

Integrating the Old with New:
Giving New Life to Historical Maps Using Geographic Information Systems

Introduction —

Whether one is an historian, geographer, visual-culture specialist, social scientist, or other Humanistic discipline practitioner maps are typically viewed as data-rich primary source artefacts. As an artefact each map can provide a bounty of information which spatially contextualizes its content. One among many identifiable areas concerns social stratification, economic hierarchies, and governance practices. The visual rhetoric presented in a map can make social stratification from earlier centuries quite detectable. This becomes increasingly apparent from the mid-sixteenth century through today. As map documents slowly became increasingly available to larger and larger audiences, they were decidedly a documentary purview of high social classes. As mass printing reproduction processes develop in the late eighteenth and early nineteenth centuries, they become an information staple. However, maps are no less a rich data source for social, cultural, economic, and commercial information all the while presenting their narrative with a geospatial backstory.

Given the current high level of data delivery Geographical Information Systems Science tool sets provide, their extensive inclusion into Humanistic disciplines as part of the primary data acquisition set palette has been gaining great cogency over the last thirty to forty years. Their information bearing potential can be leveraged to one that starts from seeking to understand the thought world which produced the map in hand or before one's eyes. However, these maps need more than digital scanning used to place them as images to accompany text. Their information bearing content needs to be incorporated into our current Geographic Information Systems in a useful format. The process of data acquisition allows each map's visual narrative and rhetoric to become readily accessible for data analysis using the many GIS tools available.

My interest for re-acquiring and then re-deploying the rich data historical maps are in possession of is to harness the information processing power accessible through Geographical Information Systems' Science which will allow these cultural artifacts a venue to become living documents. Map sheets represent an opportunity for us in the twenty-first century to enter a creative conversation with those coming before us using our current robust technological capabilities. Content presentation skills demonstrated by past cartographic crafts persons can be acquired, recreated, and in the process their visual-narrative artistry is given voice for our time.

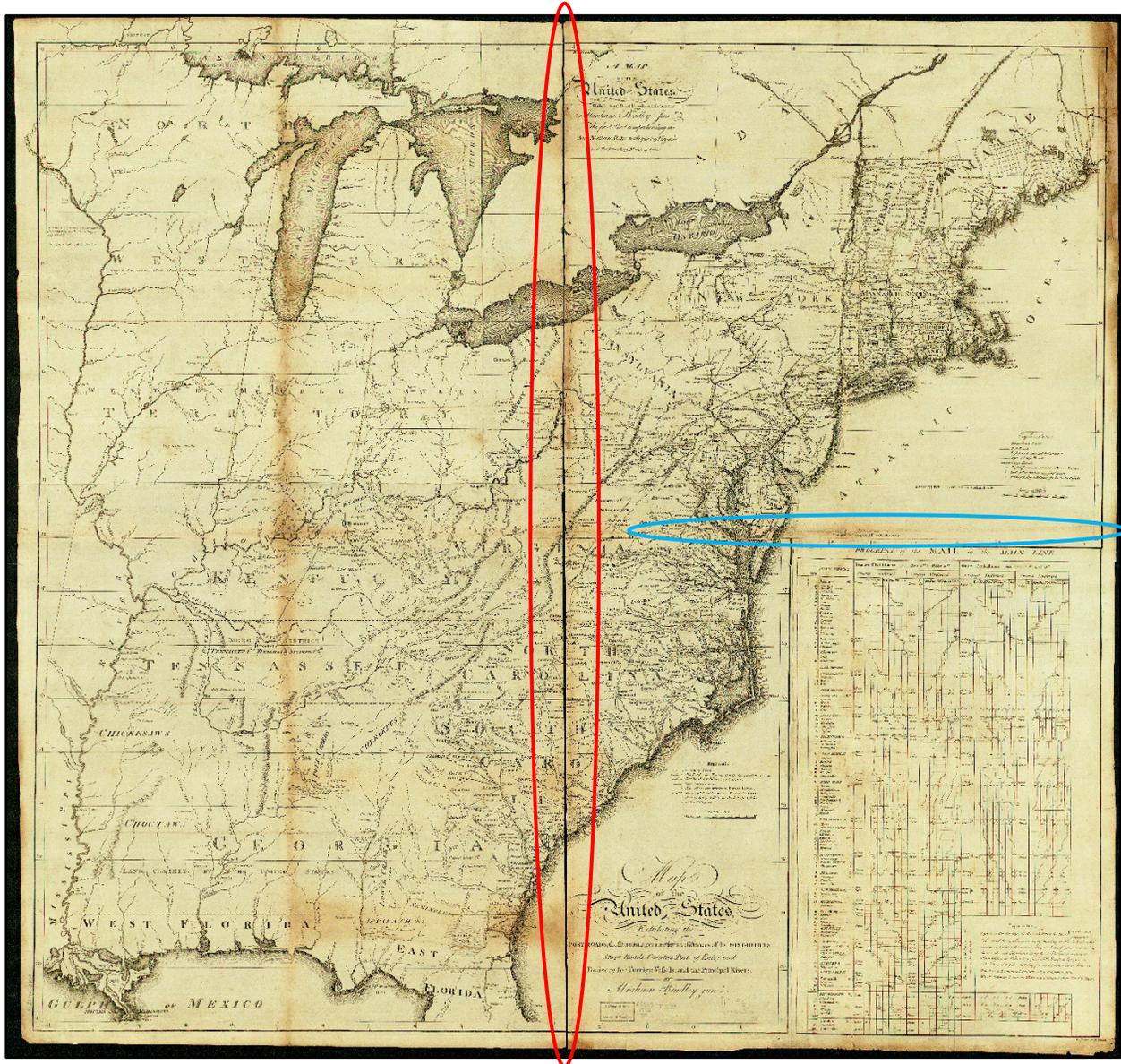
The Bradley Postal Road Map: An Initial Project Map —

I have chosen a map developed by Abraham Bradley, Junior (1767–1838), which carries the following title: *Map of the United States Exhibiting the Post-Road, the situations, connections, and the distances of the Post-Offices; Stage Roads, Counties, Ports of Entry, and Delivery for Foreign Vessels, and the Principal Rivers*. Its copyright was granted on 26 September 1796, according to an article celebrating the map’s centennial published in *The Postal Record* during 1896 (Ernst: 12). The copy I am using is held by the Library of Congress and available for download as a high-resolution 300 dots per inch in tiff file format. For a person who is in the Humanities and uses the social, cultural, and political geographer’s tools as part of their multi-disciplinary analysis palette, this map offers an ideal data-rich starting choice.

In this short article, “A Postal Centenary,” one learns that the author considered Bradley “one of the most illustrious men in the American postal service” (Ernst: 12). He was born in 1767 and “entered the General Post Office, as the Department used to be called, at the request of Postmaster-General Pickering” (Ernst: 12). Starting as a clerk, Bradley’s initial area of responsibility was collecting the data his map document contains. Again, noted in this 1896 article is the acknowledgement that it “embodies the work of the early topographers in the service of the United States, of whom Robert Erskine had made war maps for the armies of the Revolution, and Thomas Hutchins had surveyed the country west of the settled portions to the Mississippi” (Ernst: 12). For my purposes it is an apt starting place given my interest is in what impact the United States’ areal extents had on the creation of our current governance process especially as it relates to representative democratic process development and confederal governance entity power sharing.

The scanned map document from the Library of Congress is of the two sheets laid together and fully opened. Its fully scanned dimensions are 38.377 inches (97.48 centimeters) in width, 35.873 inches (91.12 centimeters) in height. It is a visually stunning engraving and given its age in excellent shape. However, there remain challenges for bringing these sheets into a GIS system. Georeferencing the map sheets is made more difficult given its large areal extents, the variations in substrate aging that has occurred across the two sheets, and simply that when they were scanned their mating, while done in a fashion one presumes to having been performed carefully, does not bring them perfectly together. On the next page I note these challenges. Also, the differences in cartographic construction between the modern shapefile outlines from

NGHIS/IPUMs and Bradley's late eighteenth-century references are striking. One must always bear in mind that our satellite and aerial imaged worldview is not one available to those making maps before the early 1900s.



This image was first examined using Adobe Photoshop. I chose not to use any of Photoshop's tools to correct the images color balance or perform any sharpening routines as would normally be done for publication, *i.e.*, unsharp masking. For examining the cartographer's process initially, it was Photoshop's capacity to enlarge the image and navigate it that made it a workable choice for me.

The mating I referred to above is noted in the area encompassed by the long, vertical red oval.

Also, the black border areas appear to me as being from the scanner bed itself since a document of this age would typically not withstand a drum scan. There appears to be an extended area that looks like a fold-line which I mark using a silvery-blue oval. This area appears to be where the substrate fibers are coming apart. While not easily discernable at this viewing size, it is clear when performing a close-in examination. Also, these sheets have skewed over time which I thought would best be overcome by doing this map's georeferencing in quadrant segments. For this project's initial success, I created the quadrant below by cropping the image in Photoshop also making sure it was as horizontally true as possible without introducing any additional sheet skewing. To do this I used its global rotation tools incrementally in 0.10-degree increments while pulling down guidelines to check against Bradley's graticule.



In the full Bradley map I want to draw one's attention to noting the differing geographic shape differences in items such as Michigan's thumb, Lake Michigan itself, the quite vertical nature of Georgia and its western territorial extents, Maine, or Cape Cod. Their rendering is visibly different from our modern knowledge. Many reasons exist for this but for this project or any project that wants to georeference an old map with a new set of outlines for mapping, this must be accounted for. Carefully selecting geographic references can help but the older substrate will undergo a significant amount of rubber sheeting.

Matching Map projection systems become a large part of this process. Initially I thought since Bradley's map looked to be very flat and elongates vertically, he was employing a Plate Carrée system. This was not helpful and after further examination and carefully reading Bradley's sheet he notes that his central meridian was chosen to be Washington and I noted his longitude lines do have a slight converging look to them. After lightly reading through *The Practical Surveyor* by John Hammond and checking Waldo Tobler's translation of J. H. Lambert's *Notes and Comments on The Composition of Terrestrial and Celestial Maps* it appeared prudent to get started by creating a custom projection of the NHGIS United States' State outlines for 1790.

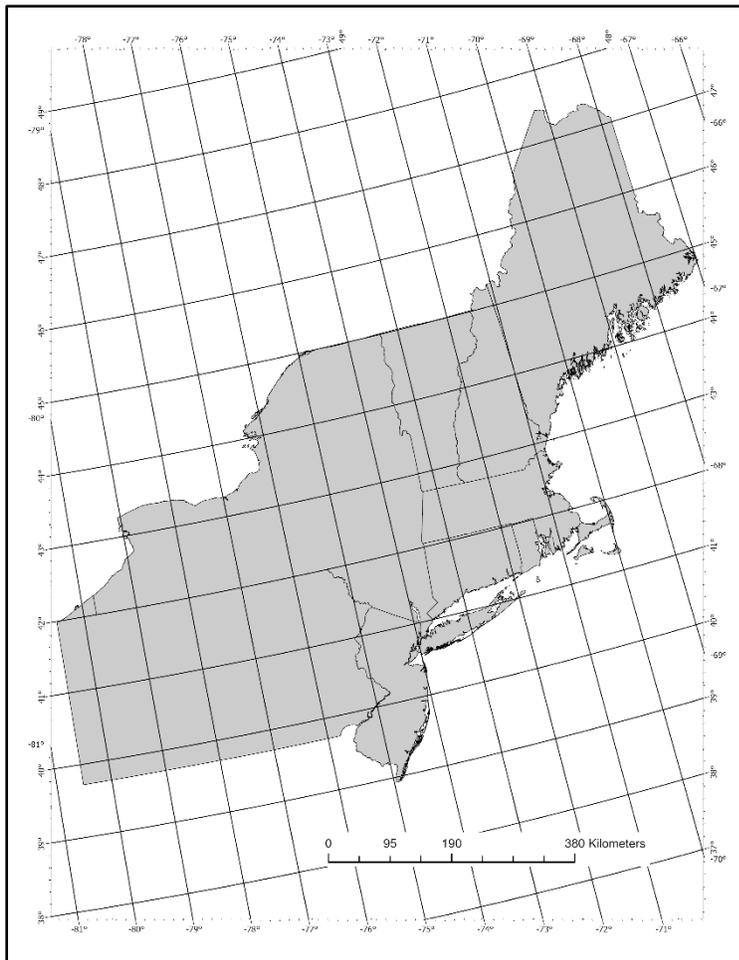
As a researcher who would like to employ these maps, I have much more research to do to understand not only current transformation methods but also earlier period ones as well. My hope is to create a more flexible set of projection transforms that historians can work with and generate period appropriate transformations. This also would include understanding each map maker-cartographer's datum concepts. How were there basic reference points created? Lambert does give one a starting place.

Custom Projection Creation for Bradley Postal Road Map using ArcGIS Pro —

Currently for me to get less rubber-sheeting distortion to Bradley's map when georeferencing it to twenty-first century outlines from NHGIS/IPUMS in ArcGIS Pro, I created a custom projection based on ESRI's contiguous United States Lambert Conformal Conic Projection System. The initial ESRI Lambert used the following central meridian, standard parallel, and latitude of origin:

- Central Meridian: -96.00°
- Standard Parallel One: 33.00° North
- Standard Parallel Two: 45.00° North
- Latitude of Origin: 39.00° North

That system from ESRI delivers the following result on the initial target region.



If one takes a moment to refer to the map on page four, the difference in page position is quite noticeable. Each viewer can easily discern that while Lambert's projection transforms (placed immediately on the left) provide a visually pleasing image, one that is conformally accurate, it does not match well with Bradley's version. After having experimented with a Plate Carrée projection system and having less than adequate results, I thought that given Lambert's ideas as contemporary with Bradley's time of working, it would be prudent to start with Lambert. Also, since it is a conic model the were two parallel

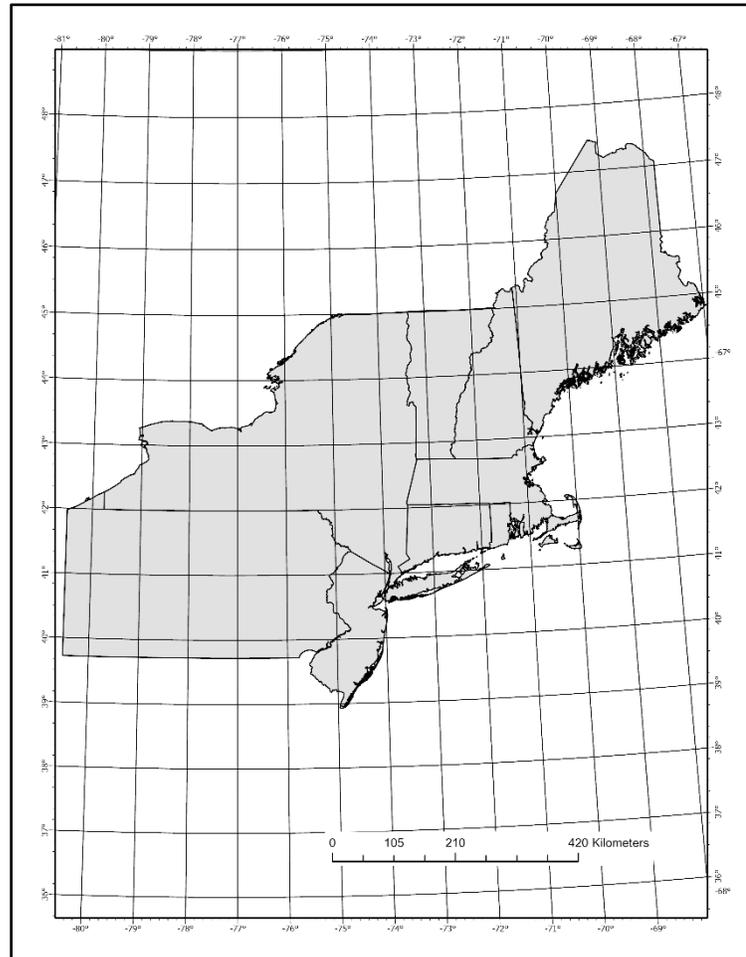
adjustments for my use and the Latitude of origin as well. I availed myself of all the choices including the changing the Central Meridian to what is currently in use for Washington, D.C. This is -77.0369° . Directly below are the transform inputs I entered.

- Central Meridian: -77.0369°
- Standard Parallel One: 24.40° North
- Standard Parallel Two: 42.50° North
- Latitude of Origin: 18.50° North

Again, for this I reasoned that at the scale I was working, I needed to bring this group of initial states into a more horizontal presentation. By doing this I knew that much of New York, Western Massachusetts, Vermont, New Hampshire, Pennsylvania, and Connecticut would be comparatively closer in alignment to Bradley's 1796 geographic rendition. It also concerned me that after taking the time to carefully examine Bradley's map in Photoshop and the

NHGIS/IPUM outline in ArcGIS Pro I was still facing a different conceptualization of the shoreline along the Atlantic Seaboard. That, however, is a cartographic difference that would require road rendering generalization on my part. The custom projection produced the results directly to the right.

The image's presentation on the page is a decidedly flatter, more horizontal one. By changing the Central Meridian, moving the latitude of origin to a lower one, and adjusting the two standard parallels to 24.40° North and 42.50° North a more extent appropriate projection system was instantiated. This still uses, according to ESRI's information provided through ArcGIS Pro, the projection transformations that are consider Lambert Conformal Conic, but this does get closer to Bradley's presentation. The graticules are still very different.



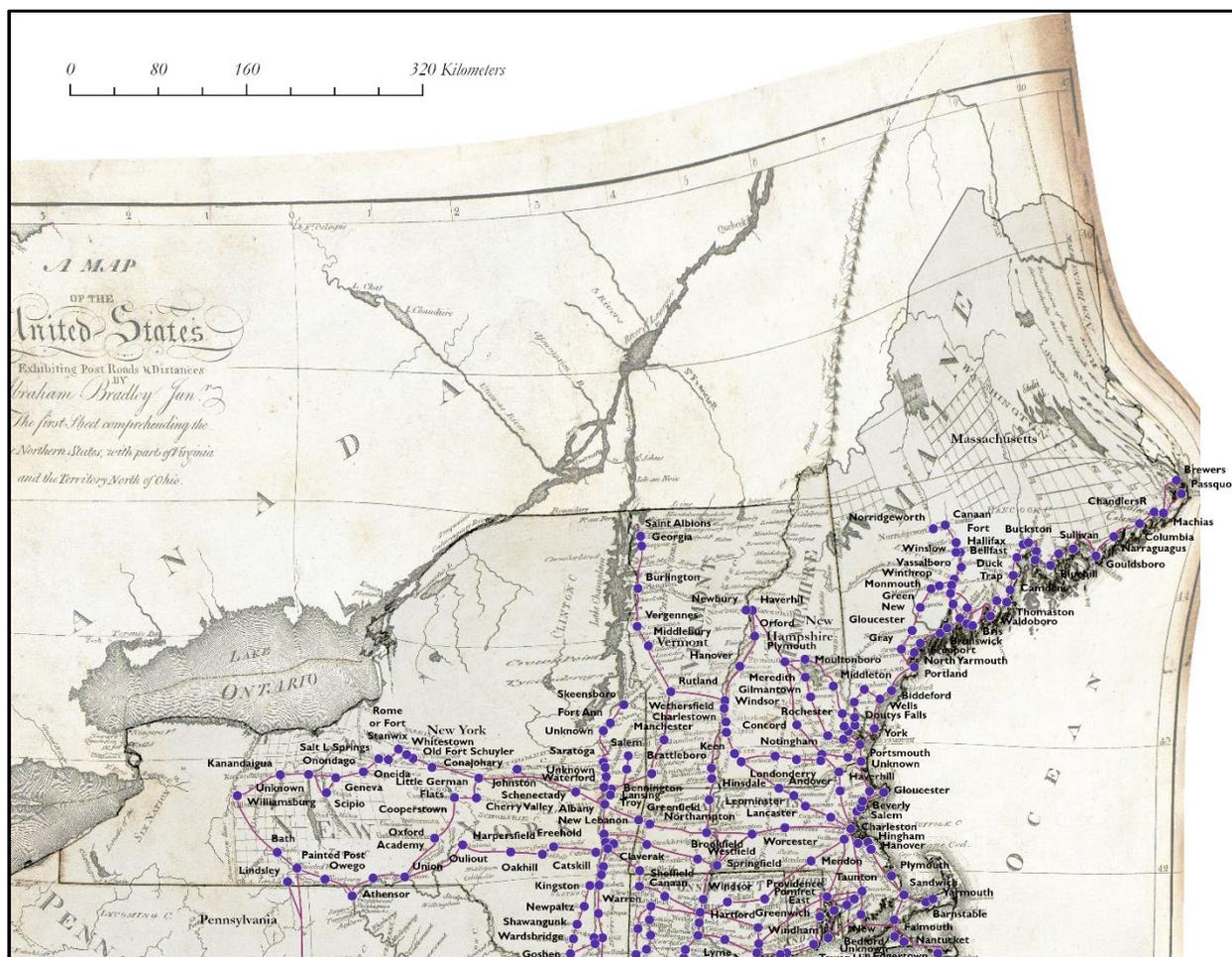
indicate to me that more research is required to develop a clear understanding of late eighteenth-century cartographic process. Additionally, having better clarity as to how the copper-plate engraving process impacts the substrate would be very helpful.

Georeferencing, Rendering Postal Roads, and Placing Postal Station Settlements —

This part of the project is admittedly very detail oriented. It is also where one starts to gain a strong appreciation for the engraver-mapmaker's technical skills. While performing the re-rendering process, in a small way one enters the original artist's realm even if indirectly. For this map Bradley provides all the postal roads, postal stations, rivers, First Nations' lands, limited topographical features, and mileage distance between each postal station. In an analog world this document is a Geographic Information System. What I hope to quickly display is a bit of the Final Project Report for Jacek Grodecki, Ph.D., Professor ▪ GIS Data Acquisition, CVEN 5382

rubber sheeting distortion and the coastline differences. Those geographic differences cannot be surmounted. They are ones that all those engaging in historic cartography and wanting to incorporate the old records as they have come down to us with our current GIS data science encounter.

The image directly below shows the distortion in the Maine area. This develops due to the differing renderings of the coastline and the New Brunswick, Canada, Maine boundary. What makes this area important to render with less generalization and approximation on my part is the Brewer, Maine, Postal Station was the northern most one in 1796. To render this Postal Road along the Maine Coastline would also require research into county level documentation concerning the routing.



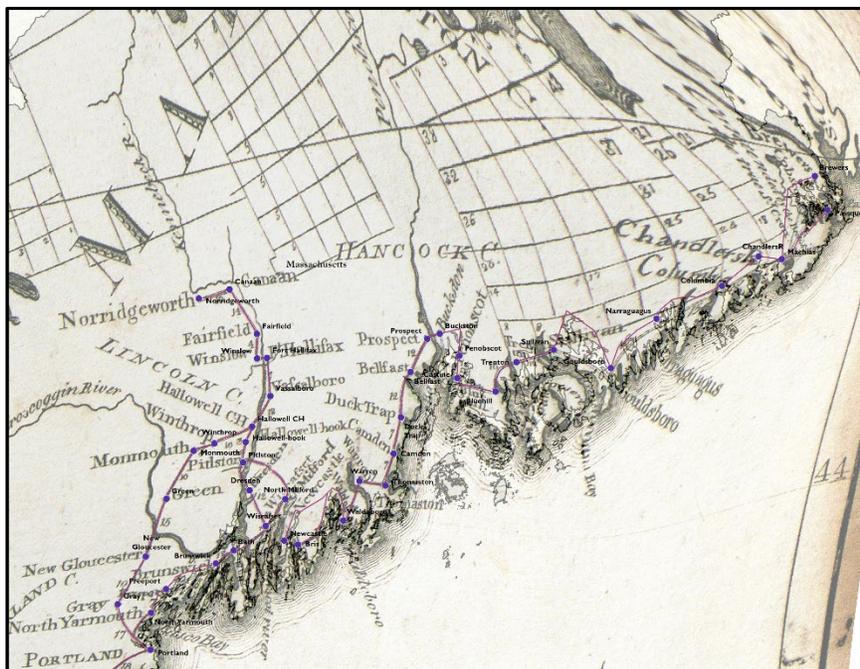
To create anchor points for the chosen Bradley map what creates some difficulty initially is choosing perimeter locations and then working toward the inner areas. My least distorting success was to line up on the state borders for New York, Pennsylvania, Massachusetts, Final Project Report for Jacek Grodecki, Ph.D., Professor ▪ GIS Data Acquisition, CVEN 5382

Vermont, and New Hampshire. Then I move outwards toward the coastline areas. As can be seen in the two examples on this page. However, on the above example the rubber sheeting required for the Maine area in the northeast map section was extensive. The transformation I used was the “Spline” and had more than eighty control points. To achieve less distortion would require much smaller map segments and this is what I am planning to do next; georeferencing and then rendering one state at a time.

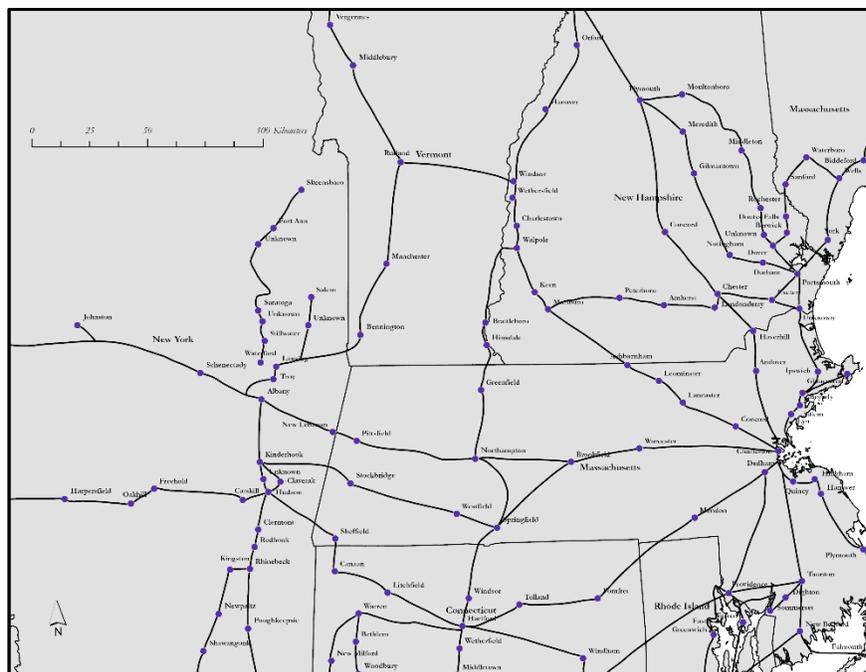


For the map areas on the left and below, first clear to me was the differing concept of what constituted Long Island, the Hudson River Mouth, and vastly different shoreline renderings. As one can see I had to make decisions to approximate road placement and Postal Stations as well. Also,

eventually through this project I envision employing ESRI’s ArcGIS Pro’s Network Tool Set to create basic 1790s’ scenarios concerning transportation impediments and constraints. It is the item I would like to embark upon next and have done some work to date.

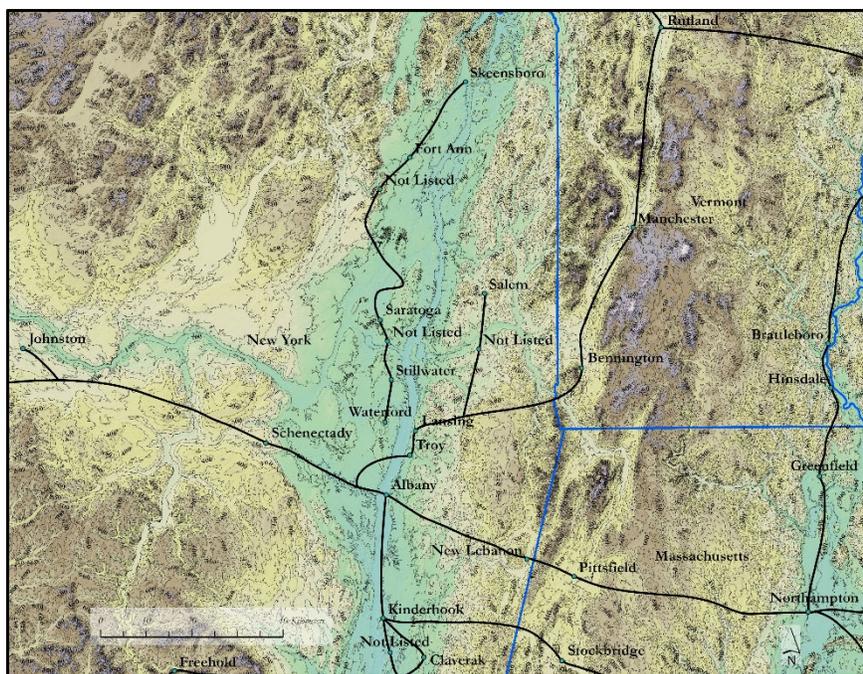


Finally, this effort is starting to bear fruit though not nearly as quickly as I would like. All the 1790 Postal Roads are placed along with all the Postal Stations and their names for this map quadrant. Initial attempts at employing the Network Tool in this type of use show promise but it is initially looking for roads that are following a grid part typical of an urban area. This network is not that and looks to require addition attribute information that will allow it to mimic that concept. Directly below are closer-in map views of the region.



The state outlines are from NHGIS/IPUMS with the Postal Roads and Postal Station settlement points coming from Bradley's map. I did use the ESRI ArcGIS Pro's locate X and Y Tool. It provides tolerable results and given that they are placed to match Bradley's this is acceptable to me.

The map on the right represents a topographical view Bradley's time could not have known. It represents ours. His world was seen from the ground. My goal is to bring high school and early college students a way to engage in a dialogue with the past on the past's term using maps and GIS.



Project Reference Resources —

Chen, Yong-qi, Yuk-Cheung Lee, et al. *Geographical Data Acquisition*. New York. Springer WienNewYork. 2001, Print.

Ernst, C.W. “A Postal Centenary” *The Postal Record*. Washington, D.C. National Association of Letter Carriers. Volume 9, Number 1. 1896, Print.

Hammond, John, with additions by Samuel Warner. *The Practical Surveyor*. London. Thomas Heath. 1750, Print.

Lambert, J. H. *Notes and Comments on the Composition of Terrestrial and Celestial Maps*. Translation and Introduction by W.R. Tobler. Michigan Geographical Publication Number 8. Ann Arbor. Department of Geography, University of Michigan. 1972, Print.

Manson, Steven; Jonathan Schroeder, David Van Riper, and Steven Ruggles. IPUMS National Historical Geographic Information System: Version 14.0 [Database]. Minneapolis, MN: IPUMS. 2019. <http://doi.org/10.18128/D050.V14.0>