Of Sextants and Satellites:
David Thompson and the Grand Portage GIS Study

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Introduction

The geographical information system (GIS) study of the Grand Portage was undertaken by Grand Portage National Monument as part of a multi-year archeological resource study. The Grand Portage (linking Lake Superior to the Pigeon River) is a 13.7 km (8.5 mile) historic trail connecting the Great Lakes with the waterways of the North American interior (Figure 1). It is the principal cultural resource and namesake for Grand Portage National Monument (GRPO), a unit of the U.S. national park system. The homeland of the Grand Portage Band of Lake Superior Ojibwe (Anishinaabeg), Grand Portage was also the inland headquarters and principal depot of the North West Company from approximately 1784 to 1802. Despite its importance and antiquity, little is known of the portage trail's cultural resources. While extensive archeological investigations have taken place around the fur trade depot and at Fort Charlotte at GRPO (Birk 1975; Woolworth and Woolworth 1982), virtually no archeological site inventory work had been conducted along the Grand Portage trail itself prior to April 2000.

The GIS study had, as its overall objective, the development of a map of the portage as it existed at the time of its peak usage, the late eighteenth and early nineteenth centuries. Central to this effort was the use of historical records, particularly the survey notes and journals of North West Company trader and surveyor David Thompson. In addition, the field notes and journals of other traders, explorers, and surveyors were utilized to supplement the data recorded by Thompson.

The principal body of available survey data is found in Thompson's unpublished field notes held by the Provincial Archives of Ontario, and available on microfilm. Portions of these field notes were transcribed by National Park Service archeologist Thomas Thiessen and made available to park researchers (Thiessen 1993).

The Thompson journals contain a variety of brief narrative observations of the Grand Portage between the years 1797, when Thompson arrived as a young fur trade clerk beginning employment with the North West Company, and 1825, when Thompson (retired from the fur trade) was the British chief astronomer (that is, surveyor) for the U.S.-British International Boundary Commission. It is these data from the boundary survey that were of principal interest to this study.

The 1822-1825 Boundary Survey

The 1783 Treaty of Paris, which formally ended the American Revolution, left the new American republic and British Canada with an imprecise and disputed Great Lakes boundary. The 1814 Treaty of Ghent, which ended the War of 1812 between the United States and Great Britain, took important steps to settle this problem. Joint US-British survey commissions were authorized to resolve key areas along the boundary. Article 7 of the Ghent treaty established a commission to chart the lake-river boundary from "the water communication between Lake Huron and Lake Superior to the most North Western Point of Lake of the Woods," including the Grand Portage of Lake Superior (Lass 1980:3-34).

The work of the commissions under Article 4 and 5 began in 1816, with the surveys of Passamaquoddy Bay and the head of the St. Croix River to the St. Lawrence River, respectively. The surveys under Article 6 and 7, though nominally separate in the treaty, were conducted by the same commission with many of the same staff, including Thompson. From 1817-1821, David Thompson led the British efforts to chart the boundary along lakes Ontario, Erie, and Huron, beginning near St. Regis, New York, and finishing near Sault Ste. Marie, Michigan, the area covered under Article 6 (Lass 1980:32-38).

The Article 7 survey commenced in 1822 near Sault Ste. Marie, Michigan, and continued for four consecutive seasons until fieldwork was completed in 1825. The commission thereafter engaged in complex negotiating on the exact placement of the international boundary, with the Grand Portage as an important bargaining chip. The disputed Article 7 boundary commission findings were put on the diplomatic back burner, and the boundary through the Quetico-Superior country, as it exists today, was not finally resolved until the Webster-Ashburton Treaty of 1842 (International Boundary Commission 1931:208-212; Lass 1980:35-54, 60-71).

Chief Astronomer Thompson

David Thompson was forty-six years old when he accepted the position of chief astronomer to the British Article 6 and 7 survey. A seasoned veteran of the northwest fur trade, a former employee of both the Hudson's Bay Company and the North West Company, and the Canadian northwest's most celebrated surveyor, it was David Thompson's grand hand-drawn 1813-1814 map of the peltry-rich Canadian northwest that hung under the avaricious gaze of the Nor'westers in their great banquet hall at Fort William (Tyrrell 1916:lxiii; Hopwood 1971:326-327; Lass 1980:36; Jenish 2003:215-216). The British commission was fortunate indeed to have the services of a man of Thompson's skill and experience. To the expedition's chief astronomer fell not only the technical duties of executing the survey, but a major portion of the planning, logistics, and field skills necessary for completing four years of extended mapping work in the Canadian wilderness. An American survey party would independently survey the same route and make a separate report of their findings for the joint commission (Lass 1980:36-39).

To his men, Thompson's experience and steady leadership were a great comfort. Observing Thompson's weathered face and iron grey hair bent in silent prayer, a companion thought he resembled "Moses in the Sinai." A font of wilderness knowledge, from native customs and languages to the hazards of the voyage, Thompson played many roles during the survey. For example, he designed and helped build the survey party's boat; cultivated native allies by giving them gifts and negotiating for their services; provided for the care of a sick boatman; read the Bible in an "extraordinary" French to his voyageurs; shot a swimming bear from the bow of his canoe; reminisced about a former narrow escape from death while bison hunting; and showed great manners and courtesy to native occupants of the region. At the conclusion of the 1823 survey, the party's medical officer stated, "we were greatly indebted under Providence to the care and skill of Mr. Astronomer Thompson" (Bigsby 1850, II:198-201, 205-206, 211, 250, 251, 266, 318; International Boundary Commission 1931:213).

Thompson's 1822-24 boundary survey methods were varied, and tailored to the needs of the job and the terrain. Distances were calculated while travelling on the water using a patent log (a propeller-like measuring device towed behind a boat), but much of the boundary survey west of Grand Portage used only rough calculations based on the average speed of Thompson's north canoes with six paddlers, 110 meters (120 yards) per minute (Bigsby 1850, II:236, 292). While more accurate but laborious trigonometric methods could be employed in certain areas, Thompson used his decades of experience at wilderness mapmaking to good effect. Thompson's medical officer describes the method: "[B]y fixing … principal points on the lake at about equal distances from each other, by observations for latitude and longitude, and then filling up the intervals by compass and log or estimate … [a] degree of accuracy is thus attained (Bigsby 1850, II:292)." Examination of Thompson's field maps and sketches confirm this method, although considerable variations in the average rate of boat speed were noted (Lass 1980:42, 126).

The exact instrumentation used by Thompson for the 1822-24 survey is unknown. Records of the Hudson's Bay Company (HBC) describe those instruments purchased by Thompson during the years 1790-1797 (Smyth 1981:3), though it is uncertain if these same instruments were still in use over thirty years later. Thompson's field notes make brief mention of some of his instruments in the course of describing his daily work. For example, on August 4, 1822, Thompson records using a theodolite, chronometer, and two compasses, his own, and that of his son (and assistant) Samuel for determining the magnetic declination at Grand Portage (Thiessen 1993:7). In 1792 Thompson purchased a brass compass, and in 1796 he purchased two additional brass compasses with 10cm (4 inch) diameter cards (Smyth 1981:6-7). HBC records indicate that in the 1790s Thompson had as many as three watches (probably used as chronometers), at least one made by Joseph Jolly of London, and all of which were periodically returned to London for repair (Smyth 1981:7-8). On numerous occasions Thompson records taking observations for latitude and longitude, using most probably a sextant. In 1791 Thompson purchased a brass sextant of 25cm (10 inch) radius manufactured by Peter Dolland of

London (Smyth 1981:5), which he may well still have been using by 1822-24. A sextant, compasses, chronometers, thermometers, an artificial horizon, parallel glasses, drafting equipment, a patent log, a theodolite, surveyor's chains, field journals, nautical almanacs and tables, and perhaps a telescope were probably the principal pieces of surveying equipment David and Samuel Thompson brought to Grand Portage.

The cornerstone of Thompson's survey efforts was the use of astronomical observations and celestial navigation methods to determine latitude and longitude. While determination of latitude was a reasonably straightforward method using a sextant and solar observations, determination of longitude required repeated lunar observations and an extraordinarily complex series of calculations using spherical trigonometry. Corrections for parallax and light refraction required additional observations, calculations, and air temperature readings. As a young apprentice Hudson's Bay Company surveyor in 1790, Thompson learned to take these observations in the subzero winter nights of northern Saskatchewan. An error of one minute in observation of lunar distance at this latitude could yield an error on the ground of twenty miles. Through calculating the mean of his repeated observations, Thompson was able to achieve an accuracy within 4.3 km (2.7 miles) in longitude and as little as .4 km (.25 mile) in latitude from known modern locations, a reasonable accomplishment for his day (Sebert 1981:406-408, 412-414).

However, when conducting rough track surveys without the benefit of repeated single-point observations under a variety of atmospheric conditions, Thompson's accuracy could be rather poor. Errors of up to 37 km (23 miles) in longitude and 12 km (7.5 miles) in latitude in single observations have been noted (Sebert 1981:413-414). His efforts at estimating distances between points through estimating his rate of progress in a canoe has yielded errors of as much as 16 km (10 miles) over an actual distance of 38.6 km (24 miles) (Stewart 1936:289-290). Thompson's precision as a surveyor has been perhaps overstated by some of his biographers (Tyrrell 1916:xvi). Nonetheless, a balanced appraisal will recognize Thompson's remarkable accomplishments as a wilderness surveyor and mapmaker, and his ability to collect geographical data under rugged conditions, using simple and cost-effective methods, with a reasonable (if not absolute) degree of accuracy.

The Thompson Data

The data used for evaluating Thompson's survey of the Grand Portage were found in his boundary commission field notes from 1822-1824, with most data derived from his survey of September 3-5, 1824 (Thiessen 1993).

The September 1824 survey was the culmination of several earlier, superficial efforts to survey the portage. The earlier efforts provided distances (some chained, some estimated) along the trail and some rough compass bearings. On June 16, 1798 while in the employ of the North West Company, Thompson measured the portage through an undisclosed means (probably through chaining or pacing) at 12,902 meters (14,110 yards) (Thiessen 1993:5-6). On August 6, 1822 in the employ of the Article 7 boundary commission survey, Thompson used a “Tape Line of 100 ft” (30.48m) (possibly of cloth or thin metal) to measure the Grand Portage, noting, “atho’ the very first time in service and handled very carefully it broke twice.” From water to water the portage measured 13,311 meters (43,670 feet) (Thiessen 1993:8). It is difficult to precisely compare the two surveys, as the 1798 survey commenced at the “west Gate of the Fort” (presumably the North West Company fort), and not at the water’s edge (Thompson June 16, 1798). The following year, on June 30, 1823 Thompson assisted by his son Samuel, used a 50 foot (15.24m) wire chain (evidently the delicate “tape line” was not a success) to measure the entire portage, noting the location of various watercourses and natural features, and recording a few rough bearings. The overall length in June 1823 was recorded as 14,378 yards (43,124 feet or 13,144 meters).

The rough bearings from June 30, 1823 were supplanted in September 1824 with a complete set of compass bearings for each trail segment, along with itinerary measurements for each course leg. All Thompson’s bearings are written in the naval quadrant format (now generally obsolete); for example S13E, which corresponds to an azimuth of 167 degrees; N30W which corresponds to an azimuth of 330 degrees, etc.

While the bearings are generally decipherable, the itinerary measurement system accompanying Thompson’s 1824 bearings took a little more interpretation. He begins the survey at Fort Charlotte, on the west end of the portage:

> I took the Cos [course] & Distce [distance] of the C Place [Carrying Place, i.e. portage] as follows
>
> N76E 2 ¼’ + 20 yards

There are 63 such course/distance measurements, with accompanying notes on the trail and observed natural features. When I commenced plotting the course of the trail using these data, I interpreted 2 ¼’ to be 2 ¼ feet. However, it quickly became clear that the tick mark did not represent feet as is usual in surveying, nor, obviously did it represent yards, as the opening measurement of “2 ¼’ + 20 yards” infers that there were two units of measurement at work. By totaling all of Thompson’s measurements, and dividing by the length of the portage which Thompson chained in 1823, it was hoped that another known unit of measurement, such as chain, cable, rod, etc. would be yielded. Breaking down the data into smaller segments of trail caused the plot to thicken further. On the west (generally flatter) half of the trail, the units of measurement averaged 63.92 yards/unit (58.45m); on the middle half of the trail, the units of measurement averaged 61.73 yards/unit (56.45m). In any case, 62 to 64 yards/unit did not correspond to any known unit of measurement, and certainly not one notated with a “tick” mark or apostrophe.

The answer should have been obvious, but it took the fresh eyes of my co-investigator Douglas Birk to suggest the answer: Thompson had modified his survey methods and was employing a new trick. Rather than using a chain or tape, as he had in the previous two years, he was now using a chronometer to time his walking, just as he was in 1823 using an average rate of speed in the canoes to calculate his distances over water (Bigsby 1850, II:236, 292). Each compass leg was timed, therefore 2 ¼' + 20 yards meant two and one quarter minutes or 135 seconds of walking, with an addition of 20 yards (18.29m) to his point of beginning. Presumably, the riverbank there was too steep to allow him to begin his pacing survey at the water's edge. It is also possible that access to the river edge was blocked by the old North West Company wharf observed by the U.S. boundary survey team the previous year (Delafield 1943:406) which might have caused Thompson to simply estimate the additional 20 yards distance.

Pacing is, in fact, a most ancient (if imprecise) method of measuring distance. Using what geographers have called an "anthropometric" system, the old Roman mile, *mille passus*, is based on a 1,000 double-step paces of 5 Roman feet each, and the European league was historically defined (at least by some) as the distance which could be walked in an hour (Chardon 1980:131-132, 134). U.S. Army Rangers to this day are trained to count and record their paces, using a system of strung beads like a rosary, to calculate distance traveled in kilometers.

Discovering Thompson's method helped tremendously with interpretation of the data. For example, it now made sense why the unit of itinerary measure seemed to change over different points of the trail. Thompson's average rate of speed changed depending on the nature of the terrain (whether hilly, flat, marshy, etc.) or other factors. Other students of David Thompson's survey methods have already noted this problem in his efforts to estimate distances and average his canoe speeds, a difficult art at best (Lass 1980:42, 126; Stewart 1936:289-290).

It is unclear why Thompson, who had laboriously chained the 13.7 km (8.5 mile) portage down to the foot in 1823, while only taking rough compass bearings, then in 1824 took detailed compass bearings, but resorted to the much less accurate system of estimating distance by timing his pacing and applying an overall average speed over ground to measure each course leg. Perhaps he was dissatisfied with his compass data from 1823, but did not feel the need for more accurate distance measurements to complete his map. The scale of the maps to be produced for the boundary commission was 2 miles to the inch (3.22 km to 2.54 cm) or 1:126,720 (Bigsby 1850, II:292). The entire Grand Portage would be plotted in an area approximately 4 1/4 inches (108 mm) in length. Clearly, for Thompson's immediate purposes his compass data and approximate itinerary measurements developed by chronometer and pacing, would be adequate.

Thus while Thompson's rough track survey data has proven to be a valuable find for Grand Portage researchers, the impreciseness of the data restricts its utility. We can only wish that the detailed bearings of 1824 had been accompanied by the detailed distance chaining of 1823, which would have yielded a much more precise map of the trail and its observable features.

With these limitations in mind, we then set out to plot and interpret the survey data. The data were plotted using an ESRI ArcView 3.1 geographic information system. The survey point of beginning at Fort Charlotte was plotted at the modern terminus of the portage.

Thompson's recorded bearings were input to the GIS, and the distance for each leg of his compass course was calculated using an estimated rate of speed over ground. Unfortunately, Thompson did not record his rate of speed in his 1824 field notes. An estimated speed was calculated by dividing the time elapsed during Thompson's 1824 pacings with the overall distance Thompson chained in 1823. This obviously makes an assumption, perhaps mistaken, that Thompson followed a fundamentally identical route in both years.

The resulting trail shapefile of 63 line segments was then rotated using Thompson's recorded local magnetic declination of 7.25 degrees (this has diminished approximately 4.75 degrees in the past 178 years) (Ridlbauer 2002:1; Thiessen 1993:7). The entire shapefile was then overlain onto digital raster graphic U.S. Geological Survey 7.5' quadrangles and checked for fit against known natural features. These included stream crossings, ravines, and hills noted in Thompson's field records. A sample might include "*N80E 2 ½' to the Meadow,*" the meadow being a former beaver meadow, today (with the return of the beaver) a large dammed-up marsh. Or, *"S36E 1 3/4' ascend & descend. A Rill now dry to)[right]"* (Thompson uses a single parenthese as an obtuse arrow pointing to the right or left). The endpoint of the Grand Portage, historically believed to lie at the lakeshore just to the northeast of the mouth of Grand Portage Creek (the location implied by Thompson's survey notes), was our hypothesized endpoint for the 1824 survey (Thompson June 30, 1823, September 5, 1824; Woolworth 1993:27, 51-54). Of his survey endpoint, Thompson only says, "S35E 2 ½ to the Shores of the lake Superior" (Thompson September 5, 1824).

The plotted line segments were not corrected for changes in elevation. A test sample of segments was corrected, modifying Thompson's level distance to a slope distance: at the relatively modest elevation changes of the Grand Portage, the difference was found to be negligible for the purposes of this project.

By slight movements and rotation, the shapefile was fine tuned into place. The results may be seen in Figure 2.

Viewed in its entirety, the plotted Thompson rough track survey data looks like a reasonably accurate representation of the historic trail, which largely conforms to today's trail and surrounding landforms. The accuracy is more than sufficient for Thompson's scale requirement of two miles to the inch. Two principal areas of deviation from the modern trail may be noted, but at this scale, neither deviation appears severe.

Zooming in to the west end of the portage (Figure 3), we see the plot from its point of beginning at Fort Charlotte. The accuracy is reasonably good throughout this segment, up to the beaver meadow area. Today, the presence of beaver and high water has caused the current trail to veer south in this area from what was probably its late eighteenth century alignment.

East of the meadow (Figure 4) the limitations of the Thompson data become more evident. Thompson rounded off his compass bearings to single degrees, and his chronometer data was rounded off to 15 second intervals, or converted to his estimated average speed over ground, about 14.94 m (49 feet). One must also allow for a small range in error on top of these adjustments. While some roundings up or down probably canceled each other out, the accuracy tends to worsen on each of the 63 course legs from the point of beginning, as each successive measurement compounds the errors introduced in earlier measurements.

There is also the possibility of a recording error on Thompson's part (either in his original rough journal, or while copying into his "fair" journal, which was used for this study). Several reviews of the microfilmed journal and checks of certain problematic measurements helped insure that investigator error was not added to the data. However, I may in a few instances have misread Thompson's sometimes-difficult handwriting and inadvertently introduced data errors.

From the meadow to the vicinity of today's Old Hwy. 61, the accuracy of the GIS plot worsens, departing almost entirely from the route of today's portage and even exiting the park. While of course possible, this is topographically and historically unlikely, as the GIS plot of the historic portage plunges off the generally level top of a diabase dike, crossing drainages and running up hills and along sideslopes in defiance of the human path of least resistance.

I then sought several versions of a "best fit" based on known anchor points and natural features. The starting point at Fort Charlotte remained unchanged, but through slight rotations the GIS plot was brought to intersect through several known watercourses (which Thompson recorded) and cross through major terrain features (such as gaps in the diabase dikes). Several improved versions of the original GIS plot were produced.

Poplar Creek, roughly one third of the way uptrail from Lake Superior, provides an important anchor point for adjusting Thompson's data on the lower portage. Possessed of relatively steep banks and modest stream flows, this watercourse has not moved significantly from its location in the early nineteenth century. The Thompson data clearly depicted the oblique approach to Poplar Creek and the crossing, but places it 150 meters (492 feet) too far to the south. It is evident that Thompson gained speed on his generally downhill course between today's Cowboy's Road and Poplar Creek, thereby stretching the line segments through this area and misplacing the creek crossing.

The search for a "best fit" led to a series of refined GIS shapefiles, developed with the assistance of a GIS specialist (Ridlbauer 2002). Each line segment was replotted in ArcView with the use of an Excel spreadsheet. New azimuths and distances were calculated for differing magnetic declinations and velocities. By splitting out and reworking sections of the trail, several much improved "best fit" versions of the data were developed. One version, anchored at Poplar Creek, has been found to be particularly valuable for archeological analysis of the 1.5 km (.93 mile) segment of trail centered on Poplar Creek and the adjacent uplands (Figure 5). Another version provides an improved, through still problematic depiction of the portage for the lower 2.5 km (1.55 mile) extending inland from Lake Superior. As observed earlier, the data quality improves closer to its point of origin at Fort Charlotte, and both “best fit” versions provide similar depictions of the portage west of the beaver meadow.

It is obvious that taken at this scale, the GIS plot ceases to become a direct, literal representation of the historical portage. However, it creates a valuable tool for interpreting the historical portage and associated cultural and natural features. It is clearly insufficient for describing the exact historic location and alignment of the trail at any given point (particularly for the eastern half of the trail). But, its utility improves for describing the relative shape and course of the portage for selected segments. It is most valuable for indicating at what point along the historic trail cultural and natural features of interest occurred, in distances that Thompson chained and paced from both ends of the portage over several surveys.

The next phase of investigation was the use of the GIS for focusing archeological investigations, locating and verifying original segments of the trail, identifying disused segments and historical alternates, and using archeology to date trail segments and identify activity areas. With a better understanding of the historic Grand Portage, archeologists would be able to develop a better understanding of the evolution and varied uses of the Grand Portage, and a more detailed understanding of the logistics, behavior, and material culture of portaging activity. Of great concern to park resource managers, the study would also allow for the identification, preservation, and interpretation of the Grand Portage as it existed throughout history, not simply as a footpath through the woods as it has survived today.

The GIS study had almost immediate payoffs. Just two months after the creation of the first fairly crude portage shapefile, archeologists used the GIS to obtain global positioning system (GPS) coordinates (GPS is a satellite-based positioning system operated by the U.S. Department of Defense) and begin surveying for cultural features identified by Thompson. In April 2000 guided by GPS and Thompson’s data, archeologists identified a series of culturally-modified pits which are believed to be watering holes referred to by Thompson as “The Fountain” (Thompson June 16, 1798, September 4, 1824). From this commenced archeological field investigations of suspected encampments, resting stops, and water sources which, along with the trail, constitute the physical record of hundreds if not thousands of years of human use of the Grand Portage corridor.

Field investigations in 2000 focused on the Fountain area, while investigations in 2001-2002 focused on a reported encampment and stream crossing at Poplar Creek. Investigations in 2003 focused on the Parting Trees, an enigmatic encampment or portage rest stop (called a posé by French-Canadian voyageurs) identified by David Thompson on one of his early crossings of the Grand Portage (Thompson June 16, 1798). In addition, preliminary investigations of three additional posé sites and another probable culturally-modified watering source have taken place. The survey has made a further effort to record, using GPS and the GIS, historic rutting (i.e. wagon tracks) and segments of abandoned roadbed along and adjacent to the current trail. In each case, the Thompson survey data, the GIS, and the GPS have assisted in refining survey areas, understanding historical alignments of the trail, suggesting locations for alternate routes of the portage, and identifying and recording archeological sites.

The results of the archeological investigation are preliminary. However, some initial conclusions may be stated. First, the archeological record of portaging, at least on this trail, is rather sparse. While twentieth century material, such as pop can tabs, aluminum foil, and spent hunting cartridges are fairly plentiful, material from the eighteenth and early nineteenth century is much less frequent. Wrought nails and occasional animal shoe nails are the principal markers of the fur trade era portage with a few other isolated eighteenth century artifacts. Posés and short-term encampments are marked by light scatters of more typical French and British fur trade material, such as knife blades, buttons, and some gun parts, but in general the evidence to date points to rapid portage crossings with very brief rests, spartan personal effects, and a lack of well-developed encampment or rest areas.

This is not to say that the archeological results have been disappointing: far from it. It is only to temper the notion that the portage represents a continuous deposit of cultural material with readily identifiable posés and encampments. The investigators have found that historic trail segments and activity areas are indeed discernable, dateable, and to a small degree predictable in location, but the evidence is often rather subtle. As our understanding of these archeological “signatures” becomes more refined, we hope to expand our investigation over the length of the entire trail, in an effort to locate and evaluate the 16-18 historically recorded posés, and other cultural and natural features. The archeological phase of the project is still ongoing, and a more detailed report of archeological findings will be forthcoming.

The Grand Portage GIS study has led park managers to think more explicitly about the portage itself as a heritage resource, an important broadening of perspective from the park’s traditional focus on the North West Company depot area on Lake Superior. Moreover, the study has led to more detailed study and mapping of the portage and all of its natural and cultural resources, thereby improving both managers’ and the public’s understanding of this historic corridor. The long-term goal is not to excavate all the archeological resources of the Grand Portage trail. In keeping with the mission of the National Park Service, the goal is to identify, preserve, and interpret the cultural resources of the Grand Portage, and to bring to the public a better appreciation of its significance and historic usage.

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Figure 1: Project Location, Grand Portage National Monument, Minnesota

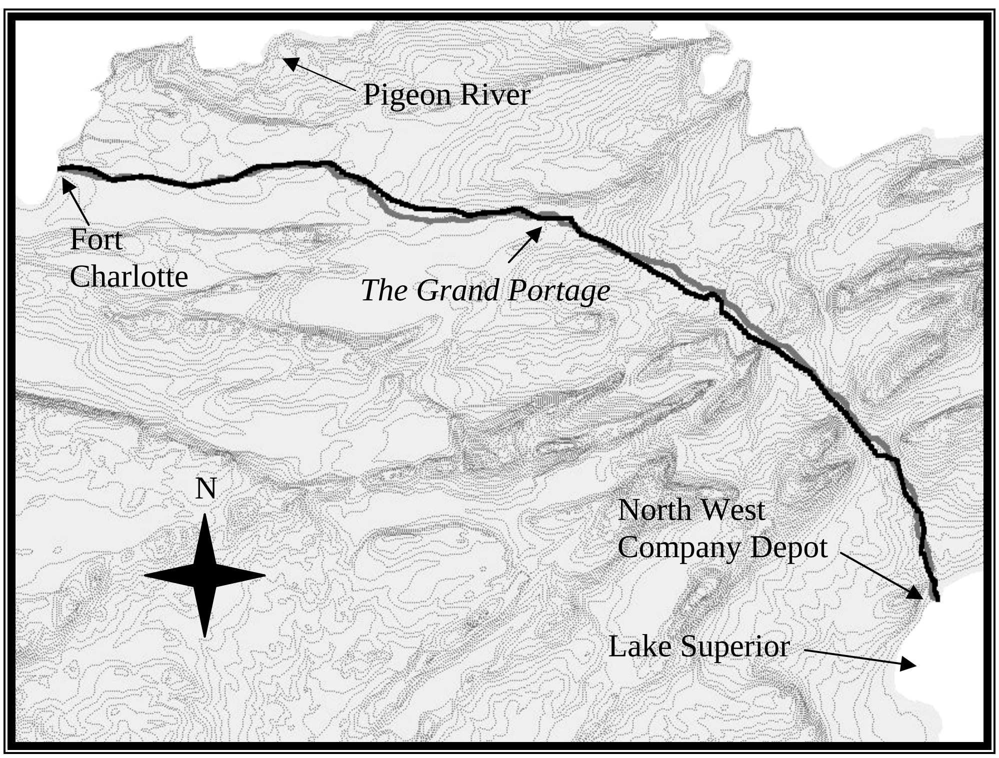

Figure 2: The Grand Portage (2002) in grey, with the GIS plot of Thompson's 1824 survey overlain in black.

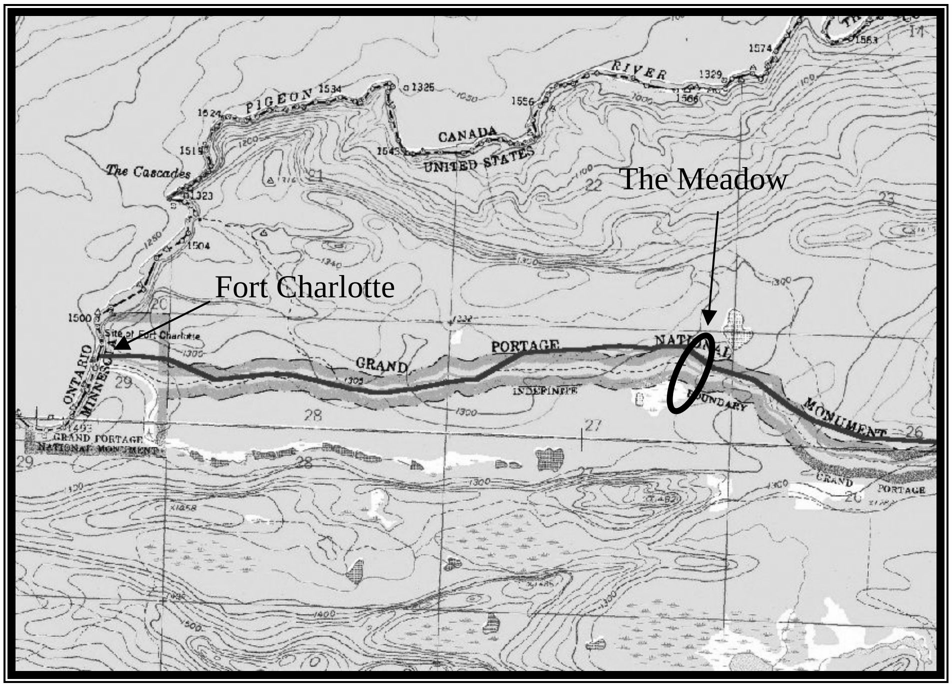

Figure 3: Western segment of Thompson's 1824 survey (black) overlain onto current trail. Survey began at Fort Charlotte.

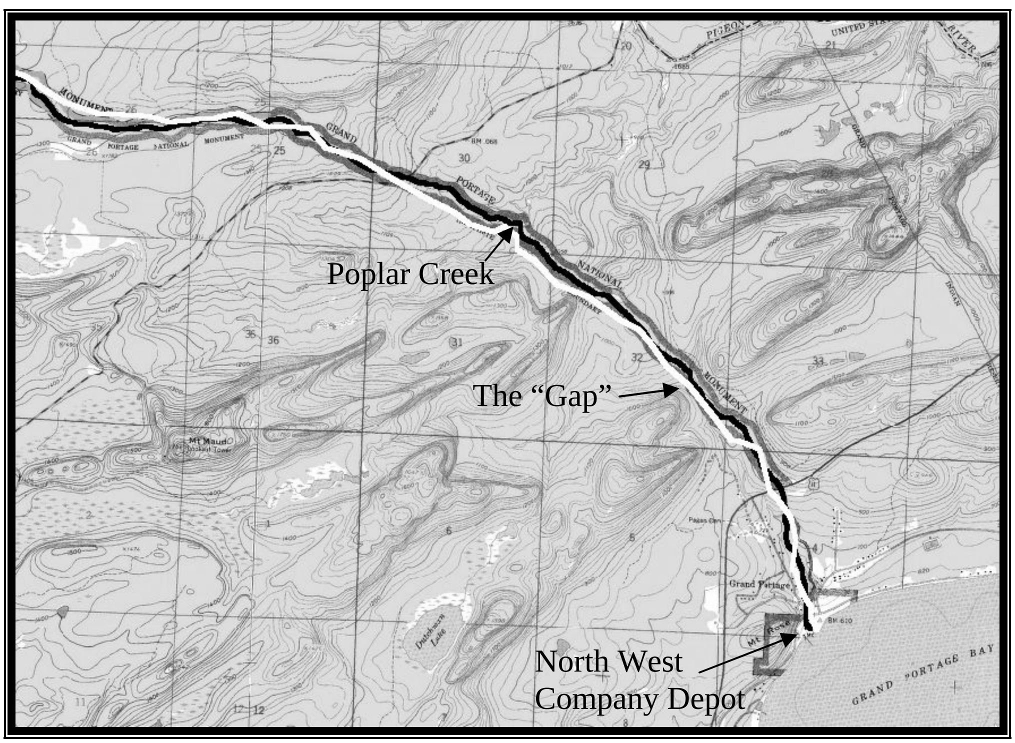

Figure 4: Eastern segment of Thompson's 1824 survey (white) overlain onto current trail (black).

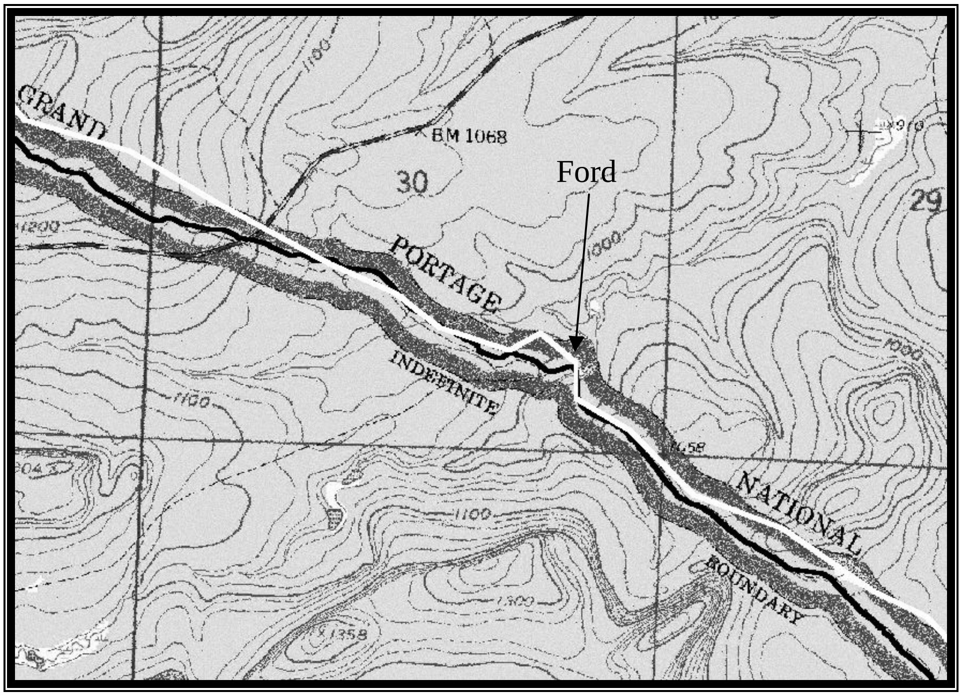

Figure 5: Detail of Poplar Creek segment corrected using Poplar Creek ford as an "anchor" point. Thompson's 1824 survey (white) overlain onto current trail (black).