The Alternative Timeline Pony Express

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1 Introduction

1.1 Background

Until the mid 1850s, mail and freight delivery from the mid-west to the booming new state of California, as well as to settlements and US military forts along the California and Oregon trails, had been managed by a number of small, sometimes ad-hoc, private companies. However, by the mid 1850s the growing needs of the military required it to change to a system of longer-term 2-year contracts. To take advantage, William H. Russell, Alexander Majors, and William B. Waddell merged their stagecoach and freight businesses into what eventually became known as the *Central Overland California & Pike's Peak Express Company* (COC&PPE Co.). Also in 1858, the US Post Office reduced mail service to the West at a time when discoveries of gold and silver in Colorado and Nevada brought an influx of people. Seeing an opportunity and hoping to win lucrative postal contracts, Russell, Majors, and Waddell created a subsidiary of the COC&PPE Co. known as the *Pony Express* [2].

The 1900 mile route from St. Joseph, Missouri to Sacramento, California was able to deliver mail in just 10 days [3]. Amazingly, the Pony Express was organized in only 3-4 months during the winter of 1859-1860. Although part of the route used COC&PPE Co.'s existing stations between St. Joseph and Salt Lake City, the route from Salt Lake City to Sacramento required building roads and stations [2]. Initially there were as few as 119 stations[2] roughly 20-25 miles apart for the first run, but after being more fully built-out there were up to 190 stations[3] roughly 10-15 miles apart. Riders were selected to be no more than 125lbs in order to fatigue the horses less. Riders rode relay-like stages of about 75-100 miles over approximately 10 hours, *day or night*, and occasionally a rider would have to ride 2 stages. After a rest at the completion of their stage, the riders would ride a stage in the return direction. Over the course of a stage between *home* stations, a rider would change horses about 8-10 times, riding each horse approximately 10 miles between *swing* stations. Horse and rider usually traveled at about 10-15mph (a fast trot or canter), but sometimes up to 25mph (full gallop) [3].

The Pony Express operated from April 3, 1860 to October 26, 1861, just 18 months. During that time, there was a 2 month suspension of service May and June 1860 due to the Paiute Indian War. The operation of the Pony Express was extremely expensive, but never received the amount of mail that was expected. Furthermore, COC&PPE Co. had long been in debt from losses to their stagecoach and freight lines during the 1857-58 Mormon War. Though they had been expecting to win a large contract with the US Post Office, congress never passed funding for the contract. Due to the financial trouble of the COC&PPE Co. and general lack of any other option to communicate with California, the US government essentially subsidized the Pony Express [2]. When the first transcontinental telegraph opened in October 24, 1861, the Pony Express ended. The transcontinental railroad followed years later in 1869.

1.2 Objective

Despite its short life, The Pony Express is a legend and icon of the American "Old West."

Imagine, however, if the Pony Express was not only financially successful, but that neither the telegraph nor railroad had come to the Western Frontier. What if the Pony Express had been able to expand and open new routes in this alternative timeline? Certainly, those in charge of the logistics and finances would want to find the most efficient route, and the best places to locate horse changing stations.

Being conveniently situated in the future, and with the power of GIS and a plethora of data beyond all dreams of 1860, this study has attempted to bring the above alternative timeline for the western United States into existence on maps and answer these questions:

1. Given the terrain and a number of western towns that existed in 1860, what might be the least cost paths between St. Joseph, MO and these destinations?
2. Given a horse's average traveling distance and a desire to locate stations at spots favorable to resting horses, can highly suitable candidate locations be located along the proposed new routes?
3. How do the delivery routes found in the study compare to the historic route for the Pony Express?

2 Methods

2.1 Data

The study area for this analysis is chosen to be the Western United States as it existed in 1860. This area comprises the same overall geopolitical boundaries as the present-day US with respects to the US-Canada and US-Mexico borders, but with different internal boundaries among states and territories. The eastern extent of the study area is the eastern extent of present-day North Dakota, South Dakota, Nebraska, Kansas, Oklahoma, and Texas. The western extent is the Pacific coast of the present-day US. Figure 4 shows a map depicting the study area with settlements (discussed below) and territorial boundaries of 1860.

The data used in this study serves the purposes of generating a *cost surface* and a *suitability surface*. Due to the nature of the study being conceptually situated in 1860, a time when modern transportation infrastructure did not exist and travel was across an essentially "unspoiled" natural landscape, I decided the inputs to the cost and suitability should reflect this, and have chosen to use topography and land cover data as my inputs to the cost and suitability surfaces.

Furthermore, creating a network and situating facilities is the primary goal of the study, so destinations or nodes of the network were chosen to be settlements within the study area that were established in 1860 or earlier. Because most of the existing settlements in 1860 could be found along the west coast and southern regions of the study area, exceptions to this 1860 cut-off were considered in order to create more "interest" in the northern regions. However, only Boise, ID with an establishment date of 1862 was decided to be an acceptable exception. Other settlements, such as Sioux Falls, SD (1865) and Cheyenne, WY (1867) were too far beyond the 1860 cut-off.

Datasets used are as follows.

DEM: raster (WGS84) [4] This is a 100m resolution DEM of the CONUS as of 2012.

NLCD: raster (Albers Conic Equal Area) [6] This is a 30m resolution National Land Cover Database of the CONUS as of 2019.

settlements: point (WGS84) [9] Originally a table on Wikipedia, I filtered it to include only US settlements established before 1860 (with one exception discussed above). It seems to have *most* of the cities of the time, and seems to mostly agree with another published source (Nelson's *Town Founding and the American Frontier*[1]).

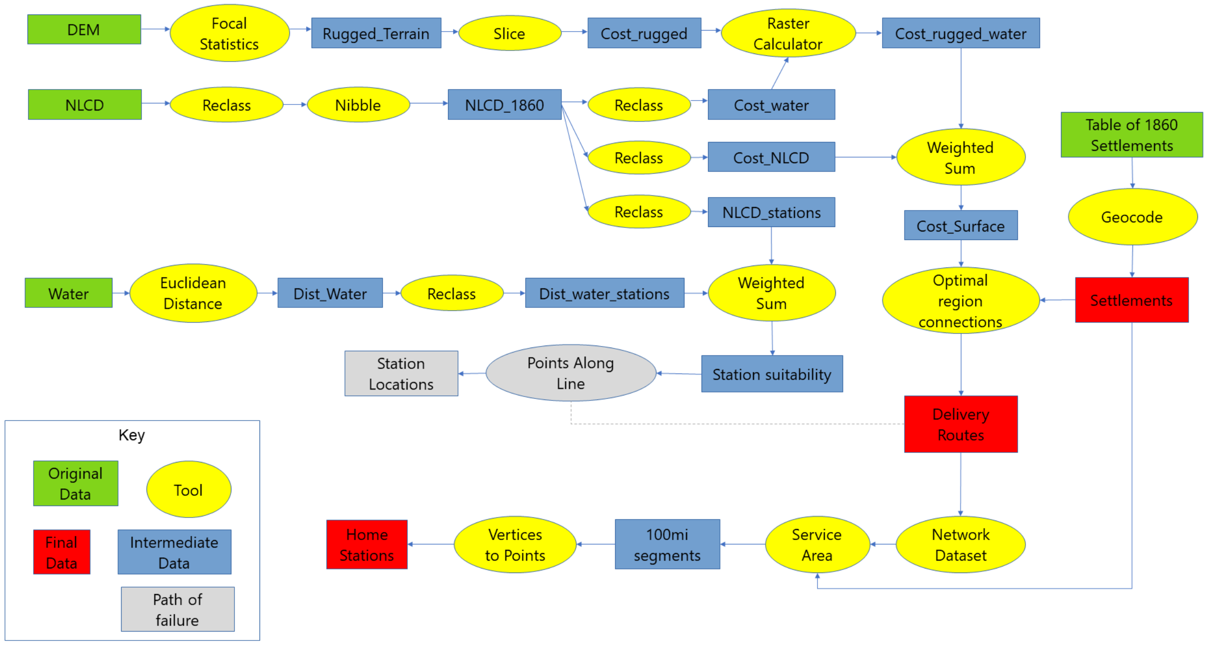


Figure 1: A simplified flowchart of analysis process.

hydrography: line & polygon (NAD83) [5] This contains natural and human-made water features in the CONUS, suitable for small scale maps.

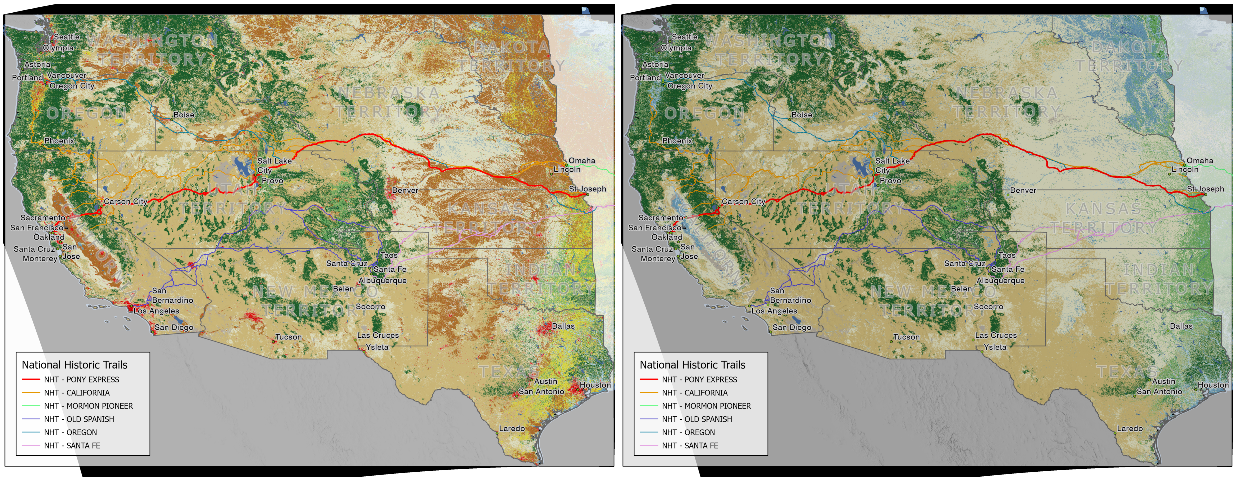
NHT: line (NAD83) [8] This is a set of designated National Historic Trails by the National Park Service. Most importantly, it contains the Pony Express which is compared to the analogous route created in this analysis. Other historic trails (eg Oregon Trail) are useful for historic context and "sanity checks" of the routes created by the analysis.

1860 states: polygon (US Contiguous Albers Equal Area Conic) [7] The states and territories of the US in 1860 per historic census records. In addition to defining the study area, it is also use for cartographic purposes.

2.2 Process

The study can be divided into 3 analysis steps: 1) a least cost path analysis to establish efficient delivery routes between settlements, 2) a suitability analysis to identify favorable areas for swing and home stations, and 3) a service area analysis to locate stations at distances from settlements along routes. A final simple analysis step was done to quantitatively compare the historic Pony Express to the analogous route segments of the network created in step 1. Standard analysis steps such as clipping data to the study area are not described below, but are included in the complete model (see Figure 3). A simplified workflow diagram is show in Figure 1.

The land cover data provided by the NLCD is modern and does not reflect the existing land cover of 1860. Though it is impossible to have actual knowledge of the land cover in 1860 across the study area in a manner such as the NLCD, for this study it was attempted to "roll back time" by replacing urbanized and cultivated areas with the "natural" land covers in their proximity. For example, one



(a) Current land cover.

(b) "Restored" 1860 land cover.

Figure 2: Results of using nibble to "reverse" time.

might expect a highway that cuts through a forest to have once been covered in the same forest that is adjacent to it, or a city that exists in a grassland area to have once been all grassland. Clearly this is a rough approximation, but this approach will work across a wide variety of land covers. A tool called *nibble* was used to do this. Its inputs are a mask where areas to be replaced are denoted with `NODATA`, an optional raster with groups, and the actual input raster. I replaced urban areas (values 21, 22, 23, 24) and farms (81, 82), using a group input of water (11) and non-water (everything else) in order to prevent water land areas being replaced by adjacent water bodies. The current and "1860" NLCD are shown for comparison in Figure 2.

With the NLCD "time-corrected," the cost surface was created using the terrain from DEM and land cover from NLCD. *Focal statistics* was used on the DEM to calculate the range of elevations of a cell's neighborhood, and this was used to represent the "ruggedness" of the terrain. Ruggedness was then reclassified using *slice* into scores from 1 to 10 using the quantile classification method, with 1 being least rugged and 10 being most rugged. The NLCD was also reclassified into scores from 1 to 10 using the mapping in Figure 3a. I also created a special reclassification of the NLCD where water is assigned a score of 10 and not-water is 0. Using raster algebra I combined this with ruggedness so that water areas in the ruggedness raster, which normally would be scored very low, would be assigned a high score. This was done to preserve the desired effect of making water "difficult" to travel over even when rugged cost raster is combined with the land cover cost raster. Finally, ruggedness and land cover were combined using a weighted sum, where the weight of ruggedness was 0.9 and land cover was 0.1. These values were chosen arbitrarily. Finally, a "Pony Express Network" of routes was created using the *optimal region connections* tool with the cost surface and settlements. This created a number of overlapping routes which were then combined using the *pairwise integrate* tool, and then further cleaned by hand to remove small loops, ensure connectedness, and topologically simplify complex multi-route intersections.

The suitability analysis for desirable sites for stations combined the NLCD and hydrography data. Again, land cover was reclassified according to Figure 3b into scores with a max of 10 (most suitable), but a minimum of 0 for water areas as it is essentially impossible to build on water. A new raster layer for distance from water was created from the hydrography using the Euclidean Distance tool, and it was reclassified with *slice* into the 0 to 10 range as well, with 0 assigned to places <= 1 meter from water

Value	Remapped
11	8
12	10
31	1
41	5
42	5
43	5
52	2
71	1
90	2
95	2

(a) NLCD reclassification for cost surface.

Value	Remapped
11	0
12	0
31	3
41	8
42	8
43	8
52	5
71	10
90	9
95	9

(b) NLCD reclassification for suitability.

and 1-10 by the (inverse) geometric classification method. These two rasters were combined using a weighted sum, with land cover's weight as 0.6 and distance from water's weight as 0.4. Thus suitable locations for stations *could* have been found if the appropriate GIS tools were available. However, there was no ready-to-use tool which could place points at an interval along a line and *also* adjust the positioning of the points towards more suitable places within a set distance range. Some methods that could achieve this are mentioned in Conclusions, but due to this tool limitation this part of the analysis was abandoned and the suitability surface was not used.

Another method to situate stations was devised using the service area solver. Using the route network I created a *network dataset*, service areas were determined for distances along the routes from settlements at 100 mile increments from 100 miles to 400 miles. This created individual route segments. I then used these segments as input to the *feature vertices to points* tool to create points at the endpoint of each 100 mile segment. Some of these points were then moved or deleted by hand in places where it was logical to consolidate stations (ie if 3 stations were within a few miles of a route junction). These points are the locations for *home stations* where a Pony Express rider would begin and end his stage. Situating *swing stations* where a rider would exchange horses at 10 mile intervals could also be done using the method described, but creates hundreds of swing station locations. Not only would a manual adjustment be infeasible, but display on a map at the small-scale necessary to display the entire study area would be cluttered and meaningless. Thus, although it could be done for both home and swing stations, only home station locations were created for this analysis.

To compare the historic Pony Express to the analogous segments of the newly created routes, I created buffers around the historic route at 10 miles and 20 miles. 10 miles was chosen based on the "standard" distance between swing stations, and 20 miles chosen as twice that. I then intersected the new route with each buffer and summed the length of the new route that fell within the 10 mi and 20 mi buffers. The absolute length within each buffer as well as the length as a percentage of the total can be used as a comparison.

3 Results and map products

Overall, the approximately 17,000 total miles of Alternative Timeline Pony Express routes (see Figure 5) generated in this study seem "reasonable." In some places, the routes followed extremely similar paths to those used by travelers along the historic trails of the west or where modern highways exist. In a few instances, however, the routes did seem implausible, usually traveling directly across extremely rugged terrain. The most notable example of this is where a route between Tuscon and Provo travels directly across the Grand Canyon. Although the *Optimal Region Connections* tool has inputs to define "forbidden" areas, I did not make any part of the study area impossible to traverse. This was a conscious choice because I wanted to avoid inadvertently blocking narrow mountain passes due to the coarse (relative to actual terrain) 100m DEM.

Unfortunately, I was not able to place stations along routes according to the station suitability surface. Using the network analyst tools, however, I was able to generate candidate locations for *home* stations and then make some improvements manually. The final number of home stations for the Alt-Timeline Pony Express is 152 across the entire network (see Figure 6). Comparing the placement of stations to the historically known stations was beyond the scope of the study, so it is unknown if using the 100 mile cutoffs was a reasonable approach. Due to the nature of route segments not being lengths evenly divisible by 100, there are some places where the manual process increased the distance between home stations to combine two or more that were in close proximity. However, a stage slightly longer than 100 miles is not historically implausible.

The original Pony Express was over approximately 1900 miles, though quoted lengths vary among sources. The analogous route segments of the Alt-Timeline Pony Express are 1910 miles long. Using the comparison methodology described, 705 miles (37%) of the Alt-Pony Express were within 10 miles of the original, and 1125 miles (59%) were within 20 miles (see Figure 7).

4 Discussion

It was very unlikely to have been impossible to generate *some* network of routes in the study area. The challenge was making them plausible, particularly for the 1860 study period. Fortunately although the landscape of the western US has changed dramatically in the last 160 years, the change is still very minor in geologic terms (imagine making a least cost network for Pangaea!). One of the more interesting parts of the analysis was figuring out how to "revert" the NLCD to a pseudo-1860 state. The nibble tool did an admirable job, particularly on small regions the be replaced (such as roads), but did a poorer job replacing large regions such as cities.

Though I could not answer the second research question in the manner originally planned, instead I had an unplanned opportunity to use the Alt-Timeline Pony Express network in the network analyst tools. I found the service area solver to be the most useful of the tools, though I experimented with a few others. Still, it was not able to "intelligently" distribute stations across the network in the way that a human would expect–for example, by consolidating stations *near* a route junction into a single station *at* the junction. This is predominantly what I did myself during the manual phase of station placement.

I was also a little disappointed to see that there was no ready-to-use method available to compare routes spatially, as I wanted to do in my third research question. Perhaps this is to be expected because each analysis might have its own peculiarities that cannot be accounted for by the maker of tools. The method I used to compare the Alt-Timeline Pony Express and the original is easy to do and, I think, a reasonable metric of comparison. However, I can imagine a few other methods that would be better.

5 Conclusions and future research

Had the COC&PPE Co. and the Pony Express survived and thrived, the operators would undoubtedly want to lay out efficient routes between settlements in order to deliver mail quickly and to minimize the expense of station maintenance and rider labor. In 1860, the tools and data did not exist to allow the extremely detailed consideration of the entire Western US that can be done today. However, when comparing the results of this study to the historic trails of the old west, credit must be given to the people of the era for their ability to find efficient routes across the landscape.

The three goals of this study were achieved in some degree. The main limitation, particularly in station placement, was the software. I think this study exposes two interesting avenues for potential development of GIS analysis tools. First, is the ability to plausibly "project" data backward and forward in the temporal dimension, as I attempted to do very simplistically with the NLCD. One could imagine, for example, an archaeologist might want enhanced tools to model the past using current data, and that a civil engineer might want tools to model the future using current data. Second, is the ability to place or distribute geometry along another set of geometries, while taking into consideration additional inputs. In this study, I wanted to distribute points along a set of polylines, taking into consideration a suitability surface. Some approaches that one could try to achieve this would be a direct iterative method, or more advanced techniques such as simulated annealing or inverse/forward kinematics.

Historical Background References

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Project Datasets

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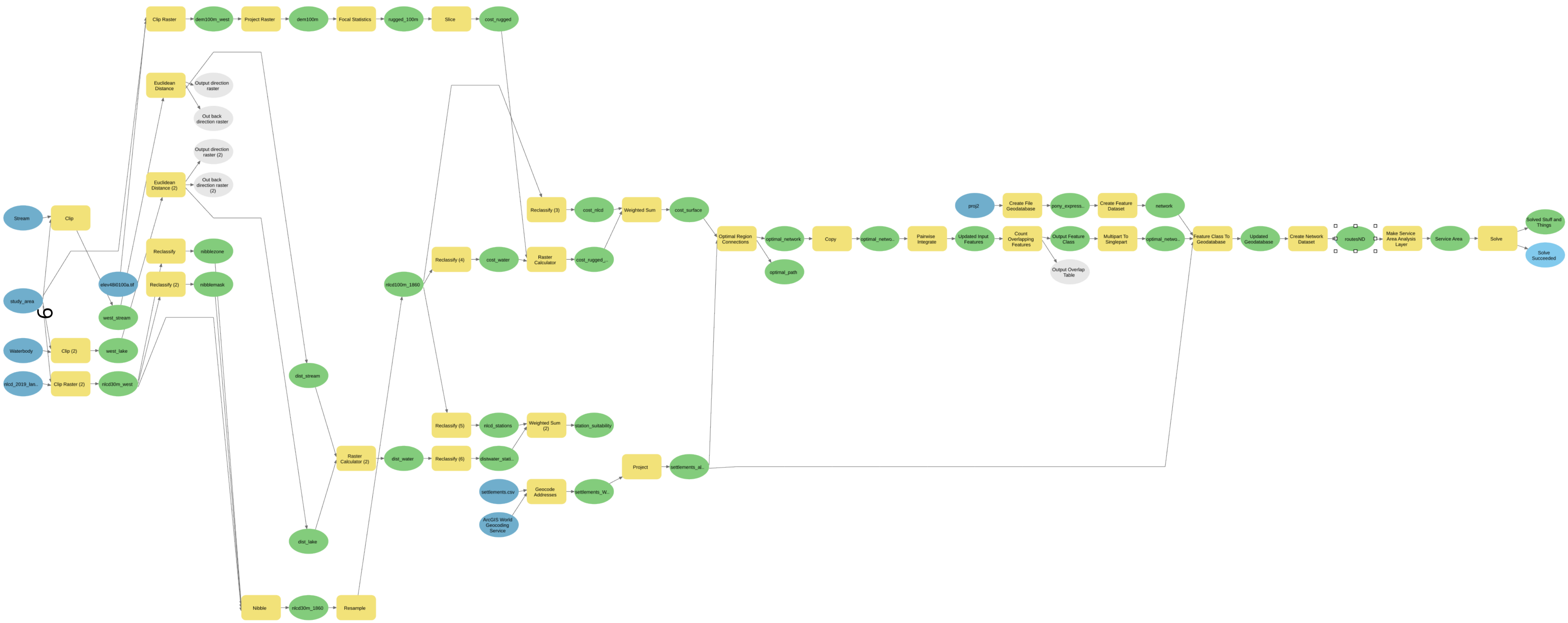

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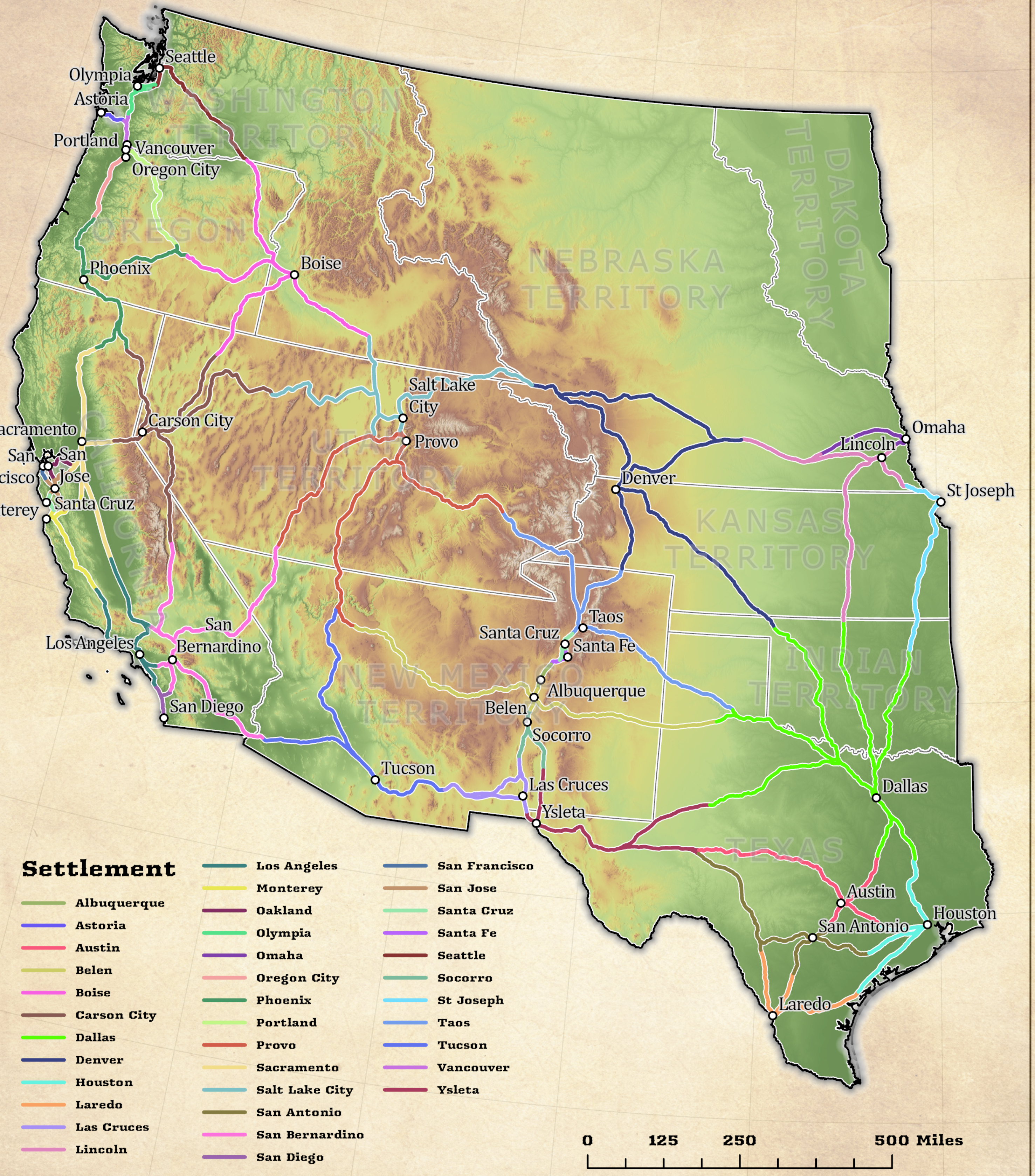
HISTORIC WESTERN TRAILS

with territories and settlements in 1860

Data from The National Map, The National Atlas, MRLC, NPS, IPUMS National Historical GIS | © 2023 Ben Stabley

PONY EXPRESS NETWORK

alternative timeline routes colorized by nearest settlement



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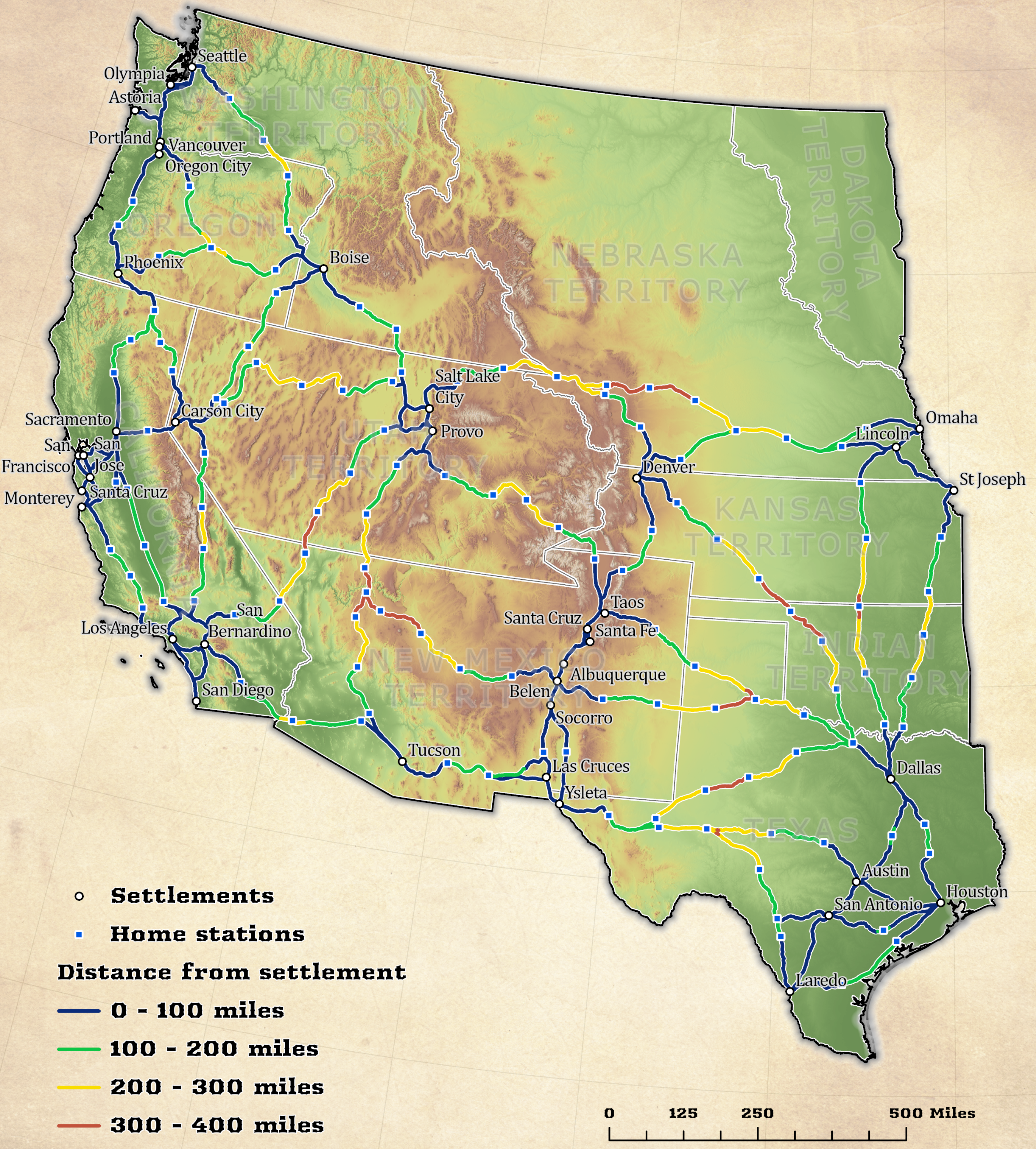
PONY EXPRESS NETWORK

home stations with routes by distance from settlement



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ALTERNATIVE TIMELINE VS ORIGINAL

comparing the new and old by the numbers

The length of the original Pony Express was between about 1925 and 1985 miles. The Alternative Timeline version is about 1910 miles long. Of that, 37% (705 miles) is within 10 miles of the original route, and 59% (1125 miles) is within 20 miles.