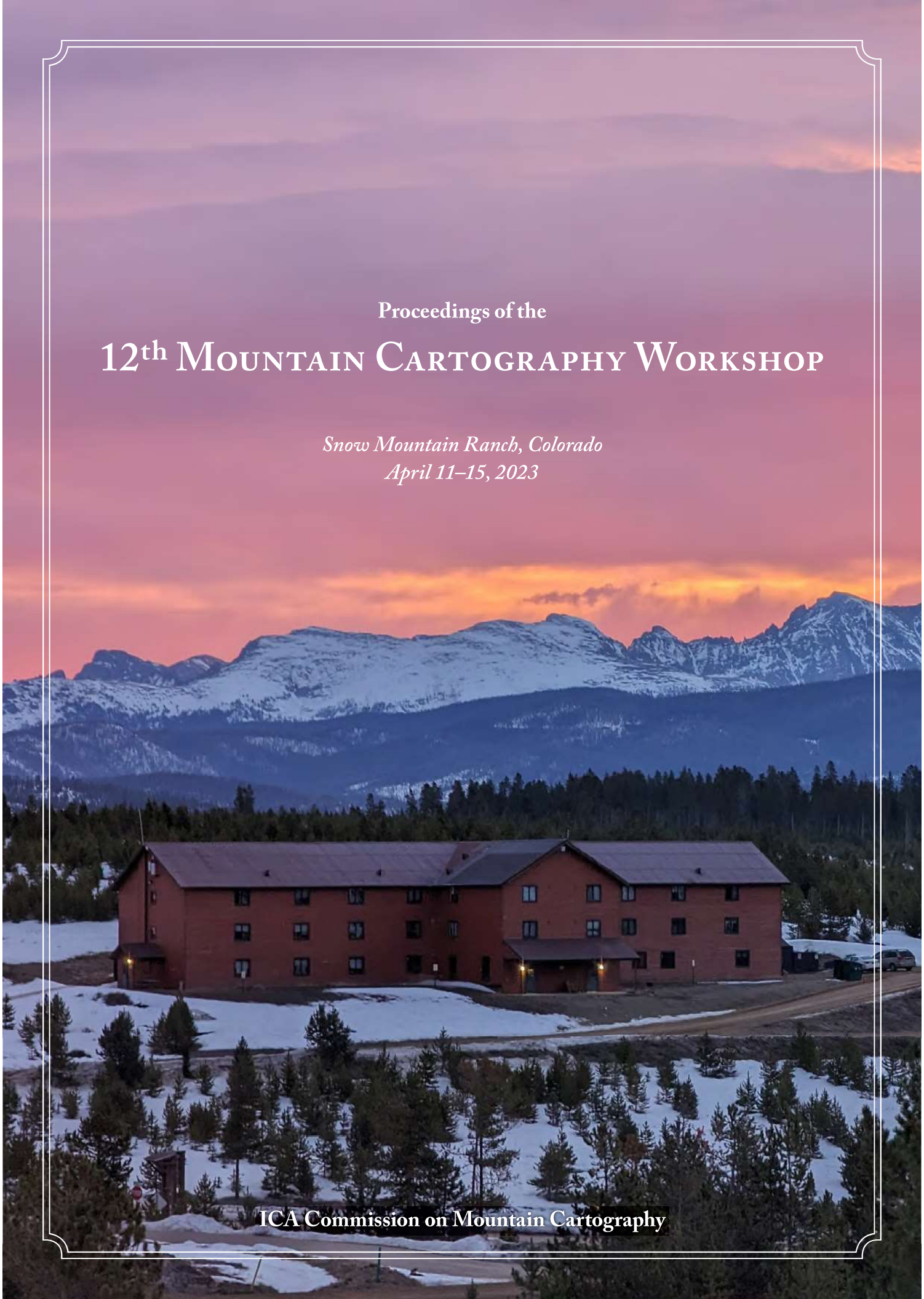
Proceedings of the

12th Mountain Cartography Workshop

Snow Mountain Ranch, Colorado
April 11–15, 2023



ICA Commission on Mountain Cartography

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Crossing Cochetopa: Time Travel, Exploration and Discovery Across the Continental Divide

Brad Allen

"Doing history is essentially an act of imagination."

Professor David Chang[1]

In the spring of 2022, I crossed the Continental Divide through the Cochetopa Pass complex[2] in the San Juan Mountains of Colorado. I was retracing a portion of an 1853 expedition led by Captain John W. Gunnison from the US Army Corps of Topographical Engineers, who was exploring "the natural Central route" along the 38th parallel. The Gunnison expedition was just one of several simultaneously fanning out across the vast territory of the trans-Mississippi west to determine the "most practicable and economical route for a railroad from the Mississippi to the Pacific." These were the expeditions of the Pacific Railroad Surveys (PRRS) of 1853–1855, the largest peacetime expeditionary force the United States had deployed before the Civil War.

My reconnaissance of Cochetopa was part of research for a book on the history of the PRRS expeditions and the creation of the first accurate map of the western United States which resulted from them.[3] "Crossing Cochetopa, Time Travel, Exploration and Discovery Across the Continental Divide" describes my cartographic examination of Gunnison's track and exploration of how modern GIS and visualization tools can bring 165-year-old maps, journals and images alive as an immersive and engaging experience.

1. Exploring "The Natural Central Route"

Missouri's powerful senior senator Thomas Hart Benton had long championed westward expansion and construction of a railroad to the Pacific. Benton's influence in Washington ensured that his son-in-law John C. Frémont was assigned to lead three expeditions west between 1842 and 1846 as a member of the elite Army Corps of Topographical Engineers. Frémont's consequential maps and reports from his exploration of the Oregon Trail earned him fame and the nickname "the Great Pathfinder" while encouraging a stream of emigrants to head west, and his report on the Great Salt Lake inspired Brigham Young to lead his Mormon disciples to their Kingdom of Deseret.

As debate over a Pacific railroad grew, Benton and Frémont were the most vocal boosters of routing the transcontinental link along the 38th parallel. Supporters pointed out that the gateway city of St. Louis and the boomtown of San Francisco both lay in the same latitude. This happy coincidence of geography, they argued,

Figure 2. Detail showing Cochetopa Pass on the 1855 Map of the Pacific Railroad Survey. Library of Congress.

Figure 2. Entrance to Cochetopa looking up Sahwatch Creek, Septbr.1st. *Richard Kern, Pacific Railroad Surveys, 1853.*

[1] Professor Chang made that comment as he was advising his students on the importance of suspending one's contemporary point of view when working with primary sources, and I had the great good fortune to sit in on his class on American Indian History at the University of Minnesota as a non-degree adult student. His comment struck me at the time as obvious yet profoundly insightful and has stayed with me ever since.

[2] Several trails skirted Cochetopa Dome across the Continental Divide. The two most traveled in 1853 were named "Carnero Pass" and, four miles to the north, "Cochetopa Pass." Subsequent name changes have attached "Cochetopa Pass" on Saguache County Road NN14 to the original Carnero Pass and "North Pass" on Colorado Highway N114 to the crossing Benton, Frémont, and Gunnison all referred to as Cochetopa.

[3] The Pacific Railroad Surveys were the largest peacetime expeditionary force the United States had mounted up to that point. The 13 volume reports of the expeditions were issued between 1855 and 1860. See United States War Dept (1855–1860), referred to in the text and subsequent notes as "USWD." It will refer to the report on the 38th parallel expedition in Volume II, unless otherwise noted.

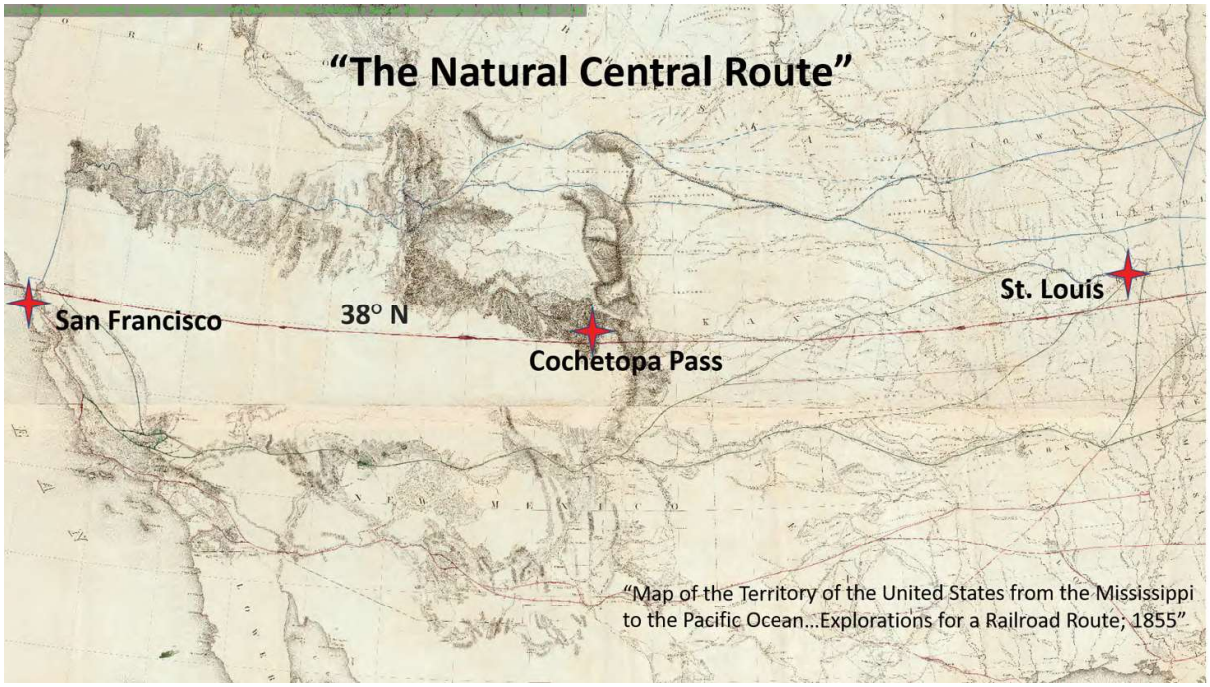

Figure 3. The "Natural" Central route along the 38th parallel connects St. Louis on the Mississippi River with San Francisco, crossing the Continental Divide through Cochetopa Pass mid-way between the two cities.

provided the most direct and therefore most practical path for the country—a "natural Central route." Equally energetic factions favoring alternate routes dismissed the 38th, pointing out that the rugged, snow-capped Colorado Rocky Mountains blocked the way. Benton and Frémont countered that Cochetopa Pass, taken from the Ute expression meaning "buffalo crossing," lay equidistant between St. Louis and San Francisco along the 38th parallel, providing a workable passage across the Continental Divide. Thus, in mid-nineteenth-century America, Cochetopa Pass became a linchpin of the debate over the Pacific Railroad.

Between 1848 and 1853, four different expeditions set out to examine the topography around Cochetopa with a railroad in mind, including the Pacific Railroad Survey expedition led by Captain John W. Gunnison. A total of 21 men perished on three of those expeditions from a combination of starvation, exposure, and attacks by hostile Indians, marking the "natural Central route" and Cochetopa itself as the costliest in human terms of any reconnaissance of the Pacific Railroad project.[4]

Among the dead were Gunnison, topographer/artist Richard Kern and six more men killed in a surprise attack along the banks of the Sevier River in Utah a few weeks after crossing Cochetopa.[5] Nonetheless, Gunnison's notes and his journal, recovered after the massacre, dismissed Benton's favored route as impractical for a railroad. The pass itself was relatively easily crossed, but its remote location, high altitude and difficult approaches,

[4] The topographer and artist Richard Kern, with his two brothers Benjamin and Edward, had accompanied Frémont on his disastrous 1848–1849 trek. Twelve men, including Benjamin Kern, perished on this unsuccessful attempt which Frémont nevertheless claimed as a success. With Richard's death along the banks of the Sevier River in Utah just a few weeks after passing through Cochetopa, the Kern family paid a high price for exploration of the Central Route. Also surviving the ill-fated 1848 expedition was the fastidious German botanist, Frederick Creutzfeldt who would perish with Gunnison and Kern in Utah.

Benton had also arranged for another favorable report on the Central Route, arranging for the appointment his friend E. F. Beale as Commissioner of Indian Affairs for California. Beale and his cousin, G. W. Heap traveled overland to California along the 38th parallel ahead of Gunnison without suffering any fatalities and published a favorable account of the journey (Beale and Heap 1854).

[5] Gunnison, with eleven men, had split off from the main contingent to explore the Sevier and a possible connection to the California Trail. His party was attacked early on the morning of October 26, 1853 as they were finishing breakfast. The attackers, by most accounts, were a band of Paiutes seeking revenge for the killing of an elder by a California-bound emigrant train a few weeks prior to Gunnison's arrival. Rumors arose in some quarters that the Mormon hierarchy were behind the massacre, stoking anti-Mormon sentiment, which was already high, in a prelude to the Mountain Meadows massacre and the Mormon War a few years later. See Mumey (1955) for an account of the attack and Fielding (1993) for a critical examination of the Mormon role in the events surrounding the massacre.

particularly along the Grand (later renamed the Gunnison) River to the west, made construction of a railroad difficult, time-consuming and expensive compared with alternate routes (USWD 1855–1860, 56). Kern's landscape sketches were also recovered and were recreated as several colored lithographs in the official report of the expedition published in 1855.

The work of these two men, Gunnison and Kern, is the subject of this paper. "Crossing Cochetopa: Time Travel, Exploration and Discovery" describes my examination of the region, both cartographic and topographic. I wanted to explore the approaches to Cochetopa, experience the topography described in the official expedition reports and see for myself the geographic advantages and challenges the Central route presented as a path across the continent. While I had previously explored portions of this and other PRRS expedition routes, the 2022 reconnaissance was my first on-the-ground examination of the Central route across the Great Divide. Though travelling in the reverse direction—moving from west to east—a friend and I retraced as best we could the track Gunnison had followed between Bent's Fort on the Arkansas River and the deep chasms of the Gunnison River.

Nineteenth century topographic expeditions were cumbersome affairs and Gunnison's, though not the largest of the Pacific Railroad surveys, was no exception. More than one hundred mules hauled eighteen wagonloads of equipment and supplies, the first wagons across this portion of the Rockies (USWD 1855–1860, 70), while a small herd of horses carried the caravan numbering approximately 50 men. In addition to Gunnison and his second-in-command, Lt. Edwin G. Beckwith, the military component included a company of 32 mounted dragoons providing both protection and labor for the arduous crossing. The remainder were civilians. They included the topographer and artist Richard Kern, whose sketches of the landscapes will be discussed later, three scientists,[6] a few assistants, a cadre of teamsters and camp roustabouts, and a changing roster of guides familiar with a particular trail segment.

Progress could be tediously slow due to the sheer size of the train, the challenges of wilderness travel—especially with wagons—and the constant requirements of topographical measurement-taking and scientific exploration. While mule teams pulled the wagons, manual labor also moved the train along as men cut temporary roads where none existed or joined the mules in hauling wagons by rope up and down steep inclines, over boulder-strewn trail segments, out of deep mud and across rain swollen streams. As the expedition progressed, the accompanying botanist and geologist filled their own notebooks and collected specimens from the largely unexamined natural laboratory of the trans-Mississippi west.

The expedition astronomer, artist/topographer, and assistants were continuously making sketches, gauging geographic features, measuring their position and recording their observations. They calculated latitudes (and sometimes longitudes)[7] from thousands of celestial observations when the weather allowed, logged altitude changes with delicate, and oft-repaired barometers, and computed point-to-point distances using cumbersome surveyor's chains as well as odometers attached to some of the wagons. They also recorded temperature, precipitation, and magnetic variations along the route, estimated the relative height of mountain peaks, and triangulated their position against known prominent landmarks. Whenever possible, they would replicate their measurements with separate sets of observations. These detailed data sets along with topographers' notes and sketches would later be compiled in the report of the expedition and a series of maps of the region.

Over their entire 1,374-mile trek from Westport on the Kansas River to the Sevier River in Utah, where Gunnison and seven of his men were killed by Paiutes, they averaged almost eleven miles a day. On a good day the expedition advanced twenty or more miles. But during the most difficult stretch, a grueling 42-day, 340-mile trek from the foothills of the Sangre de Cristo range across Cochetopa to the Gunnison River, they averaged fewer than eight miles per day. They took two long days to bring the wagons less than a mile through the heavily wooded Sangre de Cristo pass (USWD 1855–1860, Ch. X).

An equally laborious task awaited the Army cartographers who compiled the voluminous field notes, astronomical and meteorological observations, and barometric and magnetic measurements in the Office of Pacific Railroad Explorations and Surveys back in Washington. All of this information, supplemented by descriptions of the topography contained in journals and artists' annotated sketches, was compiled and meticulously translated into a geodetic frame, resulting in

[6] The expedition astronomer Sheppard Homans, whose tasks were more topographical measurement than celestial investigation, complained of the deficient instruments for ascertaining longitude. Dr. James Schiel, as was typical of nineteenth century naturalists, acted as both geologist and surgeon. The botanist Frederick Creutzfeldt, like Richard Kern, was a survivor of the Frémont disaster in 1848–49 and also perished in the attack along the Sevier, along with Kern, Gunnison and five others. His notebooks and personal diary of the expedition were retrieved after his death. The diary, written in German and only discovered years later, was highly critical of Gunnison's leadership.

[7] The topogs were plagued by instrument defects and damage. Gunnison's expedition stopped recording observations for longitude due to "defects in instrumentation" most likely chronometers which were difficult to keep calibrated over the bumps encountered when crossing rough mountain terrain (USWD 1855–1860, 113).

a series of maps and altitude profiles published between 1855 and 1860.[8] The small scale "General Map," issued in 1857 and described later, is of particular interest to me.

Unlike the men of the PRRS, when I crossed Cochetopa in 2022 I carried the advantages of twenty-first century technology and benefited from modern infrastructure. Graded gravel and paved roads eased my way through the mountains. National Forest Service personnel and NFS road condition reports aided my planning. Detailed topographic maps, marked trails, campsites, cabins, and roadside markers guided my itinerary. Unlike Gunnison, whose observations of celestial bodies to determine his latitude and longitude were dependent on clear skies and accommodating weather, my handheld GPS tracker, smartphone camera, and digital watch all communicated day or night with an overhead web of manmade satellites, while ignoring cloud cover and rainstorms. With little or no effort on my part, these tracking devices marked my progress virtually step-by-step, continuously recording latitude, longitude, altitude, date, and time at least as accurately as Gunnison's recordings of sun altitudes, barometric readings, and occultations of Jupiter's moons. The photos I took with my cellphone camera not only captured an image of the landscape but fixed the precise location, date, and time. While my digital SLR camera does not record GPS data, it did mark the date and time I took each photo, enabling me to place every shot within a chronology and therefore in an approximate location along my digital track. All of this automated geodetic data collecting greatly simplified later re-creation and examination of my reconnaissance. My chief concern centered on keeping these devices charged.

But all these advantages of modern infrastructure and technology can pose a challenge as well—especially if one is trying, as I am, to comprehend an earlier trek through a rugged mountain landscape more than a century and a half after the fact. We live in a GPS-enabled twenty-first-century world saturated in instantaneous and pervasive **precise** locational information ("Siri, where's the nearest Starbucks?"). Put simply, I wondered how a twenty-first-century observer can better understand the **experience** of Gunnison and his men passing through this rugged and remote landscape, what the records of their trek can tell us about their perceptions and, in the case of Cochetopa Pass specifically, the challenges of building a railroad along Benton's Central route. I wanted to evaluate the Gunnison Expedition, not with perfect 20-20 hindsight but within the context of their own time, purposes and nineteenth-century technologies.

In thinking about these challenges, and recalling Professor Chang's dictum, I employed twenty-first-century technology in an attempt to pierce the experiential barrier that this same technology can also create. In a word, I wanted to see if modern GIS and visualization tools could take 165-year-old maps, journals, and lithographs sitting in dusty archives and bring them alive as an immersive and engaging experience for a modern audience.

As the title indicates, I've organized this paper into three parts. *Time Travel* describes the results of georeferencing the historical map onto a modern basemap, tracing Gunnison's route onto the now digitized old map and comparing Gunnison's track depicted on the two. In *Exploration* I describe my attempt to project Gunnison's track and my own through Cochetopa onto Google Earth with its dramatic visualization tools. In *Discovery* I describe a geographic detective story, trying to identify, locate, and document specific points of view (POVs) where the Gunnison expedition artist Richard Kern stood when sketching the scenes that were posthumously rendered as colored lithographs and printed in the official Reports of Explorations.

In evaluating each of these approaches, I identify both what was learned and the limitations of each as well as untapped opportunities for further inquiry. I am neither a trained cartographer nor a skilled GIS practitioner, so errors, misstatements and missed opportunities reflect those shortcomings. Nevertheless, "Crossing Cochetopa," I believe, hints at the possibilities these modern tools promise for historical research as well as their potential benefits for a diverse audience including students, teachers, public historians, historic trails custodians, recreational hikers, experienced GIS practitioners, and an interested public. I also hope it has been true to Professor Chang's advice.

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[8] Warren produced the first PRRS Map in early 1855. He described it as "a hurried compilation," made only to display the different proposed railroad routes and it is half the scale (1:6,000,000) of the subsequent General Map. As a result, it portrays limited topographic details (i.e., major rivers and mountain ranges) and lacks the significant topographic accomplishment of Warren's later PRRS maps. He issued the first "General Map" later that year. The second edition multi-colored "Indian Map" was issued in 1857, and a third edition, without color, was issued in 1858. Each of these maps incorporated topographical corrections, changes in designations, and details and a somewhat different, always expanding list of "Authorities," i.e., exploratory expeditions cited as contributing geographic information, beginning with "Capts. Lewis and Clarke, USA, Explorations across the Continent…1804-5-6." As new surveys were conducted the list of authorities continued to be adjusted, some expeditions being removed, others added, descriptions and leaders altered. Warren left the PRRS project in 1858 and the Topographical Engineers were folded into the Corps of Engineers during the Civil War. Two post-war maps citing the PRRS and Warren were issued in 1867 and 1868. Two noteworthy changes appear on these subsequent maps. "The Hon. Jeff'n Davis, Sec'y of War" is named on the early editions. All reference to the later president of the Confederacy was expunged after the war. The final PRRS map in 1868 portrayed the newly acquired Territory of Alaska in an inset, a cartographic convention that survives, with the subsequent inclusion of Hawaii as well, to this day.

2. The Pacific Railroad Surveys

Mid-nineteenth-century America was a hopeful yet precarious place.

In the brief span of 25 months, from December 1845 to February 1848, the country grew by an astounding two-thirds. Settlement of the Oregon boundary dispute, annexation of Texas and acquisition of *Alta California* and *Nuevo Mexico* following the Mexican-American War added 1.2 million square miles to the country's recognized territory. Then, in December of 1848, President James K. Polk confirmed rumors of the gold find along the American River in the foothills of the Sierras east of Sacramento. What had been a fluctuating stream of settlers heading primarily to Oregon and Utah Territories became a tsunami of emigration to California. By early 1853, an estimated quarter of a million fortune seekers had arrived in California traveling overland and by sea (Unruh 1982, 85).

The gold rush not only set off a mass migration, it also focused the country's attention on the Pacific Coast. For more than a decade politicians, editorialists, and businessmen had debated building a railroad connecting the continent and opening up an efficient western trade route to Asia. Now the "railroad question" was no longer just about commerce. A railroad to the Pacific became an issue of sovereignty and national security. The public and politicians wanted to protect the rich gold fields and prosperous settlements of Americans along the Pacific against an acquisitive and avaricious naval power, Great Britain. In the decade before the Civil War, they also felt a growing urgency to link the country with an iron belt east to west even as sectional divisions were pulling it apart North from South.

Still, the intense national debate over "the railroad question"—that is whether, where, and how a railroad should be built—could not be resolved, with the question of **where** to locate the eastern terminus being the most contentious.

Connecting "the states" back east with the Pacific coast would be the prize of a generation. As railroad promoters and land speculators jockeyed for influence, congressmen from the interior states and their supporters back home vied for government support for their favored route over all others. Political rivalries, sectional loyalties, economic interests, and personal financial investments energized each faction against the other. Even if those rivalries could somehow be smoothed over, the great intractable obstacle casting a shadow over every important national debate in pre-Civil War America was the question of whether slavery would be extended into the newly acquired territories. So, Congress remained hopelessly deadlocked.

But Congressional backers of a railroad were determined. For weeks during the lame duck session in early 1853, the Senate debated the railroad question—and virtually nothing else. Still, they were unable to settle the question of where to route the railroad. In the vain hope that "science" and a surveyor's transit could break through the political impasse, the frustrated lawmakers instead funded a study. On the last day before the newly elected President Franklin Pierce and a new Congress would be seated, the legislators added $150,000 to the Army Appropriations Act, charging the elite Army Corps of Topographical Engineers, or *topogs*, "to ascertain the most practicable and economical route for a railroad from the Mississippi to the Pacific." Thus, was launched the Pacific Railroad Surveys (PRRS).[9]

It was the largest peace-time expeditionary force the US had mounted up until that point. It also was the last of its kind, ending the era of continental exploration begun by Lewis and Clark fifty years earlier.[10] Hundreds of men—surveyors, soldiers, scientists, artists, guides and camp hands—fanned out across the vast territory of the trans-Mississippi West.

Between 1853 and 1855 expeditions traversed the four east-to-west corridors with the most support in Congress and the country (Albright 1921, Ch. 1). Pierce's new Secretary of War, Jefferson Davis of Mississippi, also an enthusiastic supporter of building a Pacific railroad, identified each route to be explored and had a hand in picking each expedition leader.

The northernmost expedition, led by the newly appointed Governor of Washington Territory, Isaac Stevens, traveled between the 47th and 49th parallels from St. Paul over the northern Rockies to Puget Sound. Capt. Gunnison led exploration of what was called the "natural Central route" along the 38th parallel from the western border of Missouri, following the Kansas River to the Arkansas, crossing the Rocky Mountains in Colorado then proceeding to Utah Territory. A third expedition, led by Lt. Amiel W. Whipple, explored the 35th parallel route through Arizona, New Mexico and the Mojave Desert in Southern California. North-south corridors connecting San Diego and Puget Sound to San Francisco, as well as crossings through the Coast Range and Sierra Nevada Mountains, were explored by Capt. Robert Williamson and Lt. John Parke.

The far southern route along the 32nd parallel was the favorite of Secretary Davis. Initially he did not authorize an expedition along the 32nd, because it had been extensively explored by the Mexican Boundary Commission to delineate the new international border after the Mexican-American War. Davis thought the report of the Boundary Commission clearly identified the 32nd as the logical choice. But he feared that other PRRS expeditions would overshadow the conclusions of the

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[9] For a more detailed account of the Congressional machinations see Albright (1921).

[10] The great western explorations after the Civil War filled in the map of the West with greater geodetic precision and more rigorous scientific focus. But rather than replacing the Warren maps, they built onto the foundation established by them.

Boundary Survey, so Davis hurriedly added the far southern route, divided into two segments, one led by Lt. John Parke the other by Capt. John Pope.

An impatient Congress had insisted the topogs report back in eleven months—an impossible task! The expeditions would be in the field until 1855, going back to Congress twice more for additional appropriations totaling $450,000. They were not actually charting specific lines but evaluating the practicality of constructing and operating a railroad within each corridor. So, despite its name, the Pacific Railroad Surveys were less surveys and more reconnaissance, *Grand Reconnaissance.*

3. G.K. Warren and the 1857 "Indian Map"

While the PRRS expeditions could not settle the question of where to route the Pacific railroad, they accomplished much. Expedition scientists and naturalists produced careful field notes and studies documenting what they saw, including hundreds of new plant and animal species. They described the complex geology and convoluted mountain chains of the West. And they filled the research benches of the young Smithsonian Institution with animal, plant, and mineral specimens. Their research findings, delivered in papers and scientific gatherings, established the authority and professionalism of American science and scientists as equal to the leading academies of Europe. It all became an encyclopedia of the West and foundational reading for a generation of naturalists and scientists.

The reports of the PRRS expeditions were printed in 12 volumes between 1855 and 1860. The expeditions' narrative described fertile river valleys, lush prairies, vast open plains, and arid deserts populated by abundant game and a diverse array of Native Americans. Hundreds of images, some in color, depicted dramatic western landscapes, familiar as well as never-before-seen plants and animals, and exotic human inhabitants in their native dress. It all fed a public hungry for information about this largely unknown new part of the country and it described possible areas for habitation, settlement, and development across a territory that only a few years earlier had been designated on maps as "the Great American Desert."

The most consequential accomplishment of the PRRS expeditions was the series of maps produced by the Office of Pacific Explorations and Surveys, particularly the "General Map," which accurately portrayed for the first time the major geographic features of the trans-Mississippi West in proper relation to one another. Drawn to a scale of 1:3 million, the General Map spanned more than 26 degrees of latitude and 44 degrees of longitude, and pictured more than four million square miles of North America from the Great Lakes to the Pacific.

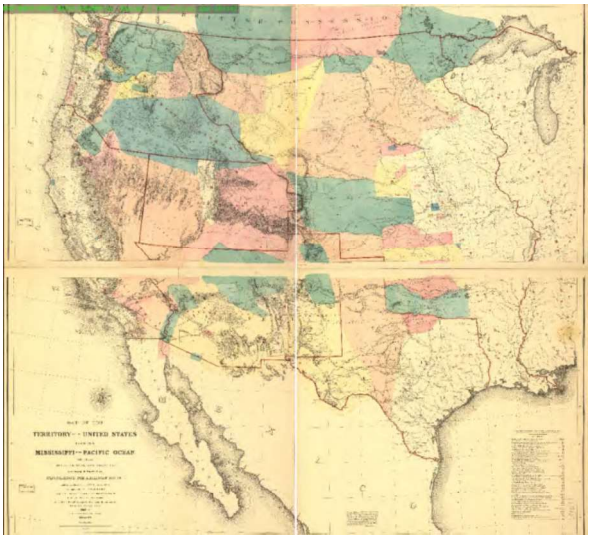

Figure 4. Map of the Territory of the United States from the Mississippi River to the Pacific Ocean. *This is the Warren General Map, also known as the "Indian Map," published in 1857. Library of Congress.*

Also known as the Warren Map, named after the young Army Lieutenant G. K. Warren, who was chief cartographer for the PRRS between 1855 and 1859,[11] it incorporated geographic information not only from the PRRS expeditions but dozens of others as well, beginning with Lewis and Clark's 1804–1806 trek to the mouth of the Columbia River. It fell to the meticulous Warren to compile all this geographic data into a coherent whole, reconciling inconsistencies across fifty years of explorations.[12]

The Warren Map has been described by historians as "a monumental work… the culminating achievement of the Great Reconnaissance period," a "foundation map," and "the most important map of the American West prior to the Civil War" (Schulten 2007; van Ee 2002; Goetzmann 1971, 316)

It was as if the country could finally hold up a mirror and see its image accurately reflected. And this mirror was more than just a map. Taken together with the descriptions, illustrations and new scientific knowledge emanating from the expeditions, the Pacific Railroad Surveys did not just produce a picture of the trans-Mississippi West, but they galvanized Americans' belief in the promise and the possibility of a country that would dare to span a continent.

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[11] Warren was only directly involved in the first three maps, before he left the PRRS project to teach at West Point. Warren is best remembered for his pivotal role in calling for reinforcement of Little Round Top during the Battle of Gettysburg.

[12] Six different editions were produced between 1855 and 1868 crediting Warren and the PRRS even as revisions incorporated information gleaned from subsequent expeditions.

While five editions of the general map were issued between 1855 and 1868, the second edition, issued in 1857, is unlike any other. The colorful map focuses the viewer's attention on regions of occupation and control held by various indigenous groups across the West, not necessarily aligned with established treaties but portraying the reality on the ground in a multi-colored mosaic. The 1855 and 1858 editions were annotated with Native American tribal names, but none delineated a clear sense of territorial control that the 1857 map did. Later maps, produced after the Civil War, eliminated tribal designations altogether. Warren's 1857 map, more than any other, not only portrayed a complicated physical geography, but the complex human landscape and convoluted geopolitical reality of the nineteenth century trans-Mississippi West, a complex reality that was by no means static but one that would persist for decades of conflict and expansion. Warren referred to the 1857 map as "the Indian map" and considered it his crowning achievement (Bernstein 2018, 198).

4. *Time Travel*: Georeferencing the Warren 1857 Map

I took my first steps in GIS cartographic exploration in 2013 when I was just beginning my work on the PRRS and enrolled in a course on techniques of historical research as an adult non-degree student at the University of Minnesota. The course, taught by Professor Donna Gabbacia (now at the University of Toronto) focused on creating collaborative digital humanities projects, and I proposed one based on the Pacific Railroad Surveys. Five undergraduate history students chose to join me and together we created a website about the PRRS with curriculum guides for secondary school teachers and students. My contribution, in addition to being the content expert, was to prepare the digital version of the 1857 Warren Map.

I found the original edition in excellent condition within the collection of the University's John R. Borchert Map Library. The small-scale map is printed on two 20 ½″ x 45″ sheets split into north and south segments between the 35th and 36th parallels. Each sheet was individually scanned on a Context SD4430 high resolution scanner as a JPEG 2000 image at 600 dpi. With the assistance of the U-Spatial Help Desk in the Department of Geography at the University, I then georeferenced these digitized images in Esri ArcGIS 10.2, using the NAD 1983 Contiguous USA Albers coordinate system for the south sheet and NAD 1983 2011 Contiguous USA Albers coordinate system for the north sheet, with the central meridian reset at -106 degrees longitude in each.

Using the ArcGIS toolkit, I then manually traced the routes of the four different east-west PRRS expeditions on this now digitized and georeferenced historical map, marking and annotating specific locations along or near the routes chosen by me and my team members. We incorporated quotes and digital images of landscape scenes taken from the PRRS reports or other public domain sources. The resulting web maps were then projected using a Web Mercator Auxiliary Sphere projection with an Esri World Topographic Map as the basemap and put on a public-facing website (arcgis.com/home/webmap/viewer.html?webmap=dd4347b6cec84508a6ff95b76d3bdc2e).

The final map posted on the UMN project web site transformed the original rectangular map image to match the underlying modern basemap, creating the slightly curved map shown here which occurred during the transformation process and is not unusual when georeferencing old maps.

More recently, I've returned to this map to make a detailed cartographic examination along two different lines of inquiry; accuracy and comparisons over time.

In examining the historic map's accuracy, I am asking three questions. How closely does the georeferenced map align with the same geodetic points on a basemap? What is the extent and range of variance? What are possible sources of variance?

I sampled a couple of dozen known places on the Warren map that were not georeferencing control points to compare with their location on the underlying basemap. These sampled points included features such as trading forts, river confluences, mountain passes and peaks and prominent named geographic features (e.g., Independence Rock, Huerfano Butte).

I found that the same location identified on the original map and the basemap could vary by as much as 20 miles. Not surprisingly, observed variances tended to be larger at the map edges. I also observed portions of Gunnison's track traced on the Warren map to be clearly misaligned between the original map and a basemap, up to five miles in places.

For example, I observed Gunnison's track projected onto the basemap was located on the wrong side of a river or a mountain range in several instances. In other instances, however, Gunnison's track observed on the basemap aligned almost perfectly with a known location. Bent's Old Fort on the Arkansas River illustrates both points and

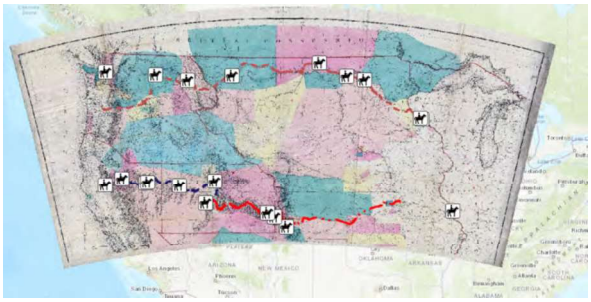

Figure 5. Warren's 1857 General Map, North Sheet, georeferenced with Stevens and Gunnison Expeditions shown, University of Minnesota Digital Humanities Web Site Project, 2013.

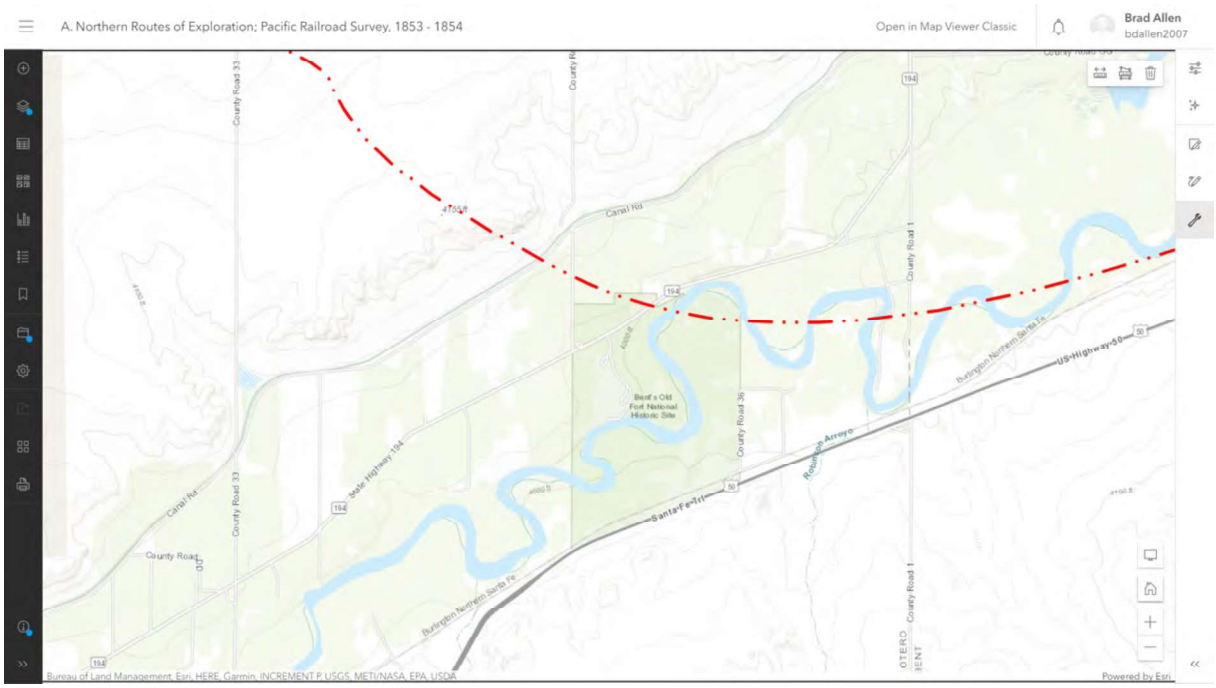

Figure 6. Gunnison's track passing the ruins of Old Bent's Fort (now a national historic site re-creation) as shown on Esri's Imagery Hybrid basemap. Notice the track is shown recrossing the Arkansas River, although the expedition kept to the north bank.

offers some hints at the source of variance, at least at this location.

Gunnison travelled along the north bank of the Arkansas River passing the ruins of William Bent's original trading post. As shown on the reprojected version of Warren's map though, Gunnison's track projected onto the basemap does not keep to the north bank of the meandering Arkansas, but crosses and recrosses it several times, which in fact he did not do. Gunnison's track on the basemap does, however, cross through the location of Old Bent's Fort Historic Site, which accurately reflects the expedition's passage by the burnt-out adobe walls described in the expedition journal.

Did the Warren map mis-locate Gunnison's trail or was I seeing the limits of georeferencing an historical map? The Arkansas as depicted on the old map meanders, but not with the same sinuous contours the actual river follows. Even allowing for some changes in the river's course over the intervening century-and-a-half, I concluded that the small-scale map was *illustrating* Gunnison's path along the river rather than charting its precise course.

4.1 Sources of Variance

Professor Bradley Skopyk, Associate Professor of History at SUNY Binghamton, writes that georeferenced historic maps are "subject to a double threat of error: the imprecision/error of base features and imprecision/error of primary features on the original map" (Skopyk 2021).[13] While error and imprecision can come from a variety of sources, here I focus on four; vintage of the original map, its scale, its intended purpose and the experience and skill of the GIS practitioner/examiner (in this case, me).

4.2 Vintage

The first limitation starts with the recognition that a historical map compiled in the 1850's was drawn without benefit of the foundational reference systems of modern North American topographic maps beginning with the Clarke ellipsoid of 1866 and the North American Datum of 1927 (NAD27). In addition, geographic surveys in remote locations were dependent on delicate equipment subject to the shocks of rugged travel. All of the expeditions cited difficulties in keeping barometers in working order. Both the Gunnison and Stevens's expeditions between the 47th to 49th parallels took very

[13] Skopyk also emphasizes the importance of carefully choosing georeferencing control points which are independent of the cartographic purpose of an original historical map. He demonstrates this by georeferencing a 1925 map which delineates irrigation infrastructure near Mexico City. In his example, he avoided using any hydrographic features, including irrigation canals or natural water courses, as control points on the presumption that non-hydrographic features such as churches or the intersection of rail, road and municipal boundaries were known and fixed elements of an established basemap over which hydrologic features were added.

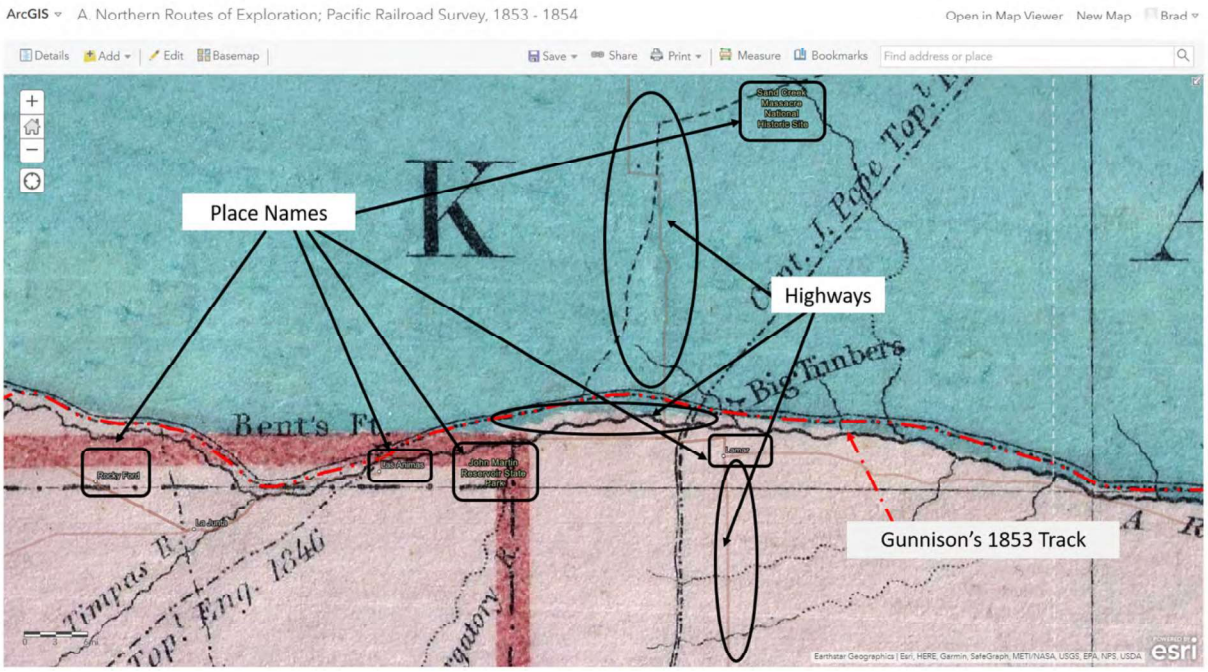

Figure 7. Detail of Warren's 1857 map showing Gunnison's track along the Arkansas River (dotted red line), georeferenced and projected atop Esri's Imagery Hybrid basemap, showing place names and highways.

few celestial observations for longitude, as Gunnison's expedition astronomer explained, due to "imperfections in the instruments," most likely chronometers which were difficult to keep calibrated over the bumps encountered when crossing rough mountain terrain (USWD 1855–1860, 113).[14] Warren, in compiling the maps absent this data, used previous survey data in the same region when compiling longitudinal information for these two PRRS expeditions (USWD 1855–1860, Vol IX, Ch. V).

4.3 Scale

As I've already pointed out, the general map was drawn to a scale of 1:3 million, depicting more than four million square miles of territory on two 20 ½″ x 45″ sheets. Expecting locational precision at that scale requires a more forgiving definition of precision when measured against a modern basemap. Even the map icon marking the location of a geographic feature, a campsite, or a trading post for example, could encompass an area significantly larger than the compact location it was designating. Because of this issue of scale, I arbitrarily deemed any location within two miles to be essentially aligned and within five miles as within an acceptable range of variability. I deemed points beyond those limits to be misaligned for whatever reason. While each expedition produced segment maps at a larger scale (1:760,320 / 1 inch:12 miles), these too suffer from problems of scale, though to a lesser degree when looking at locational precision.

4.4 Purpose

The first three editions of the General Map (1855, 1857, 1858) were produced to accompany the written reports published between 1855 and 1860. They were more illustrations as much as the landscape scenes were, intended to demonstrate the extent and comprehensiveness of the surveys and therefore strengthen their conclusions. The maps were also intended to generate enthusiasm for the Pacific Railroad project, satisfy public curiosity about newly acquired western territory and most importantly, offer documentation for those making geographic, political and military arguments in favor of one route or another. They were never intended to be used for **building** a railroad. As such, geographic features needed to be portrayed accurately in relation to one another, but not with the accuracy required for laying track.

4.5 Skill and Experience

Finally, the skill and experience of the investigator can influence accuracy in several ways; choosing appropriate georeferencing control points and the most appropriate transformation process (i.e.; the mathematical algorithm that force fits one map to the other), choosing the appropriate projection that underlies the historical map,

[14] The topogs were plagued by instrument defects and damage.

and finally the craft the investigator brings to applying the GIS tools, such as tracing a track.[15]

4.6 Comparison over time

The ease with which the Esri ArcGIS platform allows different basemaps to align with a georeferenced historical map provides a powerful example of GIS-enabled historical analysis. To illustrate, I examined two trading post locations and a prominent heavily wooded stretch of riverine topography all situated on the Santa Fe Trail along the Arkansas River: Bent's Old Fort, Bent's Trading Post or New Fort, and "Big Timbers."[16]

The adjacent close-up from Warren's 1857 map shows the segment of the Arkansas River traveled by Gunnison past Bent's trading post, through the Big Timbers, and past the ruins of Bent's Old Fort, (shown by the red dotted line). Both Bent's Old Fort and the Big Timbers area are denoted, while the square place icon at "Big Timbers" is in the approximate location for Bent's New Fort site.

Bent's Old Fort Historic Site is a faithful reconstruction of the original adobe fort, or trading post, built by William Bent in 1833 and abandoned in 1849 during a cholera outbreak. Located six miles northeast of present-day La Junta, Colorado it is operated today by the US National Park Service.

The site of Bent's New Fort, where he relocated his trading post, is listed in the National Register of Historic

Figure 9. Bent's Old Fort Site, La Junta, Colorado, Photo by B. Allen.

Figure 9. Bent's New Fort site, Lamar, Colorado, Photo by B. Allen.

Places and sits on private land nine miles west of Lamar, Colorado, where interpretive signage and remnants of the fort's stone walls are accessible to the public. Big Timbers was the name given to an extensive, heavily wooded 60-plus mile stretch along both banks of the Arkansas River favored by the Cheyenne as a winter campground and hunting ground. Though its cottonwood groves have been mostly denuded, the place name "Big Timbers" is still applied to the region.

Any identifiable feature marked on the original Warren map, including the routes of expeditions, can be examined in both its 1857 context and a modern context simultaneously. This allows a viewer to compare particular features and their surroundings on both the 1857 map and an underlying basemap, placing a historical location in a twenty-first-century context and seeing how the intervening 150+ years of human settlement and development have transformed previously sparsely settled regions. By changing the underlying basemap, the comparison can provide levels of information and visual detail to suit an examiner's different interests and research objectives.

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[15] I took care when georeferencing the original maps to known geographic features presumed to be geographically well-documented by 1857. These included major mountain passes and peaks, river junctions, and prominent landscape features. I did not record all the control points I established and am unable to recreate most of them a decade later. One I do recall, however, was Cape Flattery in the Juan de Fuca Straits, which I chose on the presumption that this northernmost point of the contiguous U.S. would have been well charted even by 1857. Even so, I violated one of Skopyk's guidelines by choosing a control point far from the center, indeed at the very edge, of the historical map. I can only guess what impact this and other control point choices I made at the time might have had on the overall accuracy of my georeferencing project, even if they were minimal.

[16] Bent's Old Fort was an important trading center operated by Bent, St. Vrain & Company in the Arkansas Valley between 1833 and 1849, and during much of its 16-year existence was the only permanent white settlement on the Santa Fe trail between Missouri and Nuevo Mexico. It was deliberately burnt during a cholera epidemic in 1849 and relocated downriver to a more defensible high bluff on the north bank of the Arkansas. This New Bent's Fort operated until 1860. See www.nps.gov/beol/learn/historyculture/index.htm and historycolorado.org/historic-resources-santa-fe-trail-1821-1880. The Old Fort site is identified on most modern basemaps and many also designate the Big Timbers area, though less precisely since it doesn't have definite boundaries. Bent's New Fort site is not identified on some basemaps.

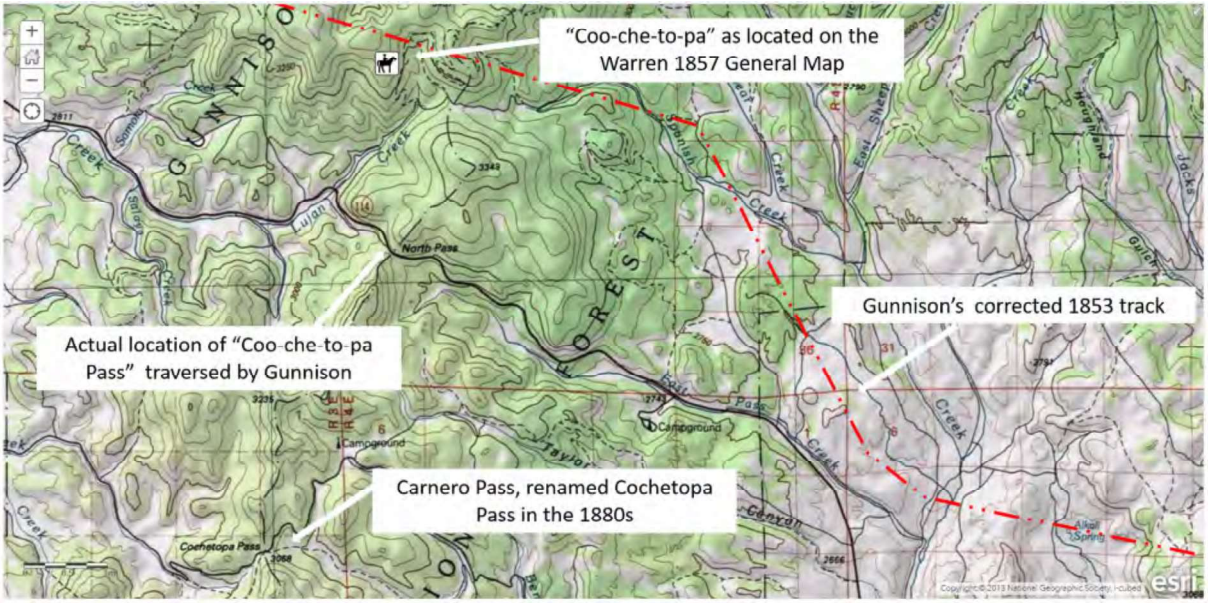

Figure 10. Gunnison's track depicted on USGS TOPO basemap. The georeferenced location of Cochetopa Pass from the Warren 1857 map is approximately 2 miles north of the actual pass. Esri ArcGIS.

To illustrate, the map titled "Arkansas River on 1857 map and hybrid basemap" depicts the same trail segment from Warren's 1857 map as shown above, but here the basemap has been changed from an Esri World Topographic Map to a Hybrid Topographic Map (Figure 7). By changing the basemap, the 1857 map now also portrays an overlay of place names and road networks where none existed when Gunnison passed through in 1853. By zooming in on the original map, this modern map is then revealed at a greater level of magnification and detail.

Changing the basemap once again then reveals a satellite image of the same region upon zooming in, giving a much more detailed view of current agricultural development, road networks and settlement patterns in an area which was largely grasslands and cottonwood groves when Gunnison and his men passed by in 1853.

Switching attention to the region around Cochetopa Pass provides another example of cartographic examination with a different focus. The 1857 map is dense with hachure marks portraying the orientation and steepness of incline in the terrain. This nineteenth-century cartographic convention was the standard method of portraying topographic relief prior to the twentieth century, when the introduction of photogrammetry led to widespread adoption of contour lines.[17]

The older hachure method can be quite visually enchanting and convey an accurate if not mathematically precise impression of the topography. In a very mountainous area such as the Cochetopa Pass complex, however, the sheer density of marks can mask other important topographic details, e.g., the label "Cochetopa Pass," its elevation (10,032) and the actual trace of Gunnison's route. Switching once again, this time to a USGS topographic basemap (Figure 10) then zooming in reveals Gunnison's tracks set against a more familiar contour line depiction of topography, again making allowance for imprecise alignment.

A larger scale, 1:760,320 segment map from the Library of Congress map collection (Egloffstein et al. 1855)

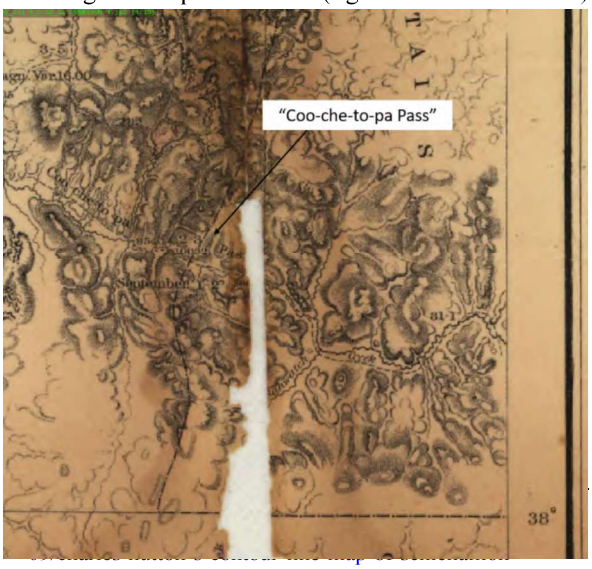

Figure 11. Detail of Cochetopa, Gunnison Segment Map #4.

[17] For a discussion on the development of mapping technology from 1884 to 2009 see esri.com/news/arcnews/fall09articles/125-years.html and esri.com/news/arcnews/winter0910articles/125-years.html. For development of contour lines, see bloomberg.com/news/articles/2016-06-

provides a bit better visibility of Gunnison's track through Cochetopa Pass, but this map, which I did not georeference, is badly worn, perhaps indicating the interest this map held for examination of the route through Cochetopa Pass.

4.7 Future Investigations:

- In general, this exercise illustrates both the utility and limitations of examining georeferenced historical maps which can be applied by others to their own research purposes.
- My primary research focus is on comparing different editions of the Warren map to one another, particularly Warren's 1857 "Indian Map" and the subsequent 1858 edition. Indications of geopolitical control by Native American groups was not just de-emphasized by the elimination of color, but in some instances, tribal names were scrubbed from the map altogether. Harnessing visual analytic capabilities could both expedite and deepen my research and analysis.
- Georeferencing larger scale segment maps along each PRRS expedition route is another avenue I hope to pursue.

5. *Exploration*: Visualization Along the Central Route

Here I attempt to demonstrate how powerful GIS visualization platforms can deliver a variety of avenues for cartographic analysis, not just for the professional but for the layperson as well. Platforms such as Google Earth and its enhancements, Google Earth Pro and Google Earth Studio, provide powerful tools for the study of historical maps as well as historical sites and potentially offer an immersive, engaging and informative experience to the viewer.

Using these platforms, I created a virtual "ride-along" following both Gunnison's 1853 trek and my own 2022 reconnaissance through the San Luis Valley and Cochetopa Pass. The multi-step process to accomplish this required first creating or capturing a digital track, then formatting and importing it into Google Earth and adapting the visual experience for specific investigative purposes.

To create a digital track of Gunnison's passage, I opted to use Warren's segment maps drawn to a scale of one inch to twelve miles (1:760,320) instead of the smaller scale General Map (1:3 million) described above, on the assumption that its larger scale would be more locationally precise and easier to work with. I did not georeference this map as I had done with the General Map. Instead, I manually read the latitude and longitude of various points of Gunnison's track, usually campsites designated as points with dates. I supplemented these with references in the expedition's journal entries as well as a table of latitudes recorded in an appendix to the report (USWD 1855–1860, Ch. X).

Using both sets of position data to create a best fit track for the Gunnison expedition, I also had the GPS data from my own reconnaissance through Cochetopa from which I created a separate track. Importing both tracks into Google Earth provided several lenses through which to explore the data.

First, starting at ground level, I overlayed both Gunnison's 1853 track and my own 2022 track onto Google Earth Pro. This allowed me to take a virtual tour of the Central route along either track with both being visible, depending on how closely aligned they were and my chosen range of view.

As I am most interested in the eastern and western approaches through Cochetopa, I shortened both tracks to concentrate on the most grueling segment of Gunnison's passage from August 8 to September 19, as the expedition crossed both the Sangre de Cristo and Cochetopa passes and skirted the ravines and chasms along the Grand (now the Gunnison) River.

Laying both tracks down together allowed me to compare Gunnison's route with my own, which was mostly on roads. It also provided a visual experience of the topography of Gunnison's route, as closely aligned to the true track as I could get it.

Here, the limits of visualization became evident. In Google Earth, the depiction of a track in a wilderness setting is denuded of all features except physical topography. It is not the dazzling visual Google Earth experience one can obtain exploring a densely built urban environment such as central Tokyo or Paris, for example. If the purpose of the inquiry is to understand the physical topography, the experience can be immersive and rewarding. But taking a ground level "tour" can also be disorienting after a while. This virtual tour did help me

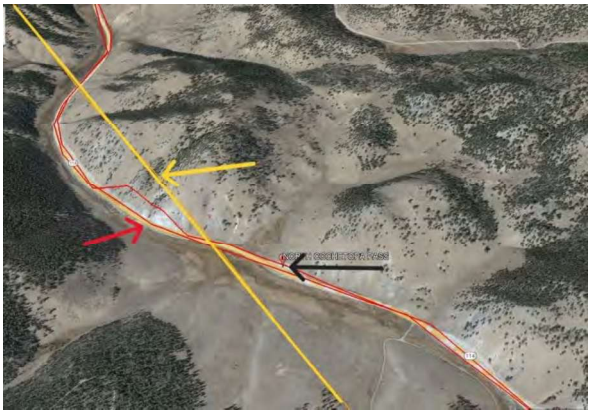

Figure 12. Google Earth screenshot showing both Gunnison's approximate 1853 track and my own crossing of Cochetopa Pass. Gunnison's point-to-point track was drawn from reading daily camp sites or other locations on the Warren map, as described above. My track was captured by my mobile GPS tracking device.

confirm the points of view I'd identified, and which were portrayed in Richard Kern's sketches, described in the next section, *Discovery*, however.

For my second lens, I took a virtual "flyover" of the same tracks at altitude, using Google Earth Studio, showing the terrain from a bird's eye view. I also selected Cochetopa Pass alone, dramatically circling in on this significant pass while illustrating the surrounding topography.

Here the visualization provided a topographical overview which was both arresting and informative. The gradual ascent and descent in the immediate approach to Cochetopa is evident, underscoring why it was seized on by supporters of the Central route as a path across the Great Divide. It's only when examining the route further afield, particularly along the deep chasms lining the Gunnison River, that the argument in favor of Cochetopa falls apart.

Finally, I employed the sunlight and date feature to recreate an important scene from the expedition—the Gunnison massacre. I moved within Google Earth to a location hundreds of miles further west along the banks of the Sevier River where, several weeks after crossing Cochetopa, Gunnison, Richard Kern, and six other members of the expedition were killed in a dawn attack. Using Google Earth's sunlight feature and setting the date to October 26, I was able to create a dramatic visualization at the site of the ambush with the Wasatch Range on the eastern horizon just at sunrise.

(I've briefly described the process of using Google Earth here, but readers interested in greater detail and tutorials can find more information in the footnotes.[18] For a more detailed description of the process, challenges and learnings from extracting latitude and longitude points off the historical map, see Appendix 1: Laying Tracks.)

5.1 *Exploration* Summary and Future Research:

- Despite the limitations described above, this exercise allows a close examination of old maps, rewarding the curious and inviting viewers to take a virtual tour along with the topogs through territory that, at the time, was little understood and lightly mapped and to imagine the western landscape through contemporaneous eyes.
- As described in Appendix 1, the detailed examination also revealed that nineteenth-century cartography, at least in the PRRS project, contained errors in both the recording of data and in the drawing of maps.
- Given the cornucopia of GIS visualization platforms, tools and options, my virtual exploration of Cochetopa was always in danger of sprawl—the occupational risk of researchers. Having said that, increasing one's own skill level and incorporating other media (e.g., video footage, narration) offer enhancements limited only by a researcher's imagination and skill (as well as time).

6. *Discovery*: Finding Richard Kern's POVs

My final line of inquiry centered on the lithographs depicting landscapes in the Gunnison expedition printed report. Here I wanted to see if I could locate the point of view (POV) from which Richard Kern, the expedition artist and topographer, sketched his original scenes.

Like most government-sponsored exploratory expeditions in the first half of the nineteenth century, an artist was a necessary member of the contingent, documenting prominent geographic features, important locations and interesting or unusual people and sights. The early photographic technique of daguerreotype would make its appearance in Cochetopa a few months after Gunnison passed through when John Charles Frémont led the last exploratory probe into the San Juan Mountains before mining and settlements transformed the region.

Though his father-in-law had tried to get Frémont appointed to lead the PRRS expedition across the Central route, Davis appointed Gunnison instead. Frémont and Benton privately financed this last attempt at a mid-winter crossing of the Continental Divide to ensure that a favorable account of Cochetopa and the "natural Central route" would be put before Congress and the public to counter what they expected would be a less positive assessment by Gunnison.

Frémont's expedition had no wagons. Instead, horses and mules carried the men and their supplies. Among the cargo were bulky wooden boxes containing carefully wrapped bottles of chemicals, dozens of copper plates and a camera—all belonging to a daguerreotypist from Baltimore, Solomon Nunes Carvahlo. Frémont was so determined to scientifically prove the practicability of the Central route that he hired Carvahlo to document the easy passage across Cochetopa. Carvahlo would become one of the first persons known to employ this early form of

[18] Turning a two-foot by four-foot paper map engraved more than 150 years ago into a digital map posted onto a website requires multiple transformations in both image and imagination. I describe the lines of inquiry I followed in Google Earth as an easy-to-use platform for a layperson to engage in topographical exploration. I do not intend to provide a detailed description of this multi-step process, however. Some excellent tutorials are available on-line. Here are some I found useful:

- Importing Global Positioning System (GPS) data into Google Earth Desktop: google.com/earth/outreach/learn/importing-global-positioning-systems-gps-data-in-google-earth
- Geographic coordinate conversion: en.wikipedia.org/wiki/Geographic_coordinate_conversion
- Converting Degrees Minutes Seconds to/from Decimal Degrees: fcc.gov/media/radio/dms-decimal

photography to successfully capture images of the Rocky Mountains.[19]

Gunnison had no daguerreotypist, but he did have Kern, who made over a hundred field sketches of the landscape as the expedition proceeded west. Though Kern was murdered in Utah a few weeks after crossing Cochetopa, his sketches survived and several of them were transformed by the artist John Mix Stanley into full landscapes that were printed in the final expedition report. These scenes illustrated the magnificent and rugged topography of the Colorado Rockies and the Gunnison River.

In my own search for Kern's vantage points I used analog as well as digital tools. First, I transferred my latitude and longitude readings of campsites and other locations read directly from the original maps onto printed large scale (1:160,000 and 1:320,000) topographic maps in the DeLorme *Colorado Atlas & Gazetteer, 13th Edition.* I could then trace Gunnison's approximate route on the printed maps. Reading descriptions of the expedition's daily progress in the PRRS report, I identified the portion of the route where each POV would likely be found.

My preparatory research also turned up a magnificent book by Robert Shlaer, who still practices the nineteenth-century art of daguerreotype: *Sights Once Seen, Daguerreotyping Frémont's Last Expedition through the Rockies* (Shlaer 2000).[20] Published in 2000, the book documents Shlaer's attempts to recreate the Carvahlo daguerreotypes.

While Shlaer's book on Carvahlo mentioned the Gunnison expedition and covered much the same route, he did not discuss any attempt to locate the POVs for the lithographs based on Richard Kern's sketches. I hoped to do just that—and be the first to do so. However, after I returned from my own reconnaissance of the 38th in late spring of 2022, I discovered that in 2021 Shlaer released *Richard Kern's Far West Sketches: A Visual History of the 1853 Gunnison Expedition* (Shlaer 2021).

Shlaer had beat me to it. Drat! (For a deeper dive on how this book came about, see Appendix 2: Robert Shlaer, Geographic Landscape Detective.)

While the preparatory research helped, I also anticipated that my lack of local knowledge would hinder my ability to identify POVs, and I was right. I was able to compensate somewhat by enquiries I made with National Forest Service personnel and local residents who were invariably helpful, but still the search for Kern's POVs relied on our own resourcefulness and willingness to retrace our steps.[21]

I thought trying to locate Kern's POVs would be an entertaining game during our more expedited reconnaissance, and it was. But it became more than that. First, and most importantly, it forced me and my on-the-road companion to examine the landscape with more focus and intensity than we otherwise might have. Visualizing the topography as Kern and Gunnison had experienced it, without the built infrastructure that now exists, was both visually and intellectually challenging.

When comparing a landscape image and a potential vantage point we came to realize that the lithographs did not necessarily depict photorealistic verisimilitude. We concluded that artistic and stylistic choices, possibly made by both Kern and Stanley, affected the representation of the landscape. This realization required a more imaginative approach to understanding each vista and contemplating why these lithographs were made. I was literally following Professor Chang's advice on conducting historical research by performing an act of imagination. When we understood where Kern's vantage point was, when a scene in front of us and Kern's landscape on my iPad screen melded, and when we **knew** we were standing where he stood, it was unexpectedly thrilling.

We were not always successful, however. Here I confess to two unforced errors which complicated my inquiry and limited its success. I made an amateur mistake for a researcher, assuming that the description of each print was accurate and each vantage point was theoretically obtainable. Reading Shlaer's book on the Kern sketches I subsequently learned that several of Kern's sketches were erroneously labeled or mis-dated, and some of the resulting lithographs were as well. In one case, Shlaer concludes that a scene was fabricated! Reading Shlaer, I gained much better insight into the artist's process and the purposes of nineteenth century topographic illustration.

I also gained a deeper appreciation for the careful topographic and artistic analysis Shlaer had conducted and the potential for this type of research in extracting a deeper understanding of nineteenth century topographic exploration.

My other unforced error was a conscious one. Travelling in reverse direction, we spent only three days retracing Gunnison's six-week trek of more than 300 miles through

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[19] Carvahlo kept a journal of his travel with Frémont (Carvalho 2004). Though they crossed Cochetopa, this final attempt also stalled in the deep snows of the San Juan mountains. They retreated back across the divide and sent for a rescue party in Taos. Only one member of this expedition died, succumbing to starvation and exposure. He was the 21st man in four years to perish exploring the natural Central route for a transcontinental railroad.

[20] Most of Carvahlo's original daguerreotypes were tragically lost in a fire, others comingled with Matthew Brady's collection. Steel engravings made from some of Carvahlo's daguerreotypes were reproduced in Frémont's 1887 edition of *Memoirs of My Life.*

[21] Chris Miller, Fort Uncompahgre NPS Interpretive Center in Delta, CO; Nancy Ruhle, resident of Gunnison, CO; Richard Trotter, National Forest Service, Saguache Ranger Station were particularly helpful.

Figure 13. Entrance to Cochetopa looking up Sahwatch Creek, Septr. 1st from a sketch by Richard Kern *(USWD 1855–1860).*

the Sangre de Cristo and San Juan mountains. So, my own self-imposed schedule constrained how thorough a search we would conduct. In hindsight, we could have profitably spent a week in and around Cochetopa, Sangre de Cristo Pass, and the Gunnison River, but we had other demands on our schedule. We did not take the time to hike through the Sangre de Cristo Pass, so did not locate the three views Kern sketched there. That would be a priority for a next visit.

I've mentioned that modern infrastructure made our trek through the mountains and across the Continental Divide easier than Gunnison's. But that modern infrastructure also includes fences, built environments, and roads both altering the topography and blocking views or access in some places. For some POVs I was seeking a general sense of the topography and so, when I concluded that a target POV was not easily obtainable, I was willing to call it "close enough" and move on. At least one POV is presumed to lie near the shore or submerged under the Blue Mesa Reservoir in the Curecanti National Recreation Area, so the scene would be difficult to recognize. A few I calculated were miles off the road we were on, one was over a steep rise and behind a fence marked with "No Trespassing" signs. In the case of scenes depicting Fort Massachusetts, which was later abandoned, I learned from Forest Service personnel that the site of the former fort is now on private land and no longer accessible. For that POV I moved south, as did the Army in 1858, to the relocated site of Fort Garland, knowing that I was a few miles south of where Kern had stood when he made his sketches.

The most memorable discovery, and most meaningful in the context of my purpose for being there, was when we identified Kern's POV depicted in the lithograph titled *Entrance to Cochetopa, looking up Sahwatch Creek, Septr. 1*. Using multiple sources, we determined that the POV had to be near the site of the Upper Crossing Guard Station, which is a cabin the USFS rents out.[22] We were unable to access the cabin itself which is behind a locked

[22] Here I relied on several indicators to locate the POV: the daily log description of their path along Sahwatch (Saguache) Creek, my trace of the track onto the DeLorme topo map, an excellent georeferenced PRRS segment map of Gunnison's route I found in the David Rumsey Map collection at OldMaps.com, and two papers on history of the Old Spanish Trail and Cochetopa National Forest. Thanks to Chris Miller, Fort Uncompahgre Interpretive Center in Delta, Colorado for providing me with a copy of Horn 2022. Thanks also to Richard Trotter, USFS, Saguache Ranger Station for providing me with a copy of Agee and Cuenin 1924.

Figure 14. View looking towards Cochetopa Pass from USFS Upper Crossing Guard Station.

fence only accessible to those renting the cabin, but standing by the gate we looked up the road following the creek, knowing we had to be in the correct location.

But we were looking on a decidedly less dramatic scene than the sweeping vista depicted in the lithograph. Sheer cliffs on the right and a rugged ridgeline on the left frame a lush meadow leading to mountains on the horizon. At first, it did not seem to connect to the landscape in front of us, moderate hills on both sides with a dry and dusty road heading in the direction of Cochetopa. But as we compared details—the shape and position of the ridge with its distinctive arrangement of a prominent knob and sharp pyramidal peak, the tree line along the creek, and a table of hills toward the horizon—all convinced us that we had found the spot Kern sketched. The lithograph shows a diminutive figure in the foreground, adding an exaggerated dramatic sense of vertical height and horizontal depth. In discussing it, we thought perhaps because Kern was not able to instruct Stanley and the lithographer on the proper dimensions of the scene that Stanley may have added the exaggeration. But we knew we had found *Entrance to Cochetopa*!

Shlaer, who spent years examining the Kern sketches, enlightened me when I read his description of Kern's stylistic approach thus:

> *Kern always employed anamorphic distortion in his representations. To varying degrees, he would stretch the vertical dimension of a scene in relation to the horizontal, or, what amounts to the same thing, compress the horizontal dimensions of the scene relative to the vertical, squeezing it together like an accordion, if you will. The result is to magnify the sense of grandeur by adding and imposing height to the verticality of a scene, while at the same time making space on the paper to represent its details with clarity. Looking at the same thing in a slightly different way, Kern compressed the horizontal dimension of a scene to encompass within the limits of his paper while avoiding having to reduce its vertical dimension to seeming insignificance (Shlaer 2021, xv).*

In some ways then, Kern's stylistic approach is similar to a modern landscape photographer using different lenses to "distort" a scene for different effects.

One lithograph, *Peaks of the Sierra Blanca near Fort Massachusetts,* Shlaer argues "is a complete puzzle." While I spent less than an hour looking for even a view of the Sierra Blanca in the vicinity of Fort Garland, Shlaer had access to the private land on which Fort Massachusetts had been built, spent several days looking for an approximate POV and analyzing Kern's sketches as well as the landscape. Here he sums up his thoughts.

> *It is difficult to understand why Kern would have taken time off from his myriad duties to concoct this fantastically rugged but imaginary scene, when he had perfectly good ones at hand! I can only imagine that Kern was asked to create an especially rugged view of the mountains in the vicinity as an illustration that would emphasize the magnitude of Gunnison's achievement in cutting a road over and through such difficult terrain. I continue to believe that Peaks of the Sierra Blanca is a drawing of a subject that does not exist (Shlaer 2021, 136–140).*

6.1 *Discovery*: Summary and Future Research

- Attempting to locate the vantage point of an artist's landscape can be both challenging and rewarding as well as immersive, bordering on obsessive. Its one great advantage is it forces an investigator to look closely at the landscape with imagination and purpose. It also reveals much about artists' choices and purposes.
- As my experience with Robert Shlaer illustrates, an equally robust search for those who came before with the same aim in mind can be as important as identifying a POV.
- I've done a similar search for POVs along Stevens's PRRS expedition between the 47th and 49th parallels. Informed by my experience here, I hope to continue this process for the Whipple expedition along the 35th and into the critical crossings in the Coast Range on the Parke expedition.

6.2 Other Sites Worth Visiting

- The David Rumsey Map Collection contains more than 150,000 maps focusing on rare sixteenth- through twenty-first-century map of North and South America, as well as maps of the world. www.davidrumsey.com.

- Old Maps Online began as a collaboration between Klokan Technologies GmbH, Switzerland and The University of Portsmouth, UK. Contributors continuously add old maps from around the world. Some are georeferenced. www.oldmapsonline.org.
- Central Pacific Railroad Photographic History Museum has an extensive image collection on railroading and a well-organized link to all the PRRS Survey Reports housed at the University of Michigan. www.cprr.org/Museum/Pacific_RR_Surveys/.
- The University of Michigan "Making of America Books" digital collection houses on-line versions of all the Pacific Railroad Survey reports. https://quod.lib.umich.edu/m/moa/.
- Old Spanish National Historic Trail Association celebrates the history of the 2,700-mile trail through six states. The organization's site contains maps and articles about the trail and its history. https://oldspanishtrail.org/.

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Date.	Locality.	Observation.	Declination.	Index error.	Double obs'd alt.	Corr. alt.	Latitude.
1853.			° ′ ″	′ ″	° ′ ″	° ′ ″	° ′ ″
July 21	Arkansas river	Jupiter	—22 13 15	1 43.5	59 39 40	29 49 11	37 57 34
23	do	Antares	—26 06 11	1 43.5	51 45 35	25 51 54	38 01 56
26	do	do	—26 06 11	1 43.5	51 22 50	25 40 31	38 13 18
27	do—noon halt	Sun	19 08 10	1 40	141 27 10	70 59 57	38 08 13
28	do	do	18 54 19	1 40	141 09 00	70 50 52	38 03 27
30	do—noon halt	do	18 25 37	2 06	140 00 00	70 16 32	38 09 05
30	Crossing Arkansas river	Altair	8 29 17	2 06	120 41 40	60 21 25	38 07 52

Figure 15. Excerpt from Table of Latitudes. The two circled entries were clearly in error (USWD 1855–1860, Ch. X).

United States War Department. 1855–1860. *Reports of explorations and surveys, to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean*. Washington: A. O. P. Nicholson, printer [etc.]

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9. Appendix 1: Laying Tracks

To create Gunnison's track, I needed a series of latitude and longitude points marking his path through Cochetopa as shown on the segment map. I read latitude and longitude at each campsite, so labeled by date, as well as other identifiable locations such as river crossings.[23] I also took latitude readings by date from the Appendix referenced earlier: "Table of Geographical Positions from Westport to Salt Lake City." Some of these entries had quite specific locations that could be matched to the map, e.g.: "Crossing Arkansas river" or "camp." I could also confirm many camp sites by reading the daily journal descriptions of the expedition's progress, where latitude was often, but not always, reported. Other table entries of latitude had less specific descriptors, e.g., "noon halt" or none at all.

Throughout this process, I had to accept a degree of uncertainty in my latitude and longitude readings. I noticed that the 30′ increments on the original map exhibited some dimensional variability. One should expect increments of longitude to shrink the further away from the equator they are drawn due to convergence at the poles. That is not the case, however, with lines of latitude which lie parallel to one another and should be unvarying across the map.

This was both surprising and a bit of a headache since I had to adjust my process for reading locational data as I moved around a given segment. Ultimately, I concluded that this lack of consistency in the maps dimensions was due to a combination of factors.

As was mentioned previously, the PRRS maps were made prior to establishment of the Clarke Ellipsoid of 1866 and the North American Datum of 1927 (NAD27). So, the hand drawn process of engraving and creating the maps occurred without benefit of these foundational geodetic frames of reference.

These segment maps were etched on copper and engraved in a time-consuming process requiring months of preparation. Making changes would be both costly and time-consuming. The private printers who were responsible for actually producing the engravings, prior to creation of the Government Printing Office, received printing contracts as political rewards and were not always the most diligent in their process. Warren and his assistant, Henry Abbot, were in on-going conflict with their engraver, demanding revisions and corrections multiple times (Pearcy 2008).

Finally, the maps were illustrations intended to accompany detailed expedition narratives arguing for one route or another. Despite the project name Pacific Railroad Surveys, the expeditions were never intended to be actual surveys in the sense of detailed geodetic measurements, but were multiple reconnaissance undertaken to break a political impasse. Precision was neither sought nor deemed necessary to fulfill that purpose.

Accepting a certain level of variability, I wanted to gauge both how "true" Gunnison's track had been rendered on the map and how skilled my reading of the map was. To do this, I first compared latitudes read from the map and the table. I assumed the latitudes recorded in the tables were accurate to within about 20″. I based that assumption on three separate repeat latitude readings taken on August 7th and 8th from the camp along the Cuchara River which varied by 21″ of latitude. The recorded latitudes from the camp were as follows: 37° 38′ 30″, 37° 38′ 44″, and 37° 38′ 51″.

[23] I used a JPEG 2000 version of the maps, downloaded from the Library of Congress, and magnified on an oversized monitor. The amount of magnification varied given the variability in increments I've described previously. I magnified each individual segment so that the 30′ increment of latitude on my screen was 30 cm, allowing for an easy reading of latitude. At that level of magnification, 30′ of longitude varied from ~23 to 25 cm, from which I was able to convert my reading into a longitude. I was consistent in my methodology and therefore assume that any errors obtained by this method would be consistent across all the readings from the maps.

I also had 55 readings of latitude which I obtained from the segment maps at campsites or other labelled points which I compared with the corresponding latitudes recorded in the tables at the same location. The average variance between latitudes was 30″, or more than half a mile. How could my readings from the map be that far off? A closer examination of the data revealed the answer.

Two of the comparisons—recorded for July 26th and 27th—stood out as the two largest variances. The latitudes recorded in the Appendix, 38° 13′ 18″ and 38° 08′ 13″, compare with the latitudes I read off the map of 38° 03′ 12″ and 38° 04′ 42″, differences of 10′ 06″ and 3′ 31″ respectively, or approximately 11 miles and 4 miles. An examination of Gunnison's track on the segment map for those dates clearly illustrates that these two latitude readings from the tables are well north of the actual track the expedition was following along the north bank of the Arkansas River. The most northerly point they reached along the Arkansas, by the map, was on July 30th before turning to the southwest following Apishpa River, erroneously believing they were following the Huerfano (USWD 1855–1860, 31). I concluded that the mistaken entries were likely due to a transcription error when printing the tables.

Removing those two erroneous latitudes from my analysis reduced the average variance to 12″ or approximately a quarter of a mile, and well below my arbitrarily assigned threshold of 20″, reinforcing my confidence in the fidelity of my readings of latitude and longitude from the maps. Now I believed I had a fair representation of Gunnison's track which I could convert and lay on a modern geodetic frame in Google Earth.

10. Appendix 2: Robert Shlaer, Geographic Landscape Detective

While searching archives for materials related to his book on Frémont's 1853 trek, Shlaer unearthed more than 100 of Kern's field sketches made on the Gunnison expedition which had lain, mislabeled, in a collection at the Newberry Library in Chicago. Shlaer received permission to study the sketches in detail and, as he did with the Carvahlo daguerreotypes, searched for the scenes Kern had captured including those transformed into the colored lithographs I was working with. This project became Shlaer's next book which I only became aware of after I returned from my own reconnaissance of Cochetopa.

Had I known about Shlaer's book before I set out, I would have benefited from his exhaustive examination of Gunnison's route and Kern's sketches as well as his much more thorough search for each POV conducted on repeated trips over several years while researching both books. I also would have been alerted to some of the inaccurate dates and location identifiers that plagued the labeling on some of the lithographs and would have been alert to Kern's habitual "anamorphic distortion" as I searched for each vantage point.

Without question, if I had been guided by Shlaer my search for POVs would have been much more efficient. On the other hand, Tim and I would not have experienced the same thrill of ownership and discovery when we visually identified the precise locations of those few sites, we did in fact locate.

One other point about Shlaer's Kern book deserves mention here. Shlaer and the University of Utah Press have produced a masterful website (www.kernsketches.com) containing all the sketches, lithographs, and Shlaer's landscape photos at the sketch sites, as well as Google Maps directions to or near the location of each. The site is a master lesson in bringing a topographical artist's important historical sketches and lithographs alive for a twenty-first-century audience.