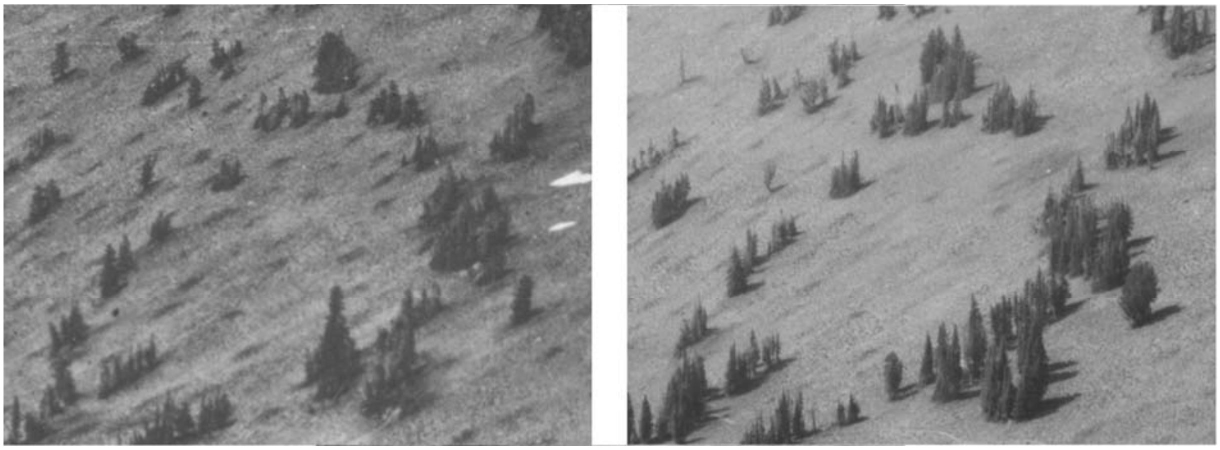

Figure 15. Example vegetation patch on southwest slope of Fred's Mountain, in 1872 (left) and 2020. Round-topped trees are likely five-needle pines. Three of them in the upper-left quadrant have died since 1872, and probably since the mid-1990’s. Pointed-top trees are subalpine fir. Note consistent arrangement of trees and the current (*Ribes*) patches, which are the small darker ovals. Surrounding vegetation is mostly forbs. Since 1872, subalpine fir has slowly increased in density, while five-needle pines have declined somewhat due to white pine blister rust or mountain pine beetle.

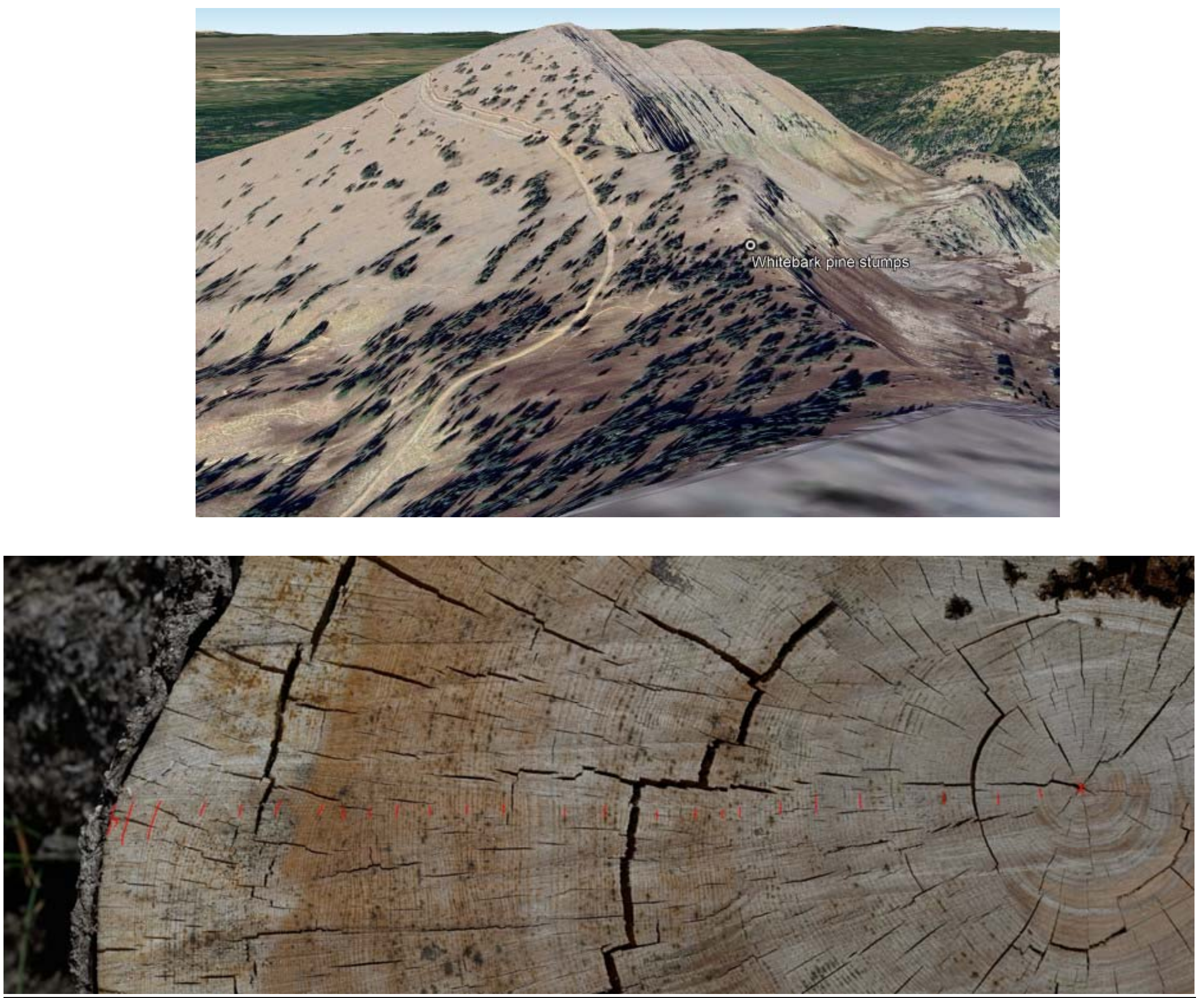

Figure 16. Location of whitebark pine stumps (above, via Google Earth and GPS location), and ring-count marks in red along the stumps surface. Total ring count is 249. This tree is at or near the location of a known “plus-tree” that fell over in 2020.

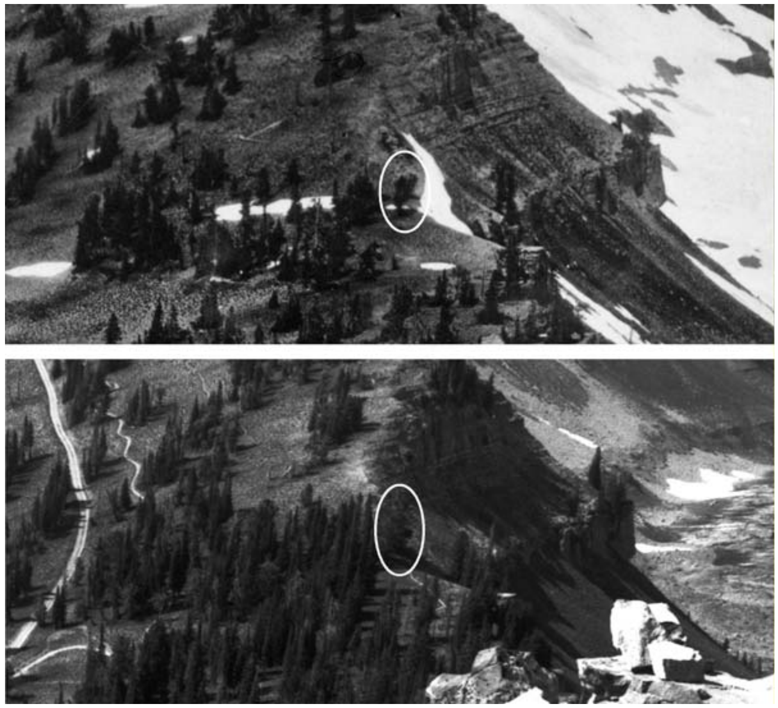

Figure 17. Aged whitebark pine (via stump) in 1872 and in 2020 before it blew down.

Bighorn sheep and its habitat

The Targhee (Teton) bighorn sheep herd's chronically small population has been an issue for over 40 years, but the reasons for it are murky, complex, and contradictory. Disease spread from domestic sheep and limited winter range are considered important, likely causes. The Targhee National Forest gradually removed domestic sheep from the west slope. The east slope, on the Teton National Forest and later converted to Teton National Park, had negligible domestic sheep grazing, and early settlers pushed/drove the sheep back into Idaho (Smith, Cole, and Dobkin 2004). Recent disease surveillance indicates that the Teton herd is relatively free of disease that causes extensive mortality (Butler et al. 2018). Meanwhile, the Jackson herd (Gros Ventre Mountains) is a much larger herd and also has much higher disease prevalence (Butler et al 2018).

The Jackson herd has much more winter range than the Targhee herd does. Deep snow prevails through much of the Teton Range, except windblown sites at high elevations. The Jackson herd migrates to the Gros Ventre valley and nearby areas and the Miller Butte area. These places usually have a thin snow pack through the winter, and many snow-free areas (Honess and Frost 1942, McCann 1956, personal observation).

Deep, soft snow impedes travel (Dailey and Hobbs 1989), and deep, hard snow buries most available forage. An observational habitat study in the Tetons estimated 1,137 acres of winter range (Whitfield 1983). These were the windblown places. The scanned version of the Whitfield thesis does not include the large maps of winter and summer ranges, but I recall seeing map symbols for the locations in the original document at Idaho State University; the actual area estimation procedure is not apparently documented, but the small amount is reasonable given the extensive deep snow in the Teton Range. Sheep could move beyond such places, as demonstrated by GPS-collared sheep (Courtemanch et al. 2017). The winter snowpack above 10,000 feet is often stiff from wind and sun exposure over extensive areas, and sheep could travel over it to get to other foraging areas.

The modeled "perennially" snow-free areas, using remote-sensing, was 13,591 acres (Courtemanch 2014) — about 12 times larger than Whitfield's, observed estimate, while modeled High-Probability-use (also called High Quality) winter habitat area was 45,278 acres. Strictly speaking, there is no "perennially-snow free areas" in the Tetons, and example photos of such that Aly Courtemanch kindly sent to me show thin snow cover. So although not totally snow-free, on a practical level these areas are easy to travel on and forage is accessible.

The DEIS uses the highest estimate (45,278 acres) and cites Courtemanch 2014 for it, and the mapped High Probability use habitat includes some of the South Bowl within the proposed expansion, and much of the steep terrain to the east below Mary's. The next-lower probability use area includes all of the South Bowl. This inclusion conflicts with Courtemanch's narrative description:

"*Therefore, winter habitat is typically areas at high elevation on wind swept slopes and ridges, near rugged escape terrain, on southerly aspects, with minimal tree cover.*" (Courtemanch et al. 2017).

Other researchers have similar descriptions for winter habitat (e.g., Whitfield 1983, McCann 1956). The vast additional habitat is due to a missing parameter in the model. There is no coefficient for the negative influence of deep snow. Snow density and depth would be extremely difficult to quantify and model. One way around this is to stay with the time-and-space GPS data for sheep and map it seasonally. This would be more intuitive with less extrapolation involved.

The South Bowl has deep snow most of the winter, and no escape terrain. Indeed, about half of the 18 game cameras there became unusable for part of the winter because of snow (Alder Environmental 2020-2021 South Bowl Game Camera Results).

The 45,278 acres of High Quality winter habitat also conflicts with the long-held assumption that winter habitat is so limiting in the Tetons. Modeled High-Quality summer habitat was 45,293 acres, and summer habitat is not considered limiting for observed population levels. Moreover, the lowest elevations along the east-and west-fringes of the Teton Range are modeled as Very Low Probability use, yet, these areas are assumed to be historic winter habitat (Courtemanch 2017, Whitfield 1983). These areas have limited to no escape terrain. The idea that Teton sheep migrated out of the mountains to lower elevations probably started with Whitfield's study, which relied on "old-timer" recollections of historic sheep habits. In the text, this is summarized as:

> Restriction of Winter Range
>
> Natural bighorn sheep populations typically summer on high, alpine ranges, and descend to lowland areas to winter (Honess and Frost, 1942; Smith, 1954). Geist (1971) notes that the natural populations he studied crossed at least one deep, timbered gorge, and traveled up to 20 miles between seasonal ranges. The historical information collected in this study infers that Teton Range bighorns once made similar movements (Appendix Table 18).

Appendix Table 18 has 122 numbered entries on sheep observations in chronological order, from 1872 to 1968. Of the nine entries for winter, two are valley locations, on buttes between Wilson and Jackson (likely East and West Gros Ventre Buttes). All others are high in the mountains. Numerous sheep from the Jackson herd still winter on Miller Butte, but they were scarce to absent from around 1910 to 1984 (Smith, Cole, and Dobson 2004).

Thus, the idea that bighorn sheep migration has been truncated hangs on two observations, and the sheep numbers associated with these two observations are respectively "several" and "1". Some sheep in northeastern Yellowstone National Park winter at high elevations, such as Sepulcher Mountain and Mount Norris (Mills 1937), so the short-migratory habit may be a natural choice. A migration that involves Grand Targhee Resort shows in Figure 18.

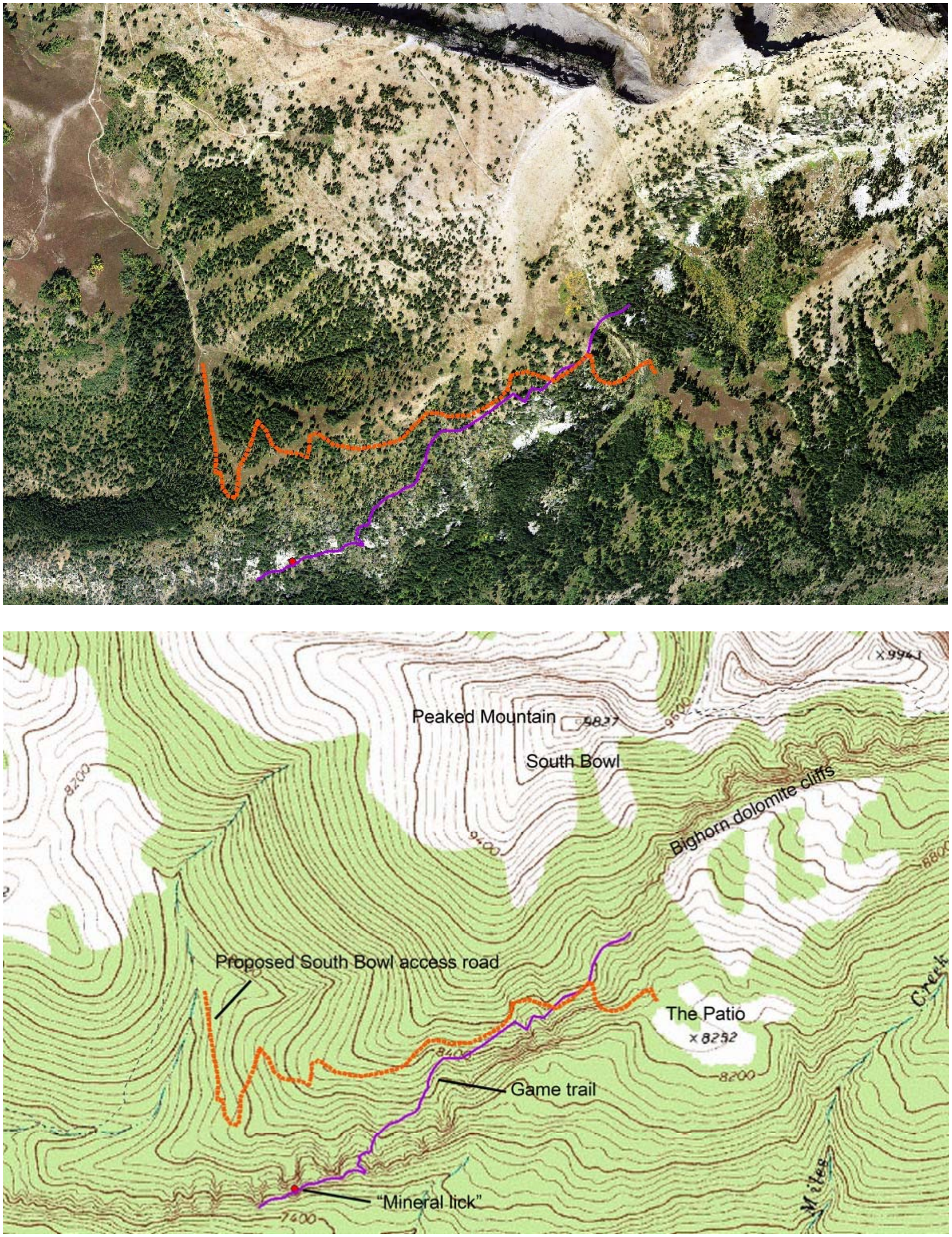

Figure 18. Field-mapped game trail leading to a "mineral lick". There were several trails leading up into the various gullies west of the mineral lick that I did not map. On the east end, the trail fades into course talus and bedrock. In some places the trail is faint. Mountain goat hairs caught on shrubs etc. were common, and I saw an adult on the trail near the lick. The Caribou-Targhee National Forest has the game trail shape file.

The field-mapped game trail follows the bottom of the Bighorn dolomite on its west end (the Apostles), climbs through thick, mature Douglas fir to the dolomite rim, then fades where the dolomite breaks down into talus, lower-angled bed rock. My search ended there, and it probably continues along the bottom of the dolomite cliffs or perhaps their top. Summer sheep locations are scattered along the Apostles area, and at 25 GPS "pings" this represents 125 hours of use over the two summers of 2008 and 2009. Curl-leaf mountain mahogany is common on the Bighorn dolomite as well as the Cambrian limestones below it. Stems that are accessible are browsed, but not severely as can happen on winter ranges elsewhere.

The topography and geology of the South Bowl area is not unique to the Tetons or NW Wyoming, and this allows comparing sheep use at these other areas with minimal skiing use. Good examples are the south-facing bowls between the North Fork of Darby Creek and the Wedge, which have the Madison limestone - Bighorn dolomite – limestone sequence, as well as mountain mahogany to the west at lower elevations. I see sheep in the mahogany area in spring on casual travels in this area.

Mountain mahogany is a preferred browse species and can provide unusual minerals as well as desirable calcium to phosphorus rations (Brotherson and Osayande 1980). Much of the mahogany in the Teton canyons is mature to old, with limited live branches and leaves low enough to be accessible browse. Being evergreen, it is possible that the fresher leaves on the ground could provide accessible, nutritious forage, and their curled edges would make them easier to lick-up from the ground. The rocky nature of mahogany sites limits fire spread, so natural fire rotations would be long, favoring mature plants, so fallen leaves could be an important forage source. The Apostles area has had high conifer cover (mostly limber pine and Douglas fir) and mountain mahogany since 1925 (Figures 19 and 20).

Figure 19. View east from the north rim of Teton Canyon. September 12, 1925. The dark timbered ridge at left is the slope above the Apostles, which are the dolomite cliffs below that partially show. A re-take of this scene on September 11, 2020 shows similar vegetation cover there, and some fire recovery on lower slopes near and on the valley floor. William C. Alden US Geological Survey.

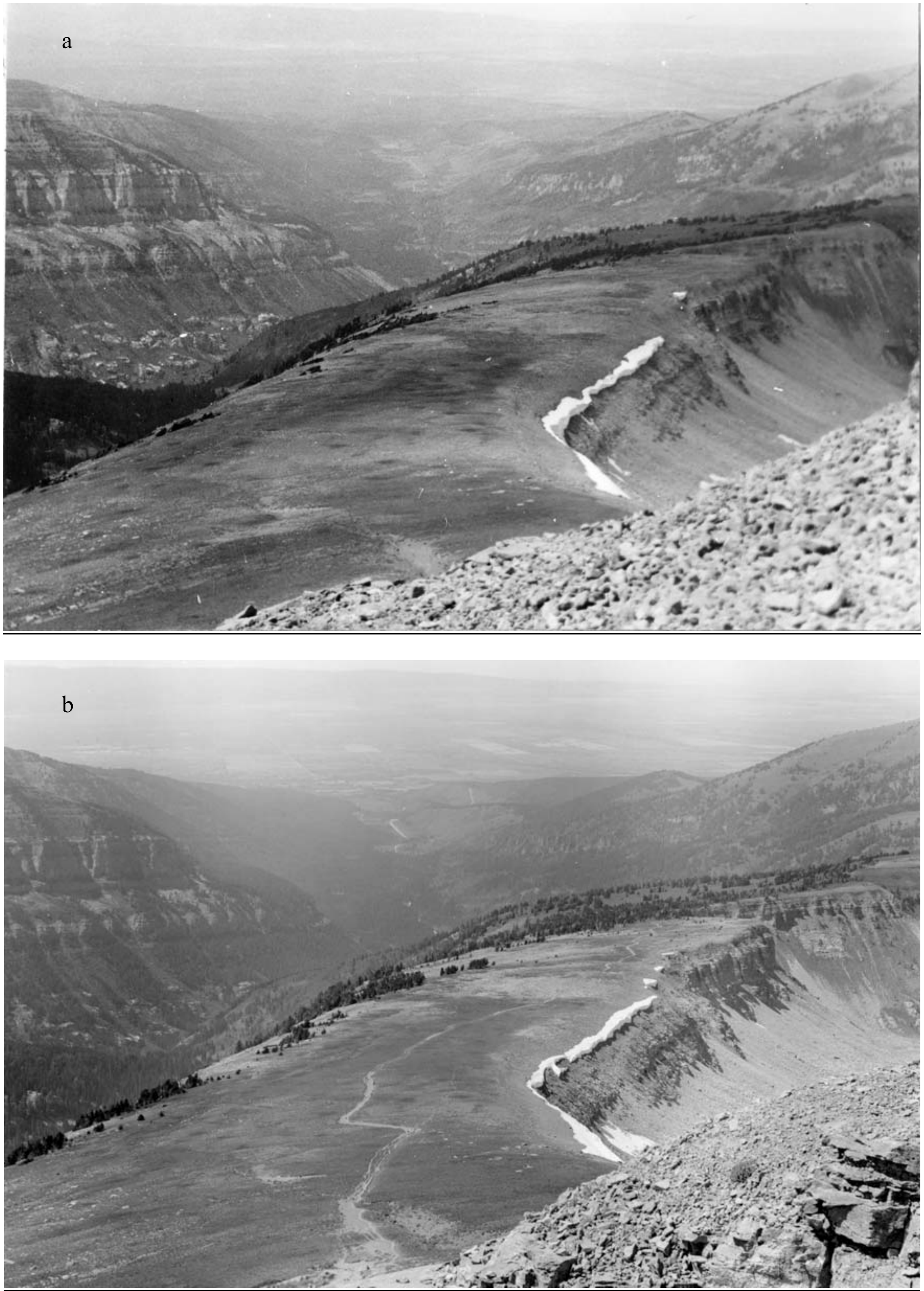

Figure 20. a) The west ridge of Table Mountain from its summit, with Teton Canyon beyond. July 1937. The upper-right quadrant shows the east side of the Mono Trees ridge, the Apostle Cliffs area in front of that, and part of the South Bowl at far upper-right. Conifers on the west ridge are whitebark pine. These are relatively young trees. Rudolph Edmund, University of Iowa. b) August 9, 2023. Mike Merigliano.

The mapped mineral lick is at the base of the dolostone (dolomite) part of the Bighorn dolomite formation. The chemical composition for it is nearly all calcium-magnesium carbonate with trace amounts of silica, aluminum, and iron oxides (Blackwelder 1912). I have passed this area several times, including spring, and have never seen mineral stains or seeps. There are several publications describing mineral licks, and I have seen many out in the wilds, but this one does not look like a mineral lick. Of course, the sheep are traveling to this key area, but it would be good to document actual licking of the rock to be sure it is minerals in the rock they are after or perhaps mountain mahogany or some other preferred browse species. The mahogany is unusual in the Teton range, and can be among escape terrain. Bighorn dolomite and adjacent rock types are very common in NW Wyoming and elsewhere.

The steep cliffy area below Mary's is part of the modeled Very High Probability use area for winter, but the snow is deep here too. The escape terrain here probably influenced the probability calculation. There are summer GPS pings here, and it could be an important lambing area, either now or in the future. Although outside of the proposed expansion, seasonal closures for lambing would be prudent.

More discussion about the nuances of the South Bowl area and sheep use is warranted before making a decision. The Teton Bighorn Sheep working group placed a designated route in the South Bowl area, and there was some confusion about whether the route was the thin line on the map or a broader area. The working group has done a lot of good things to protect sheep. But there was considerable controversy around potential closures. The issues are well known among the participants.

Considering the unusual amount of snow in the Tetons, with limited winter range, it is possible the herd has been naturally small and perhaps verging on a population sink in unfavorable years. The nearby Snake River Range had an historic bighorn sheep population, and the southern front (above Swan Valley) has a lot of escape terrain, winter browse, and less snow. The mid- and high-elevations have productive meadows. It is possible that the Snake River Range served as a source for the Teton herd. Just as the mountain goats are migrating to the Tetons now, the bighorn sheep probably did as well. Restoring disease-free bighorn sheep to the Snake River Range will be difficult on practical and political levels, and removal of the introduced mountain goats will make that even harder, but in the long-run, the Teton herd is likely to benefit from disease source from the goats (Lowrey et al. 2018), more genetic diversity, and perhaps a higher Teton Range population.

Water Quality and Quantity

The potential deterioration of water quality was raised during scoping, but the DEIS leaves the detailed investigations until the project phase when they will be actually approved or not (see section 2.54 on page 55). This is a practical approach, although much of the water quality impact could be from base area activities on private land, such as storm water runoff or other point and non-point pollution sources that evade the water treatment plant.

Although the proposed snowmaking wells at the base area are outside the US Forest Service jurisdiction, the made snow would be on national forest lands. Presumably, most of not all of the groundwater will return back into the aquifer so the local quantity affects will be small. My main concern is the water sources and how stable they are. Dry Creek Basin rests on an old strike valley filled with the Hominy Peak formation. This is an unusual geologic setting for development. The Hominy is part of Absaroka Volcanic super group (Love, Leopold and Love 1978), and includes similar conglomerates from volcanic source rocks. The super group is vast, but much of it is in wildlands. The Brooks Lake Lodge setting is on the Wiggins formation, which is also a conglomerate derived from volcanic rock. There have been water quality problems there but they are apparently more related to surface water and their naturally high phosphate.

What's immediately under the Hominy could matter to water quantity and quality. If it is the Darby formation, which is shaley, the aquifer in the Hominy could be more confined compared to the Madison and Bighorn. If it is the Madison, hydraulic conductivity would be higher, but any karst features would end at the Darby contact. The Bighorn dolomite dips far below the Hominy and the Pliocene volcanics west of the ski area. The western, exposed end of the Bighorn dolomite shows along both sides of Teton Canyon's floor about a mile east of Mill Creek.

The surface topography of the strike valley could influence groundwater flow. My main concern is the relative amounts of annual groundwater transport versus long-term storage in the Hominy or whatever the wells are accessing. All of the wells will probably be productive in the short term, but long-term use could gradually deplete them and affect the Alta water source, because the broad structure of the bedrock dips to the west and water could leave via gravity to the Teton Basin.

In the DEIS's geology report, on pages 4 and 5 is the following, astute statement:

"On the other hand, the GTR ridge between Teton Creek and South Leigh Creek has experienced erosion that has removed IPta and the upper half of Mm. Similarly, north of South Leigh Creek, erosion of the Paleozoic section has been even more severe, removing almost all of Mm, Darby Formation, and Bighorn Dolomite, uncovering a large outcropping of Cambrian rocks. This process suggests that the west flank of the Teton Range north of Teton Canyon, including the project area, has been warped upward relative to the rest of the Range. This upwarp caused erosion of the uppermost Paleozoic strata (IPta), and partial erosional planning off of Mm."

The same pattern (less Paleozoic rock) continues south of Darby Creek. This is all beyond academic musing. When viewing the Teton Range from the far west, it is small wonder that the founders of the ski area picked Fred's Mountain. Its open upper slopes stand out, largely because of the Madison limestone substrate, and it lacks the usual gentle, heavily forested slopes of Paleozoic to Permian-aged rock to its west that are so typical of the west slope south of Teton Canyon. The pre-Eocene strike valley, another unusual feature, provided convenient topography for a base area. The Pliocene volcanics provide a feasible route for the access road.

The saddle north-northeast of Point 8452 (the top of Mono Trees) is mapped as part of the Hominy Peak formation (Love, Leopold, and Love 1978). While passing over this saddle recently, I happened to notice scattered clasts of quartz monzonite, which clearly indicates glacial drift, and I am pretty sure the bedrock outcrops below were carbonate rock. It is possible that geologic mapping in the late 1960's or early 1970's used aerial photography to infer the Hominy based on more detailed work in Dry Creek basin, which was much more accessible. The distinction matters if the original topography of the strike valley and its Hominy Peak fill need to be better understood. Mill Creek has eroded through and separated the Hominy Peak, so for the present decision the continuity is not essential to know.

The drift on the saddle came from either or both of the upper forks of Teton Creek, or beyond over the hydrographic divide, the only places where quartz monzonite is common and accessible to the glaciers. The drift on the saddle is higher than all of the drift I have found along the north side of Teton Canyon, and the valley glacier passing through Teton Canyon was about 1,350-feet thick. Of course this has nothing to do with the DEIS, but this knowledge could come in handy for other resource management decisions. There is little information on west slope glaciation except for Rudy Edmunds work in the 1930's (Edmund 1938).

<u>Skier experience</u>

The DEIS mentions that ". . . the recently constructed Colter Lift within GTR's existing SUP boundary has the potential to increase accessibility to NFS lands and the JSW." This is true, but winter access to the JSW is easier via the Dreamcatcher lift, and the steep and avalanche-prone slope along the south side of Mary's Nipple (Peak 9930) is common to both access points. Also, gaining the summit of Peaked Mountain via the Dreamcatcher lift is not significantly different than it is from the Colter lift. Both require some uphill travel (112 feet from the Colter lift versus 200 feet from the Mary's-Peaked saddle). In winter, a ski-traverse from Dreamcatcher to the saddle east of Peaked Mtn. is more efficient than the summer trail.

The Colter lift increases the convenience of skiing the South Bowl, especially if one traverses back to the south ridge of peaked before skiing the lower part of the bowl (say down to the Patio, the bench at point 8292). This option provides a 1000-foot run, with a simple traverse back to the south ridge, through a gate at around 9000-feet elevation, and descent to the bottom of the Colter lift from there.

The DEIS points out the avalanche safety situation, and although not quantified, it appears that expansion into the South Bowl would allow avalanche control and ski patrol services there, but more skiers than now would likely to ski into nearby avalanche-prone terrain outside of the controlled area. So there is probably no net-gain in safety. The chutes within the cliffy area below Mary's is probably what the DEIS is referring to (Figure 21). This terrain requires more skill, and slides are probably more frequent than in the South Bowl, where if memory serves me well, slides tend to be very large and infrequent. Large storm events could build unstable snow on top of skier-compacted and bomb-stabilized slopes. Under such circumstances, the slopes and lift would be closed. The backcountry gates can still be closed under these circumstances too, so the hazard to the public, whether the expansion happens or not is about the same. Increased skier safety does not justify expansion into the South Bowl. If county search and rescue is burdened by South Bowl incidents, an arrangement with GTR ski patrol should be pursued to have primary responsibility and first-responder status go to GTR's ski patrol.

Figure 21. Typical ski terrain within the Bighorn dolomite cliffs below Peak 9930 (Mary's Nipple). March 5, 2021. This terrain is accessible from the Dream Catcher lift as well as the Colter lift, via backcountry gates.

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