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ANTHROPOGENIC INFLUENCES ON THE DECLINE, RESTORATION, AND ECO-EVOLUTIONARY DYNAMICS OF LAKE SUPERIOR'S COASTER BROOK TROUT

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Abstract

The coaster brook trout is a life history variant of the brook trout (*Salvelinus fontinalis*) that is characterized by either lake residency or migration between stream and lake habitats. Coaster brook trout were once widespread throughout Lake Superior and its tributaries, but populations declined sharply in the late 19th and early 20th centuries. Historically, brook trout were a popular target of recreational and subsistence fishing in the Lake Superior basin, and it has been hypothesized that angling pressure combined with multiple forms of industrial development are what drove the coaster brook trout's decline. In the mid to late 19th century, the logging, lumbering, and mining industries proliferated rapidly, along with the network of railroads, which provided connectivity for industry and access to once remote fishing locations. However, it is unknown to what degree each of the proposed factors influenced the coaster's decline.

In Chapter 1, we collected and analyzed historical data (Pre 1880-1950) on the distribution & abundance of brook trout in Lake Superior tributaries, along with historical data on the development and expansion of industries around Lake Superior to examine potential associations between specific anthropogenic impacts and coaster brook trout declines. The data were separated into four temporal categories (Pre 1880-1880, 1881-1900, 1901-1920, 1921-1950) to examine reports of brook trout catches during critical time periods in industrial developments around Lake Superior. We performed a geospatial analysis using ArcGIS Pro that demonstrated a decrease in both putative coaster brook trout abundance and range over time. Brook trout decreased notably between the '1881-1900' time period and the '1901-1920' time period, following large increases in both lumber mills and kilometers of railroad. We performed a principal component analysis to reveal potential associations between variation in industrial variables and brook trout abundances in watersheds between the first and final time periods (Pre 1880-1880 & 1921-1950, respectively). Our analysis showed that the majority of watersheds analyzed experienced a decrease in brook trout abundance and suggested that the industrial development variables we examined all are associated with and thus may have all influenced brook trout decline, though to varying degrees, as some developments were highly localized. Angling appears to be an important factor in the decline of brook trout populations around Lake Superior, as active angling (noted removals of brook trout) occurred in every watershed for which we found data. Furthermore, brook trout populations declined almost universally, even in watersheds for which we recorded little to no industrial footprint.

In Chapter 2, I examine historical and modern brook trout management initiatives, use an eco-evolutionary perspective to inform potential management & restoration strategies, and identify potential restoration watersheds using the historical GIS data from Chapter 1. I used these data to create a table of prioritized restoration sites by compiling watersheds that had both a high likelihood of historical migratory brook trout populations and also experienced little industrialization. With this information, we identified several locations in Wisconsin, Michigan, and northern Minnesota that may be optimal coaster restoration watersheds.

1 Thesis Introduction and Rationale

In the late 1800s and early 1900s, migratory brook trout populations declined substantially in Lake Superior and its tributaries (Huckins et al. 2008; Shiras 1935). Both historical reports and modern scholars have attributed the decline to industrialization in the Lake Superior region, as well as overexploitation by anglers (Schreiner et al. 2008; Detroit Free Press, May 17, 1925). However, these hypotheses on the anthropogenic influences on brook trout declines have remained poorly understood since the initial declines occurred. This thesis aims to explore potential drivers of the historical decline of migratory brook trout in the Lake Superior region and use this information within an eco-evolutionary framework to inform brook trout management and restoration strategies. To do this, I have collected historical data on the presence and abundance of brook trout populations and three industrial variables (lumber mills, mines, and railroads) in watersheds adjoining Lake Superior. I then performed an historical GIS analysis to understand the historical abundance dynamics of the brook trout populations, potential factors influencing their decline, and highlight watersheds for potential restoration..

Historical GIS analyses have been used previously to examine the historical environmental impacts of industries in the Lake Superior region, and have proven useful in understanding the past, present, and future impacts of industrialization on environmental factors (Baeten, Langston & Lafreniere 2016; Baeten, Langston & Lafreniere 2017). For the analysis in Chapter 1 I collected historical data on the presence and relative abundance of brook trout in watersheds of Lake Superior tributaries and the numbers of three industrial anthropogenic disturbances (lumber mills, mines, and

railroads) within those watersheds from the early 1800s to 1950. I then performed an historical GIS analysis to understand the historical patterns of migratory brook trout declines in the Lake Superior region and the industrial factors associated with their decline and use this to identify watersheds for potential restoration.

In Chapter 2, I briefly summarize the history of brook trout management around Lake Superior, explore modern rehabilitation and management initiatives, and use an eco-evolutionary perspective to elucidate future perspectives on the restoration of migratory brook trout in the Lake Superior Basin. I end the chapter by using the historical GIS data presented in Chapter 1 to identify potential migratory brook trout restoration sites.

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2 Anthropogenic Influences on the Decline of Coaster Brook Trout in the Lake Superior Basin

2.1 Introduction

Coaster brook trout (coasters), an adfluvial or lacustrine life-history variant of brook trout (*Salvelinus fontinalis*), were once abundant in Lake Superior and its tributaries. The coaster life history is characterized by lake residency or migration between stream and lake habitat and a generally large body size relative to stream resident brook trout (Huckins et al. 2008). Coasters were a popular target of recreational and subsistence fishing in the 19th and early 20th centuries (Huckins et al. 2008; Shiras 1935). In the mid to late 19th century, people began to notice a precipitous decline in the coaster brook trout population, especially along Lake Superior's south shore (Shiras 1935; Detroit Free Press, Jan. 29, 1875). This decline continued into the early 20th century, after which time the coaster brook trout was nearly extirpated from the south shore of Lake Superior and its tributaries and greatly reduced along the north shore; many anglers remarked on the degraded status of famed coaster streams such as the Salmon Trout (MI), Nipigon (Canada), and Bois Brule (WI) Rivers (Huckins et al. 2008; Wisconsin State Journal, Jan. 27, 1924). Today, the extant remnant coaster populations in Lake Superior remain greatly reduced and fragmented compared to their former status (Huckins et al. 2008, Schreiner et al. 2008).

The decline of Lake Superior's coaster brook trout populations appears to have been driven primarily and almost exclusively by human activities, particularly those of European immigrants who developed industries and communities around Lake Superior.

Factors proposed as central to the coaster brook trout's decline include overharvesting by anglers, alteration of habitat by industrial activity such as logging, lumbering and mining, the blocking of fish movements by impoundments, pollution, and the introduction of non-native salmonids into Lake Superior and its tributaries (Huckins et al. 2008; Schreiner et al. 2008; Duluth News-Tribune, May 16, 1920). This study aims to improve our understanding of the coaster brook trout's decline by using available records to document the expansion of several human activities in the Lake Superior region during the 19th and early 20th centuries and examine the role they each appear to have played in the coaster brook trout's decline.

The Lake Superior region was a popular sport fishing destination for wealthy tourists and residents who would make trips around the lake to participate in the legendary brook trout fishing reported by other travelers. Reports rfrom the 19th century indicate that anglers would often take extraordinary numbers of brook trout in a single fishing excursion. For example, parties fishing the Pilgrim River in Houghton County, Michigan, reported taking over 900 brook trout over the course of two days in 1871, shortly thereafter another fishing party had taken 720 (Duluth Minnesotian, Jul. 8, 1871). Fishing with nets and explosives was commonplace in the 1800s and into the early 1900s; these methods allowed for the harvest of large numbers of brook trout at a single time, with the potential to rapidly deplete brook trout numbers, impact entire food chains, and alter habitat conditions simultaneously. Following the expansion of industries around Lake Superior, railroads and automobiles facilitated a growing spatial connectivity between watersheds harboring coaster brook trout, that likely allowed even faster exploitation of brook trout by anglers. Moreover, the coaster brook trout's migratory life

history made populations vulnerable to multiple forms of catch-related mortality, such as being collected in mass quantities at the mouths of rivers during migratory runs and being captured within nets in Lake Superior as bycatch from nearshore commercial fishing operations (Duluth News-Tribune, Aug. 20, 1911).

As the timber industry developed and expanded around Lake Superior, large areas of land were quickly deforested. Skidding logs over land was difficult, costly, and time consuming, so the earliest white pine logging focused almost exclusively on trees located near streams and rivers that were used to transport logs during log drives in the spring months (Whitney 1987). Streams used for log drives became inundated with thousands of logs at a single time, and the presence and movement of these logs altered channel characteristics. Rapidly moving logs scoured streams and were likely a source of direct mortality for fish and inhibited the upriver movement by fish when log jams occurred. Log jams or other obstructions that hindered log movement were often cleared with dynamite, further altering in-stream habitat conditions (Peterson & Ronnander 2017) and likely killing fish. Additionally, dams that were used to control water flow to power sawmills and transport logs punctuated streams and blocked fish migration, contributing to the damaging of streams from log drives, with potential legacy effects that may have extended decades beyond the dam's operation (Miller 2010).

Waste from lumber mills was frequently deposited into streams and lakes, potentially toxifying the water via dissolved chemicals (Knight 1903; Knight 1907), degrading the habitat quality, and reducing food quality and presence (Bogue 2007). The many sawmills established during the logging and lumber boom were a frequent source of large fires that substantially contributed to the deforestation of the Lake Superior basin

in the 19th century; this deforestation was associated with multiple deleterious impacts to streams, such as increased erosion, runoff and siltation, variable stream flows, increased stream temperatures, and removal of riparian cover and concomitant reductions in riparian inputs into streams (VanDusen et al. 2005; Beschta 1978; Whitney 1987).

In addition to the growth of logging activities in the Lake Superior region, copper and iron mining industries grew rapidly in the late 19th century, bringing in a multitude of immigrant laborers and stimulating enormous economic developments. Hundreds of copper and iron mines were located along the iron and copper ranges in Michigan's Upper Peninsula, Minnesota's Mesabi iron range, and the Gogebic iron range, which reaches across northeastern Wisconsin into the western Upper Peninsula. Mining operations produced large quantities of waste, which polluted surrounding waterbodies (Jeong et al. 1999; Kerfoot & Nriagu 1999). Waste from stamp mills, known as stamp sands, contained numerous pollutants such as heavy metals and arsenic; these stamp sands were dumped into waterways to bioaccumulate in organisms and bio-magnify up aquatic trophic webs (Kerfoot et al. 2018).

Non-native salmonids such as rainbow trout (*Oncorhynchus mykiss*) and brown trout (*Salmo trutta*) were introduced into Lake Superior and its tributaries beginning in the late 1800s and may have either contributed to the decline of the coaster brook trout or hindered their recovery through competitive interactions. Introductions and invasions of exotic species continued into the 21st century, and invasive species such as the sea lamprey (*Petromyzon marinus*) further altered the composition of the fish community, adding novel predation and parasitism to the Great Lakes' changing aquatic ecology (Huckins et al. 2008; Schreiner et al. 2008).

Although all of these proposed factors likely contributed to the decline of the coaster brook trout, identifying the incremental contribution of each is difficult. To address the potential impacts of these anthropogenic watershed disturbances, we conducted a geospatial analysis to document the establishment and expansion of lumber mills, mines, and railroads around Lake Superior and investigate how these industries may have contributed to the decline of Lake Superior's coaster brook trout. Using ArcGIS Pro, we created a series of maps that display the presence and abundance of brook trout in known and potential coaster supporting watersheds around Lake Superior and demonstrate the growing industrial footprint of humans in the region. We mapped the expansion of sawmills, mines, and railroads in Michigan's Upper Peninsula, Wisconsin, and Minnesota between 1800 and 1950. These variables were compared to historical brook trout observation data during four critical time periods (Pre 1880-1880, 1881-1900, 1901-1920, and 1921-1950) to explore possible relationships between human activities and a declining presence of brook trout and reductions in brook trout abundances.

2.2 Methods

This research was part of a larger National Science Foundation funded project examining migratory species and infrastructure development across the Upper Great Lakes (NSF-STS 1921911 Langston and Huckins). Our research team consisted of myself and four other scholars from Michigan Technological University: Casey Huckins, PhD. (Biological Sciences), Nancy Langston, PhD. (Social Sciences), Daniel Lizzadro-

McPherson (Geospatial Research Scientist, Great Lakes Research Center), and Jordan Kelley (Master's Student, Social Sciences).

2.2.1 Study Area

Spatial Area: The spatial extent of this research covers the United States' side of Lake Superior: Michigan's Upper Peninsula, Wisconsin, and Minnesota (see Figure 1). This geographic range is apporpriate for several reasons. First, archival data were easier to obtain for the United States than for Canada because our entire research team is located in the U.S. Obtaining Canadian archival materials online was substantially more difficult, and access to physical archives was not feasible due to travel restrictions during the COVID-19 pandemic. Second, historical GIS data were also more readily obtainable for the United States than for Canada. This includes data for the GIS shapefiles that we created as well as existing GIS shapefiles that were used in our analysis. Within this study area, I collected historical brook trout data for watersheds of Lake Superior tributaries, and data on historic lumber mills, mines, and railroads for the entire states of Wisconsin, Minnesota, and Michigan's Upper Peninsula. For the analysis, I used the subset of these industrial development variables that fell within the Lake Superior tributary watersheds.

Determining Time Periods: To analyze changes in data values over time, I separated the mapped data into four temporal categories: Pre 1880-1880, 1881-1900, 1901-1920, and 1921-1950. Our research team chose these temporal categories for several reasons. First,

the period of time spanning from the mid-1800s to 1950 encompasses a substantial temporal range of the decline of the coaster brook trout. Second, these temporal categories represent critical periods in the history of both coaster brook trout and human activities around Lake Superior. The time period spanning the mid 1800s to 1880 was presumed to capture the initial boom of industrial development of the region as it is characterized by the incipient development of the logging and mining industries around the U.S. side of Lake Superior (Karamanski 1989; Bornhorst & Mathur 2017; Sawyer 1911, vol. 1). Shiras (1921; 1935) noted that the coaster brook trout had declined substantially sometime between 1880-1900, while other historical sources mention declines in Upper Michigan's brook trout as early as 1875 (Detroit Free Press, Jan. 29, 1875).

Thereafter, industries are noted to have peaked in this region approximately between 1881-1900 (Karamanski 1989, Larson 1949). From 1901-1920, some areas experienced continued industrial growth, albeit at a slower pace, while industrial growth in some other areas stagnated or declined and this period was assumed to capture development patterns through World War 1. It was also during this time that the artificial planting of both native and non-native salmonids became a widespread practice in Lake Superior's tributaries in Michigan, Wisconsin and Minnesota (The Minneapolis Journal, Apr. 8, 1903; The Daily Sentinel, May 9, 1901). Between 1921-1950, the industries that once dominated the Lake Superior region had dwindled substantially. The white pine and hardwood logging had given way to a pulpwood dominated lumber industry, following the shift in the forest composition around Lake Superior driven by the previous logging eras (Karamanski 1989; Whitney 1987). The once booming copper and iron mining

industries in Michigan's Upper Peninsula were reduced to a small fraction of their former status. Human populations around Lake Superior declined precipitously in many industrial towns and cities, and in some places ghost towns were all that remained of previously bustling industrial areas. (Fochs 2017; Romig 1986).

For all analyses categorized by time period, I filtered the data layer for each given brook trout report or watershed attribute as the number up to and including the latest year in that time period. For example, the railroad data for the '1901-1920' time period included all railroads built from 1901 up to those built in 1920.

2.2.2 Historical Brook Trout Data Collection and Organization

I collected historical brook trout location data from a variety of sources, including online newspaper archives, scientific publications, historic range maps, and historic pamphlets and books. I then compiled the brook trout observations recorded in these sources into four tables, one for each time period. These tables document the date and location and source of the observation, and any relevant notes that described the status of the population at the time of the observation (see appendix tables 1-4).

Because coaster brook trout have not been recognized as a separate species or subspecies of brook trout (Wilson et al. 2008) and they are not distinguishable by physical features that would have been reported, the table also includes a credence value that is an estimate of the likelihood that any report represents coaster brook trout rather than a stream resident brook trout. These credence values range from 1 to 4, with 1 representing near certainty, 2 representing high confidence, 3 representing marginal

confidence, and 4 representing low confidence or entries that are difficult to assess. I assigned the credence values to the brook trout reports by individually evaluating the source information for each entry in the data table and determining how likely it was that the source was describing coaster brook trout given the criteria for the coaster life history. For example, I assigned a value of 1, the highest possible credence, to sources that directly mention the term “coasters” or “coaster brook trout”. I assigned a credence value of 1 to sources that mention brook trout caught within the waters of Lake Superior, since spending part of the life cycle within the lake is a component of the definition of coaster brook trout (Huckins et al. 2008; Becker 1983). I also assigned a value of 1 to reports that occurred in streams that are known coaster streams with well-documented migratory populations, such as the Nipigon River in Ontario, Bois Brule River in Wisconsin, and Salmon Trout River in Marquette County, Michigan. Observations that describe brook trout with characteristics consistent with, but not wholly indicative of being coasters, I assigned a value of 2. These include large brook trout caught within Lake Superior tributaries before brook trout stocking had been implemented. I assigned a value of 3 to observations that could have possibly included coaster brook trout but lacked enough definitive information to confirm their identity with a high degree of confidence. I assigned a credence value of 4 to reports that did not rule out the possibility of migratory brook trout but also did not provide reliable evidence or indicators of a migratory population.

2.2.3 Historical Brook Trout Location Mapping

I mapped the historical brook trout observation data using ArcGIS Pro version 2.7.2. The historical brook trout reports were mapped as polygons using the HUC-12 watershed classification, with each one mapped as a polygon representing the HUC-12 watershed where the observation occurred (Figure 1). The attribute table associated with the polygon layer contains all of the data in appendix tables 1-4, along with an additional field that records the qualitative population status suggested by the observation source. I estimated the population status based on the given the information provided in each source while also considering the historical context of the observation. I assigned each brook trout polygon to one of seven population abundance categories: Very Abundant, Abundant, Somewhat Abundant, Somewhat Scarce, Scarce, Present, and No Reports. I color coded the brook trout observation polygons based on these seven abundance categories to visualize brook trout abundances between watersheds and between time periods (Figure 3).

2.2.4 Historical Railroad Data Collection

Historical railroad data were provided by Jeremy Atack (Atack 2016). These data are publicly available for download (https://my.vanderbilt.edu/jeremyatack/data-downloads/) and represent a GIS layer of United States railroads established between 1826 and 1916. I quantified railroad development within watersheds as the total km of railroad deployed within the watershed, which I calculated in ArcGIS Pro (see Ordination and Analysis).

2.2.5 Historical Mine Data Collection

Daniel Lizzadro-McPherson acquired the historical mine data from the USGS Mineral Resource Data System (MRDS) & Mineral Availability System/Mineral Industry Locator System (MAS/MILS). These data represent mines established within the entire states of Wisconsin, Minnesota, and Michigan's Upper Peninsula between 1750 and 1950. For each time period, I filtered the mine layer to display all mines operating before and up to the latest date in that time period. For example, the map for the '1921-1950' time period displays the accumulation of all mines that opened before and up to 1950.

2.2.6 Historical Lumber Mill Data Collection and Mapping

I collected historical lumber mill data to document the presence and abundance of lumber mills in a given location, as well as to act as a proxy for the general degree of logging and lumbering in an area. I collected lumber mill data for Michigan's Upper Peninsula, Wisconsin, and Minnesota between the years 1800 and 1950. The data were gathered from a variety of historic documents obtained from both digital and physical archives and compiled into a database that contains the name of the mill's builder or owner at the time of construction, along with the location, date of establishment, and date of closure when that data was available. When a precise date was not provided, I estimated the date of establishment in cases where an approximate date or a time range was provided (see appendix tables 4-7). Because information on historical sawmills is

fragmented and incomplete, these datasets do not necessarily represent every lumber mill that was built during the time period, but rather act as a representative sample of the relative degree of milling activity in an area at a given time. I collected lumber mill data for Michigan's Upper Peninsula, Wisconsin, and Minnesota between the years 1800 and 1950. The dataset contains 400 lumber mills established between 1822 and 1949 in the Upper Peninsula of Michigan and 664 lumber mills established in the state of Wisconsin between 1809 and 1910. I recorded 134 different lumber mills established in the state of Minnesota between 1822 and 1924.

2.2.7 Historical Dynamite Fishing Data

While searching for historic data on the previously mentioned variables, I opportunistically recorded data on historical dynamite fishing around Lake Superior. I documented a combined 24 instances of dynamite fishing between 1891 and 1947 within Wisconsin, Minnesota, and Michigan's Upper Peninsula.

2.2.8 Mapping and Analysis of Data

Ordination and Analysis: To analyze associations between the mapped variables and brook trout presence and abundance, I calculated the number of sawmills, mines, and density of railroad within watersheds containing brook trout reports by intersecting each of the historic GIS data layers with the historic brook trout data layer. This produces a

map that displays only the sawmills, mines, and sections of railroad that were found within watersheds with reports of brook trout catches (see Figure 3). problems of zeros and lack of continuity such as watersheds that do not appear in every time period, I analyzed only the watersheds with brook trout reports in the first time period (Pre 1880-1880). These watersheds represent the putative baseline of the coaster brook trout data. I recorded the abundance of putative disturbance variables (railroad density km/ km^2, number of lumber mills and mines) within each of the 75 watersheds in the 'Pre 1880-1880' time period. I then recorded the values of disturbance variables in these 75 watersheds in the '1921-1950' time period to assess potential changes over the course of the 'Pre 1880-1950' study period (Table 2). To look for potential associations between variation in specific variables and changes in brook trout abundance in each of the 75 watersheds, I used the data in Table 2 to conduct a principal component analysis (ggbiplot2 package in RStudio version 1.2.5033). Points in multivariate space on the PCA plot represent each watershed in the first and last time period and they were color coded according to the brook trout abundance category at the time. I connected the points representing the same watershed at two time periods with a line that was color coded to the abundance category for the watershed in the 'Pre 1880-1880' time period to allow visual assessment of potential associations between the changes in watershed attributes and changes in brook trout presence and abundance through time.

2.2.9 Results

Brook Trout Data: The resultant data set included a total of 338 reports of brook trout abundance across the study area between 1827 and 1950. The reports were not evenly distributed, as reports of good brook trout fishing became rarer over time. Both the range and abundance of brook trout around Lake Superior appear to have decreased substantially between the 19th and 20th centuries, as we found a decrease over time in the number of brook trout reports, the number of watersheds with reports of brook trout, and the proportion of watersheds in the 'Very Abundant' and 'Abundant' population abundance categories. Moreover, we documented an increase over time in the proportion of watersheds in the 'No Reports' category (meaning that there was a brook trout report in that watershed in a previous time period, but not in that time period (Figure 7 & Figure 8). Of the 338 reports of brook trout, the highest number were from the 'Pre 1880-1880' time period (132 reports). There were 87 reports from '1881-1900', 87 from '1901-1920', and 32 from the '1921-1950' time period (Appendix Tables 1-4, Figure 7).

The reported observations were distributed among a total of 108 watersheds (Figures 7 & 8). In the 'Pre 1880-1880' time period, 132 reports of brook trout observations were distributed among 75 watersheds. For the '1881-1900' time period there were 87 reports of brook trout (Table 4 & Figure 7) across 56 watersheds, and by '1901-1920'there were 87 reports distributed among 45 watersheds (Table 4 & Figure 7). The decline in reports and watersheds continued toward the '1921-1950' time period when 32 accounts of brook trout were reported among only 23 watersheds.

Of the 75 watersheds in the ‘Pre 1880-1880’ time period, 13 were identified as being in the ‘Very Abundant’ category, indicating that brook trout were “very abundant” based on the reported catches (Table 4). In this same first time period, 23 watersheds were in the ‘Abundant’ category, 39 were in the ‘Present’ category, and no watersheds were in other abundance categories (full list of categories: Very Abundant, Abundant, Somewhat Abundant, Somewhat Scarce, Scarce, Present).

In the ‘1881-1900’ time period, 18 of the 56 watersheds with reports of brook trout indicated observations suggesting brook trout were in the ‘Very Abundant’ category, 24 watersheds were in the ‘Abundant category, 9 were in the ‘Somewhat Abundant’ category, and 5 were in the ‘Present’ category, with no watersheds in any other abundance category (Table 4).

In the ‘1901-1920’ time period, 3 of the 45 watersheds with brook trout reports were in the ‘Very Abundant’ category, 14 were in the ‘Abundant’ category, 7 were in the ‘Somewhat Abundant’ category, 9 were in the ‘Present’ category, and 12 were in the ‘Scarce’ category, with no watersheds in any other abundance category (Table 4).

In the ‘1921-1950 time period, 2 of the 23 watersheds with brook trout reports were in the ‘Abundant’ category, 10 were in the ‘Somewhat Abundant’ category, 8 were in the ‘Present’ category, and 3 were in the ‘Scarce’ category, with no watersheds in any other abundance category (Table 4).

The number of ‘No Reports’ watersheds grew from 0 in the ‘Pre 1880-1880’ time period, to 42 in the ‘1881-1900’ time period. In the ‘1901-1920’ time period, the number of ‘No Reports’ watersheds increased to 61, and by the ‘1921-1950’ time period, the number of ‘No Reports’ watersheds was 85 (Table 4).

Notably, the data indicate that a sharp decline in brook trout reports occurred in the '1901-1920' time period (see Table 4 & Figure 4). This is slightly later than the hypothesized time period of the coaster brook trout's decline, which researchers have typically dated to the late 1800's (Newman, DuBois & Swainson 1997). The first two time periods, 'Pre 1880-1880' & '1881-1900', are relatively similar in brook trout abundances. The number of watersheds in the 'Very Abundant' and 'Abundant' categories is nearly identical between these two time periods, but in the '1901-1920' time period, the number of 'Very Abundant' and 'Abundant' watersheds decreases substantially (Table 4). Moreover, the '1901-1920' time period had 12 watersheds in the 'Scarce' abundance category, while the previous time period had none.

Mine Data: The historical mine dataset contained a total of 1,049 mines established within the entire states of Minnesota, Wisconsin, and Michigan's Upper Peninsula between 1750 and 1950. These data are summarized in Table 5, with the complete list of mines available in appendix tables 8-10. During the time period covered by this study, Michigan's Upper Peninsula had 654 mines, while 197 mines were started in Wisconsin, and 198 were started in Minnesota.

The mining industry in Michigan started earlier and grew faster than in Wisconsin and Minnesota, with 247 mines having been established in the 'Pre 1880-1880' time period. During this same period, we recorded only 18 mines established in Wisconsin and none in Minnesota. This growth in Michigan's mining industry continued into the '1881-1900' time period, when the data revealed another 217 mines were established. During this period, Wisconsin and Minnesota added 35 and 32 mines, respectively. Furthermore,

the only mines found within watersheds with brook trout reports were located in Michigan. There was a total of 102 mines built within watersheds with brook trout reports over the duration of our study period (Pre 1880-1950) and these mines were distributed among 16 Upper Michigan watersheds. In Wisconsin and Minnesota, there were no mines located within watersheds with brook trout reports.

In the '1901-1920' time period, mining in Michigan's Upper Peninsula appeared to begin slowing down, with 145 mines established. Wisconsin and Minnesota displayed the opposite trend, with both states experiencing their greatest increases in new mines in the '1901-1920' time period. In Wisconsin, 94 mines were established, and in Minnesota 119 mines were established.

In the '1921-1950' time period, all three states experienced a sharp decline in mine establishment, with 45 mines opened in Michigan's Upper Peninsula, 50 mines opened in Wisconsin, and 47 mines opened in Minnesota.

Although the number of mines found in watersheds with brook trout reports increased over the course of our study period (Pre 1880-1950), the number of watersheds in which these mines were found changed little, meaning that the density of mines in specific watersheds increased rather than the range of mines. In the 'Pre 1880-1880' time period, there were 13 watersheds with brook trout reports that contained mines. These 13 watersheds contained a combined 61 mines. By the final time period (1921-1950), the number of watersheds with brook trout reports that contained mines increased only to 16. However, the density of mines (i.e., the number of mines found within these watersheds) increased substantially over this time. There were a total 102 mines distributed among these 16 watersheds.

The large increases in the establishment of mines in Michigan that took place in the first two time periods ('Pre 1880-1880' & '1881-1900') coincide with the sharp decrease in brook trout abundances found in the '1901-1920' time period. In the first two time periods, our data display several 'Present' and 'Abundant' brook trout reports in watersheds in Keweenaw County, where many copper mining operations took place. In the '1901-1920' and '1921-1950' time periods, I found no brook trout reports, with all of the watersheds in Keweenaw County in the 'No Reports' category.

Railroad Data: We documented a total 27,788 kilometers of railroad established in Minnesota, Wisconsin, and Michigan's Upper Peninsula between 1830 and 1906 (Table 6). The historical railroad data demonstrate a large growth in the railroad network around Lake Superior prior to 1900. Minnesota and Wisconsin had the highest amount of railroad, with Wisconsin having a total 11,598 kilometers and Minnesota containing a total 13,027 kilometers. In contrast, Michigan's Upper Peninsula contained a total of 3,162 kilometers of railroad.

In the 'Pre 1880-1880' time period, 402 kilometers of railroad were established in Michigan's Upper Peninsula, 4,474 kilometers were established in Wisconsin, and 3,193 kilometers were established in Minnesota. For all three states, the largest increase in railroad tracks occurred in the next time period, '1881-1900'. In Michigan's Upper Peninsula alone, 2009 kilometers of rail were established, while Wisconsin's railroad system grew by 5,042 kilometers during this time period, and 6,299 kilometers were established in Minnesota.

The establishment of additional railroad track dropped substantially in the '1901-1920' time period, with 3,535 kilometers established in Minnesota, 2,083 kilometers built in Wisconsin, and 751 kilometers established in Michigan's Upper Peninsula. We have no record of historical railroad additions in the '1921-1950' time period, which is when transportation by automobile began to dominate (Hilton 1962).

Our data show that during the '1881-1900' time period, in which railroads proliferated most rapidly, there were 87 brook trout reports distributed among 56 watersheds, with 18 of the watersheds in the 'Very Abundant' category and 24 in the 'Abundant' category, and no watersheds in the 'Scarce' category. After these large increases in the railroad network around Lake Superior, the brook trout dataset shows drastic declines in population abundances. In the next time period, '1901-1920,' the number of watersheds with brook trout reports decreased to 45, with only 3 watersheds in the 'Very Abundant' category, 14 in the 'Abundant' category, and 12 in the 'Scarce' category (Table 4).

Lumber Mill Data: Lumber mill summary data show an extensive establishment of lumber mills within the 'Pre 1880-1880' time period and the '1881-1900' time period (Table 7 & Figures 12-14). The growth in lumber mills begins to level off in the '1901-1920' time period and was reduced substantially in the '1921-1950' time period. I recorded a total of 1,198 lumber mills established in Minnesota, Wisconsin, and Michigan's Upper Peninsula. Of these, 400 were located in Michigan's Upper Peninsula, of which 149 were established during the 'Pre 1880-1880' time period, 148 were established in the '1881-1900' time period, 75 were established in the '1901-1920' time

period, and 28 were established in the '1921-1950' time period (Table 7 & Figure 12). Of the 664 lumber mills recorded in Wisconsin, 556 were established during the 'Pre 1880-1880' time period, 100 were established in the '1881-1900' time period, 8 were established in the '1901-1920' time period, and we did not record any established in the '1921-1950' time period (Table 7 & Figure 13). Of the 134 lumber mills recorded in Minnesota, 67 were established during the 'Pre 1880-1880' time period, 62 were established in the '1881-1900' time period, 4 were established in the '1901-1920' time period, and 1 was established in the '1921-1950' time period (Table 7 & Figure 14). Complete lumber mill metadata are provided for each state in appendix tables 5-7.

The period of fastest growth in Upper Michigan's lumbering activity (Pre 1880-1900) was associated with a decrease in brook trout abundances (Table 4, Figure 4). I documented an increase of 148 lumber mills in the Upper Peninsula of Michigan during the '1881-1900' time period. There were 23 watersheds with brook trout reports in Upper Michigan in this time period, with the following abundance category distribution: 5 'Very Abundant,' 13 'Abundant,' 3 'Somewhat Abundant,' and 2 'Present.' The number of brook trout watersheds in Upper Michigan decreased to 12 in the next time period (1901-1920), with the following abundance category distribution: 3 'Very Abundant,' 2 'Abundant,' 5 'Somewhat Abundant,' 1 'Scarce,' and 1 'Present.'

Coaster Status Through Time and Principal Component Analysis: Over the 80+ year period addressed in this study, reported observations of brook trout suggested a decrease in brook trout abundance in 66 of the 75 watersheds analyzed in our principal component analysis. Some form of human development (lumber mills, mines, railroad) occurred in

61 of the 75 watersheds and in xx of the 66 watersheds in which reports suggest brook trout had declined. However, none of the forms of development were universally present in all watersheds and they were not evenly distributed across the watersheds, as some forms of development, such as mines, were highly localized.

The principal component analysis on the features of watershed development (lumber mills, railroads, mines) produced three principal components. Only the first two were reported because together they explained 87% of the variance. Principal component one (PC1) explained 57.3 percent of the variance in the data, principal component two (PC2) explained 29.7 percent of the variance in the data, and principal component three (PC3) explained only 13 percent of the variance in the data. PC1 was highly positively correlated with lumber mills and railroad density, while PC2 was highly positively correlated with mines and negatively correlated with railroad density (see Figure 5 & Table 8). The development of lumber mills and railroads appears to be correlated. Little to no correlation exists between rail density and mines, and between lumber mills and mines. The principal component analysis did not reveal any clear groupings among watersheds in either the first or final time periods, which supports the conclusion that the various forms of watershed development (disturbance) were not similarly distributed in space or time. The watersheds from the 'Pre 1880-1880' time period were generally clustered and the watersheds from the '1921-1950' were not clustered into any group and there was little uniformity in how the watersheds changed through time as a function of these developments, meaning that there was not a strong temporal pattern of variation that unified the watersheds.

2.2.10 Discussion

2.2.10.1 Associations Between Anthropogenic Activities and Coaster Brook Trout Population Status

The historical data and analysis show a decrease in the historical brook trout range over time, as well as a decrease in brook trout abundances, and an increase in 'No Reports' watersheds, where brook trout were reported in a previous time period but not in the later period being referenced. Moreover, the decreases in coaster abundances indicated by these data may be conservative estimates, as they occurred despite the fact that both the development and the human population around Lake Superior grew over time, making it even easier to access once remote brook trout locations and thus more easily report observations in later time periods.

The historical industrial data in this analysis suggest that multiple industrial variables may have influenced brook trout declines in potentially complex and interacting ways. The presence and distribution of these several forms of anthropogenic disturbances within brook trout watersheds around Lake Superior suggest coaster brook trout declines may have resulted from the effects of multiple stressors rather than one primary factor. Research on multiple stressors has suggested that freshwater systems may be at increased risk of experiencing multiple stressor effects (Ormerod et al. 2010). The correlation and interactions between industries and infrastructure around Lake Superior may make it difficult to disentangle the relative contribution of each specific human impact to the coaster's decline. Also, each development (mines, lumber mills, railroads) may have impacted multiple environmental variables simultaneously, or acted synergistically. Developments in one industry often coincided with developments in corresponding or

ancillary industries; this is indicated in our analysis by the correlation between lumber mills and railroad density. The establishment of railroads may have resulted in more rapid deforestation by facilitating the intensity and growth of logging, thus railroads and logging may have synergistically impacted brook trout populations. Multiple stressor interactions are more prominent in rivers than in lakes (Birk et al. 2020) suggesting the potentially numerous interactions between these watershed stressors were potentially abundant and with large effects in Lake Superior tributaries.

All of the industrial variables in our analysis proliferated rapidly in the first two time periods. It is after these swift expansions, that in the '1901-1920' time period, the brook trout data reveal a notable turn from many reports of abundant brook trout to few. Also, reports of scarce or declining brook trout increased greatly during this time period. Other variables not included in our analysis, such as log driving and the presence of non-native species, could impact brook trout abundance as well both directly as well as indirectly through multiple stressor interactions. This may explain why some watersheds experienced brook trout population declines even though they did not have record of any lumber mills, mines, or railroads. Angling likely also played a large role in decreases in brook trout abundance in watersheds, as angling by recreational fishing has been shown to have negative implications for brook trout populations and the type of management and form of take can be important (Power & Power 1993). It is important to note that angling, as well as other forms of brook trout capture, was likely occurring in nearly every watershed for which we found brook trout observations, as the majority of our data come from catch reports in newspapers or books.

This analysis suggests a compelling linkage between the decline of coaster brook trout in sub watersheds of Lake Superior and the history of human industrialization within these watersheds through logging, lumbering, mining, railroads, and angling. The following discussion sections will explore the history of each of these factors around Lake Superior to elucidate the role of each variable hypothesized to play a role in the decline of the coaster brook trout.

2.2.10.2 The Development and Growth of Logging and Lumbering in the Lake Superior Region

Previous studies have hypothesized that the development, growth, and expansion of the lumber industry around Lake Superior may have been one of the most substantial influences on the decline of the coaster brook trout (Huckins et al. 2008, Schreiner et al. 2008). Although there is quantitative support associating tree removal and associated land use activities with negative impacts on fluvial brook trout populations (VanDusen et al 2005, Erdozain et al. 2019), this association has not before been examined critically as an explanation for the decline of coaster brook trout populations. The rapid growth of the logging and lumbering industries around Lake Superior in the 19th and 20th centuries and the concomitant deforestation resulted in substantial changes to the landscape and stream habitats. The removal of trees in mass quantities led to greatly increased erosion, runoff, and sedimentation in streams, which has been implicated in blanketing fish spawning habitat and obstructing access to food resources (Alexander & Hansen 1988).

Geomorphic evidence in North Fish Creek in Bayfield County, Wisconsin suggested that historical logging and the conversion of clear-cut forestland to farmland

has contributed to large increases in sedimentation and flooding (Fitzpatrick, Knox & Whitman 1999). Furthermore, recent research has shown that ground disturbances associated with forest management can impact energy dynamics in stream ecosystems and alter food webs (Erdozain et al. 2019). Increased turbidity associated with logging runoff and sedimentation may have also altered fish feeding behaviors or made locating food more difficult; experimental evidence has demonstrated changes in reaction distance and foraging rates by juvenile chinook salmon (*Oncorhynchus tshawytscha*) in turbid waters (Gregory & Northcote 1993).

The technological constraints of the white pine logging era meant that early selective logging practices took place near streams, resulting in riparian areas being some of the first tracts of forestland to be denuded of their canopy cover. Riparian areas along log driving streams also had to be cleared of trees so that logging crews could follow the drive alongside the river and monitor for potential jams (Peterson & Ronnander 2017). The reduction of riparian canopy cover likely altered habitat conditions for brook trout in several ways including stream temperatures and flows that could have varied beyond their natural ranges. For example, without the protection of riparian trees, stream temperatures can increase due to increased sunlight, and flows can vacillate between periods of drying and flooding, which can also increase erosion (Niles 2010). Terrestrial invertebrate inputs into streams have also been reported to be reduced by intense riparian timber harvest and this can impact the prey availability and diet of brook trout. Niles & Hartman (2021) found that with increasing riparian timber harvest, consumption of terrestrial invertebrates by brook trout decreased and consumption of aquatic invertebrates increased. Furthermore, oxygen availability may also be reduced by

removing riparian canopy cover, as warmer water holds less dissolved oxygen than cooler water.

Moderate selection logging with riparian buffer zones can be performed without detrimental effects on stream habitat or invertebrate communities (Kreutzweiser, Capell & Good 2005). However, the rate and intensity of forest removal that occurred in the Lake Superior watersheds was likely responsible for drastic changes to ecological conditions in Lake Superior tributary habitats.

The logging and lumber industry was one of the first major extractive industries to impact the Lake Superior region after the colonization of the area by European settlers. Karamanski (1989) has demarcated three defining periods in Michigan's historical logging industry: the white pine era, the hardwood era, and the pulpwood era. The white pine era, which lasted from the early 1800s to approximately 1900, was characterized by extensive harvesting of pine, large log drives on streams, and rudimentary logging and lumbering technologies (Karamanski 1989). During this time period, massive quantities of pine logs were harvested by loggers working and living in lumber camps all across Michigan, Wisconsin, and Minnesota. In the early days of logging, white pine was favored over other tree species for its properties as a construction material; it was light, strong, and relatively easy to transport and work with. Logging practices during the white pine era were often extremely wasteful, as it was costly and difficult to harvest anything but the choicest timber with the unsophisticated technology present during this time period. Slash, scraps, and undesired trees that were removed to make way for desired ones were left on the forest floor to decay and desiccate, acting as fuel for the concomitant forest fires that would soon follow.

Large scale forest fires were common during the height of logging in the Great Lakes region. These fires added to the deleterious impacts of the logging industry by deforesting large tracts of land including stream habitat, contributing to sedimentation and runoff in streams, and directly killing aquatic life. For example, the Duluth, Minnesota region was ravaged by fires in 1918, and brook trout were observed to be killed from the resulting changes in stream properties (Duluth News-Tribune, Oct. 18, 1918). George O. Jones' *History of Wood County, Wisconsin* (1923) describes the scale and intensity of the forest fires generated in the pine logging era:

> Forest fires were an appalling source of loss. As lumbering operations became more extensive, and settlements pressed in close behind, the danger of forest conflagrations steadily increased. The careless logging methods of the time, still in vogue in some parts of the United States, were an invitation to the flames. The loggers removed only the choicest pine, while on the floor of the forest they left great heaps of branches and tops, known in the vernacular of the trade as 'slashings.' Such dead material, soon dry as tinder, needed only a spark from some careless hunter's camp or farmer's burning brush pile, or a chance stroke of lightning, to set it off in an all-devouring blaze. It was characteristic of the attitude of the period toward natural resources that forest fires were merely left to exhaust themselves in their own fury, no effort being made to impede or check the course of the flames.

Steam-powered sawmills also produced fires; sawdust and other scraps would often ignite, burning down the mill along with entire towns. If the area was not rebuilt, residents were left both jobless and homeless. As recounted in George O. Jones's *History of Wood County, Wisconsin* (1923):

> Sawmills and sawmill towns, flimsily constructed of inflammable pine, and consuming the airy fuel left by their saws, were periodically consumed by the flames. It was a rare sawmill that was not burned to the ground and rebuilt at least twice, while only one thing was more astonishing than the frequency with which sawmill towns were partially or wholly destroyed, and this was the speed with which they rose from their ashes.

Fires contributed to the deforestation of the Great Lakes basin not only by burning down regions of forest, but also by increasing the rate of logging after a fire. Once timber tracts were consumed by fire, the burned trees had to be harvested quickly to produce lumber products before they decayed and became unusable. When the Diamond Match Company Mill in Ontonagon, MI, caught fire in 1896, the flames engulfed the entire city, leaving the over 2,000 residents with no homes or possessions (Karamanski 1989). After the fire, the Diamond Match Company attempted to harvest all of the remaining timber it possessed in Ontonagon County, as it could still hold value if removed quickly enough. After harvesting the remaining timber over the winter, a massive quantity of logs was driven down the Ontonagon River in the spring, resulting in a multitude of severe log

jams (Kilar 2020). The Diamond Match Company ultimately decided not to rebuild and moved their milling operations to their location in Green Bay, WI, leaving the residents of Ontonagon to fend for themselves (Karamanski 1989).

The burning down of towns and cities during the Great Lakes region's logging boom further increased the demand for lumber to rebuild, which resulted in even more widespread and rapid logging in the area. In 1871, two enormous conflagrations destroyed the cities of Chicago, IL and Peshtigo, WI on the same day. In 1910, the lumber town of Cornucopia in Bayfield County Wisconsin, was surrounded on all sides by raging flames that made escape impossible except for travel via boat on Lake Superior. A steamship made trips from Cornucopia to Bayfield to transport women and children away from the blaze (Wood County Reporter, Jul. 14, 1910). These examples are only a small fraction of the total destruction caused by fires during the logging era.

Log Drives: The white pine logging era was also characterized by large and frequent log drives, in which thousands of sawed logs were floated down rivers. These river drives were a crucial and particularly destructive component of the early logging industry around Lake Superior. Rivers were the primary method of transportation for white pine logs, which were the most buoyant pine species. During the winter months extensive logging took place, logs were aggregated at the banks of rivers, and in the spring these logs were rolled into the rivers and floated downstream, either to sawmills to be processed into merchantable timber or to log booms where they would be assembled into rafts for transportation to distant processing locations. Large log drives could cover many miles of stream length. These swiftly moving logs scoured the banks of rivers, making

them wider and shallower, altered habitat conditions, and killed aquatic life (Hubbs, Tarzwell & Eschmeyer 1933).

The alterations to conditions in log driving streams did not only come from the logs themselves, as streams were often heavily manipulated to prepare them for the drives. Companies such as the Wolf River Improvement Company of Wisconsin existed for the purpose of making rivers suitable for efficient log drives. These companies would build logging dams, remove large woody debris or other impediments to log movement, and use dynamite to blast away obstructions like boulders. Logging companies or improvement companies would also alter the channel morphology of streams to prevent log jams and increase the speed of log transportation (Peterson & Ronnander 2017). Research has suggested that the large woody debris removal and channel alteration associated with log drives can leave lasting impacts on streams, such as changes in in-stream habitat and channel morphology that can persist a century later (Napolitano 1998).

Because some streams experienced heavy and frequent log drives, but had few lumber mills associated with them, the presence of lumber mills alone is not sufficient to estimate the impact of the logging and lumber industries on brook trout populations. For example, some rivers in northern Minnesota were prevalent log driving rivers, but the logs were rafted to sawmills in Duluth and Ashland for processing. This could explain why the data shows decreases in abundance over time in northern Minnesota despite having few or no lumber mills over the duration of our analysis. This possibility suggests that because we did not systematically collect and examine historic log drive data in this project, our analysis likely underestimates the impact of logging and lumbering on brook trout presence and abundance.

Technological Advancements and Railroad Development: By the late 1800s, much of the white pine in the Lake Superior states had been extracted, and in Michigan, the Upper Peninsula became the new epicenter of pine logging. Karamanski (1989) noted that the Michigan's Upper Peninsula was relied upon to pick up the slack from the declining lumber output in Wisconsin and Lower Michigan. In 1881 the seven western counties in the Upper Peninsula produced a total of 140 million feet of pine and by 1892 the output had increased to an annual production of 400 million feet (Karamanski 1989). In 1890, Michigan's lumber industry generated 4,245,717,000 feet of lumber, making it the number one lumber producer in the United States at that time (United States Department of Agriculture Forest Service 1941). From 1834 to 1897, Michigan's Upper peninsula produced approximately 24 and a half billion board feet of lumber (Maybee 1959).

This increase in lumber output was facilitated by a panoply of new technologies that paved the way for rapid and complete exploitation of forests. Steam powered sawmills, which became increasingly common around Lake Superior after the 1850's, allowed mills to produce greater outputs of lumber in less time and freed the sawmill from reliance on waterpower (Sawyer 1966). Improvements to the designs of the saws themselves further increased the rapidity with which lumber could be produced. Between roughly 1850 and 1880, the slow, inefficient, and wasteful sash saws, muley saws and gang saws were replaced first by circular saws, and then by band saws, both of which produced lumber at a quicker rate and had a reduced kerf with respect to earlier saws, producing less waste (Maybee 1959).

In the 1880s, the steam donkey, a large steam-powered winch, was invented and made skidding logs out of the woods faster and easier than the traditional method of using teams of horses or oxen to pull sleighs of logs. The steam-powered log hauler, which resembled a locomotive that pulled sleds of logs, also replaced earlier log skidding technologies after its invention around the year 1900. One popular model, the Phoenix steam log hauler, could skid as many logs as ten teams of horses at a time (Peterson & Ronnander 2017). Mill tractors were also used around this time to easily skid large loads of logs (Taylor 2006). Most likely these machines also added to watershed disturbance and erosion.

The late 1800s also saw a substantial increase in railroad expansion around Lake Superior. This is indicated in our data by a 165% increase in railroad between the first two time periods. In the 'Pre 1880-1880' time period, a total of 8,069 km of railroads existed between Minnesota, Wisconsin, and Michigan's Upper Peninsula. In the next time period, '1881-1900,' the total length of railroad between the three states increased to 21,419 km.

Railroads affected logging in myriad ways. First, the railways themselves created substantial markets for timber (Langston 1995; Cronon 1991), as lumber from timber-rich areas could be easily transported to timber-sparse areas (Larson 1949). Railroads allowed logging companies to exploit timber tracts located at a greater distance from the major waterways that had been used for log transportation during the earlier white pine logging era. In addition, the construction of railroads relied on timber rails produced from logging.

Railroads also allowed for logging of hardwoods, which generally had not been transported via streams, as they lacked the required buoyancy. Driving hardwood logs down streams could result in a great deal of shrinkage (lost logs or "deadheads"), which was costly.

Using locomotives to haul timber also meant that logging companies no longer had to be as selective in their logging practices, as transportation was made so much easier that any and all usable timber could be harvested. Railroads also made portable sawmills possible. By dedicating a railcar to sawmill equipment, lumber could be produced even faster by being processed right at the location where the logging took place. This allowed companies to quickly relocate portable mills to exploit new timber tracts. Logging camps, too, became mobilized with the adoption of the railroad, as portable logging camps were constructed once logging railroads became widely implemented. Mobile logging camps consisted of railcars that housed the typical amenities found at a stationary logging camp; these camps could be quickly transported further into the forest as timber tracts were logged, saving both time and energy (Anderson & Taylor 2008). In addition to allowing the exploitation of previously inaccessible timber resources, railroads provided connectivity between disparate locations, which facilitated faster flows of commodities and people, and expanded the range of the Great Lakes region's economy. The benefits of railroads to lumber companies is summarized in an 1883 advertisement for an H. K. Porter locomotive, which reads:

> A Logging Railroad is the cheapest and best plan for putting in logs, both on a large scale or quite a small scale. With good locomotive and cars the expense of hauling does not exceed 25 to 40 cents per thousand feet, and at the end of years of hard work the rolling stock, if of good quality and treated with decent care, will be practically as good as new. Steam logging on iron rails is independent of weather or season; the output can be doubled by working nights; more logs can be got off the same land, as the poorer grades can be hauled with profit; windfalls and burnt timber can be marketed before damaged by worms and rot; timber lands distant from streams and railroads are made as valuable as any others (Maybee 1959).

Railroads also acted as a source of fires, as sparks produced by locomotives could ignite dried slash and debris (Peterson & Ronnander 2017). This sometimes led to legal disputes such as *J. H. Worden Lumber & Shingle Co. v. Minneapolis, St. Paul & Sault Ste. Marie Railway Co., 168 Mich. 74 (1911)*, in which sparks from a passing locomotive engine resulted in a fire that destroyed $70,000 of lumber and a $500 dwelling house (Caselaw Access Project, Harvard University).

Sawmill Waste: Sawmill refuse was often deposited into streams and water bodies, obstructing habitat and clogging waterways. This waste consisted primarily of sawdust, which covered riverbeds and obstructed stream habitat. Sawmill waste may have been a particularly devastating problem in watersheds that contained many lumber mills; our analysis indicates that several large milling areas may have been especially vulnerable to

high volumes of sawmill pollution, namely Duluth, MN, Baraga, Marquette & Houghton MI, and Bayfield & Ashland, WI.

At the turn of the 20th century, logging and lumbering operations around Wisconsin's Bayfield peninsula were implicated in the decline of fisheries in Chequamegon Bay. Streams on the peninsula were used for log drives, and waste from sawmills was deposited into the water, blanketing spawning sites and impacting food supplies for fish. As catch sizes subsequently decreased, commercial fishers became frustrated and blamed the logging and lumbering industries for the declines in their business (Bogue 2007). A Minnesota newspaper exemplified the problem near the Duluth area in 1900:

> Several well-known trout streams around Cloquet and Carlton- have been ruined, so far as fishing is concerned, by sawdust, as fish will not remain long in streams where any foreign matter is deposited. This is particularly true of brook trout... (The Saint Paul Globe, Apr. 1, 1900).

Some lawmakers tried to balance environmental and economic concerns by passing conciliatory legislation intended to address the needs of both industry and the environment. But this resulted in the implementation of half-measures that allowed the ongoing environmental degradation to continue. On April 14, 1887, the state of Wisconsin made it a misdemeanor for portable sawmills to dump waste into streams in which the Fish Commission had planted fry, or "wherein brook trout abound naturally" (The Superior Times, May 12, 1888). This law carried a fine of between 50 and 100

dollars for each offense, which today would be the equivalent of a fine ranging from 1,462.89 to 2,925.77 dollars. However, the law contained a number of loopholes that allowed sawmill pollution to continue. First, it only applied to portable sawmills. Second, the law did not apply to portable sawmills erected previous to the law's passage. Third, the law did not apply to streams that were used for log drives. Weak industrial regulations such as these likely did little to curtail the environmental impacts of the logging and lumbering industries, when they were followed or enforced at all.

Splash Dams: In order to control the flow of logs downstream during log drives, rivers were often dammed extensively with logging dams known as "splash dams". These dams held back the flow of the stream while logs aggregated behind them, after which point the dam would be released and logs sent downstream with enough force to ensure they made it to the log boom or sawmill without any encumbrances. These impoundments posed a detrimental threat to coaster populations by blocking access to upstream spawning sites. Moreover, groups of migrating brook trout that assembled below logging dams were at increased risk of harvesting en masse. An 1889 issue of Forest and Stream magazine noted that fish movement would become blocked by logging dams, at which point they were then "speared, clubbed and netted by the wagon load." (Vogel 1999).

Recognizing the ongoing harm to fish populations, state legislatures made attempts to curtail the deleterious effects of these dams. By the beginning of the 20th century, the state of Minnesota began to require splash dams to be fitted with fishways that would allow passage of migrating fish up and downstream. Some logging companies complied willingly and fastidiously; those who did not had fishways installed for them by

state employees and were then administered a fine for the cost of the installation (The Saint Paul Globe, Apr. 1, 1900). However, by this time it may have been too late, as our data show that brook trout abundances were already substantially decreasing along the Minnesota shoreline around 1900. As with log drives, we did not record or map splash dams in this analysis, and therefore some watersheds in our analysis may have been impacted by the logging and lumbering industries in ways not represented by the presence of lumber mills.

2.2.10.3 Mining in the Lake Superior Region

The mining industry was a significant source of economic growth in the Lake Superior region, especially in Michigan's Upper Peninsula, where copper and iron mining provided employment to thousands of immigrant laborers. Our results suggest that among the states, mining likely had the greatest potential impact on coaster brook trout populations in Michigan, where mines were tightly concentrated within watersheds with brook trout reports.

The early copper and iron mining industries were largely associated with water and atmospheric pollution. This pollution was likely concentrated near areas where mining took place. In a geospatial analysis of historical iron mining waste in Minnesota's Mesabi Iron Range, Baeten, Langston & Lafrenier (2016) note that prior to 1910, mine waste was generally localized to the direct mining environment. It was after the development of mining technologies to exploit low-grade iron ore that mining waste became mobilized.

In the watersheds of Keweenaw County, Michigan, copper mines were tightly clustered, and localized mining pollution may have been a driver of decline for native brook trout populations. The historic mining industry in Michigan was highly polluting, as wastes from copper mining operations was deposited into waterways (Kerfoot et al. 1999). The heavy metals contained in these wastes could be incorporated into fish bodies, producing potentially toxic impacts. High concentrations of copper have been shown to have negative impacts on brook trout survival, growth, and reproduction across life stages (McKim & Benoit 1971).

2.2.10.4 Angling/Harvesting: A History of Brook Trout Angling in the Lake Superior Basin

Overharvesting by anglers has long been proposed as one of the most important, if not the primary driver of the coaster brook trout's decline (Huckins et al. 2008; Pontiac Gazette Nov. 29, 1878; Shiras 1935; Roosevelt 1865). In the 1800s especially, anglers harvested staggeringly large quantities of brook trout. For example, in 1887 two people fishing the Blackhoof River in Minnesota took 1,350 brook trout in a single day's fishing (Duluth Daily News, Jul. 13, 1887). Once industries such as logging, lumbering, and mining were established and rapidly expanded around Lake Superior, the human population grew substantially. People looking for employment, such as lumbermen from Maine, immigrated to Great Lakes states to exploit the incipient timber and mining industries, resulting in rapid growth of both human presence and natural resource extraction. The quickly growing industries around Lake Superior incentivized immigration to the region, providing the necessary fuel for an unprecedented increase in

angling pressure. In Michigan's Upper Peninsula, which was dominated by the mining and logging industries from the mid 19th to early 20th centuries, census records show that between 1850 and 1880, the population rose fifteen-fold from 5,745 to 86,085 (Magnaghi 2007). Our data show substantial growth in industrial operations during the mid 1800s and into the late 1800s. After this industrial expansion and population growth, our data show a notable decline in the brook trout fishery around Lake Superior. The number of watersheds with reports of brook trout decreased from 75 in the 'Pre 1880-1880' time period to 45 in the '1901-1920' time period, with 12 of those watersheds in the 'Scarce' abundance category. These 'Scarce' watersheds were located in popular fishing destinations: The Bois Brule River in Wisconsin, the Salmon Trout River in Marquette County, Michigan, and ten watersheds along the Minnesota shoreline, which were popular fishing destinations for anglers living in the Duluth area; the '1901-1920' time period is when the lumbering industry had reached its peak in northern Minnesota (Larson 1949).

Brook trout were a popular target of sport fishing, and news of auspicious trout fishing locations spread quickly throughout the country, first bringing wealthy tourists such as Robert B. Roosevelt (uncle of President Theodore Roosevelt) who fished for brook trout in many tributaries around Lake Superior and documented his experiences in the 1865 book, "Superior Fishing" (Roosevelt 1865). Wealthy yacht owners toured Lake Superior, making frequent stops at every popular fishing location and harvesting as many fish as they desired (*Detroit Free Press*, Jun. 25, 1897). Following the development of industries around Lake Superior that resulted in an increased human presence along with the growth of the railroad network, popular sport fishing streams, such as the Nipigon

River in Ontario and Bois Brule River in Wisconsin, became accessible to large numbers of anglers, who crowded streams in an attempt to participate in the famed catches reported in the newspapers (*The Carbon County News*, Sept. 18, 1930). Kirkland B. Alexander described the fishing scene on the Nipigon River in the early 20th century, describing that river as being clogged with canoes that bumped into one another and stating that:

> to read about the fabulous wilderness fishing that these people had is enough to make a fisherman break out in speckles himself. And to get it, you really didn't have to go further than the mouth of the nearest little river where it dropped into Lake Superior. Look at this same country now. It is amazing that it took so few people to despoil such a great land in such a short length of time, something less than seventy years! (Wilson 1990).

The recreational harvesting of brook trout was a year-round endeavor, with both summer and winter harvesting resulting in the collection of innumerable brook trout. Ice fishers visited popular fishing locations in the winter and removed mass quantities of brook trout from Lake Superior and its tributaries, to the disdain of many. In Wisconsin's Bois Brule River, one person in 1877 *"cut a hole in the ice and netted 1500lbs without seemingly depleting their numbers"* (O'Donnell 1944). During the summer months, anglers visited popular trout fishing streams, and with hook and line, harvested hundreds of brook trout at a time. Carlos D. Shelden, a son of Houghton, Michigan's founder Ransom Shelden, was reported to have taken over 1,500 brook trout from Michigan's

Pilgrim River over the course of three separate summer fishing excursions (Duluth Minnesotian, Jul. 8, 1871; Duluth Minnesotian, Jul. 6, 1872; Duluth Minnesotian, Aug. 3, 1872). One author in an 1876 issue of The Superior Times opined on the status of brook trout fishing in Wisconsin and the inadequacy of the state's stocking efforts to mitigate the immense angling pressure:

> While our legislature is devoting time and money to the propagation of fish within the State, it is a pity that they do not stop the wholesale slaughter of brook trout through the ice in the Lake Superior counties. (The Superior Times, Feb. 24, 1876).

The lack of science-based fishing regulations in the 19th and early 20th centuries allowed the overexploitation of brook trout to continue with impunity. One author writing in 1891 implored state authorities in Michigan to truncate the open season for brook trout, noting that some of the highest levels of fishing occurred in August, during which time brook trout began migrating into streams and preparing to spawn (*The L'Anse Sentinel*, Aug. 15, 1891). A decade later, this problem persisted, as made evident by a 1902 newspaper article in which anglers in Houghton County, Michigan, pleaded with the state to reduce the duration of the brook trout fishing season, which closed on September 1st, citing the excessive fishing during the spawning season as a detriment to the quality of brook trout fishing in the streams of the county (*The Minneapolis Journal*, Aug. 30, 1902).

Fishing with dynamite was a widespread and pervasive problem in the late 1800's and early 1900s, which may have also contributed to declining fisheries around Lake Superior by killing large quantities of fish, destroying crucial habitat, and contributing to the general state of disruption that took place during this time period. We recorded 24 reports of dynamite fishing within Minnesota, Wisconsin, and Michigan's Upper Peninsula between 1888 and 1947, which are displayed in Figure 2.

Dynamiting streams took place in many locations in the United States and Canada, even though it was an illegal practice (prosecuted as early as 1884 in Michigan, The Lake County Star, Dec. 18, 1884) that was generally considered ignominious by the public, with one writer describing it as "a brutal and beastly method of getting fish that not even the most barbarous sportsmen would tolerate." (Clare Sentinel, Jun. 22, 1906; Ironwood Daily Globe, May 15, 1931; The Sun Times, May 22, 1934). As early as 1888, W. F. Whitcher reported that dynamiting was damaging the streams and depleting the fish on the north shore of Lake Superior in Ontario, especially in the Steel, Gravel, and Nipigon rivers (Whitcher 1888). Of the Steel River, Whitcher reported that *"In several spots the ravage of explosives is perceptible, where this wasteful invention of loafers and poachers has been cruelly used"* (Whitcher 1888).

The Pilgrim River in Houghton County, MI, was regularly fished by dynamite; we found six recorded instances of dynamiting on the Pilgrim River between 1903 and 1911. An issue of The Calumet News from July 19, 1910 reported that fish were being dynamited on the Pilgrim River and that the offender was fined $90.15, an equivalent of over $2000 today (The Calumet News, Jul. 19, 1910). According to a 1920 issue of the Duluth News-Tribune, a multitude of barrels were filled with brook trout taken via

dynamiting from the Pine River near Ashland, Wisconsin (Duluth News-Tribune, Aug. 1, 1920).

The use of seine and pound nets was another method of fishing that contributed to the rapid decline of fish populations around Lake Superior. By extending a seine net across the mouth of a stream, a single fishing party could collect hundreds of pounds of migrating fish at once. This practice was commonly undertaken by residents of Lake Superior counties as early as the mid 1800s, with one report from 1864 noting that trout in the Rush and Kinnickinnic rivers were victimized by seine nets, as a fishing crew had taken two hundred pounds of them in a single day. Residents of Sault Ste. Marie, Michigan, complained in 1887 that brook trout were being netted daily and that the game warden did little to put a stop to their depletion (Sault Ste. Marie Democrat, May 19, 1887). However, it was not uncommon for groups of people harvesting mass quantities of trout with nets to be met with indignation and even threats of violence from concerned citizens (The Weekly Pioneer and Democrat, Jun. 24, 1864). Additionally, the visceral reaction generated by extreme harvesting methods such as netting or dynamiting led some people to underestimate the impact of anglers on brook trout populations. Writing in 1933, sportsman and conservationist Robert Page Lincoln believed that it was not hook and line fishing that resulted in the diminution of brook trout populations around Lake Superior, but rather that *"It is the man with the net, the dynamite and the lime-pot that has worked the greatest disaster on these most beautiful of the trouts or charrs that inhabit our waters"* (Star Tribune, Apr. 14, 1933).

Not only was illegal netting by groups of fishers suspected to be a substantial cause of declining brook trout populations, netting by commercial fishing was also

pointed to as a factor in the decline of coaster brook trout in particular. In the Marquette, Michigan, region, commercial fishers placed pound nets along the shores of Lake Superior, where coasters became caught and harvested as bycatch during the spawning season (Duluth News-Tribune, Aug. 19, 1911).

The increased connectivity provided by the expanding network of railroads in the late 19th and early 20th centuries made for easy travel to popular brook trout fishing destinations. Anglers visiting these famed brook trout streams were able to harvest large quantities of brook trout in a single outing, and fish at many previously disparate locations in quick succession, which likely caused populations to diminish rapidly.

Railroad companies saw the opportunity to market brook trout fishing prospects for their own purposes and took out advertisements in newspapers advising prospective anglers to make trips to the best brook trout fishing spots, which were now easily accessible thanks to their infrastructure. An 1895 advertisement in the Detroit Free Press from the Detroit & Mackinac Railroad Company reads:

> Do you fish? Do you angle? Brook trout of 3 pounds are caught every season in the streams on the line of the Detroit & Mackinac Co. and its branches. This territory is comparatively new, and is to-day the best fishing grounds in the state of Michigan. (Detroit Free Press, May 7, 1895).

Railways also worked in conjunction with steamships to provide trips between distant locations, facilitating the connectivity that permitted anglers to regularly visit and

intensely fish once remote areas. For example, in Michigan in 1902, the D., S. S. & A. railway collaborated with the steamship *Iroquois* to provide trips in which passengers would take the train from L'Anse and Baraga to Houghton, at which point they would board the steamship and be taken to Isle Royale and Port Arthur (The L'Anse Sentinel, Aug. 30, 1902).

The automobile, like the railroad before it, allowed anglers to travel far distances and harvest fish from multiple locations in a short period of time. Invented in the late 1800s, the automobile didn't become widely adopted in the United States until after 1913, when Henry Ford revolutionized the manufacturing process with the introduction of the assembly line, making automobiles both accessible and affordable to the general public (Dietsche & Kuhlgatz 2014). Within a short time after the automobile's rise to prominence in the United States, anglers began to notice its potential role in facilitating increased fishing pressures. A 1916 article in the Northern Wisconsin Advisor reads:

> The widespread use of the automobile is, without doubt, largely responsible for the increasing number of fishermen on brooks easily accessible. From almost any city, an angler or a group of anglers can in an hour or two hours' time run out to some sequestered stream and, if they are skilled in the art of fishing, return home at night with a respectable showing of trout (Northern Wisconsin Advisor, Sept. 22, 1916).

Automobiles permitted anglers to exploit brook trout populations in more remote areas, further away from larger cities and industrial areas. For example, the old Highway

No. 1 and Highway No. 61 in northern Minnesota extended farther up the Minnesota shoreline than the railway, allowing anglers to harvest large numbers of brook trout from streams in Lake and Cook Counties.

As early as 1944, Smith & Moyle (1944) hypothesized a connection between increased traffic by passenger vehicles along Highway No. 61 and growing angling pressure in northern Minnesota. They documented increasing annual average 24-hour traffic between 1925 and 1941, with most of the traffic consisting of passenger cars. Our data are consistent with this hypothesis, showing that in the '1901-1920' time period, the railroad extends roughly halfway up the Minnesota shoreline, after which point automobile traffic would have accounted for most vehicle traffic along the shoreline. In the '1881-1900' and '1901-1920' time periods, before the highway and road networks were improved and expanded, our data show abundant brook trout populations in Cook County. In the '1881-1900' time period, there were 5 watersheds with brook trout reports in Cook County: one in the 'Very Abundant,' two in the 'Abundant,' one in the 'Somewhat Abundant,' and one in the 'Present' abundance categories. In the '1901-1920' time period, our dataset shows 6 watersheds with brook trout reports in Cook County: three in the 'Abundant' and three in the 'Present' abundance categories. There are also two 'No Reports' watersheds in Cook County in this time period. By the '1921-1950' time period, which encompasses the duration of Smith & Moyle's highway data, we found a sharp decrease in brook trout abundance and distribution in Cook County. Our data show only two watersheds with brook trout reports in Cook County in this time period, with both in the 'Present' abundance category. Furthermore, the data show 6 'No Reports' watersheds in Cook County during this time period.

As sport fish become rarer, their popularity as a target of recreational angling may often increase, as people begin to view them as valuable trophies. The desire to catch one of these rare fish can result in greater efforts to locate and capture individuals from remnant populations (Cooke et al. 2016). When brook trout populations around Lake Superior began dwindling, some anglers adopted pessimistic outlooks, believing recovery as nearly impossible. While recognizing the role of overfishing in driving brook trout declines, many anglers decided to harvest brook trout anyway, with the rationale that they might as well participate in getting a piece of the final brook trout harvests, since the fish would disappear whether they fished for them or not. (Shiras 1935).

Although we did not directly quantify or measure angling in our analysis, its impact can be inferred from our data. For example, watersheds that have few industrial developments, yet experience brook trout declines similar to heavily developed watersheds, may have undergone brook trout declines as a result of angling pressure. People living in industrialized areas around Lake Superior such as Marquette, MI or Duluth, MN, could travel by boat, railroad, or automobile to surrounding watersheds with fewer developments to fish for brook trout. For example, our analysis shows one popular brook trout fishing destination, the Bois Brule River in Wisconsin, as having only one lumber mill, no mines, and no railroad, yet brook trout abundance in this watershed shifted from ‘very abundant’ in the ‘Pre 1880-1880’ time period to ‘scarce’ in the ‘1921-1950’ time period. Moreover, angling differs from the other variables in our analysis in that it was almost universally present in all watersheds, as almost all of our brook trout observation data came from fishing reports.

2.2.10.5 Contextualizing Historical Data

There are several limitations in the historical datasets that should be considered when interpreting the data and corresponding analyses. First, a lack of observations in a given watershed does not necessarily mean that brook trout were absent in that watershed at the time. Although a lack of brook trout observations in a watershed could mean that brook trout were no longer present, it could also simply be due to a lack of available data for that watershed in that time period. Furthermore, brook trout observations may be biased toward more developed areas with more people, making it appear as though more populated areas had healthier brook trout populations than remote areas.

Many 19th century towns around Lake Superior were established around industrial opportunities; once these opportunities changed, entire towns were often abandoned, resulting in some time periods having many more observations in a given area than others. The city of Munising, in Alger County, Michigan, is one such area for which observations may be biased due to this phenomenon. Originally platted in approximately 1855, Munising supported a community centered primarily around the Munising Iron Company, which folded in 1877 (Sawyer 1911, vol. 1). During this time period, we found reports of abundant brook trout fishing. After the closure of the Munising Iron Company, the town withered to a fraction of its former size. Following the decline of Munising, reports of brook trout fishing decreased dramatically. In the 1890s and into the early 1900's, Munising grew once again after several sawmills were established and the Munising Leather Company constructed a tannery there (Sawyer 1911, vol. 1). Additionally, a fish hatchery was built in Munising in 1904, which supplied brook trout to streams in the surrounding area and may have also led to an increase in

observations and inflated abundance estimates (Vogel 1999). During this time (1901-1920), we recorded numerous reports of very abundant brook trout fishing. After the fish hatchery closed in 1916, we recorded no brook trout observations near Munising.

The early days of logging and lumbering around Lake Superior were remarkably disaster prone, and catastrophes such as fires, which became more frequent and intense owing to logging practices, could consume entire towns. After a large fire, the settlement would either be rebuilt or disbanded entirely. As people moved out of disaster-stricken areas, reports of brook trout fishing likely decreased. For example, our dataset records that brook trout abounded in the Union River in Michigan's Upper Peninsula in the 'Pre 1880-1880' time period. However, in the next time period there are no brook trout reports in this stream. This may be in part due to a large forest fire that ravaged the Ontonagon area in 1896, destroying all of the bridges over the Union River during a dry period in which no rain fell for three weeks. This event could have resulted in either reduced brook trout numbers, or reductions in human presence or angling in the area, and thus no observations in the '1881-1900' time period (The True Northerner, Oct. 14, 1896).

Second, brook trout abundance estimates may suffer from a shifting baseline (sensu Soga and Gaston 2018). The same brook trout abundances that would be considered abundant to residents of the 1920s might have seemed scarce to people in the 1860s. In the mid 1800's, many anglers reported catching hundreds of brook trout in a single outing in various streams around Lake Superior, which was considered good fishing, but relatively commonplace (Wisconsin Tribune, Jul. 26, 1850; The Weekly Pioneer and Democrat, Aug. 28, 1863; Duluth Minnesotian, Jul. 8, 1871). While large catches like these continued in some areas into the 1900's, reports of them became less

frequent, and they were considered remarkable (The Minneapolis Journal, Jul. 3, 1902). In cases where specific catch numbers were mentioned, population estimates were able to be completed more reliably, but subjective, qualitative reports made across time periods could be plagued by a shifting baseline as the definition of "good" brook trout fishing changed over time.

Third, the historical brook trout data in our dataset consist primarily of catch data and qualitative population descriptions, which could overestimate the population status of brook trout due to the presence of hatchery fish, which can inflate catch numbers but do not necessarily accurately reflect population status or population recruitment.

Several fish hatcheries were established around Lake Superior's south shore in the late 19th and early 20th centuries, and hatchery fish were transported by rail to supplement streams around Lake Superior. The state hatchery of Michigan, located in Sault Ste. Marie, transported hatchery fish in a railcar named "Fontinalis," which was dedicated to supplying the state's water bodies with hatchery fish (The Calumet News, Apr. 27, 1910).

Fourth, because coaster brook trout were sometimes but not always differentiated from stream-resident brook trout in historical catch reports, our data do not necessarily represent coasters exclusively, but rather use the status of reported brook trout populations in potential coaster brook trout streams as a proxy for coasters. The term "coaster" was rarely used in early records, especially before 1900. Fortunately, the presence of coasters can be deduced from historical accounts that specifically mention lake-run or lake-resident brook trout and inferred from those that mention brook trout

with properties that are likely to be those of coasters, such as large brook trout taken near the mouths of Lake Superior tributaries.

While informative, the lumber mill data do not fully encapsulate the scope or magnitude of the effects of the logging and lumber industries, which could cause our analysis to underestimate the contribution of these industries to the coaster brook trout's decline. Other impacts associated with logging and lumbering include splash dams and log drives, which may have impacted coaster populations but are not present in our analysis. This lack of data may result in some watersheds experiencing a decrease in brook trout abundance over time without any sawmills or other human dimensions present. These watersheds may not have been free from the effects of logging, as they could have been home to log driving streams or contained impoundments that prevented upstream movement. This is the case with watersheds in northern Minnesota, where logging activities took place, logs were driven down streams, but then transported to lumber mills in the Duluth region (Smith & Moyle 1944).

2.2.10.6 Future Directions

Non-Native Salmonids: Although this paper does not examine the role of non-native salmonids in the decline of coasters, they were probably an important factor, and their effects on coaster populations warrant further research. Two salmonids were introduced as sport fishing targets concurrently with the decline of coasters, the rainbow trout (*Oncorhynchus mykiss*) and the brown trout (*Salmo trutta*). Further exotic salmonids were introduced in later years, but at a time that is apparently post coaster decline. These

species may have had an impact on hindering the recovery of the coasters, but not driving their initial decline, since they arrived after the coaster populations around Lake Superior had diminished. Beginning in the late 19th century, rainbow trout and brown trout were introduced into Lake Superior and its tributaries, acting as a potential source of competition for habitat and resources. Rainbow trout were introduced as early as 1883 in the Ontario waters of Lake Superior and were stocked at Port Arthur in 1894 (Kerr 2010; Goodier 1982, in Wilson 1990). Brown trout were introduced into Lake Superior in 1900 (Lawrie 1978).

Non-native salmonids were introduced as game fish in areas where the brook trout fishery had declined substantially and were favored by many anglers due to their perceived ability to tolerate altered environmental conditions brought about by industrial activities, such as increased thermal or siltation tolerance compared to brook trout. Shortly after these introductions, some anglers worried that planting non-native salmonids into waters inhabited by brook trout would have negative effects on brook trout populations, for example, suspecting that rainbow trout (*O. mykiss*) were consuming brook trout and reducing their numbers (Wausau Pilot, Jul. 16, 1912).

This view was not universal, however. In a 1909 piece entitled "The Rainbow Trout in Michigan," the Michigan Fish Commission's superintendent, Seymour Bower, recognized concerns that rainbow trout were responsible for reducing brook trout populations but believed that rainbow trout were simply inhabiting waters that brook trout had abandoned due to unsuitable habitat caused by the destructive industries that ravaged Michigan's landscape (Bower 1909). Bower thought that:

> It is true that a number of our larger streams, once suitable for brook trout from sources to mouth, are now occupied by rainbow trout in the middle and lower waters, almost to the exclusion of brook trout. The natural supposition is that the latter have been driven out, when as a matter of fact such waters would now be deserted by the brook trout if the rainbows had never been introduced. The clearing up of heavily timbered areas or sections has so changed the character and temperature of many streams that the brook trout have retreated nearer and nearer the headwaters.

Other anglers eagerly welcomed the stocking of non-native salmonids even though they understood that there were potential problems associated with it. Failed recovery efforts and defeatist attitudes about the dwindling brook trout populations around Lake Superior left many anglers hopeless toward the notion of maintaining a healthy brook trout fishery, encouraging them to instead acquiesce by fishing for introduced salmonids. This point is made evident by a 1907 editorial in Forest and Stream magazine which declared that:

> In many waters it is a matter of choice between other than native species, and in spite of the strong sentiment in favor of our brook trout, there are waters in which he will never again be found in any considerable numbers. The question, therefore, resolves itself into one of introduced trout or none, and the rainbow and brown trout are worthy successors to our dethroned favorite, fontinalis" (Vogel 1999).

One potential method of incorporating the effects of non-native salmonids into our analysis would be to expand this project by creating and mapping a database of historical stocking of non-natives into Lake Superior tributaries. This would allow for a quantitative and spatial analysis of the presence and abundance of non-native salmonids in watersheds around Lake Superior and a comparison of associations between sympatric populations of non-native salmonids and brook trout. However, even if such associations are found, they do not necessarily mean that a higher presence of fish such as rainbow trout or brown trout directly causes brook trout decline. For example, popular sport fishing streams may receive higher quantities of planted non-native salmonids and have fewer brook trout due to the high angling pressure.

Log Drives & Splash Dams: To strengthen and advance our research on the impacts of logging and lumbering, a logical next step would be to create a database of log drives in Lake Superior tributaries to as detailed an extent as possible, including the names and locations of streams, the dates that log drives occurred, and the approximate quantity of lumber transported per log drive. Additionally, a database of historic splash dams would further supplement our analysis by identifying crucial logging areas and which streams were heavily impounded. This chronology of log drives and logging dams would enrich our estimation of the impacts that the logging and lumber industries had on brook trout populations around Lake Superior by identifying locations impacted by the logging industry that our current analysis has missed.

Fires: Given the scale, frequency, and intensity of historic forest fires in the Lake Superior region, it would benefit our analysis to document the chronology of these fires to examine which watersheds were most severely impacted.

2.3 Conclusion

Our data and analyses are consistent with the prior hypotheses and anecdotal reports on the decline of brook trout in the Lake Superior basin that implicated angling, logging & lumbering, and mining as key drivers of the brook trout's decline. We documented a notable decrease in brook trout abundance and distribution in watersheds adjoining Lake Superior following the height of industrial development in the Lake Superior region. Lake Superior's coaster brook trout were confronted with multiple stressors simultaneously, as the developments that took place in the Upper Great Lakes in the 19th and 20th centuries changed the landscape, altered habitat conditions, connected once disparate locations with transportation routes, and ushered in a wave of human population growth that led to unprecedented levels of angling. Although the decline in brook trout populations was likely led by angling and logging, it is likely that all the modes of development and watershed disturbance worked in tandem rather than acting separately in a simple additive manner. Growing industries such as lumbering and mining acted as a direct source of pollution and habitat alteration and also contributed to the general development of the region including the establishment of railroads & ancillary industries and increases in human populations, and thus recreational angling and other forms of brook trout take.

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3 Coaster Brook Trout Management and Restoration: Historical and Contemporary Perspectives

3.1 Introduction

The decline of coaster brook trout populations around Lake Superior was met with an immediate recognition that management and restoration action was needed. However, early coaster management efforts consisted primarily of stocking waterbodies with hatchery fish and did little to curb the decline of brook trout. As brook trout populations and the quality of the fishery continued to decrease, pessimism shifted public opinion away from the likelihood of maintaining a healthy brook trout fishery. Historic angling and industrial regulations were often too lenient or entirely nonexistent until after coasters had already been severely impacted. Furthermore, enforcing the few regulations that did exist was difficult. Fish and game wardens were scarce, due to low funding, low wages, and the dangerous nature of the job.

Recent efforts have approached coaster brook trout management and restoration from a wider range of perspectives, incorporating factors such as habitat quality and community composition. Interagency collaborations have led to the synthesis of brook trout management and restoration initiatives that have attempted to address the many gaps in previous brook trout management efforts. Furthermore, mechanistic and theoretical advances in ecology, evolution and eco-evolutionary dynamics have created insights into management that allow for more thorough and holistic approaches to conservation. The growing understanding that evolution is ongoing and thus occurs on contemporary timescales has made it an increasingly important factor in ecological

dynamics and conservation biology, especially in human-impacted environments, as human activity has been shown to induce strong selection pressures (Allendorf & Hard 2009; Darimont et al. 2009; Hendry, Gotanda & Svensson 2017). This eco-evolutionary perspective, which has been dubbed "The Newest Synthesis" (Schoener 2011), aims to understand and explain ecology and evolution not as separate and related patterns and processes, but rather as a system of interconnected phenomena that influence each other on contemporary timescales (Hendry 2016).

In this thesis chapter, I briefly review the history of brook trout management and restoration around Lake Superior from the late 19th century to the early 20th century. I then use an eco-evolutionary perspective to inform potential coaster brook trout restoration action and rehabilitation in light of the history of failed conservation and restoration efforts.

3.2 Historical Conservation, Management, and Restoration Strategies

As brook trout populations began to decline around Lake Superior, concerned citizens requested that measures be taken to manage and conserve the existing populations before they dwindled and disappeared (The Superior Times, Feb. 24, 1876; The Minneapolis Journal, Aug. 30, 1902). Many people looked with disdain upon the fishing practices of the time, noting how the flagrant netting, dynamiting, and unchecked angling were expeditiously reducing brook trout numbers (Duluth News-Tribune, Feb. 16, 1893; Newberry News, Dec. 16, 1886). Governing bodies responded by enacting laws

to curb the unrestricted harvesting of brook trout and attempted to mitigate the loss of brook trout by supplying streams with hatchery fish. These efforts were generally unsuccessful for several reasons.

One of the primary reasons that historic brook trout management and restoration failed was a lack of attention to maintaining quality habitat. Historically, brook trout restoration consisted mainly of stocking brook trout in waterbodies (The Calumet News, May 28, 1912). Rather than addressing the underlying causes of the brook trout's decline, such as habitat alteration or overharvesting, legislative bodies chose instead to plant hatchery brook trout in streams to restore their numbers. In a 1924 piece for the Ironwood Daily Globe, Albert Stoll Jr. mentioned that:

> No one familiar with the trout streams of this state [Michigan] can deny that brook trout have decreased greatly in numbers during the past five years, despite the fact that more fry and fingerlings have been planted in our streams than ever before (Ironwood Daily Globe, Mar. 20, 1924).

A 1910 article attributed the existing brook trout fishery along the eastern border of Minnesota entirely to stocking, stating that *"without [stocking] there would be no brook trout"* (Belding Banner, Mar. 17, 1910).

State governments eventually made attempts to shield brook trout populations from overfishing by enacting fishing seasons and daily catch limits, but these often came too late and weren't stringent enough to reverse the effects of angling pressures and habitat loss. Some of the earliest fishing regulations aimed to stop alternative methods of

harvesting brook trout besides hook and line angling. In 1875, residents of Michigan decried the noticeable decrease in brook trout abundance and body sizes; state representative Hulbert of Houghton responded by proposing a bill which prohibited the harvesting of brook trout by any method other than hook and line fishing (Detroit Free Press, Jan. 29, 1875). State governments also implemented catch limits to mitigate the effects of angling on fish populations. These were likely ineffective at preventing the impacts of harvesting on brook trout since catch limits allowed anglers to keep large numbers of fish. In 1913, long after coaster populations began to decline, the daily catch limit in Michigan was 50 brook trout per angler. One year later, this law was amended to lower the limit to 35 brook trout per angler per day (The L'Anse Sentinel, Apr. 25, 1914).

Anglers and outdoorspeople presented brook trout management and restoration proposals that aimed to reduce mortality imposed by other animals. The Charlevoix County Herald reported in 1917 that Michigan sportsmen sought to solve the problem of reduced brook trout abundances by making it legal to kill fish-eating waterfowl year-round, as they held these animals culpable for the decline of brook trout and claimed that they were responsible for more brook trout loss than anglers were (Charlevoix County Herald, Feb. 16, 1917).

Even when fishing laws and regulations were passed, they were difficult to enforce. Game wardens were scarce, and funding issues prevented them from being hired in sufficient quantities to curb the damages inflicted by illegal angling, netting, and dynamiting. In 1894, the Newberry News reported that the Michigan state fish commission was requesting a $10,000 appropriation for game and fish law enforcement, after having previously been granted only $2,000. The author lamented the lack of

adequate funding and proclaimed that “it is alleged that as a result brook trout have been netted and dynamited freely in northern streams, and that money must be raised for detection and prosecution of violators of the laws” (Newberry News, Sep. 21, 1894). Furthermore, counties were expected to provide funding for the enforcement of game and fish laws as well, but not many actually did. In Michigan, county supervisors were in charge of setting appropriations for fish wardens and could abstain from voting on an appropriation to allow fish and game laws to go unenforced. In some instances where a vote did take place, the appropriation was set to such a paltry sum that nobody would take the job of fish warden (The L’Anse Sentinel, May 20, 1893). Furthermore, fish and game wardens were at considerable risk of being met with violence or even death upon attempting to enforce the law. One instance near Marquette Michigan was particularly gruesome. In 1936, fragments of Conservation officer Andrew Schmeltz’s body were found scattered around near the Carp River after he was murdered, and his body dismembered with dynamite (The Herald-Press, Oct. 21, 1936). This incident made Schmeltz Michigan’s third conservation officer murdered in a ten-year period, after poachers had killed two other officers who attempted to detain them several years prior.

3.3 Contemporary Management and Restoration Efforts

In contrast with the earliest management and restoration efforts that focused mainly on restocking depleted streams with hatchery brook trout, modern attempts at coaster brook trout rehabilitation and management have taken a more nuanced approach. One

such example is Newman, DuBois & Halpern's 2003 "A Brook Trout Rehabilitation Plan for Lake Superior," which established the brook trout rehabilitation goal of maintaining *"widely distributed, self-sustaining populations in as many of the original, native habitats as is practical."* The rehabilitation plan focused not only on protecting existing brook trout populations from overexploitation, but also on furthering research on coaster biology and ecology, identifying potential rehabilitation locations, watershed restoration, brook trout stocking, and monitoring and assessment of the fish community to understand interactions with introduced salmonids.

Since the publication of this restoration plan, the objectives and methods included therein have been attempted throughout the Lake Superior basin with varying results. Protection from overharvest by anglers has been reimplemented in recent decades to introduce more conservative limits and shift the public's view of the coaster fishery to a trophy fishery, in which anglers focus not on catching and keeping multiple fish, but rather seek a large, desirable trophy fish for the sake of sport rather than harvesting.

In an effort to rehabilitate coaster brook trout populations in Minnesota, the Minnesota Department of Natural Resources (MDNR) introduced new harvest restrictions for the state's brook trout in 1997. The fishing regulations included a change in minimum size limit (from 10 to 20 inches), a reduction in catch limit that allowed for possession of only one brook trout, and the implementation of a closed fishing season from September to April (Miller et al. 2016). Miller et al. (2016) found that the tightened regulations protecting larger brook trout (> 20" total length) appeared to have a positive impact on coaster brook trout rehabilitation, as both the proportional size structure and proportion of fish greater than 3 years old increased. These increasing trends in brook

trout abundance and size were corroborated by a 2018 coaster brook trout survey in northern Minnesota (Peterson 2019). An analogous effort in Michigan is currently underway, modeled after the Minnesota experiment (Miller et al. 2016), and is a collaborative effort between the Michigan DNR, the US Fish and Wildlife Service, and Michigan Technological University. This effort involves similar minimum size limits in a suite of Lake Superior tributary reaches (MDNR) including the Pilgrim River, Houghton County. Among the experimental tributaries, the Pilgrim River is the most studied and following the restrictive catch regulations, relatively large numbers of migratory brook trout have been detected (Adams 2020). Boone, Brouder & Quinlan (2021) observed an increase in adfluvial brook trout in Washington Harbor, located at Isle Royale, Michigan, which they attributed to protective regulations around the island as well as increased stream flows and water levels.

Contemporary stocking efforts have been undertaken to restore coasters to streams in their putative original range but have had mixed degrees of success. Leonard et al. (2013) examined the effectiveness of a brook trout stocking initiative that took place in three streams along the Pictured Rocks National Lakeshore in Alger County, Michigan. Brook trout from the Tobin Harbor strain, which is derived from a lacustrine population of coaster brook trout, were stocked in Hurricane River, Mosquito River, and Sevenmile Creek. The analysis by Leonard et al. (2013) found that the stocking program did little to rehabilitate the coaster life history in the supplemented brook trout populations; a small percentage of the stocked fish exhibited movement that could've been representative of a migratory life-history but was also consistent with dispersal. Furthermore, stocked brook trout did not appear to be naturally reproducing to any substantial degree. Interestingly,

the status of the Hurricane River, Mosquito River, and Sevenmile Creek as historic coaster streams is not clear; Leonard et al. (2013) note that Newman & DuBois (1997) recorded the three rivers as historic coaster streams based on accounts from Stauffer (1976) that were somewhat nebulous and had little evidentiary support. The historical brook trout data used in our historical analysis (Chapter 1) for these three rivers also originates from this source, and despite an extensive search, we found no other sources documenting historic coaster populations in them. For this reason, we assigned a credence value of 4 (lowest confidence) to these observations. This example highlights the utility of historical data in contemporary restoration efforts, as it is crucial to verify to the highest degree possible that coaster brook trout inhabited a waterbody before spending time and resources on a restoration effort.

3.4 Future Directions

3.4.1 Eco-Evolutionary Management and Restoration

Future coaster brook trout rehabilitation initiatives can benefit from an eco-evolutionary framework that encourages conservationists and managers to focus on restoring and managing population abundances, genetic variation, adaptive potential, and habitat conditions to allow persistence, adaptation and population resilience (Stockwell, Hendry & Kinnison 2003). Limiting the artificial selection pressures on reintroduced coasters may help them to adapt to stream conditions in rehabilitation streams and increase the likelihood of a successful restoration program. Furthermore, understanding

the full suite of potential eco-evolutionary effects of the coaster brook trout's decline can benefit management and restoration efforts by elucidating habitat and ecosystem rehabilitation needs.

Evolutionary changes in traits including behavior, morphology, and life-history can be driven by anthropogenic activities such as fishing, land use, and pollution, and they have been shown to have consequences on ecological variables, which can then feed back to influence further evolutionary patterns (Post & Palkovacs 2009, Pelletier, Garant & Hendry 2009, Hendry 2016). Resulting phenotypic and/or genetic alterations can then influence a populations response to future actions, such as management or environmental changes. An informed perspective on management and restoration should take into account the potential eco-evolutionary impacts of anthropogenic interventions, such as human-induced trait changes and their eco-evolutionary consequences.

Behavioral traits are often intimately linked to an organism's life history traits and can influence ecological processes such as predator-prey dynamics, competition, nutrient dynamics, reproductive success, and trophic cascades (Palkovacs et al. 2018, Cooke et al. 2007). Experimental evidence has shown that fish behavior can evolve in response to fishing through several mechanisms (Phillip et al. 2009, Olsen et al. 2012). A selection experiment on largemouth bass (*Micropterus salmoides*) conducted by Phillipp et al. (2009) indicated that vulnerability to angling was heritable and can indeed respond to selection. Angling, therefore, may change the genetic and phenotypic composition of fish populations and alter behavior, which can result in ecological changes. For example, angling may selectively remove aggressive or active individuals from a population, which

can result in altered feeding behavior, trophic interactions, and nutrient dynamics (Palkovacs 2011, Redpath et al. 2009, Vanni et al. 1997, Vanni 2002). Biro and Post (2008) simulated commercial fishing to evaluate the effects of fishing on the evolution of behavior and growth rate in rainbow trout (*Oncorhynchus mykiss*) and showed that bolder, aggressive behavior was correlated with faster growth rates, and that faster growing individuals were removed at a rate three times that of slowly growing individuals. Changes in behavioral traits can interact with and influence changes in body size each other, which can result in eco-evolutionary effects at the community level. For example, reductions in body size can lead to a decrease in per capita consumption rates, as well as prey switching (Audzijonyte et al. 2014). Prey switching can impact eco-evolutionary processes in food webs by altering trophic interactions and by relaxing selection for predator-mediated defense traits in the original prey species and introducing novel selection pressures on the new prey (Walsh 2013).

These results from a variety of species suggest that fisheries management that is based on minimum size limits may indirectly limit fish growth rates or sizes. Unless considered from an eco-evolutionary perspective, management approaches such as restrictive size-limits alone may be insufficient in mitigating fishing-induced evolutionary changes. This may suggest that to prevent further human-induced evolutionary consequences on fish populations targeted for restoration, fisheries and sport angling mortality of all sizes should be minimized to the greatest extent possible. Applying this to imperiled coaster brook trout populations, prior to 2004 the minimum legal size limit was 10”, which is smaller than the size at which coasters tended to make their first adfluvial migration for reproduction (Huckins & Baker 2008). Thereafter, the

shift to a 20” minimum length in Michigan waters of Lake Superior, matching regulations imposed by other management units around the lake, is predicted to have allowed coasters to spawn approximately 3 times based on data from the Salmon Trout River population (Huckins & Baker 2008). This allowance of reproduction by larger individuals could be conducive to increasing coaster brook trout population sizes, population size structure, and maximum body sizes.

As fish move between habitats during migration e.g., from a lentic ecosystem where they have matured and grown to the fluvial habitat where they will reproduce, they also transport nutrients and energy (Mattocks, Hall & Jordaan 2017). Reductions in the body sizes of anadromous fishes have been linked to decreased nutrient transport and loading (Twining et al. 2016). In Lake Superior tributaries, coaster brook trout migrations may have provided an energetic linkage between lake and stream systems, analogous to the important nutrient transfers documented for other iteroparous species such as migratory suckers (Childress and McIntyre 2015). However, inputs of energy to the fluvial ecosystem by these iteroparous migrations would likely not be as large as those that result from the carcasses of semelparous species such as pacific salmon that die after spawning (Wipfli et al 1998). The migratory runs by coasters were disrupted by harvesting and the impacts of logging, which may have affected the nutrient dynamics of streams. Seine nets placed near the mouths of streams were used to collect nearly entire runs of migrating brook trout (Escanaba Morning Press, Sept. 2, 1911), virtually severing the connection that brook trout facilitated between streams and Lake Superior. Additionally, logging dams prevented upstream movement by migrating brook trout and made large-scale harvesting of brook trout easier, which may have rapidly altered the

typical nutrient dynamics of coaster brook trout streams (Vogel 1999). Removing and blocking these large-bodied migratory brook trout could've altered the brook trout populations in Lake Superior tributaries in several ways simultaneously, and impacted nutrient dynamics by changing the population size, the population size-structure, and by eliminating the migratory component from brook trout populations. For example, population size structure, which is linked to nutrient dynamics and cycling, can be reduced by the effects of selective harvesting. A population of fish that consists of many small individuals can drive higher rates of nutrient fluxes than a population of the same fish at an equal biomass that is comprised of fewer, larger individuals (Vanni et al. 1997, Vanni 2002).

The reduction of body size and growth rate in predator populations, along with changes in behavioral traits, can have impacts on prey populations and community level interactions such as trophic cascades and nutrient fluxes. Trophic dynamics, for example, can be altered through both density-mediated and trait-mediated eco-evolutionary effects (Fraser 2013). Fishing, by reducing population density, can create trophic cascades, in which fish prey increase and cause subsequent reductions in lower trophic levels (Fraser 2013). Even without a change in biomass, changing the size structure of a predator population so that it is composed of smaller individuals can result in trait-mediated increases in prey populations and alter trophic cascades (Shackell et al. 2010, Fraser 2013). Shackell et al. (2010) examined the role of overfishing on commercially exploited groundfish and found predator body size can drive trait-mediated trophic cascades. Their analysis found that even though the aggregate predator biomass had not changed in 38 years, reduced predator body size resulting from fishing coincided with an

increase of over 300 percent in prey biomass. Fraser (2013) has suggested that fishing can result in eco-evolutionary trophic cascades, which can have stronger impacts than a classic density-driven trophic cascade alone. In a classic trophic cascade with four levels, fishing reduces population density in the harvested population, which drives increases in, for example, zooplanktivorous prey fish populations, decreases in zooplankton, and increased algal biomass. In an eco-evolutionary trophic cascade, selective fishing will initially drive decreases in population density and alter the phenotypic distribution of the harvested population, leaving fewer large individuals and more small individuals. This results in an amplification of the effects on lower trophic levels and can also influence their evolutionary trajectory in multiple ways. For example, changes in top predator phenotypes can alter prey community structure through shifts in feeding habits or optimal prey characteristics (Palkovacs & Post 2009). Additionally, relaxing predator induced selection can strengthen selection on prey competitive phenotypes due to increased intraspecific competition associated with increased density (Fraser 2013). Intensified intraspecific competition in prey species that have been released from predator-induced selection can increase the per capita effect that prey have on their resources, thus increasing the strength of the eco-evolutionary cascade (Palkovacs 2011, Palkovacs et al. 2011). Palkovacs et al. (2011) experimentally tested this phenomenon by subjecting guppies (*Poecilia reticulata*) to predator release; in the predator-free environment, guppy density increased, and natural selection altered feeding traits, which increased guppy consumption rates (Palkovacs et al. 2011).

Unfortunately, reversing the genetic and phenotypic changes brought about by fishing on Lake Superior's coasters may be difficult due to the potentially slow

reversibility of the selective response to harvesting. The erosion of genetic variation caused by harvesting (i.e., the removal of genetic diversity when individuals such as the largest individuals are selectively culled from a population) can result in changes in multiple correlated traits, and once harvesting is ceased, the harvested population is not necessarily met with opposing selection pressures of an equal magnitude that would drive phenotypes back toward their pre-harvesting values (Allendorf & Hard 2009; Law 2000; Swain et al. 2007; Hutchings & Fraser 2008). Animal harvesting studies have investigated reversals of harvest-driven selection and documented cases of harvest induced trait changes in animal populations for which a cessation of harvesting did not result in quick reversals (Pigeon et al. 2016; Olsen et al. 2004: Swain et al. 2007). For example, Conover et al. (2009) investigated evolutionary reversals of harvest-driven selection by performing selection experiments on *M. Menidia* and found that harvest-induced trait changes can indeed be reversible given sufficient genetic variation, but reversals can be slow (Conover et al. 2009). Furthermore, de Roos et al. (2006) used modeling to show that harvesting may lead to irreversible evolutionary responses by causing evolutionary regime shifts, in which a population is driven toward a new evolutionarily stable state (ESS) (de Roos, Boukal & Persson 2006). Their model demonstrated that harvesting late-maturing populations can result in the population shifting toward an ESS with smaller sizes at maturation. The suspension of harvesting can reverse this evolutionary regime shift process, but only if implemented early and completely (de Roos et al. 2006). However, reversals of harvest-induced trait change need not always be slow, as quick reversals are possible if natural selection is

consistently and strongly acting in opposition to harvest-selection, and periods of harvesting are short. (Coltman 2008; Carlson et al. 2007).

In order to restore genetic variation and potentially reverse the effects the negative impacts of angling on brook trout populations, human-induced brook trout mortality should be curtailed to the greatest extent possible by minimizing anthropogenic environmental disturbances and enacting restrictive fishing regulations. These include conservative harvest limits or cessation of fishing, and protection of critical habitat through limiting or preventing access to coaster reintroduction areas by anglers and industries.

The stocking of brook trout in Lake Superior tributaries must also take into consideration an eco-evolutionary perspective to maximize the likelihood of success and minimize potential negative impacts on existing populations. Stocking brook trout presents the opportunity for gene flow between stocked and native fish, which can act as both a help and a hinderance to conservation efforts. Stockwell, Hendry & Kinnison (2003) note that gene flow is "the Jekyll and Hyde of conservation," as every positive effect of gene flow for conservation has a corresponding downside. For example, artificially supplementing animal populations increases population size, which can reduce inbreeding depression and provide genetic variation which can increase adaptive potential (Frankham 1995; Hedrick 1995). However, gene flow and introgression between genetically divergent populations can drag locally adapted populations away from their respective fitness peaks and result in population declines (Stockwell, Hendry & Kinnison 2003; Lenormand 2002; Boulding & Hay 2001). The potential drawbacks of stocking and gene flow on conservation and restoration initiatives could be better avoided by

implementing coaster stocking programs that take into account the genetics and life-histories of the source population(s). If stocking is to be used in the rehabilitation of migratory coaster brook trout, migratory rather than lake resident coaster genotypes should be stocked, and vice versa. For example, the Tobin Harbor coaster population in Isle Royale, Michigan, consists of lacustrine brook trout, and therefore may not be an optimal source population for stocking in habitats where the goal is to restore migratory brook trout.

The planting of other salmonids may further hinder coaster brook trout recovery through several mechanisms. Splake, a hybrid between male brook trout (Salvelinus fontinalis) and female lake trout (*Salvelinus namaycush*) have been regularly planted around Lake Superior since 1971. Splake have been demonstrated to disperse to distant locations from where they were planted. Feringa et al. (2016) identified hatchery splake in Lake Superior tributaries that had dispersed up to 48 km away from the stocking site and notably these tributaries included the Salmon Trout River and the Pilgrim River, both of which have documented migratory brook trout populations (Huckins and Baker 2008, Adams 2020, respectively). The potential for hybridization between brook trout and splake and introgression of splake genotypes into brook trout populations could reduce brook trout fitness by degrading local adaptation. Furthermore, splake are fast-growing and highly competitive; planting hatchery splake in Lake Superior may hamper coaster brook trout restoration efforts by imposing an artificial selection pressure through competition for habitat and resources (Newman et al. 2003). Also, competitive interactions between non-native salmonids and brook trout may also make rehabilitating coaster brook trout more difficult. For example, research on stream restoration has found

that at least in some instances, the benefits of stream restoration for brook trout can depend on the absence of non-native salmonids. Huntsman et al. (2022) found that stream restoration in the Shavers Fork watershed, WV, benefited brook trout only when non-native trout species were absent.

3.4.2 Identification of Sites Prioritized for Restoration

One of the objectives of the brook trout rehabilitation plan for Lake Superior is *"location of suitable restoration sites"* (Newman et al. 2003). Our analysis can address this objective by locating potentially auspicious coaster brook trout restoration streams through the identification of watersheds that were less impacted by human activities. The Pilgrim River watershed, for example, did not experience the heavy log drives, dense sawmill or mine presence, or heavy intrusion of railroads that some watersheds in areas such as Duluth, Marquette, or Keweenaw County did. The Pilgrim River was, however, fished heavily by anglers, to the detriment of that stream's brook trout population. Given the relatively low anthropogenic footprint to the watershed's quality, and the fact that migratory brook trout have been detected in the Pilgrim River (Adams 2020), it may be an optimal location for enhanced efforts toward coaster restoration. Watersheds with a low developmental or industrial footprint may require simpler rehabilitation actions, such as reintroductions and restrictive harvest regulations, and these areas should be prioritized and protected (Schreiner et al. 2008). This is consistent with results from the previously described coaster rehabilitation efforts in northern Minnesota, in which harvest

regulations protective of large individuals appeared to have a positive effect on coaster populations.

As a first step toward the application of this approach for improving restoration success, we documented 8 candidate watersheds in northern Minnesota in which we found no railroads, mines, or lumber mills. These Minnesota rivers and other potential coaster brook trout restoration targets in Wisconsin and Michigan were identified by examining which watersheds had both the lowest industrial impacts and the highest coaster credence values. The candidate watersheds for coaster brook trout restoration were then selected based on the watershed attributes and industrial footprint and the coaster credence value (Table 13). These locations may require less restorative effort than other watersheds, as their lower level of legacy industrial footprint means less watershed rehabilitation, and the higher coaster credence values instill confidence that resources would be invested into rivers with strong evidence of historical coaster populations.

3.5 Conclusion

The history of brook trout management and rehabilitation in the Lake Superior basin was plagued by mismanagement, corruption by governing bodies, disjunction between agencies and industries, and weak regulations that were often implemented too late. The lack of adequate funding, science-based management, and enforcement of existing game and fish laws allowed for decades of overexploitation of brook trout and alteration of stream habitats in the watersheds surrounding Lake Superior. Historical management and restoration initiatives were inadequate in both the maintenance and

recovery of brook trout fisheries, and as the popularity of non-native salmonid fishing in the Great Lakes increased, the prospects for a brook trout fishery that resembled its former status faded. Fortunately, coaster brook trout rehabilitation efforts experienced a revival in recent decades, led by contemporary management and restoration plans that address the shortcomings of previous initiatives.

Modern efforts at restoring coaster brook trout require an understanding of the history, biology, ecology, and eco-evolutionary dynamics of Lake Superior's coaster brook populations. The concurrent industrial developments in the Upper Great Lakes in the 19th and 20th centuries coupled with unprecedented levels of angling suggest that Lake Superior's coaster brook trout may have been strongly influenced by multiple competing selection pressures acting simultaneously; this may have hindered or prevented adaptation by coasters. The intense harvesting that occurred in the 19th century removed large numbers of individuals from populations at a time, likely rapidly depleting genetic variation and thereby reducing the potential for adaptation to changing environmental conditions. Specific harvest methods such as nets placed at the mouths of streams during migratory runs specifically targeted coaster brook trout, removing the migratory phenotype from brook trout populations in Lake Superior Tributaries. Logging dams may have selected for stream residency as migrating brook trout could not make it back upstream to spawning grounds and were also harvested in large quantities below dams. However, the appearance of migratory populations following the implementation of restrictive takes in Minnesota (Miller et al. 2016) and Michigan (Adams 2020) indicate that the potential variation in phenotype and life-history was not fully truncated by selective fish removals of the past.

The future of coaster brook trout management, conservation, and restoration should take into account the history of coaster distribution, habitat conditions and industrial development, along with contemporary research on coaster biology and eco-evolutionary theory to fully understand where coasters were, what locations are optimal for restoration, and what requirements are needed to ensure successful reintroductions and long-term persistence.

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4 Conclusion

In order to successfully rehabilitate migratory brook trout populations in the Lake Superior Basin, it is important to understand their historical distribution, the factors influencing their decline, and potential restoration sites.

The data and analyses in this thesis are concordant with existing reports of brook trout declines around Lake Superior in that they show a nearly universal decline in brook trout populations around the lake. However, rather than identifying a single source or primary driver of brook trout declines, this research suggests that multiple stressors may have interacted in complex ways across watersheds, with differing contributions in any given watershed. As industries in the Lake Superior region developed and human populations grew, the landscape and surrounding waters were altered in myriad ways. New threats in the form of resource extraction, pollution, and the exploitation of wildlife species put enormous pressures on animal populations in the Lake Superior Basin (Langston 2017; Bogue 2000). Coaster brook trout appear to have been impacted by all of these threats, to different degrees in different areas.

For example, in heavy lumber milling regions, such as Duluth, MN, declines in brook trout populations may have been driving by some combination of angling, landscape changes owing to development and deforestation, and pollution from lumber mills. Other watersheds that contained few industrial developments may have experienced brook trout declines from the effects of angling alone. In Michigan's Keweenaw peninsula, where mining operations proliferated, mining waste may have worked in tandem with angling pressures to drive population declines.

Although historical management efforts were inadequate, modern approaches, which take into account the ecology and evolutionary history of Lake Superior's brook trout as well as habitat needs and historical impacts, have begun to produce favorable outcomes. To restore current coaster brook trout populations toward their former status, it is not only critical to identify the current distribution and ecology of migratory brook trout in the Lake Superior basin and suitable habitat, but it is also critical to understand what has occurred in the past. The historical information on the coaster's decline can prevent us from making the same mistakes again and shed light on the underlying mechanisms by which human activities drive declines in animal populations.

4.1 References

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5 Figures

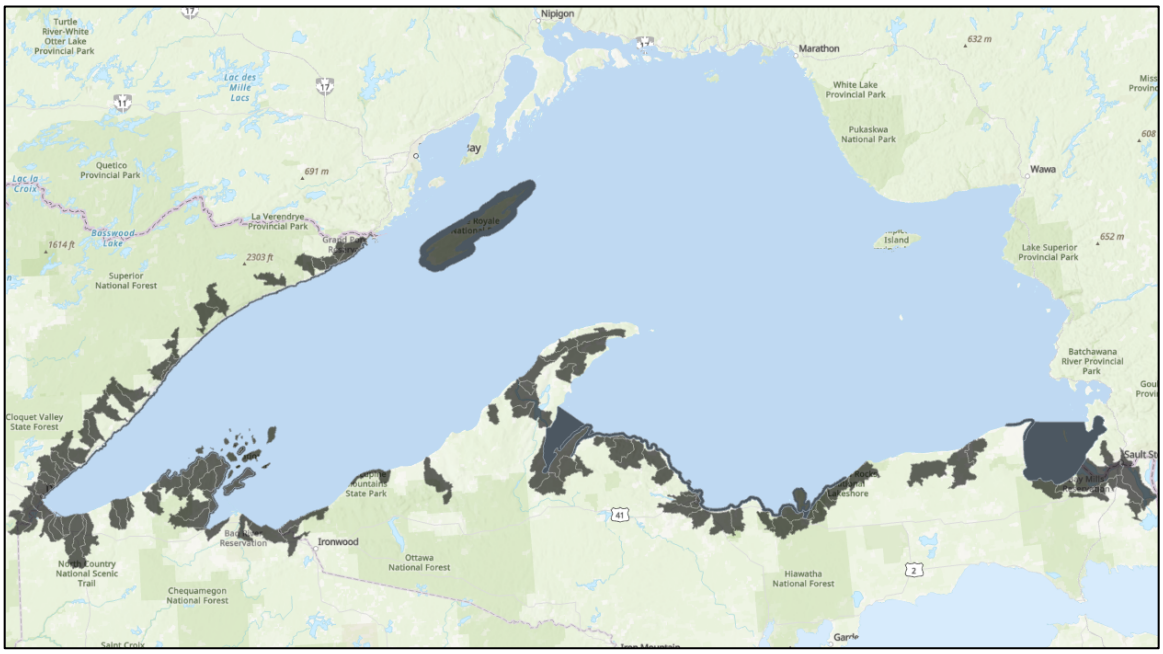

Figure 1: Spatial extent of study area for brook trout reports. Brook trout reports were recorded within Lake Superior or watersheds tributary to Lake Superior between 1800 and 1950. Three industrial variables (lumber mills, mines, and railroads) were recorded over the same time period within the states of Minnesota, Wisconsin, and Michigan's Upper Peninsula.

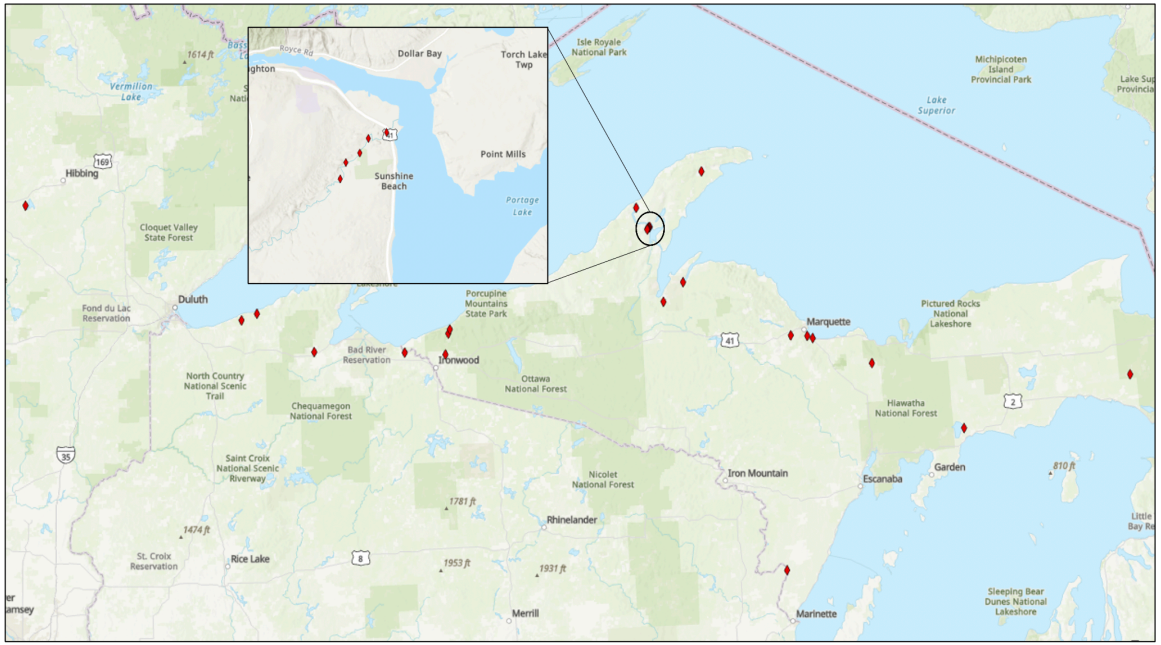

Figure 2: Historical dynamite fishing in the Lake Superior region between 1891 and 1947. Points represent a location where dynamite fishing occurred. These data can also be found in Table 1.

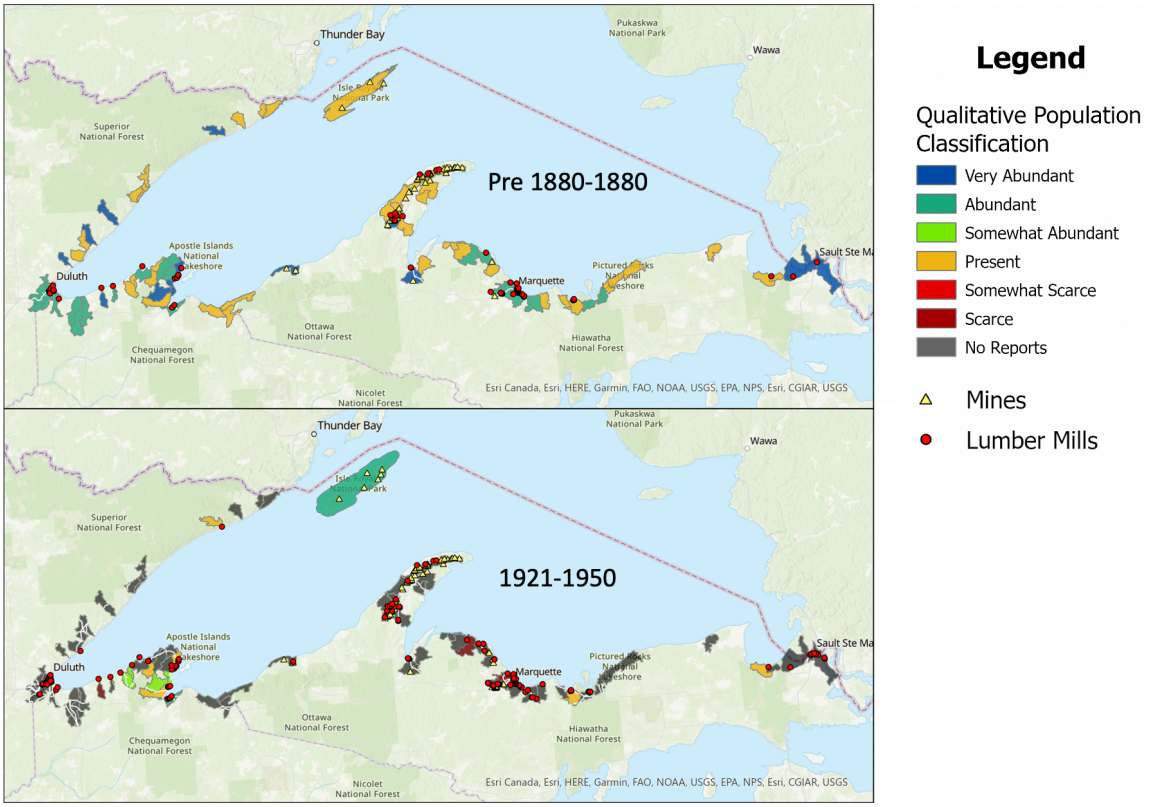

Figure 3: Intersections of industrial variables (mines, lumber mills, railroads) and brook trout watersheds between the first time period (Pre 1880-1880) and the final time period (1921-1950). Mines are represented by yellow triangles, lumber mills are represented by red dots, and railroad lines are represented by white line segments. The numeric data values are recorded in Table 2.

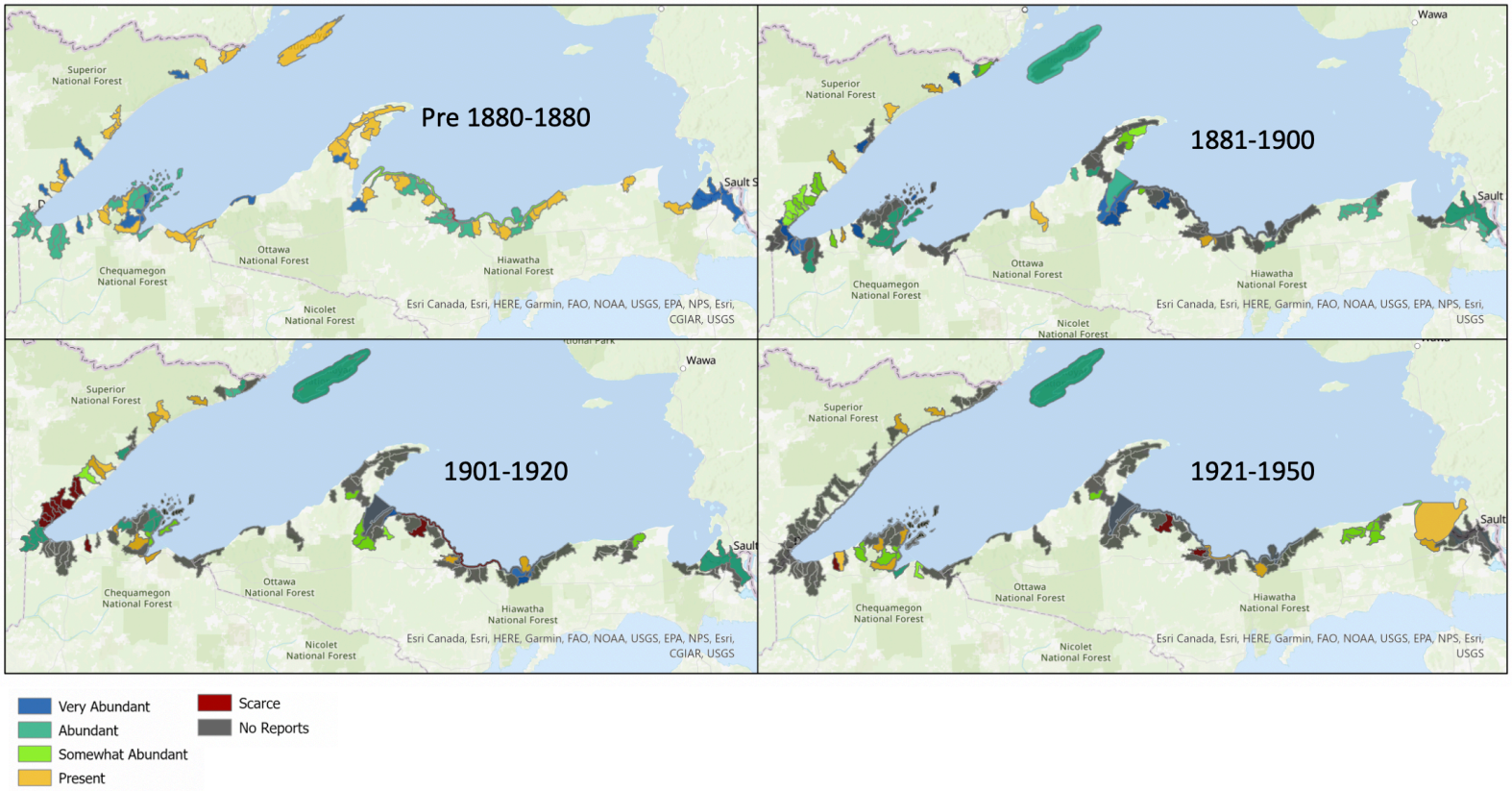

Figure 4: Brook trout reports around Lake Superior over time. Between the second time period (1881-1900) and the third time period (1901-1920) brook trout presence and abundance decrease substantially. This decrease coincides with large increases in industrial variables (see Table 4 & Tables 5-7).

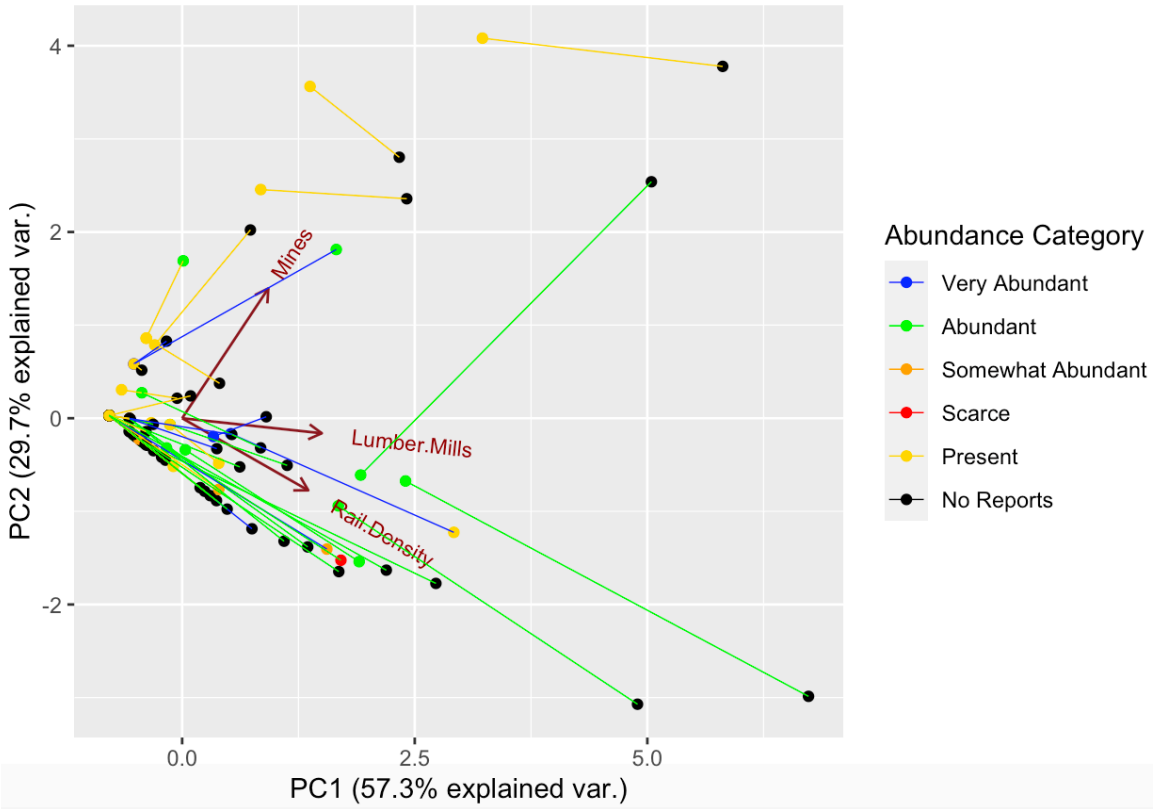

Figure 5: Principal component analysis of watersheds from the 'Pre 1880-1880' time period and the same watersheds in the '1921-1950' time period. Each point represents one watershed, with a line connecting the same watershed between the two time periods. Points are color coded according to the brook trout abundance category. Lines are color coded according to the brook trout abundance category in the 'Pre 1880-1880' time period. For PCA loadings, see Table 8.

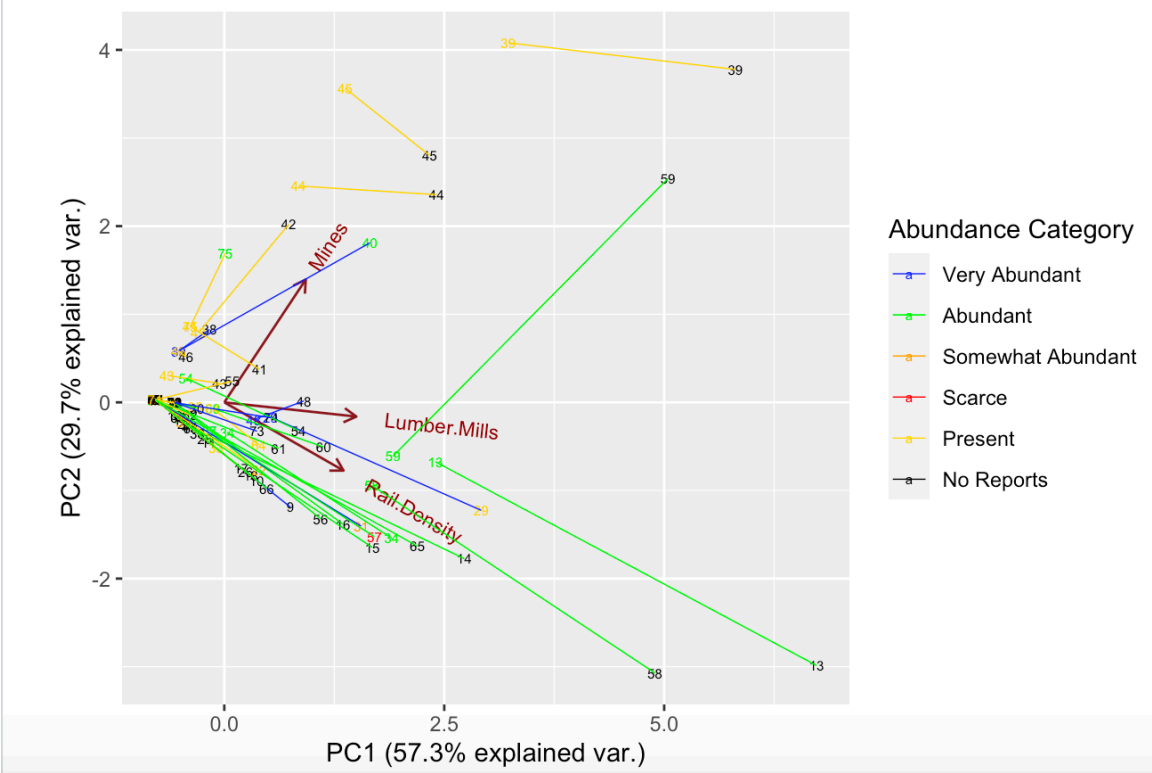

Figure 6: Principal component analysis of watersheds from the 'Pre 1880-1880' time period and the same watersheds in the '1921-1950' time period. This figure is the same as figure 1 except that watershed points are represented as a unique code number (1-75) that allows for the identification of specific watersheds in the multivariate space. Watersheds can be identified by referring to Table 9. For PCA loadings, see Table 8.

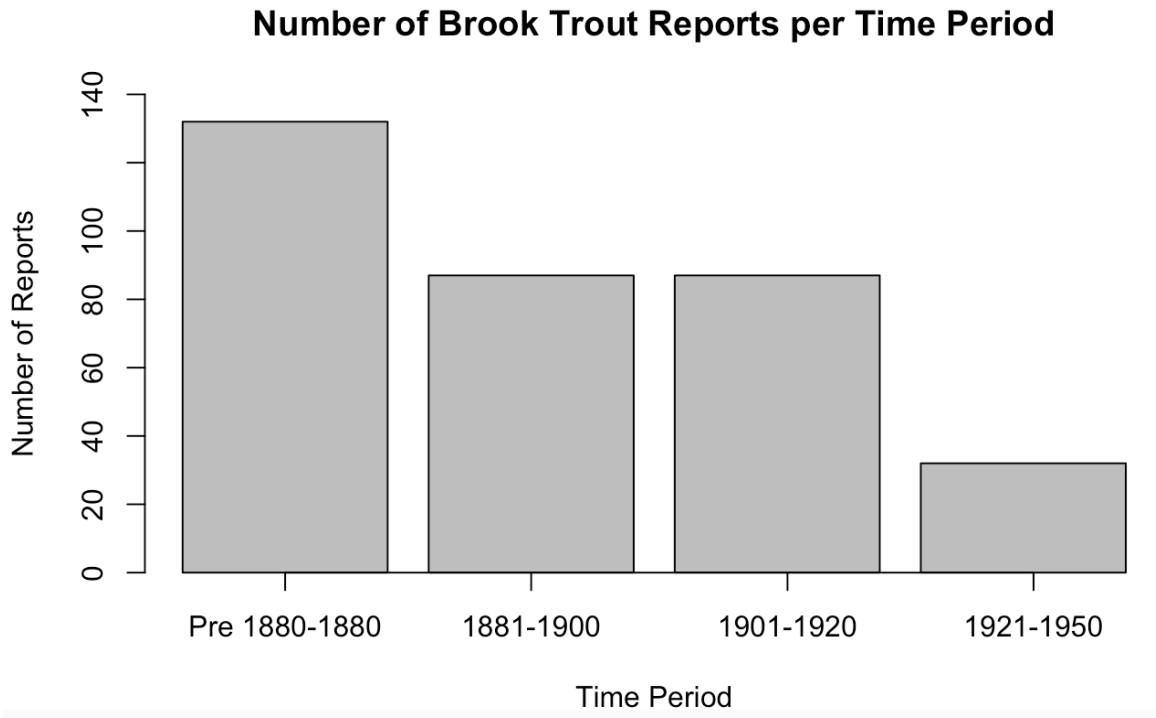

Figure 7: Number of brook trout reports per time period. The 'Pre 1880-1880' time period contains 132 brook trout reports, the next two time periods both contain 87 brook trout reports, and the '1921-1950' time period contains 32 brook trout reports.

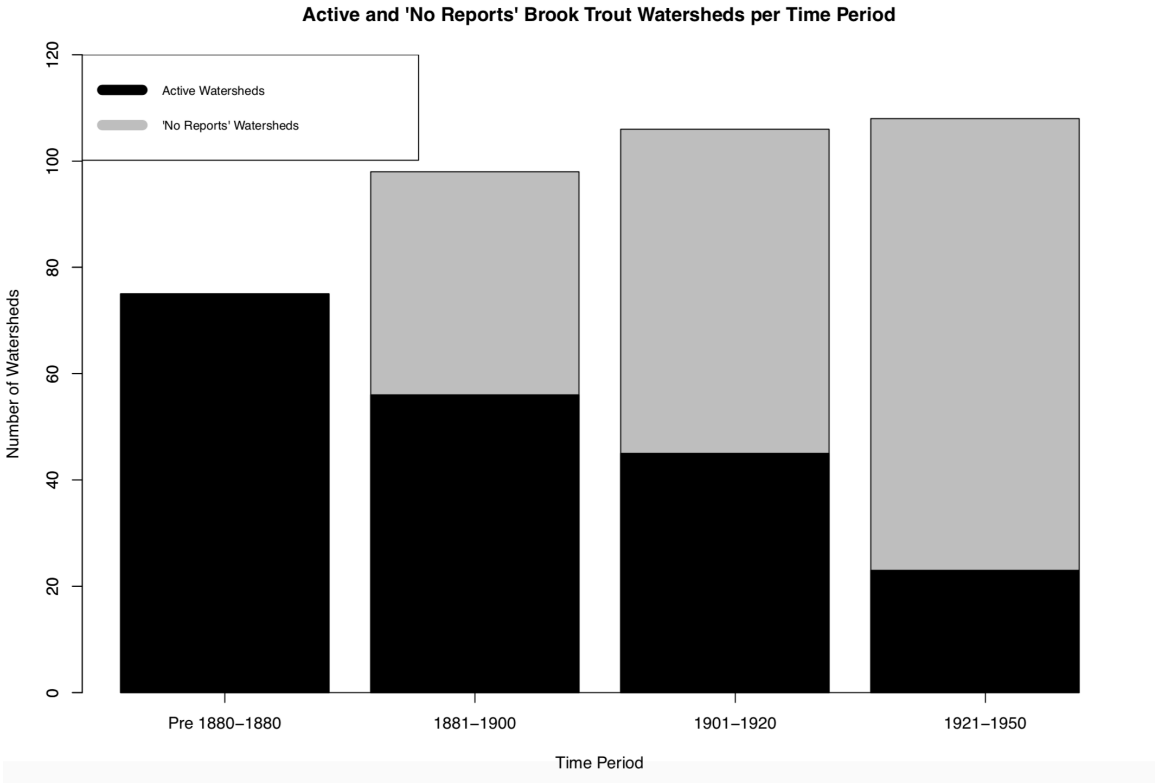

Figure 8: Changes in number of brook trout watersheds over time. "Active Watersheds" represents the number of watersheds for which there was at least one brook trout report. "No Reports" watershed category represents the number of watersheds for which there was a report in a previous time period, but no longer. Between the first and final time periods, the number of "Active Watersheds" decreased, while the number of "No Reports" watersheds increased.

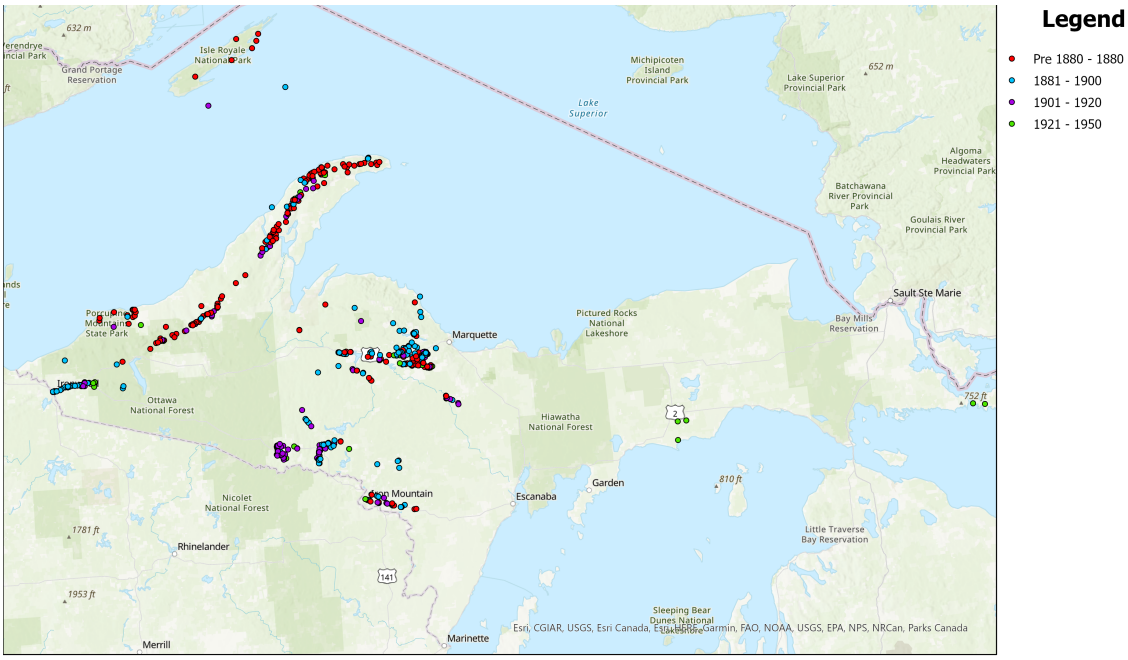

Figure 9: Map of Upper Michigan mine footprint. Mines are symbolized by color according to the time period that each mine was opened. Map displays all mines opened over the course of the study period (Pre 1880-1950). These mines did not all operate concurrently.

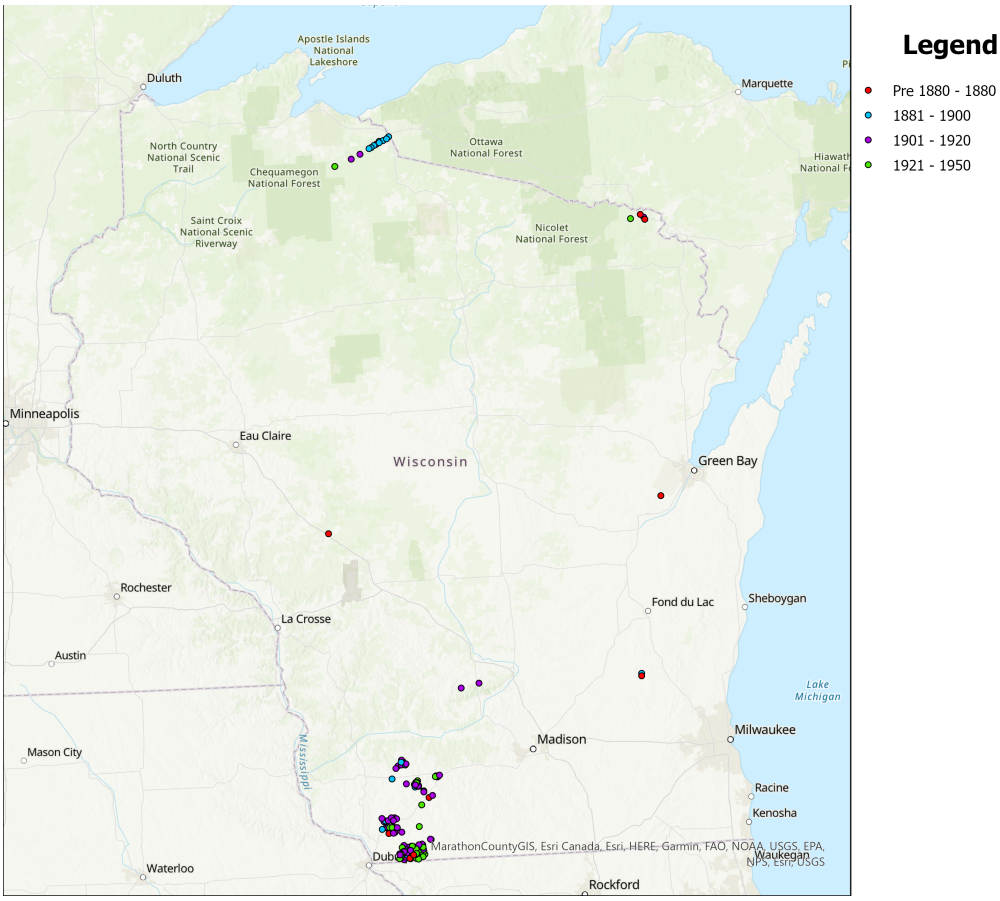

Figure 10: Map of Wisconsin mine footprint. Mines are symbolized by color according to the time period that each mine was opened. Map displays all mines opened over the course of the study period (Pre 1880-1950). These mines did not all operate concurrently.

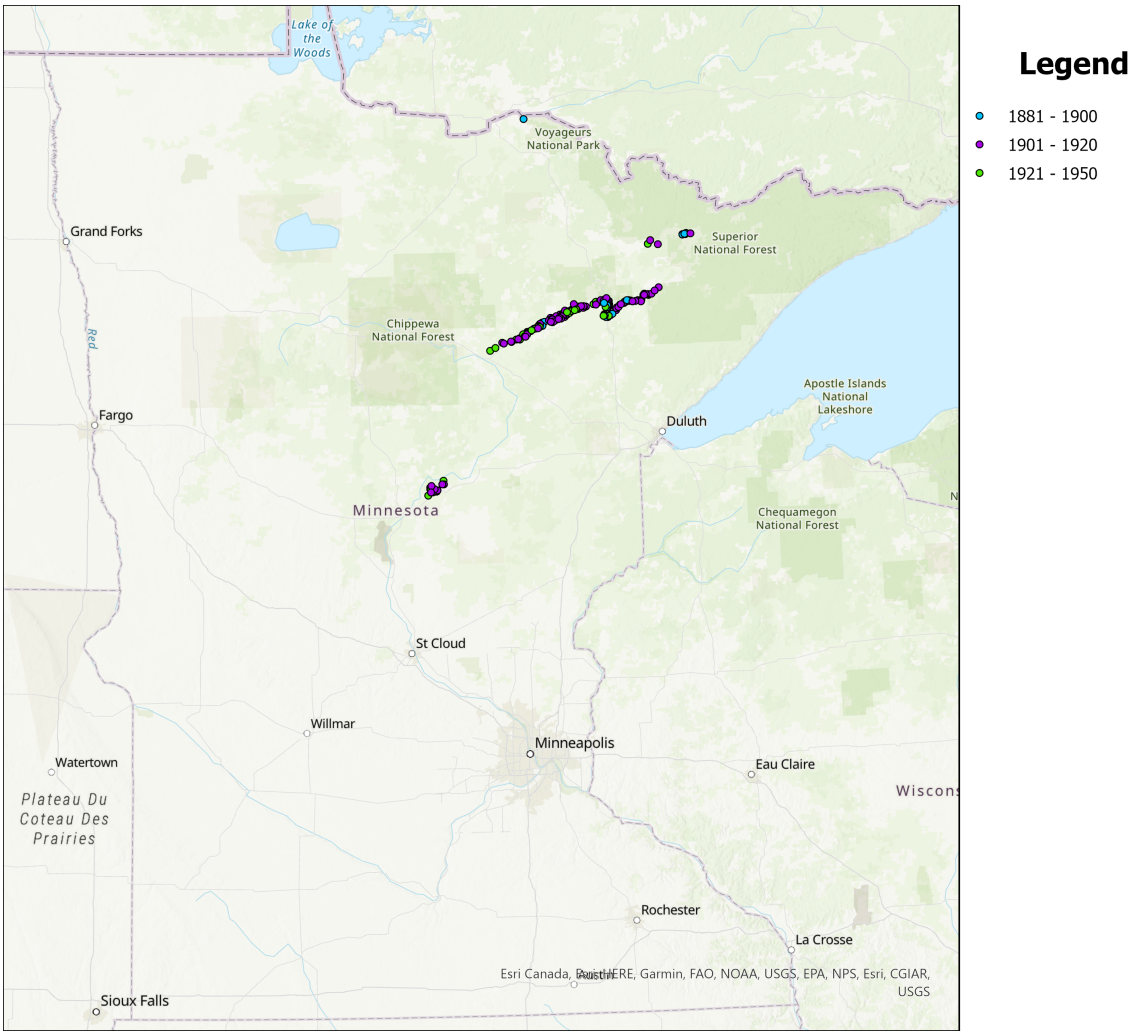

Figure 11: Map of Minnesota mine footprint. Mines are symbolized by color according to the time period that each mine was opened. Map displays all mines opened over the course of the study period (Pre 1880-1950). These mines did not all operate concurrently.

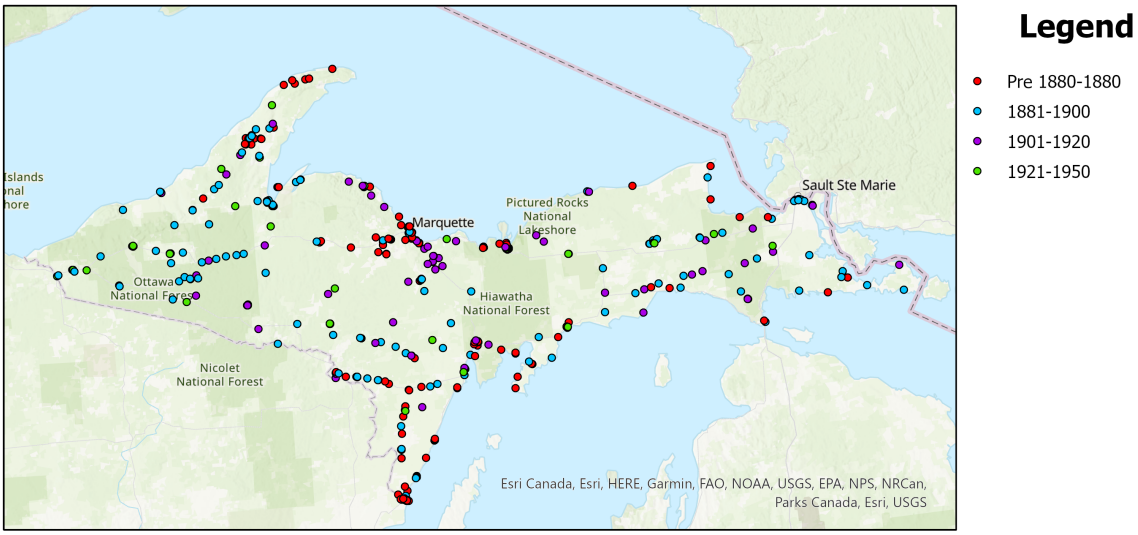

Figure 12: Map of Upper Michigan lumber mill footprint. Mills are symbolized by color according to the time period that each mill was opened. Map displays all mills opened over the course of the study period (Pre 1880-1950). These mills did not all operate concurrently.

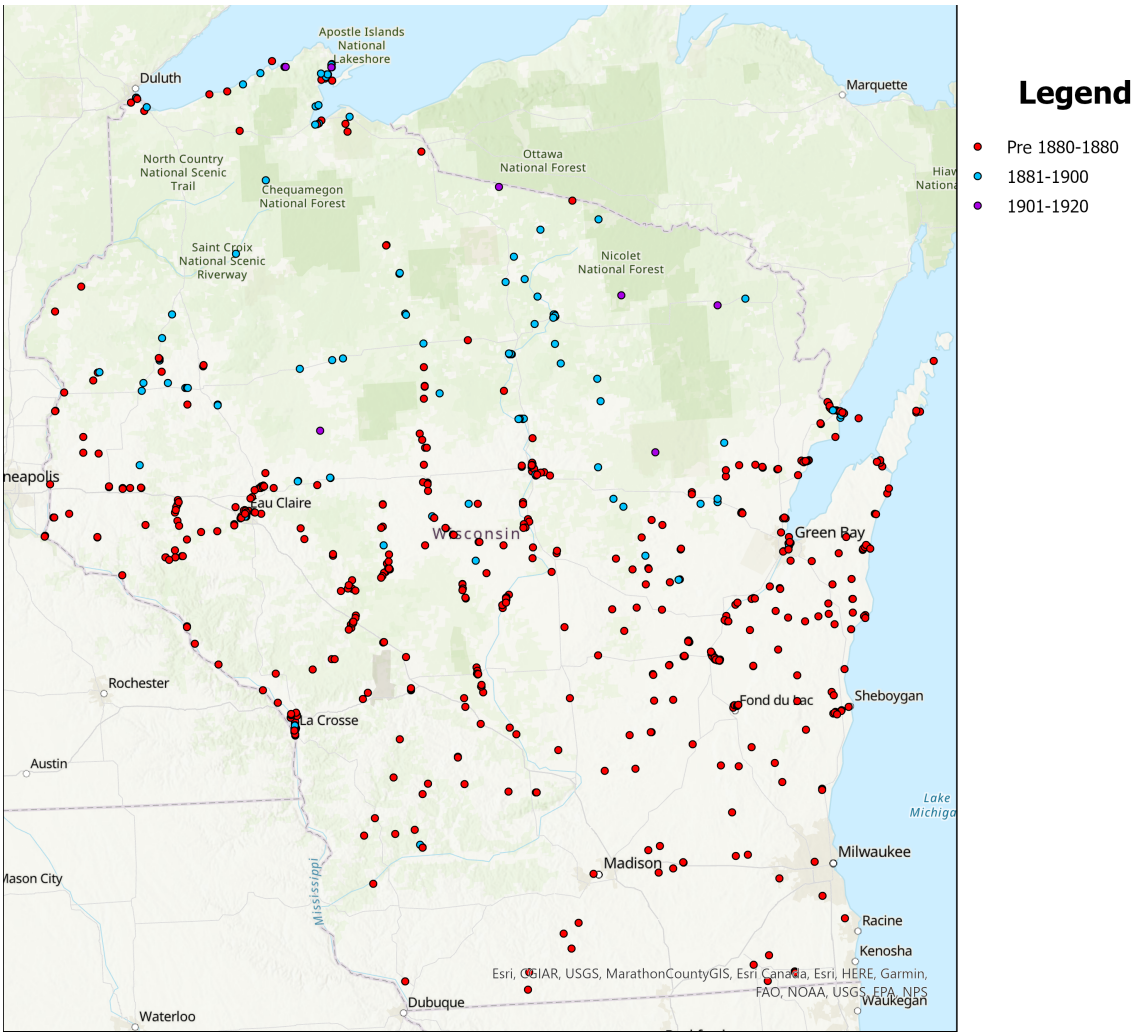

Figure 13: Map of Wisconsin lumber mill footprint. Mills are symbolized by color according to the time period that each mill was opened. Map displays all mills opened over the course of the study period (Pre 1880-1950). These mills did not all operate concurrently.

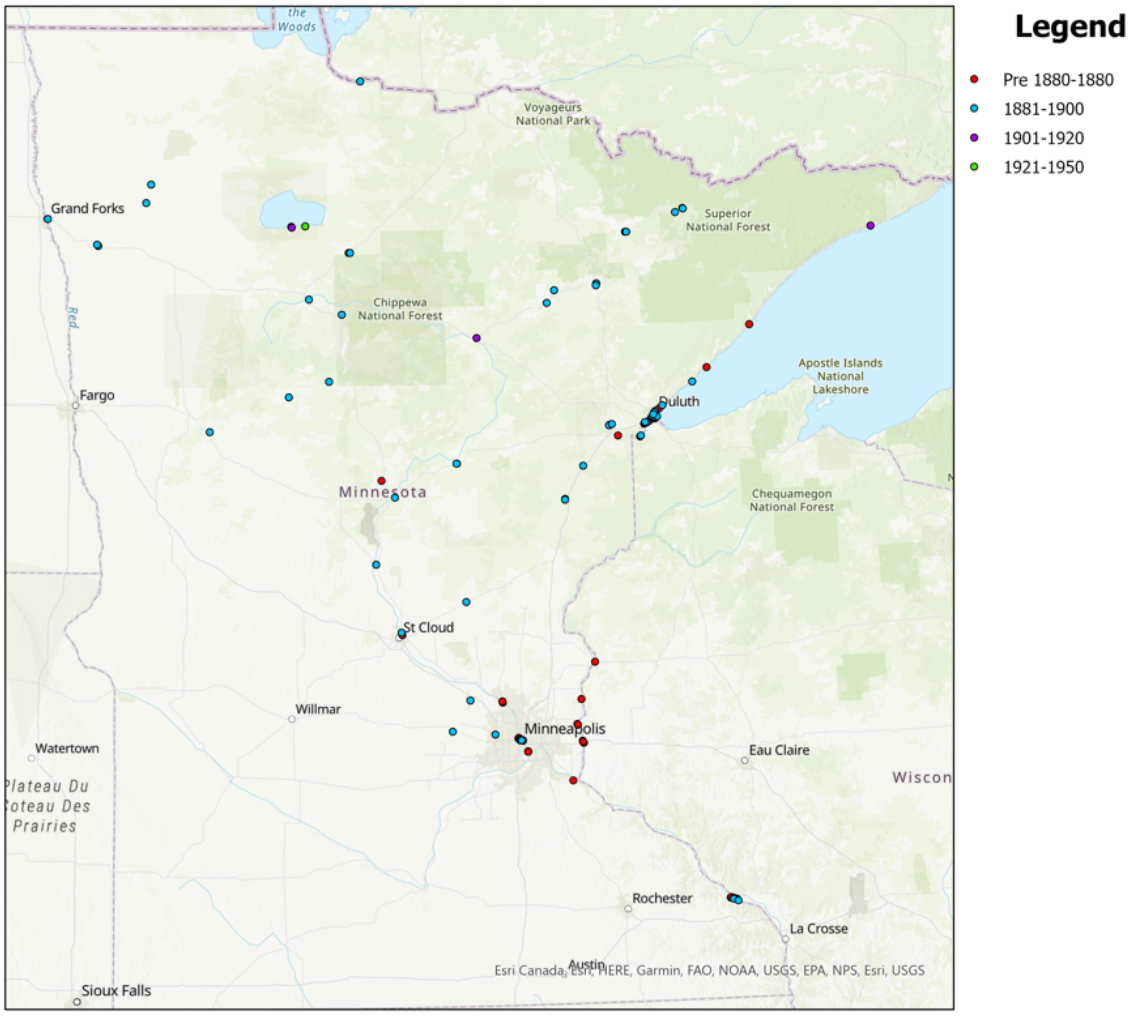

Figure 14: Map of Minnesota lumber mill footprint. Mills are symbolized by color according to the time period that each mill was opened. Map displays all mills opened over the course of the study period (Pre 1880-1950). These mills did not all operate concurrently.

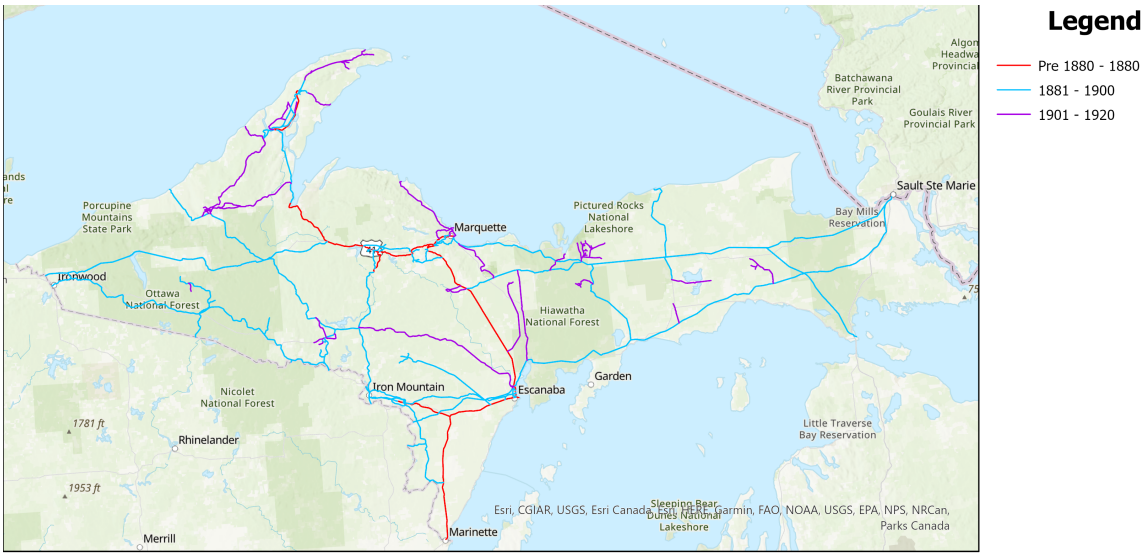

Figure 15: Map of Upper Michigan railroad footprint. Railroads are symbolized by color according to the time period that each rail line was established. Map displays cumulative railroads opened over the course of the study period (Pre 1880-1950).

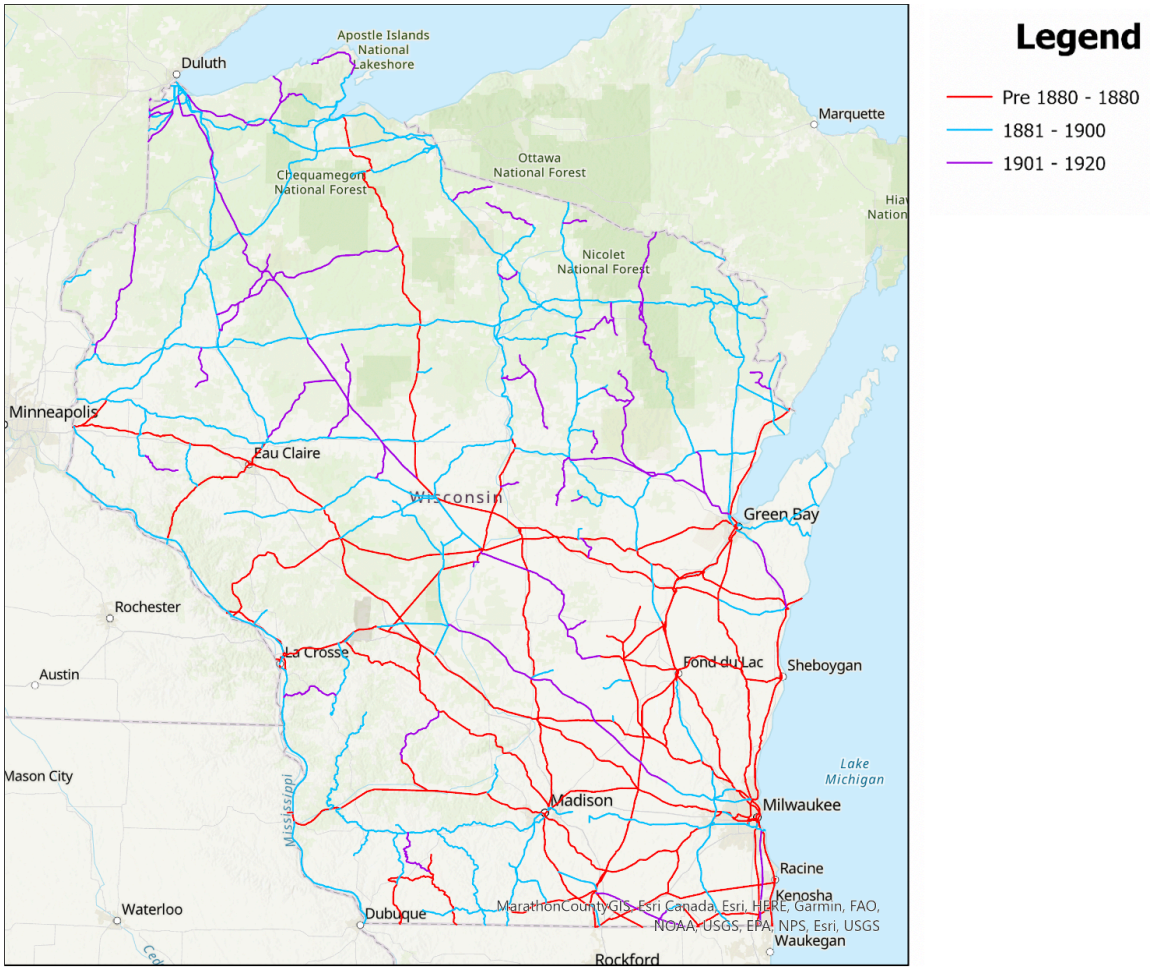

Figure 16: Map of Upper Wisconsin railroad footprint. Railroads are symbolized by color according to the time period that each rail line was established. Map displays cumulative railroads opened over the course of the study period (Pre 1880-1950).

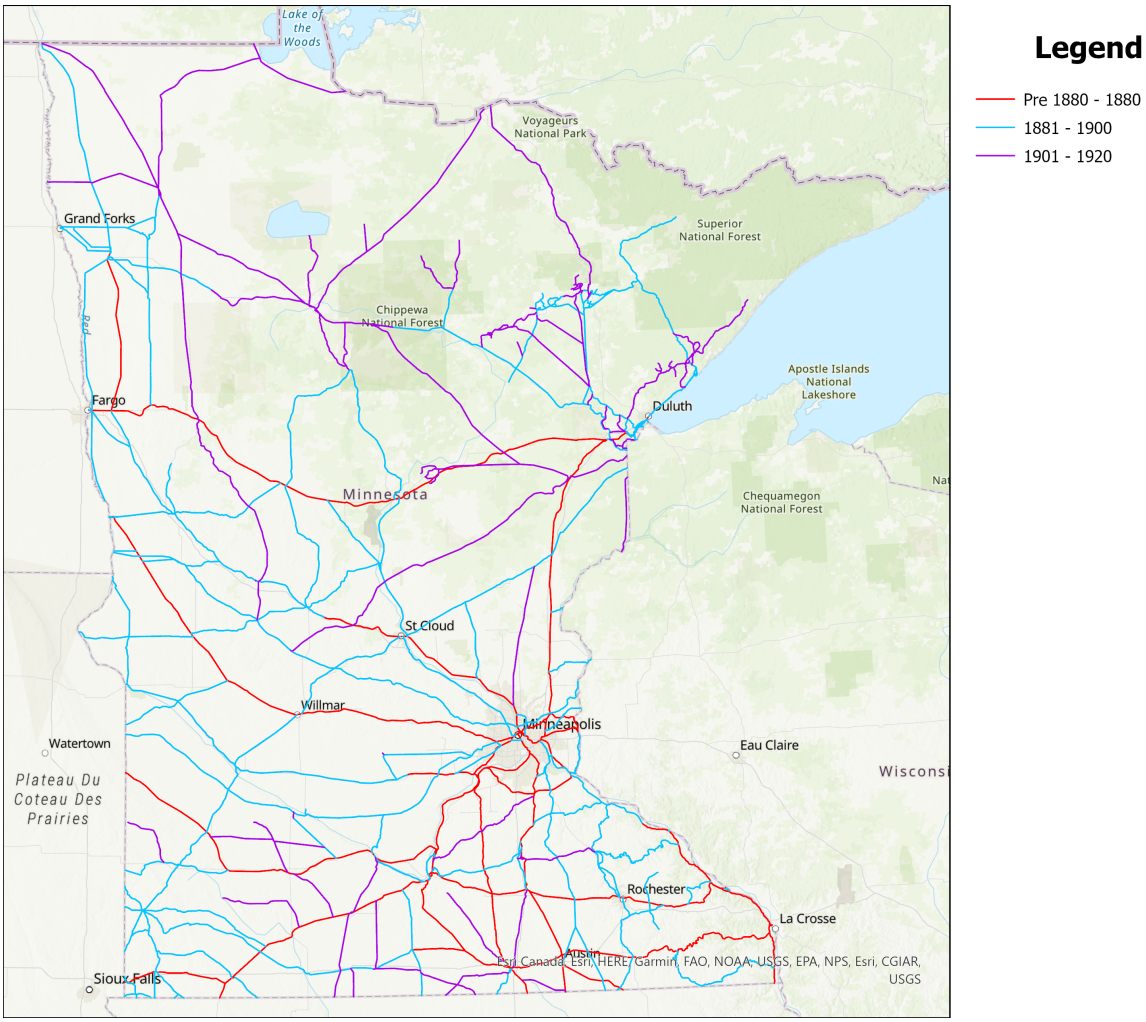

Figure 16: Map of Upper Wisconsin railroad footprint. Railroads are symbolized by color according to the time period that each rail line was established. Map displays cumulative railroads opened over the course of the study period (Pre 1880-1950).

6 Tables

Table 1: Descriptive table documenting instances of historic dynamite fishing in the Lake Superior region. Entries are sorted chronologically.

State	County	Location Details	Date	Source
MI	Chippewa County	Trout Lake	1891	Luce County Democrat, Oct. 17, 1891
MI	Gogebic County	Black River, Bessemer	1902	Minneapolis Journal, Aug. 6, 1902
MI	Houghton County	Pilgrim River	1903	Evening News, May 12, 1903
MI	Schoolcraft County	Indian Lake	1904	Evening News, Jul. 22, 1904
MI	Houghton County	Pilgrim River	1906	Duluth News-Tribune, May 18, 1906
MI	Alger County	Chatham	1907	St. Joseph Daily Press, Nov. 1, 1907
MI	Houghton County	Pilgrim River	1907	Duluth News-Tribune, Jun. 9, 1907
MI	Gogebic County	Montreal River	1908	Duluth News-Tribune, May 13, 1908
MI	Houghton County	Pilgrim River	1910	The Calumet News, Jul. 19, 1910
MI	Keweenaw County	Gratiot Lake	1910	The Calumet News, Aug. 30, 1910
MI	Houghton County	Boston Creek	1910	The Calumet News, Jun. 16, 1910
MI	Baraga County	L'Anse	1910	The L'Anse Sentinel, Jul. 16, 1910
MI	Houghton County	Pilgrim River	1911	Calumet News, Jul. 17, 1911
MN	Itasca County	Eastern Mesabi Range	1912	Duluth News-Tribune, Jun. 19, 1912
MI	Baraga County	Silver River	1913	The L'Anse Sentinel, Aug. 16, 1913
WI	Bayfield County	Iron River	1914	Duluth News-Tribune, Apr. 9, 1914
MI	Marquette County	Morgan Pond	1914	Evening News, Jun. 1, 1914
WI	Bayfield County	Pine Creek	1920	Duluth News-Tribune, Aug. 1, 1920
WI	Douglas County	Bois Brule River	1931	Ironwood Daily Globe, May 15, 1931
MI	Marquette County	Carp River	1936	The Herald-Press, Oct. 21, 1936
MI	Menominee County	Menominee River	1937	The Escanaba Daily Press, Sept. 9, 1937
MI	Marquette County	Chocolay River	1938	The Escanaba Daily Press, Apr. 9, 1938
MI	Gogebic County	Sand Island Creek	1947	Ironwood Daily Globe, Jul. 18, 1947
MI	Gogebic County	Black River, Bessemer	1947	Ironwood Daily Globe, Jul. 24, 1947

Table 2: Table of watersheds used to calculate principal component analysis. Each row represents a single watershed. The number of mines, lumber mills, and railroad density, along with the brook trout abundance category, is recorded for each of the 75 watersheds in the 'Pre 1880-1880' time period. The values of these variables are also recorded for the same 75 watersheds in the '1921-1950' time period to examine how the values of the variables within these watersheds changed over time. The data in this table were used in the Principal Component Analysis (Figure 5 & Figure 6).

State	County	Time Period	HUC12	Abundance Category	Sawmills	Rail Density (km/ km^2)	Mines
MN	Cook	Pre 1880-1880	040101010301	Present	0	0	0
MN	Cook	Pre 1880-1880	040101010302	Present	0	0	0
MN	Cook	Pre 1880-1880	040101010409	Present	0	0	0
MN	Cook	Pre 1880-1880	040101010503	Very Abundant	0	0	0
MN	Lake	Pre 1880-1880	040101011004	Present	0	0	0
MN	Lake	Pre 1880-1880	040101011305	Present	0	0	0
MN	Lake	Pre 1880-1880	040101011105	Present	0	0	0
MN	Lake	Pre 1880-1880	040101020502	Very Abundant	0	0	0
MN	Lake	Pre 1880-1880	040101020604	Very Abundant	0	0	0
MN	Lake	Pre 1880-1880	040101020301	Present	0	0	0
MN	St. Louis	Pre 1880-1880	040101020303	Present	0	0	0
MN	St. Louis	Pre 1880-1880	040101020401	Very Abundant	0	0	0
MN	St. Louis	Pre 1880-1880	040102011604	Abundant	13	0.083065932	0
MN	St. Louis	Pre 1880-1880	040102011603	Abundant	0	0.085727067	0
MN	St. Louis	Pre 1880-1880	040102011601	Abundant	0	0.063484702	0
WI	Douglas	Pre 1880-1880	040103010503	Abundant	1	0	0
WI	Douglas	Pre 1880-1880	040103010607	Abundant	0	0	0
WI	Douglas	Pre 1880-1880	040103010603	Abundant	0	0	0
WI	Douglas	Pre 1880-1880	040103010602	Abundant	0	0	0
WI	Douglas	Pre 1880-1880	040103010705	Very Abundant	1	0	0
WI	Bayfield	Pre 1880-1880	040103010806	Abundant	1	0	0
WI	Bayfield	Pre 1880-1880	040103010907	Present	0	0	0
WI	Bayfield	Pre 1880-1880	040103010906	Present	0	0	0
WI	Bayfield	Pre 1880-1880	040103010904	Abundant	1	0	0
WI	Bayfield	Pre 1880-1880	040103010903	Present	0	0	0
WI	Bayfield	Pre 1880-1880	040103010902	Present	0	0	0
WI	Bayfield	Pre 1880-1880	040103010901	Abundant	0	0	0
WI	Bayfield	Pre 1880-1880	040103011002	Abundant	0	0	0
WI	Bayfield	Pre 1880-1880	040103011003	Very Abundant	6	0	0

WI	Bayfield	Pre 1880-1880	040103011004	Abundant	1	0	0
WI	Bayfield	Pre 1880-1880	040103011007	Very Abundant	0	0	0
WI	Bayfield	Pre 1880-1880	040103011006	Very Abundant	0	0	0
WI	Bayfield	Pre 1880-1880	040103011008	Present	0	0	0
WI	Ashland	Pre 1880-1880	040103011105	Abundant	2	0.089629403	0
WI	Iron	Pre 1880-1880	040103020703	Present	0	0	0
WI	Iron	Pre 1880-1880	040103020109	Present	0	0	0
MI	Gogebic	Pre 1880-1880	040201010101	Present	0	0	0
MI	Ontonagon	Pre 1880-1880	040201010105	Very Abundant	0	0	2
MI	Houghton	Pre 1880-1880	040201030307	Present	8	0.034825543	16
MI	Houghton	Pre 1880-1880	040201030302	Very Abundant	0	0	2
MI	Houghton	Pre 1880-1880	040201030301	Present	0	0	3
MI	Houghton	Pre 1880-1880	040201030401	Present	0	0.02149805	3
MI	Keweenaw	Pre 1880-1880	040201030402	Present	0	0	1
MI	Keweenaw	Pre 1880-1880	040201030404	Present	2	0	9
MI	Keweenaw	Pre 1880-1880	040201030501	Present	2	0	13
MI	Keweenaw	Pre 1880-1880	040201030503	Present	0	0	2
MI	Keweenaw	Pre 1880-1880	040201030504	Present	0	0	0
MI	Baraga	Pre 1880-1880	040201050602	Very Abundant	2	0.129429359	1
MI	Baraga	Pre 1880-1880	040201050605	Present	0	0	0
MI	Baraga	Pre 1880-1880	040201050503	Present	0	0	0
MI	Marquette	Pre 1880-1880	040201050403	Present	0	0	0
MI	Marquette	Pre 1880-1880	040201050402	Present	0	0	0
MI	Marquette	Pre 1880-1880	040201050401	Abundant	0	0	0
MI	Marquette	Pre 1880-1880	040201050303	Abundant	1	0	1
MI	Marquette	Pre 1880-1880	040201050105	Present	0	0	0
MI	Marquette	Pre 1880-1880	040201050106	Abundant	1	0	0
MI	Marquette	Pre 1880-1880	040201050205	Abundant	1	0.093504966	0
MI	Marquette	Pre 1880-1880	040201050106	Abundant	7	0.219996424	0
MI	Marquette	Pre 1880-1880	040201050102	Abundant	8	0.1942948	1
MI	Marquette	Pre 1880-1880	040202010104	Abundant	3	0	0
MI	Marquette	Pre 1880-1880	040202010102	Abundant	0	0	0
MI	Marquette	Pre 1880-1880	040202010201	Present	0	0	0
MI	Alger	Pre 1880-1880	040202010204	Present	0	0	0
MI	Alger	Pre 1880-1880	040202010304	Present	3	0	0
MI	Alger	Pre 1880-1880	040202010502	Abundant	0	0	0
MI	Alger	Pre 1880-1880	040202010503	Abundant	0	0	0
MI	Alger	Pre 1880-1880	040202010504	Present	0	0	0

MI	Alger	Pre 1880-1880	040202010505	Present	0	0	0
MI	Alger	Pre 1880-1880	040202010506	Present	0	0	0
MI	Luce	Pre 1880-1880	040202010802	Present	0	0	0
MI	Chippewa	Pre 1880-1880	040202030103	Present	0	0	0
MI	Chippewa	Pre 1880-1880	040202030104	Present	1	0	0
MI	Chippewa	Pre 1880-1880	042000020203	Very Abundant	1	0	0
MI	Chippewa	Pre 1880-1880	042000020303	Very Abundant	1	0	0
MI	Isle Royale	Pre 1880-1880	041800000101	Present	0	0	3
MN	Cook	1921-1950	040101010301	No Reports	0	0	0
MN	Cook	1921-1950	040101010302	No Reports	0	0	0
MN	Cook	1921-1950	040101010409	No Reports	0	0	0
MN	Cook	1921-1950	040101010503	No Reports	1	0	0
MN	Lake	1921-1950	040101011004	No Reports	0	0	0
MN	Lake	1921-1950	040101011305	No Reports	0	0	0
MN	Lake	1921-1950	040101011105	No Reports	0	0.082447268	0
MN	Lake	1921-1950	040101020502	No Reports	0	0.050049717	0
MN	Lake	1921-1950	040101020604	No Reports	0	0.360134381	0
MN	Lake	1921-1950	040101020301	No Reports	0	0.27061645	0
MN	St. Louis	1921-1950	040101020303	No Reports	0	0.141905454	0
MN	St. Louis	1921-1950	040101020401	No Reports	0	0.052288669	0
MN	St. Louis	1921-1950	040102011604	No Reports	21	0.690867206	0
MN	St. Louis	1921-1950	040102011603	No Reports	7	0.466433278	0
MN	St. Louis	1921-1950	040102011601	No Reports	2	0.476989201	0
WI	Douglas	1921-1950	040103010503	No Reports	2	0.398559682	0
WI	Douglas	1921-1950	040103010607	No Reports	0	0.229370118	0
WI	Douglas	1921-1950	040103010603	No Reports	0	0.254687771	0
WI	Douglas	1921-1950	040103010602	No Reports	0	0.068142751	0
WI	Douglas	1921-1950	040103010705	Scarce	1	0	0
WI	Bayfield	1921-1950	040103010806	No Reports	1	0	0
WI	Bayfield	1921-1950	040103010907	Somewhat Abundant	1	0.225235498	0
WI	Bayfield	1921-1950	040103010906	Somewhat Abundant	1	0	0
WI	Bayfield	1921-1950	040103010904	No Reports	1	0.002428938	0
WI	Bayfield	1921-1950	040103010903	Present	2	0.00376566	0
WI	Bayfield	1921-1950	040103010902	No Reports	0	0.24084308	0
WI	Bayfield	1921-1950	040103010901	No Reports	0	0.078730248	0
WI	Bayfield	1921-1950	040103011002	No Reports	0	0.132224556	0
WI	Bayfield	1921-1950	040103011003	Present	12	0.256042989	0
WI	Bayfield	1921-1950	040103011004	No Reports	2	0.008769526	0

WI	Bayfield	1921-1950	040103011007	Somewhat Abundant	3	0.395764104	0
WI	Bayfield	1921-1950	040103011006	Somewhat Abundant	0	0.075025704	0
WI	Bayfield	1921-1950	040103011008	Present	0	0.161710695	0
WI	Ashland	1921-1950	040103011105	Abundant	4	0.426124686	0
WI	Iron	1921-1950	040103020703	No Reports	0	0.060448404	0
WI	Iron	1921-1950	040103020109	No Reports	0	0.111881406	0
MI	Gogebic	1921-1950	040201010101	No Reports	0	0	0
MI	Ontonagon	1921-1950	040201010105	No Reports	1	0	3
MI	Houghton	1921-1950	040201030307	No Reports	15	0.22108459	18
MI	Houghton	1921-1950	040201030302	Abundant	2	0.190598994	9
MI	Houghton	1921-1950	040201030301	No Reports	1	0.133785343	3
MI	Houghton	1921-1950	040201030401	No Reports	1	0.056189619	8
MI	Keweenaw	1921-1950	040201030402	No Reports	0	0.108972491	2
MI	Keweenaw	1921-1950	040201030404	No Reports	2	0.275141647	12
MI	Keweenaw	1921-1950	040201030501	No Reports	2	0.225166454	13
MI	Keweenaw	1921-1950	040201030503	No Reports	0	0.01981643	2
MI	Keweenaw	1921-1950	040201030504	No Reports	0	0.090747276	0
MI	Baraga	1921-1950	040201050602	No Reports	4	0.129429359	2
MI	Baraga	1921-1950	040201050605	No Reports	0	0	0
MI	Baraga	1921-1950	040201050503	No Reports	0	0	0
MI	Marquette	1921-1950	040201050403	No Reports	0	0	0
MI	Marquette	1921-1950	040201050402	No Reports	1	0	0
MI	Marquette	1921-1950	040201050401	Scarce	0	0	0
MI	Marquette	1921-1950	040201050303	No Reports	4	0.146391814	1
MI	Marquette	1921-1950	040201050105	No Reports	1	0.09186293	2
MI	Marquette	1921-1950	040201050106	No Reports	1	0.390007214	0
MI	Marquette	1921-1950	040201050205	Scarce	3	0.431266463	0
MI	Marquette	1921-1950	040201050106	No Reports	10	0.821740277	0
MI	Marquette	1921-1950	040201050102	No Reports	10	0.390098405	15
MI	Marquette	1921-1950	040202010104	No Reports	7	0.091044186	0
MI	Marquette	1921-1950	040202010102	No Reports	4	0.12490999	0
MI	Marquette	1921-1950	040202010201	No Reports	1	0.041671298	0
MI	Alger	1921-1950	040202010204	No Reports	0	0.094385596	0
MI	Alger	1921-1950	040202010304	Present	3	0.122869673	0
MI	Alger	1921-1950	040202010502	No Reports	5	0.443546342	0
MI	Alger	1921-1950	040202010503	No Reports	0	0.297589672	0
MI	Alger	1921-1950	040202010504	No Reports	0	0	0
MI	Alger	1921-1950	040202010505	No Reports	0	0	0
MI	Alger	1921-1950	040202010506	No Reports	0	0	0

MI	Luce	1921-1950	040202010802	No Reports	0	0	0
MI	Chippewa	1921-1950	040202030103	Present	0	0	0
MI	Chippewa	1921-1950	040202030104	No Reports	1	0	0
MI	Chippewa	1921-1950	042000020203	No Reports	4	0.066928836	0
MI	Chippewa	1921-1950	042000020303	No Reports	6	0.002576959	0
MI	Isle Royale	1921-1950	041800000101	Abundant	0	0	6

Table 3: Credence values of coaster brook trout abundances highlighted in 338 total reports distributed across the time period. The number and percentage of brook trout reports that fall into each category is shown, with 1 being the highest confidence that a report is describing coaster brook trout and 4 being the lowest confidence.

Time Period	Coaster Credence Value Count/Percent				Total Reports
	1	2	3	4	
Pre 1880-1880	36 (27.3%)	41 (31%)	28 (21.2%)	27 (20.5%)	132
1881-1900	32 (36.7%)	18 (20.7%)	31 (35.6%)	6 (7%)	87
1901-1920	26 (30%)	7 (8%)	20 (23%)	34 (39%)	87
1921-1950	13 (40.6%)	1 (3.1%)	6 (18.8%)	12 (37.5%)	32

Table 4: Number of watersheds in each category of brook trout abundance during each time period. These data correspond to the brook trout abundance maps in Figure 4. For each time period, the number of watersheds in each brook trout abundance category and the total number of watersheds containing brook trout reports for that time period. The "Total Reported Watersheds" row represents the number of watersheds with brook trout reports each time period. The "No Reports Watersheds" row represents the number of watersheds for which there are no reports but had brook trout reports in a previous time period.

Abundance Category	Time Period			
	Pre 1880-1880	1881-1900	1901-1920	1921-1950
Very Abundant	13	18	3	0
Abundant	23	24	14	2
Somewhat Abundant	0	9	7	10
Present	39	5	9	8
Somewhat Scarce	0	0	0	0
Scarce	0	0	12	3
Total Reported Watersheds	**75**	**56**	**45**	**23**
'No Reports' Watersheds	0	42	61	85
Total Watersheds	**75**	**98**	**106**	**108**

Table 5: Number of mines opened within each state in each time period. The total new mines are tallied across the states in each time period as is the cumulative total mines established through time.

Time Period	Mines Established by State per Time Period			Total Mines Established per Time Period	Cumulative Mines per Time Period
	MI (U.P.)	WI	MN		
Pre 1880-1880	247	18	0	265	265
1881-1900	217	35	32	284	549
1901-1920	145	94	119	358	907
1921-1950	45	50	47	142	**1049**
Cumulative Mines per State	**654**	**197**	**198**		

Table 6: Kilometers of historical railroad recorded for each state in each time period. These data are tallied as the total railroad length built in each time period and the cumulative total railroad length for each state and for each time period. Note: railroad lengths are rounded to the nearest km within a time period and state.

Time Period	Railroad (km) Established by State per Time Period			Total Railroad Built per Time Period	Cumulative Railroad per Time Period
	MI (U.P.)	WI	MN		
Pre 1880-1880	402	4474	3193	8069	8069
1881-1900	2009	5042	6299	13350	21419
1901-1920	751	2083	3535	6369	27788
1921-1950	0	0	0	0	**27788**
Cumulative Railroad by State	**3162**	**11599**	**13027**		

Table 7: Descriptive table of historical lumber mill data. The number of lumber mills established is recorded for each state in each time period, along with the total number of lumber mills established in each time period and the cumulative total mines established for each state and for each time period.

Time Period	Lumber Mills Established by State per Time Period			Total Mills Established per Time Period	Cumulative Mills per Time Period
	MI (U.P.)	WI	MN		
Pre 1880-1880	149	556	67	772	772
1881-1900	148	100	62	310	1082
1901-1920	75	8	4	87	1169
1921-1950	28	0	1	29	**1198**
Cumulative Mills per State	**400**	**664**	**134**		

Table 8: Principal component analysis loadings table. Table displays the loadings for each of the principal components along with the proportion of variance explained by each principal component and the cumulative variance.

Industrial Variable	Principal Component 1	Principal Component 2	Principal Component 3
Lumber Mills	0.6748888	-0.1006735	-0.7310198
Rail Density	0.6092224	-0.4829716	0.6289566
Mines	0.4163811	0.8698295	0.2646196
Proportion of Variance	0.5727	0.2973	0.13
Cumulative Variance	0.5727	0.87	1

Table 9: Descriptive table of watersheds used in the principal component analysis (Figure 5 & Figure 6). Table includes the location, HUC 12 code, and the unique ID code assigned to each watershed.

Code	State	County	HUC12
1	MN	Cook	040101010301
2	MN	Cook	040101010302
3	MN	Cook	040101010409
4	MN	Cook	040101010503
5	MN	Lake	040101011004
6	MN	Lake	040101011305
7	MN	Lake	040101011105
8	MN	Lake	040101020502
9	MN	Lake	040101020604
10	MN	Lake	040101020301
11	MN	St. Louis	040101020303
12	MN	St. Louis	040101020401
13	MN	St. Louis	040102011604
14	MN	St. Louis	040102011603
15	MN	St. Louis	040102011601
16	WI	Douglas	040103010503
17	WI	Douglas	040103010607
18	WI	Douglas	040103010603
19	WI	Douglas	040103010602
20	WI	Douglas	040103010705
21	WI	Bayfield	040103010806
22	WI	Bayfield	040103010907
23	WI	Bayfield	040103010906
24	WI	Bayfield	040103010904
25	WI	Bayfield	040103010903
26	WI	Bayfield	040103010902
27	WI	Bayfield	040103010901
28	WI	Bayfield	040103011002
29	WI	Bayfield	040103011003
30	WI	Bayfield	040103011004
31	WI	Bayfield	040103011007
32	WI	Bayfield	040103011006
33	WI	Bayfield	040103011008
34	WI	Ashland	040103011105

35	WI	Iron	040103020703
36	WI	Iron	040103020109
37	MI	Gogebic	040201010101
38	MI	Ontonagon	040201010105
39	MI	Houghton	040201030307
40	MI	Houghton	040201030302
41	MI	Houghton	040201030301
42	MI	Houghton	040201030401
43	MI	Keweenaw	040201030402
44	MI	Keweenaw	040201030404
45	MI	Keweenaw	040201030501
46	MI	Keweenaw	040201030503
47	MI	Keweenaw	040201030504
48	MI	Baraga	040201050602
49	MI	Baraga	040201050605
50	MI	Baraga	040201050503
51	MI	Marquette	040201050403
52	MI	Marquette	040201050402
53	MI	Marquette	040201050401
54	MI	Marquette	040201050303
55	MI	Marquette	040201050105
56	MI	Marquette	040201050106
57	MI	Marquette	040201050205
58	MI	Marquette	040201050106
59	MI	Marquette	040201050102
60	MI	Marquette	040202010104
61	MI	Marquette	040202010102
62	MI	Marquette	040202010201
63	MI	Alger	040202010204
64	MI	Alger	040202010304
65	MI	Alger	040202010502
66	MI	Alger	040202010503
67	MI	Alger	040202010504
68	MI	Alger	040202010505
69	MI	Alger	040202010506
70	MI	Luce	040202010802
71	MI	Chippewa	040202030103
72	MI	Chippewa	040202030104
73	MI	Chippewa	042000020203

74	MI	Chippewa	042000020303
75	MI	Isle Royal	041800000101

Table 10: Changes in abundance category for the 75 watersheds used in the principal component analysis. The 'Pre 1880-1880' column displays the quantity of watersheds in each abundance category for the 75 watersheds in the 'Pre 1880-1880' time period. The '1921-1950' column displays the abundance category distribution for the same 75 watersheds in the '1921-1950' time period

Abundance Category	Time Period	
	Pre 1880-1880	1921-1950
Very Abundant	13	0
Abundant	23	3
Somewhat Abundant	0	4
Present	39	6
Somewhat Scarce	0	0
Scarce	0	3
No Reports	0	59

Table 11: Changes in cumulative industrial variables for the 75 watersheds used in the principal component analysis. Table displays the cumulative number of lumber mills, mines, and kilometers of railroad found within the watersheds between time periods.

Industrial Variable	Cumulative Value per Time Period	
	Pre 1880-1880	1921-1950
Lumber Mills	67	150
Mines	61	96
Railroads (km)	88.2	871.2

Table 12: Expansion of industrial variables across the 75 watersheds used in the principal component analysis. Table displays the number of watersheds in each time period that contain at least one lumber mill, one mine, or any length of railroad.

Industrial Variable	Number of Watersheds per Time Period	
	Pre 1880-1880	1921-1950
Lumber Mills	22	38
Mines	13	14
Railroad	10	52

Table 13: Descriptive table of potential coaster brook trout restoration target streams. These streams are found in watersheds with low quantities of industrial variables and high coaster credence values. Values represent the total cumulative lumber mills, mines and rail density in each watershed in the final time period (1921-1950). Coaster credence values range from 1 to 4, with 1 being the highest confidence and 4 being the lowest confidence.

Waterbody	HUC 12	State	County	Lumber Mills	Mines	Rail Density (km/ km^2)	Coaster Credence Value
Brule River	040101010409	MN	Cook	0	0	0	1
Salmon Trout River	040201050401	MI	Marquette	0	0	0	1
Bois Brule River	040103010705	WI	Douglas	1	0	0	1
Sand River	040103010901	WI	Bayfield	0	0	0.07915722	2
Lester River	040101020404	MN	St. Louis	0	0	0.07944989	2
Baptism River	040101011105	MN	Lake	0	0	0.082447268	2
Miner's River	040202010503	MI	Alger	0	0	0.297589672	2
Iron River	040103010806	WI	Bayfield	1	0	0	2
Cranberry River	040103010906	WI	Bayfield	1	0	0	2
Streams near Chicago Bay	040101010304	MN	Cook	0	0	0	3
Flute Reed River	040101010303	MN	Cook	0	0	0	3
Devil Track River	040101010503	MN	Cook	1	0	0	2
Poplar River	040101010705	MN	Cook	0	0	0	3
Temperance River	040101010805	MN	Cook	0	0	0	3
Cranberry River	040103010906	WI	Bayfield	1	0	0	2
Silver River	040201050605	MI	Baraga	0	0	0	3
French River	040101020401	MN	St. Louis	0	0	0.06195827	3
Manitou River	040101011004	MN	Lake	0	0	0	4
Little Marais River	040101011305	MN	Lake	0	0	0	4
Pilgrim River	040201030302	MI	Houghton	1	8	0.19059906	1

7 Appendix

7.1 Appendix Tables

Appendix Table 1: Descriptive table of brook trout reports from the 'Pre 1880-1880' time period. Table records the location and date of the report, along with the source. Also included is a "Coaster Credence Value," which is used to display the likelihood that the observation is describing coasters rather than stream-resident brook trout. The values range from 1-4, with 1 representing the highest degree of confidence and 4 representing the lowest confidence.

State	County	Location Details	Date	Coaster Credence Value	Source
MI	Chippewa County	St. Mary's River	1827	1	McKenney (1827) "Sketches of a Tour to the Lakes" page 193
WI	Douglas County	Bois Brule River	1831	1	O'Donnell (1944) "A History of Fishing in the Brule River"
MI	Chippewa County	Sault St. Marie (St. Mary's River)	1846	1	New-York Daily Tribune, Aug. 5, 1846
MI	Chippewa County	St. Mary's River	1846	1	Lake Superior News and Miners' Journal, Oct. 24, 1846
WI	Douglas County	Bois Brule River	1846	1	O'Donnell (1944) "A History of Fishing in the Brule River"
MI	Chippewa County	Sault Ste. Marie (Saint Mary's River)	1847	1	Pontiac Jacksonian, Aug. 4, 1847
MI	Marquette County	Salmon Trout River	1849	1	George Shiras, 3rd (1935). "Hunting Wild Life With Camera and Flashlight"
MI	Chippewa County	Sault Ste. Marie	1850	1	Wisconsin Tribune, Jul. 26, 1850

MI	Chippewa County	St. Mary’s River	1850	1	William Henry Herbert (1850) "Supplement to Frank Forester's Fish and Fishing of the United States and British Provinces of North America"
MI	Chippewa County	Sault Ste. Marie (Saint Mary’s River)	1853	1	Pontiac Gazette, Aug. 27, 1853
MI	Marquette County	Marquette (Lake Superior)	1856	1	Mining Journal, Jul. 26, 1856
MI	Marquette County	Chocolay River	1857	3	Mining Journal, Nov. 14, 1857
MI	Marquette County	Carp River	1857	3	Mining Journal, Nov. 14, 1857
MI	Marquette County	Dead River	1857	3	Mining Journal, Nov. 14, 1857
MI	Ontonagon County	Union River	1858	3	Lake Superior Miner, Jul. 17, 1858
MI	Marquette County	Carp River	1860	2	The Press and Tribune, Jul. 26, 1860
MI	Marquette County	Streams around Marquette	1860	1	Detroit Free Press, Aug. 3, 1860
WI	Bayfield County	Bayfield	1863	2	The Weekly Pioneer and Democrat, Aug. 28, 1863
WI	Bayfield County	Bayfield	1865	2	R. B. Roosevelt (1865) "Superior Fishing"
MI	Marquette County	Salmon Trout River	1865	1	R. B. Roosevelt (1865) "Superior Fishing"
MI	Marquette County	Yellow Dog River	1865	2	R. B. Roosevelt (1865) "Superior Fishing"

MI	Marquette County	Dead River	1865	2	R. B. Roosevelt (1865) "Superior Fishing"
MI	Marquette County	Marquette	1865	1	R. B. Roosevelt (1865) "Superior Fishing"
MI	Marquette County	Marquette	1866	1	The Manitowoc Pilot, Jul. 27, 1866
MI	Alger County	Grand Island	1866	1	H. B. Small (1866) "The Canadian Handbook and Tourists' Guide" pg. 144
WI	Ashland County	Apostle Islands	1866	2	H. B. Small (1866) "The Canadian Handbook and Tourists' Guide" pg. 144
MI	Alger County	Chapel Beach	1867	1	Vogel (1999) "Historical Study of Fish and Fisheries in Pictured Rocks National Lakeshore"
MN	Lake County	Split Rock River	1868	2	The St. Cloud Journal Sept. 10, 1868
MN	St. Louis County	Duluth	1869	1	The National Republican, Jul. 10, 1869
MN	St. Louis County	French River	1869	3	Duluth Minnesotian, Jul. 3, 1869
WI	Bayfield County	Whittlesey Creek	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Bayfield County	Bono Creek	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Bayfield County	Thompson Creek	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html

WI	Bayfield County	Sioux River	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Bayfield County	Onion River	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Bayfield County	Pike's Creek/Birch Run	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Bayfield County	Chicago Creek/Red Cliff Creek	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Bayfield County	Raspberry River (Raspberry Bay)	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Bayfield County	Sand River (Near Sand Bay)	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Bayfield County	Saxine Creek	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Bayfield County	Siskiwit River	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Bayfield County	Lost Creek (in Siskiwit Bay)/Bark River	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Bayfield County	Cranberry River	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html

WI	Bayfield County	Flag River	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Bayfield County	Iron River (below Orienta Falls)	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
WI	Douglas County	Bois Brule River	1870	2	WI DNR Map https://dnr.wisconsin.gov/topic/Fishing/lakesuperior/cbrktrout.html
MI	Chippewa County	Sault St Marie	1871	1	Chicago Tribune, Jul. 27, 1871
WI	Bayfield County	Bayfield	1871	3	Watertown Republican, Mar. 22, 1871
MI	Houghton County	Pilgrim River	1871	2	Duluth Minnesotian, Jul. 8, 1871
MI	Marquette County		1872	2	Chicago Tribune, Mar. 26, 1872
MI	Marquette County	Lake Superior (Within 50 miles of Marquette)	1872	1	Forest and Stream v. 1, 1873-1874 (page 107 in book, 117 in pdf)
MI	Houghton County	Pilgrim River	1872	2	Duluth Minnesotian, Aug. 3, 1872
WI	Bayfield County	Sioux River	1872	2	Duluth Minnesotian, Jul. 27, 1872
MI	Houghton County	Pilgrim River	1872	2	Duluth Minnesotian, Jul. 6, 1872
MI	Baraga County	Falls River	1873	3	Wisconsin State Journal, Jul. 31, 1873
MI	Marquette County	Lake Superior 30 miles NW of Marquette	1873	1	Wisconsin State Journal, Jul. 31, 1873

WI	Bayfield County	Bayfield (stream near Bayfield)	1874	2	The New York Herald, May 16, 1874
MI	Marquette County	Marquette	1874	2	Chicago Daily Tribune, Jul. 12, 1874
WI	Douglas County	Bois Brule River	1874	1	O'Donnell (1944) "A History of Fishing in the Brule River"
WI	Douglas County	Bois Brule River	1874	1	The Superior Times, Aug. 8, 1874
WI	Bayfield County	Sand River (Near Sand Bay)	1874	2	The Superior Times, Aug. 8, 1874
WI	Bayfield County	Sand River (Near Sand Bay)	1874	1	Duluth Minnesotian, Aug. 8, 1874
WI	Bayfield County	Raspberry River (Raspberry Bay)	1874	3	The Superior Times, Aug. 8, 1874
WI	Bayfield County	Pike's Creek (Bayfield)	1874	3	The Superior Times, Aug. 8, 1874
WI	Bayfield County	Sioux River	1874	3	The Superior Times, Aug. 8, 1874
WI	Bayfield County	Onion River	1874	3	The Superior Times, Aug. 8, 1874
WI	Bayfield County	Fish Creek (Near Ashland, Chequamegon Bay)	1874	3	The Superior Times, Aug. 8, 1874
WI	Bayfield County	Lake Superior Shoreline - Bark Point through Ashland Bay (Chequamego n Bay)	1874	1	The Superior Times, Aug. 8, 1874
WI	Bayfield County	Apostle Islands	1874	1	The Superior Times, Aug. 8, 1874

WI	Bayfield County	Tributaries from Bark Point to Siskiwit Bay	1874	2	The Superior Times, Aug. 8, 1874
WI	Douglas County	Amnicon River (Shore of Lake Superior east of Superior WI)	1874	3	The Superior Times, Feb. 7, 1874
MI	Douglas County	St. Louis River	1874	3	The Superior Times, Feb. 7, 1874
WI	Douglas County	Middle River (Shore of Lake Superior east of Superior WI)	1874	3	The Superior Times, Feb. 7, 1874
WI	Douglas County	Nemadji River	1874	3	The Superior Times, Feb. 7, 1874
WI	Douglas County	Bois Brule River	1874	3	The Superior Times, Feb. 7, 1874
WI	Douglas County	Poplar River (Directly east of Middle River)	1874	3	The Superior Times, Feb. 7, 1874
MI	Alger County	Grand Island	1874	1	John Disturnell (1874) "Sailing on the Great Lakes and Rivers of America" pg. 202
WI	Bayfield County	Bark Point waters (Lake Superior)	1874	2	John Disturnell (1874) "Lake Superior Guide" pg. 28
WI	Bayfield County	Bark Point surrounding streams	1874	2	John Disturnell (1874) "Lake Superior Guide" pg. 28
MI	Chippewa County	St. Mary's River	1874	2	John Disturnell (1874) "Sailing on the Great Lakes and Rivers of America" pg. 79

MI	Alger County	Anna River	1874	2	John Disturnell (1874) "Sailing on the Great Lakes and Rivers of America" pg. 202
MI	Alger County	Miners River	1874	2	John Disturnell (1874) "Sailing on the Great Lakes and Rivers of America" pg. 202
MI	Chippewa County	Sault St. Marie	1875	1	National Republican, Aug. 18, 1875
WI	Douglas County	Bois Brule River	1875	1	The Superior Times, Feb. 20, 1875
WI	Douglas County	Amnicon River	1875	3	The Superior Times, Feb. 20, 1875
WI	Bayfield County	Iron River	1875	3	The Superior Times, Feb. 20, 1875
WI	Ashland County	Ashland	1877	3	The Superior Times, Sept. 10, 1877
WI	Bayfield County	Bayfield Streams	1877	1	Bayfield County Press (In Newman & DuBois 1996, "Status of Brook Trout in Lake Superior")
WI	Bayfield County	Bayfield Shoreline Lake Superior	1877	1	Bayfield County Press (In Newman & DuBois 1996, "Status of Brook Trout in Lake Superior")
WI	Douglas County	Bois Brule River	1877	1	O'Donnell (1944) "A History of Fishing in the Brule River"
MN	Lake County	Stewart River	1877	3	Duluth Weekly Tribune, Jul. 20, 1877
MN	Cook County	Devils Track River	1877	3	Duluth Minnesotian-Herald, Sept. 1, 1877
WI	Douglas County	Bois Brule River	1878	1	O'Donnell (1944) "A History of Fishing in the Brule River"

WI	Douglas County	Bois Brule River	1880	1	O'Donnell (1944) "A History of Fishing in the Brule River"
MI	Marquette County	Salmon Trout River	1880	1	George Shiras, 3rd (1935). "Hunting Wild Life With Camera and Flashlight"
MN	Lake County	Baptism River	1880	2	Forest and Stream v. 15, 1880-1881 (page 131 in book, 139 in pdf)
MI	Marquette County	Pine River	Pre 1880	3	Carl L. Hubbs (1929) The Book of Huron Mountain, "The Fishes"
MI	Alger County	Hurricane River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Chippewa County	Pendill's Creek	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Chippewa County	Halfaday Creek	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Alger County	Au Train River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Luce County	Little Two Hearted River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Alger County	Sevenmile Creek	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Alger County	Mosquito River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Alger County	Rock River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Alger County	Sand River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Marquette County	Campeau Creek	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Marquette County	Big Garlic River	Pre 1880	4	Newman, DuBois & Halpern 2003

MI	Keweenaw County	Gratiot River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Keweenaw County	Montreal River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Keweenaw County	Traverse River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Keweenaw County	Tobacco River	Pre 1880	3	Newman, DuBois & Halpern 2003
MI	Houghton County	Schlot Creek	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Houghton County	Boston Creek	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Marquette County	Little Huron River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Marquette County	Big Huron River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Baraga County	Silver River	Pre 1880	3	Newman, DuBois & Halpern 2003
MI	Keweenaw County	Eagle River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Gogebic County	Omans Creek	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Gogebic County	Montreal River	Pre 1880	4	Newman, DuBois & Halpern 2003
MI	Houghton County	Sevenmile Creek	Pre 1880	4	Newman, DuBois & Halpern 2003
WI	Iron County	Graveyard Creek	Pre 1880	4	Newman, DuBois & Halpern 2003
WI	Bayfield County	Birch Run	Pre 1880	4	Newman, DuBois & Halpern 2003

WI	Bayfield County	Bark River	Pre 1880	4	Newman, DuBois & Halpern 2003
MN	Lake County	Knife River	Pre 1880	3	Newman, DuBois & Halpern 2003
MN	Lake County	Split Rock River	Pre 1880	2	Newman, DuBois & Halpern 2003
MN	Lake County	Baptism River	Pre 1880	2	Newman, DuBois & Halpern 2003
MN	Lake County	Little Marais River	Pre 1880	4	Newman, DuBois & Halpern 2003
MN	Lake County	Manitou River	Pre 1880	4	Newman, DuBois & Halpern 2003
MN	Cook County	Brule River	Pre 1880	1	Newman, DuBois & Halpern 2003
MN	Cook County	Reservation River	Pre 1880	3	Newman, DuBois & Halpern 2003
MN	Cook County	Hollow Rock Creek	Pre 1880	2	Newman, DuBois & Halpern 2003

Appendix Table 2: Descriptive table of brook trout reports from the '1881-1900' time period. Table records the location and date of the report, along with the source. Also included is a "Coaster Credence Value," which is used to display the likelihood that the observation is describing coasters rather than stream-resident brook trout. The values range from 1-4, with 1 representing the highest degree of confidence and 4 representing the lowest confidence.

State	County	Location Details	Date	Coaster Credence Value	Source
WI	Ashland County/Bayfield County	Streams around Ashland	1881	3	The Inter Ocean, Aug. 1, 1881
WI	Douglas County	Superior	1881	4	The Superior Times, May 21, 1881
WI	Bayfield County	Bayfield shoreline, Lake Superior	1881	1	Daily Globe, Jun. 14, 1881
WI	Bayfield County	Pike's Creek (Bayfield)	1881	3	Daily Globe, Jun. 14, 1881
MN	St. Louis County	French River	1881	3	Duluth News-Tribune, May 27, 1881
MN	St. Louis County	French River	1882	3	Duluth News-Tribune, Jun. 14, 1882
MN	Lake County	Knife River	1882	3	Duluth News-Tribune, Jul. 18, 1882
MN	Lake County	Knife River	1882	3	Duluth News-Tribune, Jun. 9, 1882
MN	St. Louis County	Sucker River	1882	3	Duluth News-Tribune, Jun. 9, 1882
WI	Douglas County	Superior	1883	3	The Superior Times, Aug. 25, 1883

WI	Douglas County	Superior	1883	3	The Superior Times, Jun. 23, 1883
MN	St. Louis County	Lester River	1884	3	Duluth Weekly Tribune, Jul. 18, 1884
WI	Douglas County	Bois Brule River	1884	1	O'Donnell (1944) "A History of Fishing in the Brule River"
WI	Bayfield County	Flag River	1884	2	The Superior Times, Aug. 16, 1884
WI	Bayfield County	Flag River	1884	2	Duluth Weekly Tribune, Aug. 15, 1884
WI	Douglas County	Bois Brule River	1885	1	O'Donnell (1944) "A History of Fishing in the Brule River"
WI	Douglas County	Bois Brule River	1885	1	O'Donnell (1944) "A History of Fishing in the Brule River"
WI	Douglas County	Bois Brule River	1885	1	Star Tribune, Mar. 30, 1933
MN	Lake County	Split Rock River	1885	3	Duluth News-Tribune, Mar. 26, 1886
WI	Ashland County	Madeline Island	1886	1	New Ulm Weekly Review, Aug. 4, 1886
WI	Bayfield County	Streams around Bayfield	1886	2	New Ulm Weekly Review, Aug. 4, 1886
MN	Cook County	Brule River	1886	1	St. Paul Daily Globe, Jun. 7, 1886
MN	St. Louis County	Chester Creek	1887	4	Duluth Daily News, Sept. 21, 1887
MI	Chippewa County	Sault Ste. Marie	1887	1	The Sun, Oct. 9, 1887

WI	Bayfield County	Sioux River	1887	3	St. Paul Daily Globe, Jun. 4, 1887
MI	Luce County	Two Hearted River	1887	3	Newberry News, Jul. 14, 1887
MI	Isle Royale	Washington Harbor	1887	1	Duluth Daily News, Sept. 21, 1887
MI	Marquette County	Salmon Trout River	1887	1	Pontiac Gazette, Sept. 16, 1887
MN	St. Louis County	Rice's Point Creek	1887	2	Duluth Daily News, Sept. 21, 1887
MN	Lake County	Knife River	1887	2	Duluth Daily News, Sept. 21, 1887
MN	St. Louis County	Lester River	1887	2	Duluth Daily News, Sept. 21, 1887
WI	Bayfield County	Iron River	1887	2	Duluth Daily News, Sept. 21, 1887
MN	Cook County	Devils Track River	1887	2	Duluth Daily News, Sept. 21, 1887
MN	St. Louis County	Sucker River	1887	2	Duluth Daily News, Sept. 21, 1887
WI	Bayfield County	Onion River	1887	2	Duluth Daily News, Sept. 21, 1887
MN	Lake County	Stewart River	1887	2	Duluth Daily News, Sept. 21, 1887
WI	Ashland County	Manitou Island	1887	1	Duluth Weekly Tribune, Jun. 17, 1887

WI	Douglas County	Bois Brule River	1887	1	Duluth Weekly Tribune, Jun. 17, 1887
WI	Douglas County	Middle River	1888	3	The Superior Times, Jun. 23, 1888
MI	Ontonagon County	Ontonagon River	1889	2	Detroit Free Press, Jan. 9, 1889
WI	Douglas County	Bois Brule River	1889	1	The Appeal, Jun. 29, 1889
MI	Marquette County	Salmon Trout River	1890	1	The Book of Huron Mountain, "The Fishes" by Carl L. Hubbs (1929)
MI	Baraga County	Keweenaw Bay	1891	1	The L'Anse Sentinel, May 30, 1891
MI	Chippewa County	St. Mary's River	1891	1	Sault Ste. Marie News, May 23, 1891
MI	Alger County	Anna River	1891	3	Detroit Free Press, Apr. 12, 1891
WI	Douglas County	Bois Brule River	1892	1	The Appeal, Jun. 4, 1892
MI	Baraga County	Silver River	1893	3	The L'Anse Sentinel, Jul. 29, 1893
MI	Chippewa County	St. Mary's River	1893	3	Milford Times, Jul 1., 1893
WI	Douglas County	Bois Brule River	1893	1	O'Donnell (1944) "A History of Fishing in the Brule River"
MN	Cook County	Temperance River	1893	3	The Cook County Herald, Aug. 19, 1893
MN	Lake County	Knife River	1893	3	Duluth News-Tribune, Aug. 20, 1893

MI	Marquette County	Cherry Creek	1893	2	Newberry News, Jun. 2, 1893
MI	Isle Royale	Lake Superior	1893	1	Duluth News-Tribune, May 29, 1893
MI	Isle Royale	Isle Royale	1893	1	Duluth News-Tribune, Aug. 9, 1893
WI	Douglas County	Bois Brule River	1894	1	O'Donnell (1944) "A History of Fishing in the Brule River"
MI	Chippewa County	St. Mary's River	1894	1	Sault Ste. Marie News, Jul. 28, 1894
MI	Chippewa County	Waiska River	1894	2	Sault Ste. Marie News, Jul. 28, 1894
MN	Lake County	Knife River	1894	3	Duluth News-Tribune, Jan. 1, 1894
MN	St. Louis County	Streams from Duluth to Two Harbors	1894	2	Duluth News-Tribune, Jul. 29, 1894
WI	Douglas County	Bois Brule River	1894	1	Duluth News-Tribune, Jan. 1, 1894
MI	Chippewa County	St. Mary's River	1894	1	Sault Ste. Marie News, Feb. 17, 1894
WI	Douglas County	Bois Brule River	1895	1	O'Donnell (1944) "A History of Fishing in the Brule River"
MI	Baraga County	Silver River	1895	3	The L'Anse Sentinel, Aug. 17, 1895
MN	St. Louis County	Stewart River	1895	3	The Virginia Enterprise, Jul. 26, 1895

MI	Baraga County	Falls River	1895	3	The L'Anse Sentinel, Jan. 12, 1895
MI	Baraga County	Linden Creek	1895	3	The L'Anse Sentinel, Jan. 12, 1895
MI	Baraga County	Silver River	1895	3	The L'Anse Sentinel, Jan. 12, 1895
WI	Douglas County	Bois Brule River	1896	1	The Superior Times, Oct. 10, 1896
WI	Bayfield County	Bois Brule River	1896	1	Duluth News-Tribune, May 26, 1896
MI	Keweenaw County	Tobacco River	1897	3	The Copper Country Evening News, Jul. 14, 1897
MI	Baraga County/Marquette County	Huron River	1897	3	The L'Anse Sentinel, May 29, 1897
MI	Chippewa County	St. Mary's River	1897	1	Sault Ste. Marie News, Sept. 18, 1897
MI	Keweenaw County	Lac la Belle	1898	4	The Copper Country Evening News, Jul. 26, 1898
MI	Houghton County	Pilgrim River	1898	1	The Copper Country Evening News, Jun. 1, 1898
MI	Isle Royale	Tobin Harbor	1898	1	The Cook County Herald, Sept. 3, 1898
MI	Isle Royale	Streams in island	1898	1	The Cook County Herald, Sept. 3, 1898
MN	Cook County	Devils Track River	1898	3	The Cook County Herald, Sept. 3, 1898

MN	Cook County	Reservation River	1898	3	Duluth News-Tribune, Aug. 18, 1898
WI	Baraga County	L'Anse	1899	3	The L'Anse Sentinel, Jul. 8, 1899
MN	Cook County	Hollow Rock Creek	1899	2	The Cook County Herald, Aug. 12, 1899
WI	Bayfield County	Washburn	1900	3	The Washburn Times, Aug. 15, 1900
MI	Chippewa County	Sault Ste. Marie (Saint Marys River)	1900	2	The Saint Paul Globe, Jul. 8, 1900
MN	St. Louis County	French River	1900	4	Duluth News-Tribune, Aug. 5, 1900
MN	St. Louis County	Sucker River	1900	4	Duluth News-Tribune, Aug. 5, 1900
MI	Chippewa County	St. Mary's River	1900	2	Sault Ste. Marie News, Jul. 14, 1900
WI	Douglas County	Bois Brule River	1900	1	Duluth News-Tribune, Aug. 5, 1900
MI	Houghton County	Graveraet River	1900	4	Detroit Free Press, May 12, 1901

Appendix Table 3: Descriptive table of brook trout reports from the '1901-1920' time period. Table records the location and date of the report, along with the source. Also included is a "Coaster Credence Value," which is used to display the likelihood that the observation is describing coasters rather than stream-resident brook trout. The values range from 1-4, with 1 representing the highest degree of confidence and 4 representing the lowest confidence.

State	County	Location Details	Date	Coaster Credence Value	Source
MI	Chippewa County	St. Mary's River	1901	2	Evening News, May 10, 1901
WI	Bayfield County	Raspberry Bay	1901	1	The Washburn Times, May 23, 1901
WI	Bayfield County	Bayfield (streams along lakeshore)	1901	1	The Saint Paul Globe, Apr. 28, 1901
MN	Lake County	Baptism River	1901	3	Duluth News-Tribune, Aug. 22, 1901
MI	Isle Royale	Tobin Harbor	1901	1	Duluth News-Tribune, Jul. 15, 1901
MI	Isle Royale	Washington Harbor	1901	1	Duluth News-Tribune, Jul. 15, 1901
MI	Baraga County	L'Anse Bay	1902	1	The L'Anse Sentinel, Aug. 2, 1902
MI	Baraga County	L'Anse (Falls River)	1902	3	The L'Anse Sentinel, May 3, 1902
MN	Cook County	Streams around Chicago Bay	1902	3	The Saint Paul Globe, Apr. 12, 1902
MN	Cook County	Reservation River	1902	3	The Saint Paul Globe, Apr. 12, 1902
MN	Cook County	Flute Reed River	1902	3	The Cook County Herald, Jun. 21, 1902

MI	Baraga County	Huron Bay (Lake Superior)	1902	1	The Minneapolis Journal, Jul. 3, 1902
WI	Douglas County	Bois Brule River	1902	1	The Minneapolis Journal, May 3, 1902
MN	Cook County	Reservation River	1902	3	The Cook County Herald, Jun. 21, 1902
MN	Cook County	Devils Track River	1902	4	The Cook County Herald, Jun. 7, 1902
MI	Baraga County	L'Anse (Slate River)	1903	4	The L'Anse Sentinel, Jun. 13, 1903
MI	Chippewa County	Sault Ste. Marie (Saint Marys River)	1903	1	Willmar Tribune, Jul. 1, 1903
MN	Lake County	Gooseberry River	1903	2	Duluth News-Tribune, Aug. 3, 1903
MN	St. Louis County	French River	1903	3	Duluth News-Tribune, Jun. 28, 1903
MN	St. Louis County	Sucker River	1904	4	Duluth News-Tribune, May 1, 1904
WI	Bayfield County	Pike's Creek (Bayfield)	1905	4	The Washburn Times, Jul. 20, 1905
WI	Ashland County	Madeline Island	1905	2	The Washburn Times, Aug. 24, 1905
MI	Alger County	Grand Island (Lake Superior)	1905	1	Duluth News-Tribune, Nov. 19, 1905
MI	Alger County	Munising	1905	4	The Minneapolis Journal, May 23, 1905
MN	St. Louis County	Sucker River	1905	3	Duluth News-Tribune, May 28, 1905

WI	Douglas County	Bois Brule River	1906	1	O'Donnell (1944) "A History of Fishing in the Brule River"
MN	St. Louis County	Stewart River	1906	4	The Virginia Enterprise, Jul. 6, 1906
MI	Chippewa County	St. Mary's River	1906	2	Evening News, Jul. 18, 1906
MN	Lake County	Gooseberry River	1906	4	Duluth News-Tribune, Jul. 12, 1906
MI	Isle Royale	Washington Harbor	1906	1	Duluth News-Tribune, Aug. 21, 1906
MI	Isle Royale	Washington Harbor	1906	1	Duluth News-Tribune, Jun. 16, 1906
MN	St. Louis County	Lester River	1907	4	Duluth News-Tribune, Jun. 10, 1907
WI	Bayfield County	Lost Creek (in Siskiwit Bay)	1907	4	The Washburn Times, Aug. 1, 1907
MN	Cook County	Flute Reed River	1907	4	The Cook County Herald, Aug. 3, 1907
MN	Lake County	Knife River	1907	4	Duluth News-Tribune, Oct. 24, 1907
MN	St. Louis County	French River	1907	4	Duluth News-Tribune, Apr. 20, 1907
MI	Chippewa County	St. Mary's River	1907	1	Evening News, Jul. 19, 1907
MI	Isle Royale	Washington Harbor	1908	1	Duluth News-Tribune, Jul. 12, 1908
MI	Isle Royale	Isle Royale	1908	1	Duluth News-Tribune, Jul. 24, 1908
WI	Bayfield County	Cranberry River	1909	2	The Washburn Times, Jun. 17, 1909

MI	Isle Royale	Isle Royale (Davidson Island, Tourist Home resort, opened in 1907)	1909	1	The Redwood Gazette, Aug. 25, 1909
MN	St. Louis County	Miller Creek	1909	4	Duluth News-Tribune, Jan. 5, 1909
MI	Sault Ste. Marie	St. Mary's River	1909	3	Evening News, Aug. 31, 1909
MN	St. Louis County	Miller Creek	1909	4	Duluth News-Tribune, Apr. 22, 1909
MI	Baraga County	Baraga	1910	1	The L'Anse Sentinel, May 14, 1910
WI	Bayfield County	Washburn	1910	4	The Washburn Times, May 26, 1910
MN	St. Louis County	Lester River	1910	4	Duluth News-Tribune, Apr. 3, 1910
MN	Lake County	Knife River	1910	4	Duluth News-Tribune, Aug. 12, 1910
MI	Marquette County	Lake Superior	1911	1	Escanaba Morning Press, Sept. 2, 1911
MI	Marquette County	Little Presque Isle (Lake Superior)	1911	1	Escanaba Morning Press, Sept. 2, 1911
MN	St. Louis County	French River	1911	4	Duluth News-Tribune, Jun. 18, 1911
MN	St. Louis County	Chester Creek	1911	4	Duluth News-Tribune, Apr. 19, 1911

MI	Isle Royale	Lake Superior (waters around isle royale)	1911	1	Duluth News-Tribune, Jul. 24, 1911
MI	Marquette County	Salmon Trout River	1911	1	Escanaba Morning Press, May 19, 1911
MI	Baraga County	Sixmile Creek	1912	2	The L'Anse Sentinel, Jul. 27, 1912
MI	Houghton County	Pilgrim River	1912	1	The Calumet News, May 28, 1912
MI	Baraga County	Falls River	1912	4	The L'Anse Sentinel, May 11, 1912
WI	Bayfield County	Fish Creek (Near Ashland)	1912	4	The Washburn Times, Apr. 18, 1912
MN	St. Louis County	Tischer Creek	1912	4	Duluth News-Tribune, May 19, 1912
MN	St. Louis County	St. Louis River	1912	4	Duluth News-Tribune, May 19, 1912
MN	St. Louis County	Lester River	1912	4	Duluth News-Tribune, May 19, 1912
MI	Isle Royale	Tobin Harbor	1912	1	Duluth News-Tribune, Jun. 30, 1912
MI	Isle Royale	Belle Isle (Lake Superior)	1912	1	Duluth News-Tribune, Jun. 30, 1912
MI	Baraga County	Slate River	1912	4	The L'Anse Sentinel, May 25, 1912
MI	Alger county	Anna River	1913	4	The Calumet News, Jun. 16, 1913
WI	Bayfield County	Sioux River	1913	4	The Washburn Times, May 15, 1913

MN	St. Louis County	French River	1913	4	The Labor World, Jun. 7, 1913
MN	Saint Louis County	French River	1913	3	Star Tribune, Aug. 24, 1913
MI	Chippewa County	St. Mary's River	1914	2	Evening News, May 1, 1914
MN	St. Louis County	Sucker River	1915	3	Duluth News-Tribune, Apr. 12, 1915
MN	Lake County	Split Rock River	1915	3	Duluth News-Tribune, Apr. 12, 1915
MN	Cook County	Temperance River	1915	3	Duluth News-Tribune, Apr. 12, 1915
MN	Cook County	Poplar River	1915	3	Duluth News-Tribune, Apr. 12, 1915
MN	Lake County	Gooseberry River	1915	3	Duluth News-Tribune, Apr. 12, 1915
MN	Lake County	Split Rock River	1916	3	Duluth News-Tribune, May 28, 1916
MN	Lake County	Baptism River	1916	3	Duluth News-Tribune, May 28, 1916
MN	Lake County	Beaver River	1916	3	Duluth News-Tribune, May 28, 1916
MN	Lake County	Gooseberry River	1916	3	Duluth News-Tribune, Jun. 4, 1916
MN	St. Louis County	Duluth Streams	1916	4	Duluth News-Tribune, Mar. 11, 1916
MN	St. Louis County	Lester River	1916	3	Duluth News-Tribune, Jun. 15, 1916

MI	Isle Royale	Washington Harbor (Lake Superior)	1916	1	Duluth News-Tribune, Jun. 25, 1916
MI	Chippewa County	St. Mary's River	1917	1	Evening News, May 25, 1917
WI	Bayfield County	Sioux River	1917	4	Duluth News-Tribune, Sept. 13, 1917
WI	Bayfield County	Onion River	1917	4	Duluth News-Tribune, Sept. 13, 1917
MI	Marquette County	Dead River	1919	4	The Diamond Drill, Feb. 22, 1919
MI	Luce County	Little Two Hearted River	1919	4	Evening News, May 16, 1919
MI	Baraga County	Falls River	1920	4	The L'Anse Sentinel, Jul. 16, 1920

Appendix Table 4: Descriptive table of brook trout reports from the '1921-1950' time period. Table records the location and date of the report, along with the source. Also included is a "Coaster Credence Value," which is used to display the likelihood that the observation is describing coasters rather than stream-resident brook trout. The values range from 1-4, with 1 representing the highest degree of confidence and 4 representing the lowest confidence.

State	County	Location Details	Date	Coaster Credence Value	Source
MI	Chippewa County	Whitefish Bay, near the wreck of the SS Superior City 46°43.51′N 84°52.37′W	1921	1	Evening News, Jun. 11, 1921
WI	Bayfield County	Fish Creek	1922	1	The Washburn Times, Jun. 15, 1922
WI	Bayfield County	Flag River	1922	3	The Washburn Times, Jun. 15, 1922
WI	Bayfield County	Cranberry River	1922	4	The Washburn Times, Jun. 15, 1922
WI	Bayfield County	Sioux River	1922	4	The Washburn Times, Jun. 15, 1922
WI	Ashland County	Bad River	1922	4	The Washburn Times, Jun. 15, 1922
MN	Cook County	Devils Track River	1922	4	The Cook County News-Herald, Aug. 31, 1922
MN	Cook County	Poplar River	1922	4	The Cook County News-Herald, Jun. 8, 1922
MI	Marquette County	Dead River/Silver Creek	1922	4	The Diamond Drill, Feb. 10, 1922
WI	Douglas County	Bois Brule River	1924	1	Wisconsin State Journal, Jan. 27, 1924
MI	Luce County	Two Hearted River	1928	4	Detroit Free Press, Jun. 10, 1928

MI	Marquette County	Salmon Trout River	1929	1	The Book of Huron Mountain, "The Fishes" by Carl L. Hubbs (1929)
MI	Isle Royale	Isle Royale	1930	1	The Escanaba Daily Press, Jul. 6, 1930
MI	Marquette County	Salmon Trout River	1933	1	The Border Cities Star, Sept. 2, 1933
MI	Chippewa County	Whitefish bay (Lake Superior)	1934	1	Detroit Free Press, Sept. 16, 1934
MI	Marquette County	Lake Superior (Near Marquette)	1934	1	Detroit Free Press, Sept. 16, 1934
MI	Marquette County	Salmon Trout River	1935	1	George Shiras, 3rd (1935). "Hunting Wild Life With Camera and Flashlight"
WI	Bayfield County	Brickyard Creek	1935	4	Greene, W. C. (1935). "The Distribution of Wisconsin Fishes"
WI	Bayfield County	Fish Creek (Ashland)	1935	4	Greene, W. C. (1935). "The Distribution of Wisconsin Fishes"
WI	Bayfield County	Thompson Creek	1935	4	Greene, W. C. (1935). "The Distribution of Wisconsin Fishes"
WI	Bayfield County	Onion River	1935	4	Greene, W. C. (1935). "The Distribution of Wisconsin Fishes"
WI	Bayfield County	Siskiwit River	1935	4	Greene, W. C. (1935). "The Distribution of Wisconsin Fishes"
MI	Alger County	Au Train Lake	1937	3	The Escanaba Daily Press, Sept. 28, 1937
MI	Chippewa County	Halfaday Creek	1938	3	Detroit Free Press, Sept. 25, 1938
MI	Alger County	Au Train River	1938	3	The Escanaba Daily Press, Aug. 2, 1938

WI	Bayfield County	Fish Creek (Near Bois Brule River)	1938	1	Wisconsin State Journal, May 22, 1938
WI	Bayfield County	Flag River	1938	1	Wisconsin State Journal, May 22, 1938
WI	Douglas County	Bois Brule River	1938	1	Wisconsin State Journal, May 22, 1938
MN	St. Louis County/Lake County/Cook County	Lake Superior (Lester River to Grand Portage)	1940	1	Star Tribune, Apr. 26, 1940
MI	Alger County	Au Train River	1941	3	Detroit Free Press, Sept. 21, 1941
MI	Houghton County	Pilgrim River	1941	2	Lansing State Journal, May 15, 1941
WI	Douglas County	Bois Brule River	1950	3	The La Crosse Tribune, May 21, 1950

Appendix Table 5: Descriptive table of historical lumber mills in Upper Michigan. Table consists of information included in the historical lumber mill GIS shapefile layer. Lumber mills are listed chronologically by the date of establishment.

Name	County	Specific Location Details	Date of Establishment	Date Closed
Fort Brady Sawmill	Chippewa	Sault Ste. Marie, Old Fort Brady	1822	
William Farnsworth and Charles Brush	Menominee	Menominee	1832	1842
Alden Chandler	Delta	Escanaba	1836	
Built by Donald McLeod, then owned by J. B. Smith & Jefferson Sinclair	Delta	Mouth of the Escanaba River	1838	
Charles Childs	Baraga	L'Anse	1838	1850
Charles McLeod	Delta	Escanaba River	1838	
Unknown	Menominee	Cedar River	1838	
Charles McLeod	Menominee	Menominee	1841	
John and Joseph Smith	Delta	Escanaba, on the Escanaba River	1844	
William G. Boswell	Baraga	Mouth of Falls River near L'Anse	1844	
Farnsworth & Brush	Menominee	Menominee River	1844	1856
J. C. Hall	Menominee	Menominee River	1844	
Abner Bangs	Menominee	5 miles north of Menominee	1844	
Billings, Richards & Bliss	Delta	Ford River	1845	1856
Lake Superior Copper Company	Keweenaw	Eagle River	1845	
Edward Light	Delta	Nahma	1845	
Darius Clark	Delta	Whitefish River near Rapid River	1847	
Mason & Holt	Delta	Little Bay de Noc, Whitefish River	1847	
George Richards & S. H. Kerfoot	Delta	Sturgeon River near Nahma	1848	
Jackson Iron Company	Marquette	Negaunee, Carp River Forge	1848	1854
James P. Pendill	Chippewa	Along the bank of a creek flowing into Whitefish Bay (Pendills Creek)	1849	

Mason & Holt	Delta	Masonville	1849	1904
Ferguson & Williamson	Delta	White Fish River mouth	1850	
Marquette Iron Company	Marquette	Worcester (Marquette) near the lake shore, south of the intersection of Baraga Avenue and Lake St.	1850	1858
John Burt	Marquette	Carp River	1851	
Samuel Hamilton & Sylvester Lynn	Menominee	Mouth of the Cedar River	1851	
James Bendry	Baraga	L'Anse, Falls River	1851	1878
John G. Parker	Ontonagon	Ontonagon	1852	
W. H. Stevens, Levi Hanna & John G. Parker	Ontonagon	Ontonagon River	1852	
Northwestern Mining Company	Keweenaw	Central	1852	
Hill Mine	Keweenaw	Copper Falls	1852	
Douglass Houghton Mining Company	Ontonagon	Near M-26	1852	
Ransom Shelden	Houghton	Dollar Bay	1852 (estimated)	
Mr. Parish	Marquette	Eagle Mills	1852 (estimated)	
A. R. Harlow & Robert Graveraet	Marquette	Dead River	1853 (estimated)	
Kirby-Carpenter Lumber Company	Menominee	Menominee	1853	
N. Ludington Company	Menominee	Menominee	1853	
W. W. Henderson	Houghton	Hancock	1853	
Guy H. Carleton	Chippewa	Carletonville (near Raber)	1853	
Hogeboom & Boyden	Menominee	On the Cedar River	1854	
Sidney Adams	Marquette	Marquette	1855	
John P. Haynes	Schoolcraft	Near the mouth of the Manistique River	1855	
Ransom Shelden	Houghton	2 miles below Houghton	1855	
Peacock	Delta	Masonville	1855 (estimated)	
Spinney & Boyd	Schoolcraft	Manistique River	1855	
W. H. Stevens	Keweenaw	Copper Harbor	1855 (estimated)	

Sydney Adams	Marquette	Cherry Creek		1855	
Louis Schweitzer	Marquette	Little Carp (Morgan Creek)	1855 (estimated)		
Peter White	Marquette	Forestville		1855	
A. R. Harlow	Marquette	Marquette		1856	
Kirby-Carpenter Company Mill	Menominee	Menominee		1857	
Victoria Mining Company	Ontonagon	Victoria	1857 (estimated)		
Bagley & Boswell	Menominee	Menominee, bay shore		1857	
Hamilton & Boyd	Menominee	Cedar River		1858	
Anson Bangs	Menominee	Little River		1858	1871
Mr. Whittley	Alger	Au Train		1859	1861
Matt M. Moralee	Houghton	North shore of Portage Lake (west Hancock)		1860	
Matt M. Moralee & J. H. Olds	Houghton	Ripley		1860	
Amygdaloid Mining Company	Keweenaw	Delaware Road		1860	
Edwards & Company (J. W. Edwards & Charles T. Harvey)	Marquette	Chocolay River near the mouth		1860	1863
Pennsylvania Mining Company	Keweenaw	Delaware Road		1861	
Peacock & Legan	Delta	Ford River		1862	
Harrison Ludington, Daniel Wells Jr., and Robert & Isaac Stephenson	Menominee	Michigan side of the Menominee River		1863	
Cutler, Witbeck & Co.	Schoolcraft	Manistique, mouth of the river		1863	
Harrison Ludington, Daniel Wells Jr., and Robert & Isaac Stephenson	Menominee	Michigan side of the Menominee River		1863	1865
George Wagner	Alger	Grand Island bay near Munising		1863	1873
A. R. Harlow	Marquette	Marquette, lower harbor		1863	
Pewabic Mining Company	Houghton	Pewabic		1864	
James Bendry	Baraga	Baraga		1864	
Eugene Allen Ormes	Houghton	Hancock	1864 (estimated)		
Harrison Ludington, Daniel Wells Jr., and Robert & Isaac Stephenson	Menominee	Michigan side of the Menominee River		1865	

Charles B. & E.S. Ingalls	Menominee	Ingallston Township		1866	1874
J. Foster & Company	Marquette	Marquette, lower harbor		1866	
Joseph Gregory & Co.	Houghton	Lake Linden		1867	
Jackson Iron Co.	Delta	Fayette, Big Bay de Noc	1867 (estimated)		
Kirby-Carpenter Co.	Menominee	Menominee		1867	
George Wagner	Chippewa	Laughing Whitefish Point		1868	
Deer Lake Iron Co.	Marquette	Deer Lake		1868	
Chicago & Northwestern Railroad	Marquette	Little Lake		1869	
Mr. Parmenter	Alger	Au Train		1869	
Napoleon Collett	Delta	Rapid River		1870	
Eugene Allen Ormes	Menominee	Menominee	1870 (estimated)		
Mellen Smith	Menominee	Wallace		1870	
A. R. Harlow	Marquette	Little Presque Isle (Harlow Creek)	1870 (estimated)		
Iron Cliff Co.	Marquette	Near the Foster Mine	1870 (estimated)		
Jackson Iron Co.	Marquette	Negaunee	1870 (estimated)		
Bay Iron Co.	Alger	Onota		1870	
Michigan Iron Co.	Marquette	Clarksburg	1870 (estimated)		
John Semer & Israel Wickstrom	Delta	Ogontz River mouth	1870 (estimated)		1890
Cascade Iron Company	Marquette	Palmer		1871	
Bagley and Copp	Menominee	Menominee		1872	
Mellen Smith	Menominee	Bay shore, Ingallston Township		1872	
F. J. Sevart	Mackinac	Prentiss Bay		1872	
Lindquist & Landrie	Menominee	Ingalls		1872	1882
Mr. Peacock	Delta	Garth		1872	1910
Lorenzo D. Harvey	Marquette	Chocolay River near the mouth		1872	
The Michigamme Co.	Marquette	Michigamme		1872	
Edward Fraser	Marquette	Cherry Creek		1872	1900

Sturgeon River Lumber Company	Houghton	North shore of Portage Lake, on the west end of Hancock		1873	
F. W. Reed & Co.	Marquette	Michigamme		1873	1895
Fox, Weston & Co.	Schoolcraft	Manistique River		1873	
Harrison Ludington, Daniel Wells Jr., and Robert & Isaac Stephenson	Menominee	Michigan side of the Menominee River		1873	
Spalding Lumber Company	Menominee	Spalding		1873	1901
Read Lumber Company	Marquette	Eagle Mills		1873	1897
Alfred Green	Marquette	Marquette		1873	
John Gillett (Marquette Lumber Company)	Marquette	Marquette, intersection of Lake Shore Boulevard and Ridge Street		1874	
Bagley & Copp	Menominee	Menominee		1874	
Lemoyne, Hubbard & Wood	Menominee	Spalding		1874	
S. L. Benjamin	Menominee	18 miles up the railroad from menominee		1874	
John Bagley	Menominee	Bagley	1874 (estimated)		
Weston Lumber Company	Schoolcraft	Manistique River		1874	
Louis Schweitzer	Marquette	Cascade (Palmer)		1874	1879
John Gillett	Marquette	Marquette		1875	
John W. Wells	Menominee	On the bay shore, just north of Menominee		1875	
Weston Lumber Company	Schoolcraft	Manistique River		1875	
Ebenezer James	Schoolcraft	Jamestown (near Manistique)		1875	1882
Brunswick-Balke-Collander Company	Marquette	Big Bay		1875	1932
Antoine Deloria	Delta	Garden Peninsula, south side of Garden Creek		1875	
Fox, Weston & Co.	Schoolcraft	Manistique River		1876	
Cook & Wilson Lumber Company	Luce	Deer Park		1876	1906
C. Doucette, Sr.	Alger	Au Train		1876	

Mr. Buell	Dickinson	Quinnesec		1876	
Unknown	Menominee	Daggett	1876 (estimated)		
Hulbert & Pond	Chippewa	Hulbert		1876	1893
Spies Lumber Company	Menominee	Menominee		1876	
Joseph Weller	Alger	Munising - Across the Lake from Grand Island		1877	
Norris Lumber Company	Chippewa	Bay Mills		1877	
Charles & Edward Hebard and H. C. Thurber	Baraga	Pequaming		1878	1942
Booth & Warner	Delta	Hunters Point on the west side of the Stonington Peninsula		1878	1885
Leathem & Smith	Menominee	Arthur Bay (formerly Leatham)		1878	
Mackinac Lumber Company	Mackinac	St. Ignace	1878 (estimated)		
Samuel Elliott	Delta	Sac Bay		1878	1887
Charles L. Meyer	Menominee	Hermansville		1879	1910
Brazel Bros./Burt & Henry Gamble	Alger	Grand Marais, west bay		1879	
Fountaine LeRouge	Delta	Garden Peninsula		1879	
Atlantic Mine	Houghton	Atlantic Mine		1879	
Ransom, Burtis & Marsh	Marquette	Marquette		1880	
Hebard & Thurber Lumber Company	Baraga	Pequaming		1880	
Delta Lumber Company	Schoolcraft	Lakeshore at Thompson		1880	1903
Norword Brown	Menominee	Ingalls		1880	1883
Curt Emerson/Chesbrough Lumber Company	Chippewa	Tahquamenon River mouth at Emerson		1880	1912
Tom Nester	Ontonagon	Ewen		1880	1908
M. Perron	Menominee	Perronville		1880	1906
Frank D. Wilson	Menominee	Wilson	1880 (estimated)		
Nadeau Bros (Barney Nadeau)	Menominee	Nadeau		1880	1910
Hudson Lumber Company	Mackinac	Naubinway	1880 (estimated)		

Unknown	Menominee	Cunard	1880 (estimated)	
Engadine Lumber Co.	Mackinac	Engadine	1880 (estimated)	
Chapin Mine	Dickinson	Iron Mountain	1880	
Mackinaw Lumber Company	Mackinac	Black River	1881	
Mackinaw Lumber Company	Mackinac	Point St. Ignace	1881	
Robert Dollar (American Lumber Company)	Luce	Banks of Tahquamenon R River, Dollarville	1881	1902
George Farnsworth	Delta	Mouth of the Sturgeon River in Nahma	1881	
Albany & Boston Mining Company	Houghton	Boston Location	1881	
Thomas Nestor	Baraga	Baraga, two miles across the bay from L'Anse	1881	
Isaac Johnson	Marquette	Negaunee	1881	
D. C. Lockwood	Iron	Crystal Falls	1881	
Ontonagon Lumber Company	Ontonagon	Ontonagon River	1881	
Wolfgang Stauber	Menominee	Ingallston	1881 (estimated)	
Michigan Slate Company	Baraga	Huron Bay	1881	
Van Winkle & Montague	Delta	Vans Harbor	1881	1908
Bay Shore Lumber Company	Menominee	Menominee	1881	1895
Isaac Johnson	Marquette	Negaunee, Teal Lake	1881	1901
American Lumber Company	Luce	Dollarville	1882	
Hall, Thompson & Co.	Mackinac	Millecoquins	1882	
William Mueller Co., 1909 - Wisconsin Land and Lumber Co.	Menominee	Labranche	1882	1943
George D. Sisson & Francis Lilly	Ontonagon	Ontonagon River	1882	
North Shore Lumber Company	Schoolcraft	South Manistique	1882	
Unknown	Chippewa	Strongville (Pickford Township)	1882 (estimated)	
Hall & Munson	Chippewa	Bay Mills, Waiska River	1882	1904
Krause Lumber Company	Delta	Bark River	1882 (estimated)	
Island Cedar Co., 1890 - H. C. Johnson Co., 1916 - Charles Wood (Kreetan Company)	Chippewa	Drummond Island, Scammon Cove	1883	1925

Lake Superior Chemical & Iron Company	Luce	Tahquamenon River north of Newberry	1883	1910
Sturgeon River Lumber Company	Baraga	Baraga	1883	
Hall & Buell	Schoolcraft	Southtown (South Manistique)	1883	1903
Lily Lumber Company	Menominee	Talbot	1883 (estimated)	1915
Carley & Parmenter	Menominee	Ingalls	1883	
John C. Cook	Schoolcraft	Cooks	1883	
Weston Lumber Company (Chicago Lumber Company)	Schoolcraft	Manistique, Manistique River	1884	
Delta Lumber Company	Schoolcraft	Walsh	1884	1929
Diamond Match Company	Ontonagon	Ontonagon	1884	1896
Eugene Allen Ormes	Gogebic	Marenisco	1884	
Kirby-Carpenter Co.	Menominee	Menominee	1884	
Patrick Garvie	Marquette	Chocolay River	1884	
Cleveland Saw Mill & Lumber Company	Marquette	Dead River	1885	
Alger & Smith	Alger	Grand Marais	1885	
White & Friant	Dickinson	Hardwood	1885	1907
Harmon Lumber Company	Dickinson	Foster City	1885	1922
Calderwood Lumber Co.	Ontonagon	Calderwood	1885 (estimated)	
George McDonald	Baraga	Redruth	1885 (estimated)	
Waucedah Lumber & Cedar Co.	Dickinson	Waucedah	1885	1887
John Finck	Baraga	Baraga	1885 (estimated)	
O'Callaghan & McIntyre	Dickinson	Metropolitan	1885	
Mr. Salter	Mackinac	Gould City	1886 (estimated)	
Girard & Morrisette	Marquette	Little Lake	1886	
Mason & Davis	Delta	Gladstone	1886	1901
Baraga Lumber Co.	Baraga	Baraga	1886	
South Side Lumber Co., 1911- Tula Lumber Co., 1913 - Lewis Jenson, 1919 - John Schroeder	Gogebic	Tula	1887	1925
Sturgeon River Lumber Company	Houghton	Chassell	1887	

O'Callaghan Bros.	Dickinson	Norway		1887	1891
Pewabic Mine	Dickinson	Iron Mountain		1887	1918
Metropolitan Lumber Co.	Dickinson	Metropolitan		1887	1891
Isaac Stephenson	Delta	Wells		1888	
Fair Brothers	Gogebic	Marenisco		1888	
Giddings	Baraga	Giddings (3 miles west of Baraga)	1888 (estimated)		
August Neuman	Ontonagon	Bruce Crossing	1888 (estimated)		
Aragon Mine	Dickinson	Norway		1888	
Hassel Saw and Planing Mill	Mackinac	Hessel		1888	
Clark & Farnum Lumber Company	Ontonagon	Ewen		1889	1896
Cleveland Saw Mill & Lumber Company	Marquette	Marquette		1889	
Stack & Atkinson	Iron	Gibbs City on Paint River		1889	1912
Bay de Noquet Lumber Company	Delta	Nahma		1889	
A. L. Harmon	Dickinson	Waucedah		1889	
Peninsular Cedar Company	Schoolcraft	Parkington		1889	
Maas Lumber Co.	Marquette	Turin		1890	1905
John Spry Lumber Company	Chippewa	Sault Ste. Marie		1890	
Harvey W. Seymour	Chippewa	Sault Ste. Marie		1890	
S. J. Rolph	Houghton	Kitchie		1890	1895
Diamond Match Company	Ontonagon	Matchwood		1890	1910
Scott & Howe	Gogebic	Ironwood		1890	1933
Menasha Woodenware Company	Menominee	Carney		1890	1905
Lake Independence Lumber Company	Marquette	Big Bay		1890	
Peters & Morrison	Ontonagon	Interior		1890	1897
Robert Dollar	Houghton	Dollar Bay	1890 (estimated)	1930 (estimated)	
DeHass, Powell & Co.	Baraga	Huron Bay (Skanee)	1890 (estimated)		
G. T. Werline/Hall, Werline & Company	Delta	Trombly	1890 (estimated)		
Been-Bush Sawmill	Baraga	Skanee	1890 (estimated)		
Dead River Lumber Co. (Hawley & McGraw)	Marquette	Marquette		1890	
Rupright & Croziers	Gogebic	Crozier's Mills (4 miles NE of Watersmeet)		1890	1898

H. M. Loud & Sons	Alger	Munising	1890 (estimated)	
John Funke	Houghton	Chassell	1890 (estimated)	
L. W. Trenary	Alger	Trenary	1890 (estimated)	
Moyles Brothers	Chippewa	DeTour	1890	
Rostad Lumber Company	Iron	Milwaukee road line between Channing and Sidnaw, about 12 miles NW of Amasa	1891	1908
John McRae Lumber Company	Ontonagon	Ewen	1891	1896
Sparrow-Kroll Lumber Company	Houghton	Kenton	1891	1910
Rostad Lumber Company	Houghton	Pori	1891	1908
Albert Cullen	Chippewa	Fibre	1891 (estimated)	1911
Penn Iron Mining Co.	Dickinson	Norway	1891	1895
Laing Lumber Co.	Dickinson	Sagola	1891	
S. P. Saxton	Dickinson	Waucedah	1891	
Martel Furnace Company	Mackinac	Ozark	1891 (estimated)	
Holley & Bullen	Chippewa	Hulbert	1891	
Edward Fraser	Marquette	Whetstone Creek	1891	
Ainsworth & Alexander	Chippewa	Sault Ste. Marie	1892	
Oshkosh Log and Lumber Company	Ontonagon	Choate, about 4 miles south of M-28, south of Ewen	1892	1899
Booth & Tucker Lumber Company	Houghton	Sidnaw	1892	1900
Brown & Robins	Ontonagon	Robbins	1892	
Stack & Atkinson	Iron	Metropolitan (Atkinson - Gibbs City)	1892	1900
Stack & Atkinson	Menominee	East of Helps	1892	1895
Zasto & Sanderman	Menominee	Faunus	1892	1906
Edward L. Parmenter	Dickinson	Between Loretto & Vulcan on the Sturgeon River (Sturgeon Mills)	1892	1900
Barclay Lumber Company	Ontonagon	Barclay	1892	1902
Harris Saw Mill	Delta	Harris	1892	

L'Anse Lumber Co.	Baraga	L'Anse		1893	
William L. Marble	Schoolcraft	Little Harbor		1893	
J. H. Weed	Ontonagon	Paulding		1893	1894
Winger Lumber Company	Schoolcraft	Germfask		1893	
J. B. Smith	Baraga	L'Anse		1893	1896
Russell Alger (Alger Smith Co.)	Alger	Grand Marais		1893	1909
Peter Lofberg	Gogebic	Ironwood		1893	
Hubbell	Houghton	Hubbell	1894 (estimated)		
Sagola Lumber Company	Dickinson	Sagola		1895	1932
Feltus & Treadway	Chippewa	Raber		1895	
Penoyer Brothers	Chippewa	Shelldrake		1895	1925
The Halliwell Copper Company	Ontonagon	Porcupine Mountains		1895	
O'Callaghan Bros.	Dickinson	Norway		1895	
Griff's Sawmill	Houghton	Hancock		1895	
C. E. Moor	Alger	Munising		1896	
John Colburn	Delta	Cornell	1896 (estimated)		1903
Hudson & Donaldson (Hudson Lumber Co.)	Mackinac	Garnet		1897	
Sutherland Innis	Alger	Munising		1897	
George L. Burtis	Alger	Munising		1897	
Grand Island Lumber Co.	Alger	Munising		1897	
Tilden Mine	Gogebic	Bessemer		1897	
Winona Copper Company	Houghton	Winona		1898	
Hunter & Love Lumber Company	Luce	Tahquamenon River 4 miles north of Newberry		1898	
James McIntyre	Ontonagon	Barclay		1898	1902
Metropolitan Lumber Company	Iron	Atkinson (Gibbs City)		1898	
Wyandot Mining Co. Saw Mill	Houghton	Wyandotte		1898	
Unknown	Chippewa	Strongs		1899	
C. A. Wright	Houghton	Hancock		1899	
Gus Tollent & Co.	Ontonagon	Mass City		1899	
Victoria Mining Co. Saw Mill	Ontonagon	Victoria		1899	
Trimountain Mine	Houghton	Trimountain		1899	
Von Platen-Fox Co.	Dickinson	Iron Mountain		1900	1930
Mr. Van Slyke	Houghton	Anthony (Ghost Town)		1900	1910

Hood Lumber Company	Iron	Pentoga		1900	1920
Robert Gerstner	Dickinson	North of Randville in Sagola Township	1900 (estimated)		
Gunlak A. Bergland	Ontonagon	Bergland		1900	
Stegath Lumber Company	Delta	Escanaba	1900 (estimated)		
William Ross	Mackinac	Kenneth		1900	
James Pendill	Marquette	Marquette		1900	1907
R. McKee	Chippewa	Goetzville		1900	
J. B. Sweatt	Chippewa	Sault Ste. Marie		1900	
Franklin Mine	Houghton	Hancock		1900	
Sensiba Bros.	Iron	Atkinson (Gibbs City)		1900	
O'Callaghan Bros.	Dickinson	Norway		1901	1909
Johnson Bros.	Marquette	West Branch		1901	
Champion Mine	Houghton	Painesdale		1901	
Covington Saw Mill	Baraga	Covington		1901	
D. A. Rideout & Company	Dickinson	Foster City		1901	
Wolverine Cedar Company	Marquette	Northland		1902	1910
Simmons Lumber Company	Mackinac	Simmons Woods		1902	1913
William Mueller	Schoolcraft	Blaney Park		1902	1926
Yalmer Lumber Company	Marquette	Yalmar		1902	
John M. Longyear	Marquette	Ives Lake		1902	
August Duscette	Marquette	Little Lake		1902	
A. W. Quirt	Iron	Iron River		1903	
Cook, Curtis & Miller	Alger	Grand Marais Bay, South Side		1903	
LaBranch Brothers	Menominee	LaBranche		1904	1911
Cleveland Cedar Company	Chippewa	Maxton, Drummond Island		1904	
Munising Paper Company	Alger	Munising		1904	
Dalton Lumber Co.	Marquette	Skandia (New Dalton)		1904	
Unknown (Possibly Pluchak)	Ontonagon	Mass City	1905 (estimated)		
Sckeraszy	Mackinac	Moran		1905	
J. H. Worden Lumber & Shingle Co.	Chippewa	Dick	1905 (estimated)		1914
Freis Brothers	Marquette	Dukes	1905 (estimated)		
Dupras Brothers	Marquette	Mangum		1905	
Unknown	Chippewa	Rudyard		1906	
Mashek Lumber Company	Menominee	Gourley		1906	

Rush Culver (Northern Lumber Company)	Marquette	Birch		1906	1912
Tyoga Lumber Company	Alger	Deerton	1906 (estimated)		
D. A. Stratton Company	Houghton	Atlantic Mine	1907 (estimated)		
Mercer & DeLaittre	Ontonagon	Calderwood		1907	
Wilman & Sons	Mackinac	Wilman	1907 (estimated)		
F. J. Sweitzer & Son	Marquette	Pickeral Lake		1907	1908
Thomas Connor	Marquette	Antlers, on the Marquette & Southeastern Railroad between Birch & Big Bay		1907	
Greenwood Lumber Company	Ontonagon	Ontonagon		1908	1925 (estimated)
Wiekko Bowman (owner as of 1942)	Chippewa	Baie de Wasai		1908	
Oscar Maki (owner as of 1942)	Chippewa	Baie de Wasai		1908	
Peter Maleport (owner as of 1942)	Chippewa	Baie de Wasai		1908	
Lafe Quay, Quay Lumber Co.	Mackinac	Moran		1908	
Stone Anderson	Delta	Ensign	1908 (estimated)		
Brunswick-Balke-Collander Company	Marquette	Big Bay		1909	
Sagola Lumber Co.	Dickinson	Sagola		1909	1919
Sveitner	Mackinac	Moran		1909	
Isaac Stephenson	Delta	Escanaba River		1909	1922
Jackson Tindall Sawmill	Alger	Munising		1910	
Bennett & Brown	Ontonagon	Bergland		1910	1920
Gwinn Lumber Company	Marquette	Gwinn		1910	
C. A. Bergland	Ontonagon	Bergland		1910	1920
Zephire Tousignant	Marquette County	Harvey		1910	
John Stack	Marquette	Yalmar		1910	
Larson Bros.	Marquette	Skandia		1910	
Peterson Bros.	Marquette	Skandia		1910	
Jensen Lumber Company	Ontonagon	Ewen		1911	1918
Samuel Jenkins	Dickinson	Iron Mountain		1911	1925
J. W. Wells Lumber Company	Menominee	Menominee		1911	
Weidman Lumber Company	Ontonagon	Trout Creek		1911	1926

Manigold	Marquette	Carlshend	1911	
Cleveland Cliffs Company	Alger	Melstrand	1912	
Eddy Lumber Co.	Houghton	Lake Linden	1912	
C. Y. Bennett	Chippewa	Near Eckerman (Seewhy)	1912	1927
McLeod	Mackinac	Rexton	1912	
Claude McClucks	Marquette	Green Garden	1912	
Brunswick-Balke-Collander Company	Marquette	Big Bay	1912	
Marshall Butters Lumber Company	Baraga	L'Anse	1913	
Worcester Lumber Company	Alger	Cusino	1914	
Richardson & Avery	Chippewa	Raco	1914	
Frank Chesbrough	Mackinac	Wilwin	1915	
R. F. Gibbs	Iron	Gibbs City	1915	1921
Munising Company	Alger	Munising	1917	
Helena Lumber Company	Marquette	Little Lake	1917	1922
Appleford Bros.	Mackinac	Moran	1917	
Barrett Logging Co.	Luce	Newberry	1918	
Vulcan Lumber Company (Originally Case Lumber Company)	Houghton	Donken	1919 (estimated)	
Collins Land & Lumber Company	Delta	Rapid River	1919	
Cadillac-Soo Lumber Company	Chippewa	Sault Ste. Marie	1920	
Weidman Lumber Company	Ontonagon	Bergland	1920	1931
Ford Motor Company	Dickinson	Iron Mountain (Kingsford)	1920	1950
Mr. Anderson	Gogebic	Fuller	1920	
Brown Lumber Co.	Schoolcraft	Manistique	1921	
Northern Sawmill Co.	Dickinson	Sagola	1921	1940
Ford Motor Company	Baraga	L'Anse	1921	1940
Bergland Lumber Company	Ontonagon	Ewen	1922	1938
Brunswick Lumber Company	Ontonagon	Ewen	1922	1928
Calumet Hecla Company	Keweenaw	Ahmeek	1922 (estimated)	
Cleveland Cliffs Iron Company	Alger	Munising	1923	1940
Northern Sawmill Co.	Dickinson	Sagola	1923	1927
Sheldon Lumber Co.	Chippewa	Eckerman	1924	
Cleerman Bros.	Delta	Stegath's Spur	1925	1930

Wixtrom Lumber Company	Marquette	2191 County Road 601, Republic, MI 49879	1926	
William Bonifas Lumber Co.	Gogebic	Watersmeet	1926	
Eklund Brothers	Schoolcraft	Walsh	1927	1929
Alston Lumber Company	Houghton	Alston	1930	1938
Connor Lumber Company	Gogebic	Wakefield	1933	
Marathon Paper Company	Gogebic	Ironwood	1933	1952
J. L. Barrett	Luce	Newberry	1933	
Underwood Veneer Company	Gogebic	Bessemer	1935	1948
Henry Ford - Alberta	Baraga	Alberta, Ford Center	1936	1954
William Berklund	Marquette	Big Bay	1939	
Superior Cedar Products	Menominee	101 Fence Rd Carney MI 49812	1940	
Chassell Lumber Company	Houghton	East of Chassell on US 41	1941	1957
Besteman Sawmill	Chippewa	15689 S. Tilson Rd, Rudyard, MI 49780	1945	
White River Timber Company	Ontonagon	Bergland	1946	
Anthony & Company	Delta	1501 N. 23rd St. Escanaba, MI 49829	1947	
John & Arthur Penegor, Inc.	Houghton	32865 Highway M-26, Twin Lakes, Toivola, MI 49965	1947	
Paul Steiger	Gogebic	Bessemer	1947	
Hancock Lumber Company	Alger	Sand River	1949	

Appendix Table 6: Descriptive table of historical lumber mills in Wisconsin. Table consists of information included in the historical lumber mill GIS shapefile layer. Lumber mills are listed chronologically by the date of establishment.

Name	County	Specific Location Details	Date of Establishment	Date Closed
Jacob Franks	Brown	Devil River	1809	
Government Mill	Brown	Little Kaukauna River (Green Bay)	1816	
Col. John Bowyer	Brown	Dutchman's Creek	1818	
Constant A. Andrews	Wood	Yellow River, 30 to 40 miles east of Lake Pepin (possibly Pittsville)	1819	
Pierre A. Grignon	Brown	Dutchman's Creek, Green Bay region	1822	
James H. Lockwood & Joseph Rollett	Dunn	Red Cedar River	1822	
John P. Arndt	Brown	2 miles from the mouth of Pensaukee River	1825	
Unknown	Brown	Green Bay	1826	
John P. Arndt	Brown	Duck Creek	1827	
James H. Lockwood	Dunn	Wilson's Creek, Menomonie	1828	
Asa E. Hough	Grant	Platte River	1828	
Daniel Whitney	Portage	Plover Portage	1830	
Hardin Perkins	Dunn	Branch of the Menomonie River (Red Cedar)	1830	
Daniel Whitney	Wood	Wisconsin River "Whitney Rapids" across the river from Nekoosa	1831	
Government Mill	Winnebago	Neenah	1832	
William Paine & John Crocker	Sheboygan	Sheboygan falls, at the junction of the Sheboygan and Mullet Rivers	1834	
William Paine	Sheboygan	3 miles up from the mouth of the Sheboygan River	1835	
George Wales	Pepin	Eau Galle River	1835	
Charles Hart	Milwaukee	Wauwatosa	1835	
Moody Mann	Calumet	Brothertown	1836	
Daniel Whitney	Calumet	Brothertown	1836	
R. A. Warren	Walworth	Geneva	1836	
George Langdon, George Ehrie & George Lerwich	Oconto	Oconto	1836	

Jacob W. Conroe	Manitowoc	Manitowoc		1836	
Robert M. Ebbers & John Lowe	Manitowoc	Two Rivers		1836	
Amable Grignon, Randolph B. Morey & Samuel Merrill	Wood	Grignon Rapids (Wisconsin Rapids)		1836	
A. A. Bird, Zenas Bird & Mr. Petrie	Dane	Marshall		1836	
Gilbert Conant & Daniel Campbell	Portage	Wisconsin River "Conant's Rapids"		1837	
Amable Grignon II & Morgan L. Martin	Lincoln (estimated)	Menominee territory, upper Wisconsin River		1837	
John Gale	Waukesha	Waukesha		1837	
A. Wheeler	Dane	Lake Mendota, slightly west of Butler Street in Madison		1837	
Joseph Keyes	Jefferson	Lake Mills		1837	
Montgomery & Patterson	Kewaunee	3 Miles up from the mouth of Kewaunee River		1837	
William Farnsworth	Sheboygan	3 miles from the mouth of Sheboygan River		1837	
Silas Steadman	Sheboygan	Sheboygan falls, 5 miles up from the mouth		1837	
George Conroe	Manitowoc	Neshota (possibly Shoto), in the western part of Two Rivers		1837	
Thayer, Rouse & Thompson	Manitowoc	Two Rivers, a few miles north of Manitowoc		1837	
Hogaboom	Oconto	Oconto River at Oconto Falls	1838 (estimated)		
Nelson Strong	Wood	Grand Rapids		1838	
The St. Louis Company	Polk	St. Croix Falls		1838	
H. L. Dousman, Gen. Sibley, Col. Aiken & Lyman Warren	Chippewa	Chippewa Falls	1838 (estimated)		
E. Lenaville	Manitowoc	Branch, mouth of Branch River		1838	
James Harper & Robert Bloomer	Portage	Plover River		1839	
John L. Moore	Marathon	Mosinee		1839	
George Stevens	Marathon	Big Bull Falls (Wausau)		1839	
Jacob Spaulding	Jackson	Black River Falls		1839	
James & Alexander O'Neill	Jackson	3 miles south of Black River Falls		1839	1845
Judge Lockwood	Dunn	West side of the Red Cedar		1839	

Abraham Brawley, later Andrew Dunn	Portage	Mill Creek		1839	
J. McCollins & James O'Neill	Chippewa	O'Neill's Creek (Niellsville)		1839	
Holt Lumber Company	Oconto	Oconto		1840	
Abram Wood & Willis Rowan	Sauk	Baraboo		1840	
Shepherd & P. B. Crosby	Marathon	Big Eau Claire River		1840	
James O'Neill	Jackson	Perry Creek, at the mouth		1840	
John C. Clark	Marathon	Wausau		1840	
St. Louis Lumber Company	St. Croix	Mouth of the St. Croix River		1840	
John Edwards & Henry Clinton	Wood	Port Edwards (Frenchtown)		1840	
Miles McKnight	Lafayette	South Wayne		1840	
Thomas Lyons & Sons	Walworth	Lyons		1840	
John Rockwell	Waukesha	Oconomowoc	1840 (estimated)		
Orson Reed	Waukesha	Okauchee		1840	
Benjamin Nute & William Lamphear	Jefferson	Milford		1840	
Shepherd & Valentine	Jackson	3 miles below Black River Falls		1841	
John Levis	Jackson	Levis Creek (Black River Falls)	1841 (estimated)		
Samuel Farnsworth	Shawano	Shawano		1842	
Robert & Thomas Douglas	Jackson	North Bend		1842	1854
Spaulding & Woods	Jackson	Black River Falls		1842	
Thomas & Peter Hall	Jackson	Hall's Creek		1842	
Alman D. Heaton, William Kean & William Mahoney	Polk	Osceola		1842	
J. B. McNiel, Elmore & McAllister	Juneau	Mauston, on the Lemonweir River		1842	
Joseph Perrington	St. Croix	Hudson, mouth of the Willow River		1842	
Thomas J. Parrish & Mr. Estes	Richland	Eagle		1842	

Simon Randall	Eau Claire	Eau Claire	1842
Hiram McDonald	Green Lake	Grand River	1843
Hiram McDonald	Green Lake	Markesan	1843
Samuel Farnsworth	Shawano	Shawano, on the Wolf River	1843
B. G. Plummer	Marathon	Wausau, Barkers Island (estimated)	1843
Smith & Wilson	Juneau	New Lisbon on the Lemonweir River	1843
Arthur McCann & J. C. Thomas	Chippewa	Chippewa River	1843
Robert Witter	Green	Monticello, Little Sugar River	1843
Abraham & Ira Brooks	Jefferson	Waterloo	1843
John J. Driggs & Warren Morely	Fond du Lac	Fond du Lac	1844
"The Phalanx"	Fond du Lac	Ripon	1844
Littlefield & Giddings	Sheboygan	Sheboygan	1844
Daniel Smith	Manitowoc	Mishicot	1844
C. P. Hazleton & Co.	Marathon	Wausau	1844
Benjamin Single	Marathon	Little Rib River	1844
William Kent & Bros	Polk	Osceola	1844
James Moore	Marathon	Wausau	1844
John Langdon & Sons	Columbia	Cambria, Duck Creek	1844
Forest & Smith	Fond du Lac	Waupun	1845
Joseph Richardson	Sheboygan	Sheboygan Falls	1845
Hubbell Mill	Oconto	Oconto River at Oconto Falls	1845 (estimated)
James & Alexander O'Neill	Clark	Neillsville	1845
American Fur Company	Bayfield	Bayfield, Section 21, township 50, range 4	1845
Alvin & William Foster and Chester May	Dodge	Williamstown	1845
Byron Kilbourn & Barton Salisbury	Washington	West Bend	1845
William Scholfield	Marathon	Schofield	1845 (estimated)
Daniel E. Cotton	Dodge	Neosho	1845
James O'Neill	Jackson	Black River just above the falls	1845 (estimated)

J. McCollins & James O'Neill	Clark	Cunningham's Creek	1845 (estimated)	
Unknown	Jefferson	Kroghville	1845	
Stone & Cady	Eau Claire	Eau Claire River	1846	
William Wilson & John Holly Knapp	Dunn	Menomonie	1846	
Davis & Ruggles	Fond du Lac	East bank of Wolf River near Fond du Lac	1846	
James Preston & Rev. Huntington Lyman	Sheboygan	Cascade	1846	
Shirwood & Dart	Green Lake	Dartford (now Green Lake)	1846	
John B. Seward	Green Lake	Markesan	1846	
Daniel Smith	Manitowoc	Mishicot	1846	
Moore Brothers	Waupaca	Little Wolf	1846	
Walter McIndoe	Marathon	Wausau	1846	1872
Benjamin Berry	Marathon	Trapp River	1846	
Andrew Grover	Clark	Cunningham's Creek, ~2 miles below O'Neil's mill	1846	
Dibble's mill	Clark	Cunningham's Creek	1846	
Jonathan Nichols	Clark	Cowley's Creek (Cawley Creek)	1846	
Amasa Dunn	Juneau	Clearfield on the Lemonweir River	1846	
McCann, Randall & Thomas	Eau Claire	Eau Claire	1846	
Ervin Leihy	Ashland	Bad River Falls	1846	
William Paine	Ozaukee	Saukville, 25 miles up the Milwaukee River	1846	
Hamilton, McClum & Beebe	Clark	Cunningham Creek	1846	
Nelson Beckwith	Winnebago	Omro	1847	
Morris Foreman	Winnebago	Oshkosh	1847	
Foreman & Bashford	Winnebago	Oshkosh	1847	
Pierce & Bruce	Manitowoc	Cooperstown	1847	
James & T. W. Christie	Oconto	Oconto Falls	1847	
Andrew Tainter & Blois Hurd	Dunn	Irving Creek, 2 miles below Menomonie	1847	

Myrick & Miller	Clark	Black River	1847
John Frederick	Dane	Belleville	1847
Jesse H. Myer	Washington	Kewaskum	1847
J. J. Gage, James Reed & Capt. Dix	Eau Claire	Eau Claire river, on the north bank	1848
Charles Lindsay & Harvey Jones	Winnebago	Neenah	1848
Wilson & Phelps	Green Lake	Berlin City	1848
Robert Grignon	Waupaca	Near the mouth of the Little Wolf River	1848
C. S. Ogden	Waupaca	Ogdensburg	1848
Hugh McFarlane & Andrew Dunn	Wood	Yellow River	1848
Leander & Benjamin Merrill	Clark	Black River	1848
John Lane	Clark	Black River	1848
John Morrison	Clark	Black River (Morrison Creek)	1848
Van Dusen & Waterman	Clark	Eatontown	1848
Albert Lambert	Clark	Eatontown	1848
J. J. Gage, James Reid & Captain Dix	Eau Claire	Eau Claire	1848
Mr. Bloomer	Chippewa	Duncan Creek	1848
Solomon Juneau	Dodge	Theresa	1848
James Gay	Crawford	Gays Mills	1848
Yates Ashley	Columbia	Pardeeville	1848
James Dickinson	Walworth	Bloomfield, near Geneva Lake	1849
Andrew Warren	Lincoln	Merrill	1849
Esau Johnson	Monroe	Oil City	1849
T. Weston & Co.	Juneau	Necedah	1849
Alexander Stewart	Marathon	Wausau	1849
Henry Carpenter & Randall	Juneau	Kildare	1849

John (or Michale) Kellner	Manitowoc	Kellnersville	1849	
Colton & Moses	Wood (estimated)	Yellow River	1850	
Alexander & Henry O'Neil	Chippewa	O'Neil's Creek, 0.5 miles from where it empties into the Chippewa River	1850	
Joseph Keyes	Winnebago	Menasha, at the head of Lake Winnebago	1850	
Knapp & Jenkins	Winnebago	Oshkosh	1850	1893
Sylvanus Ripley & J. L. Mead	Winnebago	Oshkosh	1850	
Curtis Reed & Cornelius Northup	Winnebago	Menasha	1850	
Hyde Brothers	Winnebago	Winneconne	1850	
Jacob Spies	Oconto	East of Oconto on the river	1850	
Ira Clark	Manitowoc	Cato	1850	
Shumway Brothers	Waushara	Wautoma	1850	
George Hiles & Henry Searles	Wood	Dexterville	1850	
Samuel Hiles	Wood	Yellow river, north of Necedah	1850	
T. & H. Gill	Waupaca	Royalton	1850	
Unknown	Manitowoc	Keil	1850	
Peter & Thomas Hall	Jackson	Alma Center	1850	
C. B. Cox	Pierce	Clifton Hollow (Clifton) Kinnickinnic River	1850	
James Micklejohn	Waupaca	Little Wolf, 3 miles below Manawa	1850	
Cochrane Brothers	Marquette County	Westfield	1850	
Knapp, Stout & Co.	Dunn	Menomonie	1850	
L. D. Ward & Harris Searles	Wood	Yellow River	1850	
Albert "Wabigog" McEwen	Ashland	White River (Bad River)	1850 (estimated)	
Alanson Sweet	Door	Baileys Harbor	1850 (estimated)	
Alexander Ellis Briggs	Marquette County	Briggsville	1850	
Leroy Graves	Calumet	Gravesville (Chilton) on the Manitowoc River	1850	

Hazel P. Clark & William Pool	Sheboygan	Glenbeulah	1850	
J. M. & E. B. Rounds and William Starr	Polk	Eureka	1851	
Smith & Vibbert	Polk	Eureka	1851	1871
Swiss colony	Green	New Glarus	1851	
John Volt	Kewaunee	4 miles up from the mouth of Kewaunee River	1851	
Unknown	Kewaunee	Mouth of the Kewaunee River on Lake Michigan	1851	
Abraham Hall	Kewaunee	Ahnapee, on the south branch of the river near the lake	1851	
John Week	Marathon	Big Eau Pleine River	1851	1881
Benjamin Single	Marathon	Little Rib River	1851	
Mr. Werner	Juneau	Mouth of the Yellow River	1851	
George Willard	Juneau	Wonewoc	1851	
Daniels & Hutchinson	Marathon	Hutchinson	1851	
Unknown	La Crosse	La Crosse	1852	
Anson Eldred	Oconto	Stiles	1852	1872
Otis Day	Brown	Greenleaf	1852	
J. & A. Stuart	Marathon	Wausau	1852	
F. M. Rublee	La Crosse	Mouth of the La Crosse River	1852	
N. N. & O. S. Powell	Pierce	Clifton Hollow	1852	1856
W. F. Holbrook	Pepin	Arkansaw Creek	1852	
Seth Angel	Monroe	Angelo	1852	
Peter Arntz	Juneau	Lemonweir River, 2 or 3 miles from the mouth (near Lemonweir)	1852	
Timothy Burns	La Crosse	La Crosse	1852	1857
Simon Sharp & Henry Miller	Richland	Eagle	1852	
Canute Anderson	Burnett	Grantsburg	1852 (estimated)	
Isaac Taylor & Co.	Manitowoc	Two Rivers	1852	
David Davidson	Brown	Suamico	1853	
Anson Bangs	Dunn	Little River, near Menominee	1853	
F. Arpke	Milwaukee	Franklin	1853	
D. S. Crandall	Door	Sturgeon Bay	1853	
L. M. Marshall	Brown	Duck Creek	1853	
Strong	Waupaca	Lind	1853	
J. A. Lathrop	Waupaca	Dayton	1853	
Frank A. Flower	Bayfield	Iron River	1853	

George & William Holbrook	Pepin	Arkansaw Creek	1853	
Durgan & Stewart	Door	Baileys Harbor	1853	
Allen Perkins	Richland	Cazenovia	1853	
Unknown	Bayfield	On the Iron River just south of Lake Superior	1854	
G. W. Sexsmith	Fond du Lac	Fond du Lac	1854	
Daniel H. Burtis	Door	Sturgeon Bay	1854	
Doty & Smith	Waupaca	New London	1854	
German settler colony mill	Brown	Eaton	1854	
Orestes Garrison	Wood	Centralia (Wisconsin River, right bank)	1854	1875
Mr. Foster	Pierce	North branch of the Kinnickinnic River	1854	
Edmund Bishop	Buffalo	Fountain, between Alma & Winona	1854	
John F. Stone	Eau Claire	Bridge Creek Township	1854	
Thomas Bickford Jewell & Trueworthy Jewell	St. Croix	Star Prairie	1854	
M. P. Bateman	Chippewa	Paint Creek mouth	1854	
Edward J. Saxe	Waushara	Saxeville	1854	
David Giddings	Sheboygan	Giddings Mills (Onion River near Sheboygan Falls)	1854	
Neil Munroe	Brown	Suamico	1855 (estimated)	
New York Lumber Company	Marinette	Menekaunee, Menominee River	1855	
T. S. Henry & Co.	Fond du Lac	Fond du Lac	1855	
Paine Lumber Company	Winnebago	Oshkosh	1855	
William Mann	Douglas	Superior (Nemadji River)	1855	
David Davidson	Brown	Suamico Township	1855	
A. H. & A. J. Dufur	Waupaca	Iola	1855	
Mr. Mills	Manitowoc	Centerville	1855	
Merryman & Co.	Fond du Lac	Fond du Lac	1855	
I. M. Hill & Co.	Jackson	Robinson's Creek	1855	
Woodbury, Bothwick & Shaylor (later John D. Howard)	Douglas	Connor's Point	1855	1883
C. N. Averill	Pepin	Bear Creek	1855	
J. D. Trumbull	Pierce	Maiden Rock	1855	
L. G. Merrill & A. S. Hayden	Jackson	Merrillan	1855	

Henry Jacobs	Jackson	Melrose		1855	
George Gale	Trempealeau	Galesville, Beaver Creek		1855	
W. W. Jackson	Monroe	Tomah		1855	
B. C. B. Foster	St. Croix	New Richmond		1855	
Samuel L. Plummer	Pepin	Bear Creek, Durand		1855	
Daniel Shaw & C. A. Bullen	Eau Claire	Eau Claire		1855	
Goldthwaite & Brown	La Crosse	La Crosse		1855	
C. C. Washburn	Pepin	Waubeek		1855	1871
Ebenezer Thompson	Dunn	Downsville		1855	
Reed	Manitowoc	Reedsville	1855 (estimated)		
O.H. Ingram and Kennedy	Eau Claire	Eau Claire, Chippewa River, near Menomonie street		1856	
Valley Mill	Eau Claire	Chippewa River, Menomonie Street, on the site of Kaiser Field		1856	
Pierce, Smith & Co.	Fond du Lac	Fond du Lac		1856	
I. K. & W. C. Hamilton	Fond du Lac	Fond du Lac, on the lakeshore		1856	
Burnham, Foster & Knapp	Winnebago	Oshkosh		1856	
Bray & Tolman	Winnebago	Oshkosh		1856	
F. Beckfield	Sheboygan	Howard's Grove on Pigeon River		1856	
Charnley Bros.	Door	Unknown		1856	
Norton & Co.	Oconto	Oconto		1856	
Hugh Jones	Oconto	Oconto River a mile up from the falls		1856	
Oconto Lumber Company	Oconto	Oconto		1856	
Farnsworth	Oconto	Oconto		1856	
John Balk	Oconto	Oconto Falls		1856	
J. M. Brinknall	Juneau	Baraboo river, at the east end of the prairie (possibly Wonewoc)		1856	
Cady & Chamberlain	Waushara	Plainfield		1856	
New York Lumber Company	Marinette	Menominee River, at the mouth		1856	
N. Ludington Company	Marinette	Mission Point, upriver from Menekaunee		1856	1921
L. A. Houston	Wood	Dexterville		1856	
Conant & Russell	Waupaca	Fremont		1856	
John Brinknell	Sauk	Baraboo		1856	

Oliver W. Pitts	Wood	Pittsville	1856	
Bredenthal, King & Co.	Trempealeau	Trempealeau	1856	
William Scholfield	Marathon	Big Eau Claire River	1856	
Silverton & Dudley	Pierce	Prescott	1856	
Ladd & Jenkins	Juneau	Necedah	1856	
Humes & Beckwith	Juneau	2 or 3 miles north of Necedah on the river	1856	
William & D. R. W. Williams	Juneau	Werner (Germantown)	1856	
Crosby & Hixon	La Crosse	Mouth of the Black River (Lake Onalaska)	1856	
Albert W. Pettibone & I. M. Hill	Jackson	Robinson's Creek	1856	
Valley Lumber Co.	Eau Claire	Eau Claire	1856	
Robert E. Gillett	Monroe	Tomah	1856	
W. W. Jackson	Monroe	Tomah	1856	
Bayfield Land Company	Bayfield	Bayfield, 4th Street	1856	
Royce, Boice, Melville & Co.	La Crosse	Onalaska	1856	1865
C. M. Nichols	La Crosse	Onalaska	1856	
Milhauser & Hirscheimer	La Crosse	North La Crosse	1856	
Daniel Shaw Lumber Co.	Polk	Half Moon Lake, lower outlet	1856	1912
Whitney	La Crosse	La Crosse	1856	
Sherman & Griswold	La Crosse	La Crosse, at the flats below the city	1856	
R. E. Gillett	La Crosse	North La Crosse	1856	1860
Crosby, Hanscombe, Hixon & Co.	La Crosse	North La Crosse	1856	1863
Shepherd & Valentine	La Crosse	North La Crosse	1856	
Sill, Loomis & Root	La Crosse	North La Crosse	1856	
Chippewa Falls Lumber Co.	Chippewa	Chippewa Falls	1856	
Edward Pinick	Richland	Yuba	1856	
Reason & James T. Barnes	Richland	Boaz	1856	
Isaac Miles	Richland	Akan	1856	
J. W. Perry	Waupaca	Marion	1856	
Charles Seeley	Vernon	La Farge, Kickapoo River	1856	
A. M. and J. S. Sherman	Eau Claire	Dells Pond, on the low flat east of Mt. Smith	1857	
Abner Kirby	Marinette	Menominee River	1857	

William E. Bagley & William G. Boswell	Marinette	On the bay shore near Marinette	1857	
Ulrich Legler	Fond du Lac	Ashford	1857	
D. B. Johnson	Douglas	Superior	1857	1893
H. G. Miller	Sheboygan	A mile south of Howard's Grove	1857	
Anson Eldred	Oconto	Oconto	1857	1881
Clinton	Waupaca	Larrabee	1857	
H. B. Mills	Jackson	Robinson's Creek	1857	
W. F. Prindle, George Ellsworth & W. E. Hays	Pepin	Durand	1857	
Michael	Buffalo	Buffalo City	1857	
Joel H. Duncan	Chippewa	Duncan Creek	1857	
Mr. Allen	Chippewa	Duncan Creek	1857	
Denton & Hurd	La Crosse	La Crosse	1857	
Dole, Ingram & Kennedy	Eau Claire	Eau Claire	1857	1861
Buttrick Bros.	La Crosse	North La Crosse	1857	1858
Seymour	Eau Claire	Seymour, Eau Claire River	1857	
Joseph Brightman	Crawford	Soldiers Grove	1857	
James & Z. Jones	Richland	Bloom	1857	
S. V. R. Ableman	Sauk	Rock Springs, Narrows Creek	1857	
William Campbell	Winnebago	Oshkosh	1858	
A. M. Josher & Co.	Jackson	Black River Falls, two miles above the falls	1858	
John Werner	Juneau	On the Yellow River just below the town of Werner (Germantown)	1858	
Jacob A. Johnson	Jackson	Douglas Creek, at the mouth	1858	1861
Daniel Shaw & Martin Daniels	Chippewa	Grand Island (possibly Gravel Island) near Chippewa Falls	1858	
N. B. Holway	La Crosse	Onalaska	1858	
Doctor Sparks	La Crosse	Onalaska, above the Nichols mill	1858	
J. Q. Griffith	Fond du Lac	Fond du Lac	1859	
Carlton Foster	Winnebago	Oshkosh	1859	
McMillan & Davis	Winnebago	Oshkosh	1859	
Bailey & Coull	Oconto	Oconto	1859	
Peshtigo Lumber & Manufacturing Co.	Marinette	Peshtigo	1859	
Hurley & Burns	Wood	Grand Rapids	1859	
Edwards & Clinton	Wood	Grand Rapids	1859	

John Werner	Juneau	Werner (Germantown)	1859	
Gilbert Bros.	Dunn	Red Cedar River	1859	
Simon Strauss	Brown	Somewhere on the Green Bay shore	1860	
George Hawthorne	Marinette	Menominee River	1860	1871
C. W. Day	Brown	Greenleaf	1860	
Eldred & Balcom	Oconto	Oconto	1860	
Eldred & Balcom	Oconto	Stiles	1860	
Frederick W. Cooke	Green Lake	Berlin City	1860	
J. C. Lathrop	Brown	Green Bay	1860 (estimated)	
Charles F. Buckman	Eau Claire	Bridge Creek Township	1860 (estimated)	
Earl & Case	Kenosha	Lily Lake	1860	
George B. Burch & Co.	Juneau	Necedah	1860	
John Paul	La Crosse	La Crosse	1860	
Arthur M. & John S. Sherman (Later Ingram & Kennedy)	Eau Claire	Eau Claire	1860	
A. H. & Hilton Blake	Monroe	Sparta, Beaver Creek	1860	1864
R. E. Gillett	Monroe	Tomah	1860	
Robinson D. Pike	Bayfield	Pike's Creek	1860 (estimated)	
B. G. Davidson & Co.	Bayfield	Bayfield	1860 (estimated)	
Bothwick & Shaylor	Douglas	Connor's Point	1860 (estimated)	
Richard & Thomas Hooper	Jefferson	Milford	1860 (estimated)	1914
Ernest Schmidt	Ozaukee	Saukville, Milwaukee River	1860	
Slausson & Grimmer	Kewaunee	Scarboro, on Scarboro Creek	1860	
Edson Chub	Chippewa	Edson, Hay Creek	1860	
Andrew Mack	Pierce	Elmwood	1861	
Reuben C. Lyons	Wood	Centralia (estimated)	1861	
Edward Dexter Brown	Portage	Plover river, 2 miles east of Stevens Point	1861	1881
S. A. Jewett	St. Croix	Erin Prairie (Jewett)	1861	
Government Mill	Bayfield	Red Cliff	1861	1872
Henry Naason	Marinette	On the island ~2 miles from the Menominee River (Green Island)	1862	1862
Beach & Conlee	Winnebago	Oshkosh	1862	

J. H. Weed	Winnebago	Oshkosh		1862	
George Challoner	Winnebago	Omro		1862	
Daniel L. Libbey	Winnebago	Oshkosh		1862	
Slauson, Grimmer & Co.	Kewaunee	Kewaunee River		1862	
W. H. Bradley	Winnebago	Oshkosh		1862	
Charles Crain	Fond du Lac	Fond du Lac		1863	
James L. Clark	Winnebago	Oshkosh		1863	
The Hill Mill	Door	Clay Banks		1863	
Dikeman & Latimer	Kewaunee	Kewaunee River		1863	
F. N. Wright	Brown	Wrightstown		1863	1865
Alois Stark & Bro.	Marathon	Knowlton		1863	
Charles Coleman	Chippewa	Chippewa Falls		1863	1880
Uriah D. Mihills	Fond du Lac	Fond du Lac		1864	
Derby & Curran	Winnebago	Oshkosh		1864	
M. E. Tremble	Brown	Big Suamico		1864	
H. M. Peyton	Douglas	Connor's Point		1864	
John Barnes	Pierce	Ellsworth		1864	
Evans & Sanderson	Pierce	Ellsworth		1864	
H. Daniels shingle mill	Marathon	Wausau, west side of the river		1864	
Porter, Brown & Meredith	Eau Claire	Porterville (3 miles SW of Eau Claire on the Chippewa River)		1864	
Unknown	Grant	Woodman		1864	
J. J. Demiseg	Outagamie	Bear Creek		1865	
Frederick Lane & Charles Schattle	Buffalo	Alma		1865	
Robert Mariner	Chippewa	Cadotte Falls (Cadott)		1865	
Unknown	Bayfield	Bark Point	1865 (estimated)		1870
Charles Tisch	Kewaunee	Tisch Mills		1865	
William McCartney	Marinette	Menominee River		1866	
Buckstaff Bros. & Chase	Winnebago	Oshkosh		1866	
George Badger & James C. Spalding	Winnebago	Oshkosh		1866	
William McCartney	Marinette	Marinette (estimated)		1866	
J. W. Perry	Waupaca	Dupont		1866	
Eau Claire Lumber Co.	Dunn	Meridean		1866	
Eau Claire Lumber Co.	Buffalo	Alma		1866	

Robinson D. Pike	Ashland	La Pointe	1866	
Israel Stone	Lincoln	Tripoli, Somo River	1866	
Kirby-Carpenter Co.	Marinette	Menominee River	1867	
H. W. Webster	Winnebago	Omro	1867	
Beach & Conlee	Winnebago	Oshkosh	1867	
Bray & Tolman	Oconto	Oconto	1867	1869
Fred Carney Mill	Marinette	Marinette, Menominee River	1867	
Edward Gessner	Burnett	Lincoln Township	1867	1871
Henry Fall	Polk	Balsam Lake	1867	1872
North Western Lumber Co.	Eau Claire	Eau Claire	1867	
Herbert C. Scofield	Brown	Green Bay	1867	
Prescott, Burditt & Co.	Eau Claire	On the small island in the Chippewa River	1868	
Dells Lumber Company	Oconto	Gillett	1868	
Hamilton & Merryman Company	Marinette	Marinette	1868	
R. McMillan & Bro.	Winnebago	Oshkosh	1868	
Charles S. Webb	Winnebago	Oshkosh	1868	
Peshtigo Lumber & Manufacturing Co.	Marinette	Peshtigo, mouth of the river	1868	
L. L. Curtis	St. Croix	Hersey	1868	
Dells Lumber Company	Eau Claire	Eau Claire	1868	
Knapp, Stout & Co.	Barron	Rice Lake	1868	
James A. Mitchel & Edward Coleman	Wood	Frenchtown (later Port Edwards)	1868	1878
George Warren & James Gamble	Monroe	Warrens	1868	
Mix & Orr	Oconto	Oconto	1869	
H. Witbeck & Co.	Marinette	Marinette	1869	
J. W. Raisler	Outagamie	Bear Creek	1869	
Bradford, McCoy & Co.	Juneau	Necedah	1869	
Robinson D. Pike	Bayfield	Bayfield	1869	1924
Robinson D. Pike	Bayfield	Bayfield	1869	
Ira Mead	Chippewa	Wheaton Township	1869	1880
Empire Lumber Co.	Eau Claire	Shawtown (Eau Claire)	1869	
John Leatham	Door	Unknown	1870	
C. L. Fellows	Kewaunee	Ahnapee, on the south branch of the river near the lake	1870	

C. Ruggles	Racine	Caledonia		1870	
Frederick Fisher	Buffalo	Alma		1870	
Ira S. & Leroy Graves	Clark	Colby, on the Wisconsin Central Railroad		1870	
Knapp, Stout & Co.	Barron	Rice Lake		1870	
W. H. Polleys	La Crosse	French Island		1870	
Bradley Bros.	Lincoln	Tomahawk	1870 (estimated)		
Van Auken	Eau Claire	Fairchild Township		1870	1874
William Wilson	St. Croix	Wilson		1870	
Upham Brothers	Shawano	Angelica		1871	1878
William E. Bagley & Daniel Corey	Marinette	Menominee River		1871	1871
S. Radford & Bro.	Winnebago	Oshkosh		1871	
William Campbell & Sons	Winnebago	Oshkosh, south side of the river		1871	1877
S. A. Coleman	Oconto	Oconto		1871	
J. P. Laird & Co.	Shawano	Angelica		1871	
J. & A. Stewart	Marathon	Wausau, on the east bank of the river		1871	
M. B. Dille & Co.	Juneau	Necedah		1871	
Robert G. Wallace	Marathon	Knowlton		1871	
Garland & Nichols	Dunn	Rock Creek		1871	
Menominee River Lumber Company	Marinette	Menominee River		1872	
Beach & Bishop	Calumet	Brillion		1872	
Tufts Mill	Door	Clay Banks		1872	
Peshtigo Lumber & Manufacturing Co.	Marinette	Peshtigo, west side of the river		1872	
Forest W. & John J. Kingsbury	Wood	Auburndale		1872	1880
Ashland Lumber Company	Ashland	Chequamegon Bay		1872	
La Crosse Lumber Company	La Crosse	La Crosse		1872	
J. S. Ellminster	Clark	Colby		1872	
Wilson, Van Vliet & Co.	St. Croix	Wilson		1872	
Smith & Packett	Shawano	Angelica		1872	
Olesen & Peters	Shawano	Angelica		1872	
Mooney family	Barron	Hillsdale		1872	

A. A. Kelly	St. Croix	Woodville	1872	
N. A. Harris	Calumet	Forest Junction	1873	
A. Winquist, Charles A. Noyes & O. A. Risum	Shawano	Oconto river near Shawano	1873	
Appleton Paper and Pulp Company	Outagamie	Appleton	1873	
Isaac Brown	Door	Northport	1873	
Scott & Ogden	Eau Claire	Union	1873	
Robert, James & John Connor	Wood	Auburndale	1873	
W. P. Kelley & Bro.	Marathon	Wausau	1873	
Hixon & Withee	La Crosse	French Island	1873	1895
D. R. & L. M. Bailey	St. Croix	Baldwin	1873	
Valley Lumber Co.	Eau Claire	Just above the upper race leading from Half Moon Lake	1874	
Mihills Manufacturing Co.	Fond du Lac	Fond du Lac	1874	
Thompson & Porter	Winnebago	Neenah	1874	
Knapp & Fowler	Winnebago	Neenah	1874	
Henry Christman	Kewaunee	Montpelier	1874	
Partridge, Truman & Co.	Marathon	Spencer	1874	
Kerr, Kelter & Co.	Marathon	Spencer	1874	
J. L. Robinson	Marathon	Spencer	1874	
Hoskins & Roe	Wood	Auburndale	1874	
Duncan, Taylor & Richie	Taylor	Westboro	1874	
Bradford, McCoy & Co.	Juneau	Necedah	1874	
H. Ketchum	Jackson	3 miles north of Merrillan	1874	
B. M. Holmes	Price	Ogema, Little Jump River	1874	
J. S. Anderson	St. Croix	Woodville	1874	1876
R. C. Evans	Clark	Dorchester	1874	
Hiram Goddard	La Crosse	French Island	1874	
William Allyne	St. Croix	Baldwin	1874	
North Western Lumber Co.	Eau Claire	Porterville (3 miles SW of Eau Claire on the Chippewa River)	1875	
L. M. Marshall	Taylor	Chelsea	1875	
E. K. Buttrick	Taylor	Stetsonville, a few miles south of Medford	1875	
B. H. Merrill	Jackson	1.5 miles west of Merrillan	1875	
Isaiah F. Stetson	Taylor	Stetsonville	1875	

Rudolf Otto	Vilas	Land O' Lakes	1875 (estimated)	1908
Reif Brothers	Manitowoc	Reifs Mills	1875 (estimated)	
John W. Wells	Marinette	Menominee River	1876	
Andrew Hassel	Kewaunee	Kewaunee River	1876	
J. W. Woodruff & Co.	Kenosha	Lily Lake	1876	
N. C. Foster	Eau Claire	Fairchild Township	1876	
William Stevens	Clark	Colby	1876	1877
J. D. Thomas	Clark	West of Colby	1876 (estimated)	
Knapp, Stout & Co.	Barron	Chetek Township	1876	1888
N. B. Holway	La Crosse	La Crosse	1877	
Fred Arlt	Door	Baileys Harbor	1877	
R. F. Wilson	Chippewa	Chippewa River just above Madison St. bridge	1878	
Sawyer Goodman Company	Marinette	Menekaunee, Menominee River	1878	
Unknown	Winnebago	Winneconne	1878	
E. McNutt	Winnebago	Winneconne	1878	
Campbell Brothers & Cameron	Winnebago	Oshkosh	1878	1890
R. W. Merryman	Marinette	Menominee River	1878	
Atlas Paper Company	Outagamie	Unknown	1878	
C. Upham & Brother	Wood	Marshfield	1878	
Union Mill Company	Ashland	Ashland	1878	
Karpe, Russell & Aldrich	Ashland	Butternut	1878	
George Parr, John Post & S. J. Parr	Barron	Barron	1878	
Wakefield, Trow & Co.	Jackson	1.5 miles east of Merrillan (Trow Lake)	1878	
Sterling D. Cone	Taylor	Westboro	1879	
William H. Upham	Wood	Marshfield	1879	
M. H. McCord & H. E. Howe	Lincoln	Merrill	1879	1881
Wausau Lumber Company	Marathon	Wausau	1879	
N. H. Withee	Clark	Hemlock	1879	
Karke, Russell & Aldrich	Ashland	Butternut	1879	
J. Demean, William Taylor & James Ritchie	Taylor	Westboro	1879	

C. C. Palmer	Taylor	Westboro	1879
Stephen H. Richardson	Barron	Turtle Lake	1879
William T. Everton & O. C. Meggs	St. Croix	Woodville	1879
W. G. & J. H. Wharton	Wood	Vesper	1879
Samuel Budgett	Douglas	Mouth of the Bois Brule River	1880
Dikeman	Kewaunee	Kewaunee River	1880
Anson Eldred	Brown	Fort Howard	1880
Frambach & Stovekin paper mill	Outagamie	Kaukauna	1880
Hewitt Bros.	Outagamie	Kaukauna	1880
A. W. Priest shingle mill	Outagamie	Kaukauna	1880
Valley Pulp and Paper	Outagamie	Unknown	1880
Sawyer Goodman Company	Marinette	Marinette, Menominee River	1880
W. W. Fry	Taylor	Medford	1880
C. G. Reul	Clark	Hemlock	1880
Potter and Ferguson Bros.	Clark	Colby	1880 (estimated)
E. Decker & Co.	Clark	2 miles below Colby	1880 (estimated)
Davis & Starr Lumber Co.	Taylor	Little Black	1880 (estimated)
Sprague Bros.	Barron	Sprague (south of Cumberland, no longer exists)	1880
T. P. Stone & J. C. Maxwell	Barron	Cumberland	1880
Mansfield & Lang	Barron	North Cumberland	1880
Hall & Co.	Marathon	Spencer	1880 (estimated)
Joseph Meyer	Portage	Little Eau Pleine River	1880 (estimated)
C. J. Kershaw & Co.	Marathon	Mannville (Spencer Township)	1880 (estimated)
Buckstaff Bros.	Marathon	Mannville (Spencer Township)	1880 (estimated)
B. F. McMillan & Bro.	Portage	Little Eau Pleine River	1880 (estimated)

John Magnus	Lafayette	Woodford	1880 (estimated)	
William F. Underhill	Oconto	Underhill	1880 (estimated)	
Unknown	Clark	Chili	1880 (estimated)	
George Hooper	Wood	Milladore	1880	
A. M. and J. S. Sherman	Polk	east bank of Half Moon Lake	1881	
Hall & Crozier	Marinette	Somewhere on the Green Bay shore	1881	
Spies & Martin	Marinette	Somewhere on the Green Bay shore	1881	
North Wisconsin Lumber Company (Anthony Judson Hayward)	Sawyer	Hayward	1881	
A. J. Fullerton & C. Schmall	Shawano	Hartland	1881	
Unknown	Shawano	Bonduel	1881	
A. K. Porter	Shawano	6 miles SE of Shawano	1881	
Newbold & Livingston	Shawano	Whitcomb	1881	
Paige-Sexsmith Lumber Company	Douglas	Connor's Point	1881	
M. H. McCord	Lincoln	Merrill	1881	
H. E. Howe	Lincoln	Merrill	1881	
C. K. Pier, Charles Mihills & Peter Skinner	Lincoln	Merrill	1881	
Champayne Lumber Co.	Lincoln	Merrill	1881	1896
P. A. Thayer	Marathon	Spencer	1881	
Mueller & Ritchie	Ashland	Ashland	1881	
Marathon Lumber Company	Marathon	Wausau	1881	
Arthur M. & John S. Sherman	Eau Claire	Eau Claire, east side of Half Moon Lake	1881	
Superior Lumber Company	Bayfield	Chequamegon Bay	1881	
Sterling Lumber Company	Clark	Sterling	1881	
Daniel Shaw	Eau Claire	Eau Claire	1882	

Jump River Lumber Company	Price	Prentice	1882	
Phillips Lumber Co.	Price	Phillips on Elk Lake	1882	
Tolman, Conroe & Co.	Oneida	Rhinelander	1882	
Brown Bros.	Oneida	Rhinelander	1882	
R. M. Moore/Sawyer & Austin Company	La Crosse	North La Crosse	1882	
McDonald Brothers	La Crosse	North La Crosse, just below Sawyer & Austin mill	1882	
Rust-Owen Lumber Company	Bayfield	Drummond	1882	
Joseph Suring	Oconto	Suring	1882	
J. J. Kennedy	Taylor	Rib Lake	1882	1948
W. S. Monroe & Daniel Clarke	Chippewa	Cadotte Falls	1883	
Barronett Lumber Company	Barron	Barronett	1883	
Shell Lake Lumber Company	Washburn	Shell Lake	1883	
John R. Davis Lumber Co.	Price	Phillips	1883	
Bray & Tolman	Lincoln	Merrill	1884	1888
T. B. Scott Lumber Company	Lincoln	Merrill	1884	
Mr. Barber, later (1901) Schroeder	Ashland	Ashland	1884	1939
Unknown	Shawano	Birnamwood	1884	
R. C. Brown & C. F. Wallace	Richland	Basswood	1884	
Robert Corbett	Rusk	Ladysmith	1885	
Northern Pine Land Company	Bayfield	Washburn	1885	1924
Kirby-Carpenter Co.	Marinette	Menominee River	1886	
S. J. Murphy Lumber Co.	Brown	Green Bay	1886	
Tomahawk Lumber Co.	Lincoln	Tomahawk	1886	
Hall & Dunn Barrel Company	Barron	Barron	1886	
Glenwood Manufacturing Company	St. Croix	Glenwood	1886	

W. B. Judd	Barron	Barron	1886	
A. A. Bigelow & Co.	Bayfield	Washburn	1886	1905
Rood & Maxwell	Bayfield	Washburn	1886	1917
Baird & Robbins	Oneida	Rhinelander	1887	
Poskin Lake Lumber Co.	Barron	Poskin Lake	1887	
Cyrus Yawkey	Oneida	Hazelhurst	1887	
Olsen & Fry	Oneida	Rhinelander	1888	
Stevens mill	Oneida	Rhinelander	1888	
Willis Glaze	Barron	Chetek Township	1888	
King & Weymouth	Lincoln	Tomahawk	1888	
Glen Flora Manufacturing Co.	Rusk	Glen Flora on Duncan Creek	1888	
Bradley & Kelly Lumber Company	Oneida	McNaughton	1888	
Girard Lumber Company	Marinette	Dunbar	1889	
West Superior Lumber Company	Douglas	Connor's Point	1889	
Hatton & Micklejohn	Waupaca	New London	1889	
Rhinelander Lumber & Shingle Company	Oneida	Rhinelander	1889	1893
Soo Lumber Company	Oneida	Rhinelander	1889	1895
Fifield Manufacturing Company	Price	Fifield	1889	
Prairie River Lumber Company	Langland County	Parish	1889	
J. W. Stone	Barron	Turtle Lake	1890	
Andrews & Perley	Barron	Perley	1890	
Buttrick Mill	Oneida	Rhinelander	1890	1897
F. Turcot	Rusk	Ingram on Main Creek	1890	
Parr Manufacturing Co.	Barron	Barron	1890	
George Wood	Oneida	Woodboro	1890 (estimated)	
Crane Bros.	Lincoln	Tomahawk	1890	1904
Alexander Rodgers	Lincoln	Tomahawk	1890	
John B. & Antoine Arpin	Wood	Arpin	1890	
E. S. Koepenick	Langlade	Koepenick	1890 (estimated)	

Parr Manufacturing Co.	Barron	Barron		1891	
Beaver Dam Lumber Co.	Barron	Cumberland		1891	
Montreal Lumber Company	Chippewa	Stanley		1891	
William Knight	Bayfield	Roy's Point		1891	1913
Ellis, Hopkins & Knowles	Bayfield	Bayfield		1891	
W. D. Connor	Marathon	Stratford (Big Eau Pleine)		1891	
David K. Jeffris	Lincoln	Jeffris		1891	
Ellis, Hopkins & Knowles	Bayfield	2 miles from Bayfield		1891	
Northwestern Lumber Co.	Chippewa	Stanley		1892	
Lake Shore Lumber Company	Oneida	Tomahawk Lake		1892	
Campbell Brothers & Cameron	Waupaca	Helvetia		1894	
John Ross	Vilas	Arbor Vitae		1894	
J. S. Stearns Lumber Co.	Ashland	Odanah		1894	
Williams & Salisch Lumber Company	Vilas	Star Lake		1894	
Fred Newbold	Shawano	Tigerton		1894	
Fifield Lumber Company	Price	Fifield		1895	
McCord-Ogilvie Lumber Co.	Douglas	Superior		1895	
W. H. Bradley (possibly Hall & Munson Co.)	Bayfield	Bay Mills		1895	
Thompson & Bonnell Lumber Company	Vilas	Phelps		1896	
Brooks & Ross Lumber Co.	Marathon	Schofield		1897	
Rib River Lumber Company	Oneida	Rhinelander		1897	
Everett Brooks	Marathon	Schofield		1897	
Red Cliff Lumber Company	Bayfield	Northern end of Buffalo Bay		1898	1910
Farmers' Cooperative	Langlade	Deerbrook		1898	
Unknown	Bayfield	Port Wing	1900 (estimated)		1915
Unknown (possibly Cranberry Lumber Company)	Bayfield	Herbster	1900 (estimated)		

Ed Hawn	Chippewa	Ruby (Arnold)	1901	
Cornucopia Land Company	Bayfield	Cornucopia	1902	
Franklin P. Hiles	Forest	Hiles	1903	
J. J. Foster	Vilas	Presque Isle	1905	
Menominee Indian Reservation	Menominee	Neopit	1908	
James B. Goodman	Marinette	Goodman	1908	
Thompson & Fleith	Bayfield	Cornucopia	1908	
Kurz-Downey Company	Bayfield	Roy's Point	1910	1913
Bronson	Chippewa	Chippewa Falls	Sometime before 1845	
Wisconsin Valley Lumber Company	Calumet	Harrison	1870s (estimated)	
Lawrence & Peters	Marathon	Mosinee	Early to mid 1800s	
Brooks & Ross Lumber Co.	Marathon	Weston	Pre 1880 (estimated)	
D. B. Lyons & Son	Jackson	Halls Creek, north branch, two miles north of the village	Pre 1880	
Nelson Beckwith	Juneau	Necedah	Pre 1880 (estimated)	
William & Theodore Douglas	Jackson	Black River Falls	sometime between 1840-1850 (estimated)	
Montreal Lumber Company	Iron	Hurley	Pre 1880 (estimated)	

Appendix Table 7: Descriptive table of historical lumber mills in Minnesota. Table consists of information included in the historical lumber mill GIS shapefile layer. Lumber mills are listed chronologically by the date of establishment.

Name	County	Specific Location Details	Date of Establishment	Date Closed
Government Mill	Hennepin	St. Anthony (Minneapolis)	1822	
Marine Lumber Company	Washington	Marine	1839	1889
Jesse Taylor & Henry Baker	Chisago	Taylors Falls	1840	
Stillwater Lumber Company	Washington	Stillwater	1844	
Franklin Steele	Hennepin	St. Anthony (Minneapolis)	1848	
Moses Perin/Freeman C. Tyler	Washington	Lakeland	1852	
Hersey & Bean Lumber Co.	Washington	Stillwater	1853	1904
Hersey, Staples, and Company	Washington	Stillwater	1854	
F. Schulenburg, A. Boeckler & Company	Washington	Stillwater	1855	
James Highland & James Wycoff	Winona	Winona	1855	
Farnham	Hennepin	Hennepin Island	1855	
Highland & Wycoff	Winona	Winona	1855	

Laird Brothers	Winona	Winona		1855	
Henry W. Wheeler	St. Louis	Duluth (Oneota)		1856	
Major Bassett	Hennepin	Minneapolis, mouth of Bassett Creek		1856	1858
Edwin F. Ely	St. Louis	Oneata (Duluth)		1856	
Wieland Bros.	Lake	Beaver Bay		1856	
Keeley	St. Louis	Duluth, 2 miles up the bay shore from Ely's		1856	1859 (estimated)
Lewis Merritt	St. Louis	Duluth (Oneota)	1857 (estimated)		
Red Lake Indian Reservation	Beltrami	Red Lake		1856	
A. Marr & Co.	Hennepin	Minneapolis, east bank of the river		1857	
E. S. & A. B. Youmans	Winona	Winona		1857	1898
Laird, Norton & Co.	Winona	Winona		1857	
J. J. Hibbard	Lake	Burlington Bay		1857	
Hale, Faye & Company	Washington	Lakeland		1857	
C. N. Nelson Lumber Company	Washington	Lakeland		1857	

Unknown	Stearns	St. Cloud, Mississippi River	1859
Major Bassett & Isaac Gilpatrick	Hennepin	St. Anthony's Falls	1859
F. Schulenburg, A. Boeckler & Company	Washington	Stillwater, on the st croix river	1860
George E. Nettleton	St. Louis	Minnesota Point	1860 (estimated)
Edward Jones	Hennepin	Minneapolis, west side of the river	1861
W. P. Aukney, J. B. Robinson & C. H. Pettit	Hennepin	Minneapolis, west side of the river, adjoining the Jones mill	1862
Dorillus Morrison	Hennepin	Minneapolis, west side of the river, adjoining the Aukney mill	1863 (estimated)
W. D. Washburn	Hennepin	Minneapolis, west side of the river, between Morrison & Aukney mills	1863
Merriman, Barrows & Co.	Hennepin	Minneapolis, lower east bank of the river	1864
Cook, Gaines & Co.	Hennepin	Minneapolis, lower east bank of the river, adjoining the Merriman mill	1865 (estimated)
W. D. Washburn	Hennepin	Minneapolis	1865
R. C. Libbey	Dakota	Hastings	1865
John Martin Lumber Co.	Hennepin	Minneapolis, lower east bank of the river	1867

W. W. Eastman	Hennepin	Minneapolis, lower east bank of the river	1867 (estimated)	
Major Bassett	Hennepin	Minneapolis	1867	
Unknown	Beltrami	Mill Creek (or Pike Creek, Red Lake)	1868	
L. G. Hughes	St. Louis	Minnesota Point, below the canal	1869	
Youmans brothers & Hodges	Winona	Winona	1870	
Sherwood, Ely & Hostein	St. Louis	Duluth (Minnesota Point)	1870	
J. M. Paine	St. Louis	Duluth (Oneota)	1870	
Weld & Petrie	St. Louis	Rice's Point, west side	1870	
Miller & Wyncoop	Carlton	Thomson	1870	
E. A. Gyde	Aitkin	Aitkin	1870	
Emil D. Munch	Washington	Lakeland	1870 (estimated)	
Patterson, McWade & Co.	St. Louis	Duluth, just below the canal	1871	1875 (estimated)
Nelson-Tenney Co.	Hennepin	Minneapolis	1872	
Joseph Dean & Co.	Hennepin	Minneapolis	1872	

W. D. Washburn	Anoka	Anoka, mouth of the Rum River	1872	1889
A. P. Foster	Winona	Winona	1872	
Bedford, Boyce & Baker	Hennepin	Minneapolis	1873	
Reed & Sherwood	Anoka	Anoka, bank of the Rum River	1875	
Levi Butler	Hennepin	Minneapolis, east bank of the river	1877	
Unknown	Carlton	Cloquet	1878	
Laird, Norton & Company	Winona	Winona	1879	1887
C. N. Nelson Lumber Co.	Carlton	Cloquet	1879	
Winona Lumber Company	Winona	Winona	1880	
Pillsbury's	Crow Wing	Gull Lake	1880	
Unknown	St. Louis	Tower	1880 (estimated)	
Cutler, Gilbert & Pearson	St. Louis	Rice's Point	1880	

John S. Taylor	St. Louis	Duluth	1880	1885
R. A. Gray/Cranberry Lumber Co.	St. Louis	Rice's Point	1880	
Smith & Richardson - Diamond Mill	Hennepin	Minneapolis	1881	
Winona Lumber Company	Winona	Winona	1881	
Taylor, Fish & Haupt	St. Louis	Rice's Point	1881	1885
Graff, Little & Co.	St. Louis	Rice's Point	1881	
J. W. Norton & Co.	St. Louis	Rice's Point	1881	
Duluth Lumber Co.	St. Louis	Duluth	1881	
W. T. Bailey	St. Louis	Duluth	1881	
Nathaniel Leighton & F. C. Barrows	Hennepin	Plymouth	1882	
Northern Lumber Co. Lower Mill	Carlton	Cloquet	1882	
Crookston Lumber Co.	Polk	Crookston	1882	

Scott & Holston	St. Louis	West Duluth	1882	
T. B. Walker	Polk	Crookston	1883	
Heimbach, Dailey & La Chappelle	St. Louis	Minnesota Point	1883	1885
W. P. Heimbach	St. Louis	New Duluth	1883 (estimated)	
John Owens	St. Louis	Tower	1884	
Henry Fall & R. H. McCoy	Washington	Lakeland	1885	
Stetson & Clough Brothers	Hennepin	Minneapolis	1885	
Northern Mill Company	Hennepin	Minneapolis	1885	
J. Neils Mill Co.	Benton	Sauk Rapids	1885	
Ingram & Kennedy	Winona	Winona	1886	
Hall & Shevlin Company	Hennepin	Minneapolis	1886	
Empire Lumber Co.	Winona	Winona	1886	

Cloquet Lumber Co.	Carlton	Cloquet	1886
Hubbard & Vincent	St. Louis	West Duluth	1886
Duncan, Brewer & Company	St. Louis	Duluth	1887
Howe Lumber Company	St. Louis	Tower	1888
Mitchell, McClure & Company	St. Louis	Duluth	1890
Pine Tree Lumber Company	Morrison	Little Falls	1890
Merrill & Ring	St. Louis	Duluth	1891
Mitchell & McClure	St. Louis	West Duluth	1891
Rutledge Lumber Co.	Pine	Willow River	1891
Swallow & Hopkins	St. Louis	Winton	1892
Finlayson	St. Louis	Virginia	1893
Saginaw Lumber Company	St. Louis	West Duluth	1893

Duncan, Brewer & Co.	St. Louis	West Duluth	1893	
Huntress & Brown Lumber Co.	St. Louis	West Duluth	1893	
Knox Lumber Co.	St. Louis	Ely	1893	1923
J. D. Reekie, Virginia & Frank Hibbing	St. Louis	Hibbing	1893	
C. S. Murray & Co.	St. Louis	Duluth, upper bay	1894	
B. B. Richards Lumber Co.	St. Louis	New Duluth	1894 (estimated)	
W. T. Bailey Lumber Co.	St. Louis	Virginia	1894	
Brainerd Lumber Co.	Crow Wing	Brainerd	1894	
G. W. Foutsch	Wright	Delano	1894	
Lesure Lumber Co.	St. Louis	West Duluth	1895	
Atwood Lumber Co.	Pine	Willow River	1895	
Foley-Bean Lumber Co.	Mille Lacs	Milaca	1895	

Commonwealth Lumber Co.	Becker	Frazee	1896	
Hodgedon & McDonald	Aitkin	Aitkin	1896	
Helec Clementson	Lake of the Woods	Rainy River, on the mouth of Rapid River in Gudrid Township (Clementson)	1896	
St. Hilaire Lumber Co.	Pennington	St. Hilaire	1897	
E. J. Sveback	Beltrami	Bemidji	1897	
Unknown	Wright	St. Michael (Crow River)	1898	
Alger, Smith and Company	St. Louis	Duluth (Knife River)	1899	
Park Rapids Lumber Co.	Hubbard	Park Rapids	1899	
East Grand Forks Lumber Co.	Polk	East Grand Forks	1899	
Unknown	Beltrami	Blackduck	1899	
T. B. Walker/Red River Lumber Company	Hubbard	Akeley	1899	1915
Thief River Falls Lumber Co.	Pennington	Thief River Falls	1900	

St. Croix Lumber Co.	St. Louis	Winton	1900
J. Neils Lumber Co.	Cass	Cass Lake	1900
Unknown	St. Louis	Chisholm	1900
Johnson & Wentworth Lumber Co.	Carlton	Barnum	1900 (estimated)
Itasca Paper Co.	Itasca	Grand Rapids	1902
Unknown	Beltrami	Black Duck	1904
Red Lake Indian Reservation	Beltrami	Red Lake	1907
Andrew Hedstrom	Cook	Devil Track River	1914
Red Lake Indian Reservation	Beltrami	Redby	1924

Appendix Table 8: Descriptive table of historical mines in Upper Michigan. Table contains the information included in the historical mine GIS shapefile layer. Mines are listed chronologically by year opened. Data provided by USGS Mineral Resource Data System (MRDS) & Mineral Availability System/Mineral Industry Locator System (MAS/MILS).

Name	County	Year Opened	Commodity
Lafayette Mine	Ontonagon	1844	Copper
Phoenix Fissure Mine	Keweenaw	1844	Copper
Boston & North American Silver Prospect	Ontonagon	1845	Silver
Douglass Houghton Exploration	Houghton	1845	Copper
Cliff Fissure	Keweenaw	1845	Copper
Northwestern Fissure	Keweenaw	1845	Copper
Old Copper Falls Mine	Keweenaw	1845	Copper
Ohio Trap Rock Mine	Ontonagon	1846	Copper
Mendenhall Mine	Ontonagon	1846	Copper
Union Mine	Ontonagon	1846	Copper
North American Mine	Keweenaw	1846	Copper
Lac La Belle	Keweenaw	1846	Copper
Epidote Mine	Keweenaw	1846	Copper
Datolite Mine	Keweenaw	1846	Copper
New York and Michigan Exploration	Keweenaw	1846	Copper
Agate Harbor Mine	Keweenaw	1846	Copper
Algonquin Mine	Ontonagon	1847	Copper
Delaware Mine	Keweenaw	1847	Copper
Siskowit Mine	Keweenaw	1847	Copper
Suffolk Exploration	Keweenaw	1847	Copper
Cliff	Keweenaw	1847	Silver, Copper
Minesota Mine	Ontonagon	1848	Copper
National Mine	Ontonagon	1848	Copper
Bohemian Mine	Ontonagon	1848	Copper
Marquette Iron District	Marquette	1848	Iron
Victoria Mine (Cushin)	Ontonagon	1849	Copper
Old Mass Mine	Ontonagon	1849	Copper
Boston & Lake Superior Exploration	Ontonagon	1849	Copper
Cleveland Mine	Marquette	1849	Iron
Cleveland Lake Group	Marquette	1849	Iron
Norwich Mine	Ontonagon	1850	Copper
Mass Consolidated Mine	Ontonagon	1850	Copper
Victoria	Ontonagon	1850	Copper
Peninsula Mine	Ontonagon	1850	Copper
Hudson Mine	Ontonagon	1850	Copper
Hilton Mine	Ontonagon	1850	Copper

Henwood Mine (Douglass Houghton)	Ontonagon	1850	Copper
Lac La Belle Exploration	Keweenaw	1850	Copper
Mendota Mine	Keweenaw	1850	Copper
Adventure Consolidated Mine	Ontonagon	1851	Copper
Wheal Kate Prospect	Houghton	1851	Copper
Medora Mine	Keweenaw	1851	Copper
Star Mine	Keweenaw	1851	Copper
Dana Mine	Keweenaw	1851	Copper
Aztec	Ontonagon	1852	Copper
Norwich	Ontonagon	1852	Copper
United States Exploration	Ontonagon	1852	Copper
Sharon Mine	Ontonagon	1852	Copper
Merryweather Prospect	Ontonagon	1852	Copper
Firesteel Mine	Ontonagon	1852	Copper
Derby Mine	Ontonagon	1852	Copper
Pittsburg Mine	Ontonagon	1852	Copper
Isle Royale Amygdaloid	Houghton	1852	Copper
Hanover Mine	Keweenaw	1852	Copper
Hill Fissure Mine	Keweenaw	1852	Copper
Childs Fissure Mine	Keweenaw	1852	Copper
Flintsteel River Mine	Ontonagon	1853	Copper
Rockland Mine	Ontonagon	1853	Copper
National	Ontonagon	1853	Copper, Silver
Toltec	Ontonagon	1853	Copper
Clifton Mine	Ontonagon	1853	Copper
Fulton Fissure	Keweenaw	1853	Copper
Isle Royale Mine	Houghton	1853	Copper
Isle Royale	Houghton	1853	Copper, Silver
Montezuma Prospect	Houghton	1853	Copper
Webster Prospect	Houghton	1853	Copper
Eagle Exploration	Houghton	1853	Copper
Meadow Mine	Keweenaw	1853	Copper
Humboldt Mine	Keweenaw	1853	Copper
Gratiot Lake Project	Keweenaw	1853	Copper
Eagle River Mine	Keweenaw	1853	Copper
Rockland	Ontonagon	1854	Copper, Silver
Erie-Ontario Mine	Houghton	1854	Copper
Cleveland Lake Mine	Marquette	1854	Iron
Central Mine	Keweenaw	1854	Copper
Cape Mine	Keweenaw	1854	Copper
Washington Mine	Keweenaw	1854	Copper
Owl Creek Fissure Mine	Keweenaw	1854	Copper
Nebraska	Ontonagon	1855	Copper
What Cheer Mine	Ontonagon	1855	Copper
Atlantic Amygdaloid	Houghton	1855	Copper

Huron Mine	Houghton	1855	Copper
Phoenix Ashbed	Keweenaw	1855	Copper, Silver
Minesota	Ontonagon	1856	Copper, Silver
Quincy Mine	Houghton	1856	Copper, Silver
Quincy	Houghton	1856	Copper, Silver
Madison Fissure	Keweenaw	1856	Copper
Old Mass	Ontonagon	1857	Copper, Silver
Pewabic Amygdaloid	Houghton	1857	Copper
Carp Lake Mine	Ontonagon	1858	Copper
Lake Superior Group	Marquette	1858	Iron
Lake Superior Group	Marquette	1858	Iron
Lone Rock Silver Prospect	Ontonagon	1859	Silver
Mesnard Mine	Houghton	1859	Copper
Garden City Mine	Keweenaw	1859	Copper
North Cliff	Keweenaw	1859	Copper
Superior	Ontonagon	1860	Copper
Brooklyn Mine	Ontonagon	1860	Copper
South Side Mine	Houghton	1860	Copper
Marquette Prospect	Marquette	1860	Iron
Marquette Mine	Marquette	1860	Iron
Arnold Copper Mine	Keweenaw	1860	Copper
Hancock Mine	Houghton	1861	Copper
Petherick Mine	Keweenaw	1861	Copper
Indiana Mine	Ontonagon	1862	Copper
Oneco Exploration	Houghton	1862	Copper
Franklin Junior Mine	Houghton	1862	Copper
Copper Falls	Keweenaw	1862	Copper
Phoenix Fissure	Keweenaw	1863	Copper, Silver
Caledonia Mine (Nebraska)	Ontonagon	1863	Copper
Eureka Mine	Ontonagon	1863	Copper
Arcadian Mine	Houghton	1863	Copper
Saint Mary's Mine	Houghton	1863	Copper
Ripley Exploration	Houghton	1863	Copper
Phoenix Mine	Marquette	1863	Iron
Winthrop Mine	Keweenaw	1863	Copper
Cherokee Mine	Ontonagon	1864	Copper
Hartford Mine	Ontonagon	1864	Copper
Lake Angeline Mine	Marquette	1864	Iron
Lake Angeline Mine	Marquette	1864	Iron
New York Mine	Marquette	1864	Iron
Marquette Silver Prospect	Marquette	1864	Silver
Holyoke Silver Mine	Marquette	1864	Silver
New York Mine	Marquette	1864	Iron
Allouez Conglomerate Lode	Keweenaw, Houghton	1864	Copper

Aetna Exploration Copper Mine	Keweenaw	1864	Copper
Vulcan Exploration Copper Mine	Keweenaw	1864	Copper
Eagle Harbor Mines	Keweenaw	1864	Copper
Girard Exploration	Keweenaw	1864	Copper
Resolute Mine	Keweenaw	1864	Copper
Calumet and Hecla Conglomerate Lode	Houghton	1865	Copper
Calumet No.1	Houghton	1865	Copper
Calumet No 2	Houghton	1865	Copper
Lake Sally Reserve	Marquette	1865	Iron
Humboldt (Old) Mine	Marquette	1865	Iron
Lake Sally Mine	Marquette	1865	Iron
St. Clair Fissure	Keweenaw	1865	Copper
Bluff Wyoming Mine	Keweenaw	1865	Copper
Atlantic Mine	Houghton	1866	Copper
Atlantic	Houghton	1866	Copper
New England Mine	Marquette	1866	Iron
Sampson Mine	Marquette	1866	Iron
New England Mine	Marquette	1866	Iron
Tilden Mine	Marquette	1866	Iron
Nonesuch Mine	Ontonagon	1867	Copper
Champion Mine	Marquette	1868	Iron
Foster Mine	Marquette	1868	Iron
Foster	Marquette	1868	Iron
Champion Mine	Marquette	1868	Iron
Centennial Mine	Houghton	1869	Copper
Centennial No. 3-6	Houghton	1869	Copper
Winthrop Mine	Marquette	1869	Iron
Allouez Mine	Keweenaw	1869	Copper
Allouez	Keweenaw	1869	Copper
Naumkeag Mine	Houghton	1870	Copper
Tracy Mine	Marquette	1870	Iron
Lucy Mine	Marquette	1870	Iron
Winthrop	Marquette	1870	Iron
Lucy Mine	Marquette	1870	Iron
Rolling Mill Mine	Marquette	1871	Iron
Volunteer (Old) Mine	Marquette	1871	Iron
Rolling Mill Mine and Kruse Open	Marquette	1871	Iron
Old Volunteer Mine-Includes Palme	Marquette	1871	Iron
Scranton Silver Mine	Ontonagon	1872	Silver
Huron Bay Slate Co	Baraga	1872	Slate, Dimension
Michigamme Mine	Marquette	1872	Iron
Albion Mine	Marquette	1872	Iron
East Champion	Marquette	1872	Iron
Excelsior Prospect	Marquette	1872	Iron
Michigan Prospect	Marquette	1872	Iron

Mitchell Mine	Marquette	1872	Iron
Republic Mine	Marquette	1872	Iron
Saginaw Mine	Marquette	1872	Iron
Salisbury Mine	Marquette	1872	Iron
Princeton Mine	Marquette	1872	Iron
Albion Mine	Marquette	1872	Iron
Republic Mine	Marquette	1872	Iron
Saginaw Mine	Marquette	1872	Iron
Mitchell Mine	Marquette	1872	Iron
Michigamme	Marquette	1872	Iron
Excelsior Mine	Marquette	1872	Iron
Salisbury Mine	Marquette	1872	Iron
Michigan Mine	Marquette	1872	Iron
Princeton Mine- Includes No.1, No	Marquette	1872	Iron
Clark	Keweenaw	1872	Copper
Island Mine	Keweenaw	1872	Copper
Seneca No. 2 Mine	Keweenaw	1872	Copper
Seneca No. 1 Mine	Keweenaw	1872	Copper
Superior Silver Mine	Ontonagon	1873	Silver
Ontonagon Silver Mine	Ontonagon	1873	Silver
Mammoth Silver Prospect	Ontonagon	1873	Silver
Beaser Silver Prospect	Ontonagon	1873	Gold
Spurr Mine	Baraga	1873	Iron
Spurr Mine	Baraga	1873	Iron
Carr Mine	Marquette	1873	Iron
Columbia Mine	Marquette	1873	Iron
Goodrich Prospect	Marquette	1873	Iron
Himrod Prospect	Marquette	1873	Iron
Howell-Hoppock Prospect	Marquette	1873	Iron
Moore Mine	Marquette	1873	Iron
Star West	Marquette	1873	Iron
Howell-Hoppock	Marquette	1873	Iron
Goodrich	Marquette	1873	Iron
Mexican Mine	Marquette	1873	Iron
Columbia Mine	Marquette	1873	Iron
East Champion Mine	Marquette	1873	Iron
Moore	Marquette	1873	Iron
Star West Mine	Marquette	1873	Iron
Cleveland Silver Prospect	Ontonagon	1874	Silver
Steward Mine (Orleans)	Baraga	1874	Iron
Steward	Baraga	1874	Iron
Cambria-Jackson Mine	Marquette	1875	Iron
Cambria-Jackson Mine	Marquette	1875	Iron
Minong Mine	Keweenaw	1875	Copper
Saginaw Mine	Keweenaw	1875	Copper

Erie Mine	Marquette	1876	Iron
Erie Mine	Marquette	1876	Iron
Menominee Iron District (Range)	Dickinson	1877	Iron
Breen Mine	Dickinson	1877	Iron
Penn Mines	Dickinson	1877	Iron
Emmett Mine	Dickinson	1878	Iron
Quinnesec Mine	Dickinson	1878	Iron
National Mine	Marquette	1878	Iron
National Mine	Marquette	1878	Iron
Osceola Amygdaloid	Houghton	1879	Copper
Osceola No.1	Houghton	1879	Copper
Osceola	Houghton	1879	Copper
Osceola No. 2	Houghton	1879	Copper
Saginaw Mine	Dickinson	1879	Iron
Stephenson Mine	Dickinson	1879	Iron
Chicago Prospect	Marquette	1879	Iron
Milwaukee-Davis Mine	Marquette	1879	Iron
Section 12 Mine	Marquette	1879	Iron
Chicago Mine	Marquette	1879	Iron
Section 12	Marquette	1879	Iron
Taylor Mine	Baraga	1880	Iron
Taylor Mine	Baraga	1880	Iron
Mabbs Mine	Houghton	1880	Copper
Chapin Mine	Dickinson	1880	Iron
Globe-Cornell Mine	Dickinson	1880	Iron
Ludington Mine	Dickinson	1880	Iron
Pewabic Mine	Dickinson	1880	Iron
American Mine	Marquette	1880	Iron
American Mine	Marquette	1880	Iron
Mather B Mine	Marquette	1880	Iron
Bjork & Ludin Gold Prospect	Marquette	1880	Gold
Babbitt Fissure	Keweenaw	1880	Copper
Nanaimo Mine	Iron	1881	Iron
South Mastodon Mine	Iron	1881	Iron
Millie Mine	Dickinson	1881	Iron
Phoenix	Marquette	1881	Iron
Clark Manganese Deposit	Keweenaw	1881	Manganese
Webster Mine	Baraga	1882	Iron
Titan Mine	Baraga	1882	Iron
Beaufort Mine	Baraga	1882	Iron
Imperial Mine (Wetmore)	Baraga	1882	Iron
Imperial Mine	Baraga	1882	Iron
Webster Mine	Baraga	1882	Iron
Titan Mine	Baraga	1882	Iron
Beaufort Mine	Baraga	1882	Iron

Youngstown Mine	Iron	1882	Iron
Fairbanks	Iron	1882	Iron
Mastedon Mine	Iron	1882	Iron
Great Western Mine	Iron	1882	Iron
Balkan-Judson Mine	Iron	1882	Iron
Columbia Mine	Iron	1882	Iron
Alpha Mine	Iron	1882	Iron
Nanaimo	Iron	1882	Iron
Mastadon	Iron	1882	Iron
Great Western Mine	Iron	1882	Iron
Paint River	Iron	1882	Iron
Columbia Mine	Iron	1882	Iron
Crystal Falls Mine	Iron	1882	Iron
Lot 3 #1 Mine	Iron	1882	Iron
Tamarack Mine	Houghton	1882	Copper
Wolverine Mine	Houghton	1882	Copper
Brier Hill Prospect	Dickinson	1882	Iron
Calumet Mine	Dickinson	1882	Iron
Indiana Mine	Dickinson	1882	Iron
Metropolitan Mine	Dickinson	1882	Iron
Detroit Mine	Marquette	1882	Iron
Non Pareil Mine	Marquette	1882	Iron
Pascoe Mine	Marquette	1882	Iron
Wicks Prospect	Marquette	1882	Iron
Ropes Mine	Marquette	1882	Gold, Silver
Ropes	Marquette	1882	Gold
Pascoe Mine	Marquette	1882	Iron
Detroit Mine	Marquette	1882	Iron
Nonpariel	Marquette	1882	Iron
Lowthian Mine	Marquette	1882	Iron
Marquette Exploration	Baraga	1883	Gold
Delphic Mine	Iron	1883	Iron
Delphic Mine	Iron	1883	Iron
Northwestern Mine	Dickinson	1883	Iron
Manganese Mine	Marquette	1883	Iron
Chase Mine	Marquette	1883	Iron
Manganese Mine	Marquette	1883	Iron
Calumet Gold Exploration	Marquette	1883	Gold
Madden & Hogan Exploration	Marquette	1883	Gold
Alger Gold Prospect	Marquette	1883	Gold
Milwaukee-Davis Mine	Marquette	1884	Iron
Berringer & Thurber Gold Exploration	Marquette	1884	Gold
Foley & Adams Gold Prospect	Marquette	1884	Gold
Phillips Gold Exploration	Marquette	1884	Gold
Ruppe Prospect	Marquette	1884	Gold

Colby Mine	Gogebic	1884	Iron
Ashland Mine	Gogebic	1884	Iron
Penokee Group	Gogebic	1884	Iron
Peterson Mine (as of 1951)	Gogebic	1884	Iron
Colby Mine	Gogebic	1884	Iron
Ashland Mine	Gogebic	1884	Iron
Summitt Prospect	Gogebic	1884	Gold
Holland Prospect	Gogebic	1884	Gold
Gogebic Iron District (Range)	Gogebic	1884	Iron
Grummett (Ned Lake) Exploration	Baraga	1885	Gold
Gibson Mine	Iron	1885	Iron
Gibson Mine	Iron	1885	Iron
Gibson Prospect	Marquette	1885	Iron
Gibson	Marquette	1885	Iron
Breitung Gold Exploration	Marquette	1885	Gold
Gordon Gold Exploration	Marquette	1885	Gold
Morgan Gold Prospect	Marquette	1885	Gold
Sunday Lake Group Mines	Gogebic	1885	Iron
Sunday Lake Group	Gogebic	1885	Iron
Townsite Mine	Gogebic	1885	Iron
North Norrie	Gogebic	1885	Iron
Penokee Group	Gogebic	1885	Iron
Beta Mine	Iron	1886	Iron
Beta Mine	Iron	1886	Iron
Lackawanna Mine	Marquette	1886	Iron
Pioneer Mine	Marquette	1886	Iron
Pioneer	Marquette	1886	Iron
Lackawanna	Marquette	1886	Iron
Regent Group- Includes: Prince Of	Marquette	1886	Iron
Queen Group- Now Includes Buffalo	Marquette	1886	Iron
Regent Group	Marquette	1886	Iron
Grummett Gold Prospect	Marquette	1886	Gold
Coon Gold Exploration	Marquette	1886	Gold, Copper
Puritan Mine	Gogebic	1886	Iron
Ironton Mine	Gogebic	1886	Iron
Yale Mine	Gogebic	1886	Iron
Newport Mine	Gogebic	1886	Iron
Puritan Mine	Gogebic	1886	Iron
Ironton Mine	Gogebic	1886	Iron
Newport Mine	Gogebic	1886	Iron
Yale Mine	Gogebic	1886	Iron
Norwood Mine	Baraga	1887	Iron
Dunn Mine	Iron	1887	Iron
Lee Peck Mine	Iron	1887	Iron
Dunn	Iron	1887	Iron

South Mastadon		Iron	1887	Iron
Kearsarge Amygdaloid		Houghton	1887	Copper
Kearsarge Amygdaloid No.1		Houghton	1887	Copper
Kearsarge Amygdaloid No.2		Houghton	1887	Copper
Cliffs Shaft Mine		Marquette	1887	Iron
Hortense Mine		Marquette	1887	Iron
Negaunee Mine		Marquette	1887	Iron
Richards Prospect		Marquette	1887	Iron
Cliffs Shaft Mine	Includes	Marquette	1887	Iron
Negaunee Mine		Marquette	1887	Iron
Richards		Marquette	1887	Iron
Hortense		Marquette	1887	Iron
Michigan Gold Mine		Marquette	1887	Gold
Seneca		Keweenaw	1887	Copper
Anvil-Palms-Keweenaw Group		Gogebic	1887	Iron
Geneva Mine		Gogebic	1887	Iron
Anvil-Palms-Keeweenaw Group		Gogebic	1887	Iron
Geneva Mine		Gogebic	1887	Iron
Hancock Exploration		Baraga	1888	Gold
Riverside Mine		Marquette	1888	Iron
Riverside		Marquette	1888	Iron
Lake Superior / Detroit Exploration		Marquette	1888	Gold
Peninsula Gold Prospect		Marquette	1888	Gold
Grayling Gold Prospect		Marquette	1888	Gold
Brown Gold Prospect		Marquette	1888	Gold
Mockler Gold Exploration		Marquette	1888	Gold
Armania Mine		Iron	1889	Iron
Hemlock Mine		Iron	1889	Iron
Lamont Mine		Iron	1889	Iron
Sheridan Mine		Iron	1889	Iron
Armenia Mine		Iron	1889	Iron
Lamont Mine		Iron	1889	Iron
Sheridan		Iron	1889	Iron
Aragon Mine		Dickinson	1889	Iron
Superior Gold & Silver Exploration		Marquette	1889	Gold, Silver
Dead River Gold Mine		Marquette	1889	Gold
Grand Rapids & Ishpeming Gold Prospect		Marquette	1889	Gold
Crystal Falls Mine		Iron	1890	Iron
Hollister Mine		Iron	1890	Iron
Mansfield Mine		Iron	1890	Iron
Bristol-Youngstown Mine		Iron	1890	Iron
Mansfield Mine		Iron	1890	Iron
Hollister		Iron	1890	Iron
Nighthawk Exploration		Iron	1890	Iron
Fitch Mine		Marquette	1890	Iron

Moro Mine	Marquette	1890	Iron
Fitch Mine	Marquette	1890	Iron
Detroit Gold & Silver Prospect	Marquette	1890	Gold
Fissure Mines	Keweenaw	1890	Copper
Eureka-Asteroid Mine	Gogebic	1890	Iron
Eureka-Asteroid	Gogebic	1890	Iron
Tobin Mine	Iron	1891	Iron
Lincoln Mine	Iron	1891	Iron
Hemlock Mine	Iron	1891	Iron
Lincoln	Iron	1891	Iron
Groveland Mine	Dickinson	1891	Iron, Manganese
Bessie Mine	Marquette	1891	Iron
Bessie Mine	Marquette	1891	Iron
Daniel Sec 30 Gold Prospect	Marquette	1891	Silver, Gold, Copper
Boulson Exploration	Marquette	1891	Gold
Grant, U.S. Mine	Marquette	1891	Iron
Crescent Gold Exploration	Marquette	1891	Gold
Fire Center Prospect	Marquette	1891	Gold
Tilden Mine	Gogebic	1891	Iron
Hope Mine	Iron	1892	Iron
Hope- Includes South Hope	Iron	1892	Iron
Bristol-Youngstown	Iron	1892	Iron
Lee Peck	Iron	1892	Iron
Tamarack Junior Mine	Houghton	1892	Copper
Platt Mine	Marquette	1892	Iron
Platt	Marquette	1892	Iron
Chicago Mines (Sparta)	Gogebic	1892	Iron
Jackpot	Gogebic	1892	Iron
Chicago- Includes Former Sparta	Gogebic	1892	Iron
Jackpot	Gogebic	1892	Iron
Hiawatha Mine #1	Iron	1893	Iron
Michigan Mine	Iron	1893	Iron
Hiawatha No. 1	Iron	1893	Iron
Michigan Mine	Iron	1893	Iron
Loretto Mine	Dickinson	1893	Iron
Francis Mine	Marquette	1893	Iron
Francis	Marquette	1893	Iron
Antoine Mine	Dickinson	1895	Iron
Plymouth Mine	Gogebic	1895	Iron
Mikado Mine	Gogebic	1895	Iron
Mikado Mine	Gogebic	1895	Iron
Halliwell Mine	Ontonagon	1896	Copper
Knowlton Mine	Ontonagon	1896	Copper
Cundy Mine	Dickinson	1896	Iron

Richmond Mine (Old)	Marquette	1896	Iron
Old Richmond Open Pit	Marquette	1896	Iron
Ogden Mine	Marquette	1897	Iron
Ogden	Marquette	1897	Iron
North Kearsarge	Houghton	1897	Copper
Michigan Mine	Ontonagon	1898	Copper
Baltic Amygdaloid	Houghton	1898	Copper
Baltic Mine	Houghton	1898	Copper
Baltic	Houghton	1898	Copper
Wolverine	Houghton	1898	Copper, Silver
B & M Gold Exploration	Marquette	1898	Gold
Daniel Sec 5 Gold Prospect	Marquette	1898	Gold
Wauneta Exploration	Ontonagon	1899	Copper
Hilltop Mine	Iron	1899	Iron
Victoria Mine	Iron	1899	Iron
Hilltop	Iron	1899	Iron
Pacific Exploration	Houghton	1899	Copper
Cuff Mine	Dickinson	1899	Iron
Krieg Mine	Marquette	1899	Gold
Peak Copper Exploration	Gogebic	1899	Copper
South Kearsarge Mine	Houghton	1900	Copper
South Kearsarge	Houghton	1900	Copper
Verona	Dickinson	1900	Iron
Mohawkite Fissure	Keweenaw	1900	Copper
Mohawk Mine	Keweenaw	1900	Copper
Baltic Mine	Iron	1901	Iron
Tobin Mine	Iron	1901	Iron
Monongahela Mine	Iron	1901	Iron
Buck Group	Iron	1901	Iron
Buck Mine	Iron	1901	Iron
Monongahela (New) Mine	Iron	1901	Iron
Foxdale Reserve	Marquette	1901	Iron
Foxdale Mine	Marquette	1901	Iron
Caspian Mine	Iron	1902	Iron
Genesee Mine	Iron	1902	Iron
Champion Mine	Houghton	1902	Copper
Trimountain Mine	Houghton	1902	Copper
Champion	Houghton	1902	Copper
Trimountain	Houghton	1902	Copper
Vivian Mine	Dickinson	1902	Iron
Rowland	Marquette	1902	Iron
Winona	Houghton	1902	Copper
Mohawk	Keweenaw	1902	Copper, Arsenic
Caspian Mine	Iron	1903	Iron
Alpha Mine	Iron	1903	Iron

Munro Mine	Dickinson	1903	Iron
Breitung-Hematite Mine	Marquette	1903	Iron
Barasa Mine	Marquette	1903	Iron
Mary Charlotte Mine	Marquette	1903	Iron
Barasa Mine	Marquette	1903	Iron
Mary Charlotte Mine - Includes A	Marquette	1903	Iron
Includes Old New York Hematite	Marquette	1903	Iron
Miskwabic Exploration	Keweenaw	1903	Copper
Michigan	Ontonagon	1904	Copper, Silver
Artic	Ontonagon	1904	Copper
Copper Crown Mine	Ontonagon	1904	Copper
Youngs Mine	Iron	1904	Iron
Centennial No.2	Houghton	1904	Copper, Silver
Forest Mine	Dickinson	1904	Iron
Ahmeek Copper Mine	Keweenaw	1904	Copper
Lake Mine	Ontonagon	1905	Copper
Youngs	Iron	1905	Iron
Austin Mine	Marquette	1905	Iron
Austin Mines Numbers 1 and 2	Marquette	1905	Iron
James Mine	Iron	1906	Iron
Magnetic Mine	Marquette	1906	Iron
Magnetic Mine	Marquette	1906	Iron
Kimball Mine	Iron	1907	Iron
Fogarty Mine	Iron	1907	Iron
Chatham Mine	Iron	1907	Iron
James Mine	Iron	1907	Iron
Zimmerman Mine	Iron	1907	Iron
Kimball Mine	Iron	1907	Iron
Wild Cat Exploration	Iron	1907	Iron
Edlund Exploration	Iron	1907	Iron
Lenox Exploration	Iron	1907	Iron
Channing Exploration	Iron	1907	Iron
Barras Exploration	Iron	1907	Iron
Atlantic Section 16 Exploration	Houghton	1907	Copper
Few Mine	Dickinson	1907	Iron
Archibald Mine	Marquette	1907	Iron
Maas Mine	Marquette	1907	Iron
Stephenson Mine	Marquette	1907	Iron
Empire Mine	Marquette	1907	Iron
Stephenson Mine	Marquette	1907	Iron
Empire	Marquette	1907	Iron
Maas Mine	Marquette	1907	Iron
North Lake Mine	Ontonagon	1908	Copper
Berkshire Mine	Iron	1908	Iron
Berkshire Mine	Iron	1908	Iron

South Dunn Exploration	Iron	1908	Iron
Superior	Houghton	1908	Copper, Silver
Lake	Ontonagon	1909	Copper
Portland Mine	Baraga	1909	Iron
Portland Open Pit	Baraga	1909	Iron
Mcdonald Mine	Iron	1909	Iron
Tully Mine	Iron	1909	Iron
Baker Mine	Iron	1909	Iron
Bengal-Tully Mine	Iron	1909	Iron
Mcdonald	Iron	1909	Iron
Baker Mine	Iron	1909	Iron
Hector Exploration	Iron	1909	Iron
Stegmiller Mine	Marquette	1909	Iron
Mass Fissure	Keweenaw	1909	Copper
Algomah Mine	Ontonagon	1910	Copper
Bates Mine	Iron	1910	Iron
La Salle Mine	Houghton	1910	Copper
Chase Mine	Marquette	1910	Iron
Ravenna-Prickett Mine	Iron	1911	Iron
Ravenna Mine	Iron	1911	Iron
Davidson Group Mines	Iron	1911	Iron
Wickwire Mine	Iron	1911	Iron
Chicagon Mine	Iron	1911	Iron
Ravenna-Prickett	Iron	1911	Iron
Chicagon Mine	Iron	1911	Iron
Davidson Group	Iron	1911	Iron
Wickwire	Iron	1911	Iron
Lloyd Mine	Marquette	1911	Iron
Archibald Mine	Marquette	1911	Iron
Lloyd Mine	Marquette	1911	Iron
Ojibway Mine	Keweenaw	1911	Copper
Ojibway	Keweenaw	1911	Copper
Cortland Mine	Iron	1912	Iron
Forbes Mine	Iron	1912	Iron
Rogers Mine	Iron	1912	Iron
Spies-Johnson Mine	Iron	1912	Iron
Cortland	Iron	1912	Iron
Spies-Virgil Mine	Iron	1912	Iron
Morris Mine	Marquette	1912	Iron
Morris Mine	Marquette	1912	Iron
Richards Mine	Iron	1913	Iron
Carpenter Mine	Iron	1913	Iron
Davidson No. 4 Mine	Iron	1913	Iron
Bengal Mine	Iron	1913	Iron
Davidson No. 4	Iron	1913	Iron

Richards	Iron	1913	Iron
Balkan-Judson Mine	Iron	1913	Iron
Forbes Mine	Iron	1913	Iron
Kimberly Exploration	Iron	1913	Iron
Adams Mine	Marquette	1913	Iron
Adams Mine	Marquette	1913	Iron
Wakefield Mine	Gogebic	1913	Iron
Wakefield Mine	Gogebic	1913	Iron
Bughole Exploration	Baraga	1914	Vanadium
Porter Mine	Iron	1914	Iron
Homer Mine	Iron	1914	Iron
Rogers Mine	Iron	1914	Iron
Carpenter Mine	Iron	1914	Iron
White Pine Extension Mine	Ontonagon	1915	Copper
Homer Mine	Iron	1915	Iron
Warner Mine	Iron	1915	Iron
Cottrell Mine	Iron	1915	Iron
Warner Mine	Iron	1915	Iron
Cottrell Mine	Iron	1915	Iron
Bates Mine	Iron	1915	Iron
South Chicago	Gogebic	1915	Iron
Odgers Mine	Iron	1916	Iron
Porter Mine	Iron	1916	Iron
Isabella Mine	Marquette	1916	Iron
Isabella Mine	Marquette	1916	Iron
Plymouth Mine	Gogebic	1916	Iron
Athens Mine	Marquette	1918	Iron
Athens Mine	Marquette	1918	Iron
Cardiff Mine	Iron	1919	Iron
Gardner-Mackinaw Mine	Marquette	1919	Iron
Gardner-Mackinaw	Marquette	1919	Iron
Lawrence Mine	Iron	1920	Iron
Wauseca-Aronson Mine	Iron	1920	Iron
Delta Mine	Iron	1920	Iron
Delta	Iron	1920	Iron
Corry '40' Mine	Iron	1922	Iron
Buck Group	Iron	1922	Iron
Corry 40 Mine	Iron	1922	Iron
West Chapin	Dickinson	1922	Iron
Barnes-Hecker Mine	Marquette	1923	Iron
Barnes-Hecker Mine	Marquette	1923	Iron
Wakefield-Morgan Mine	Gogebic	1923	Iron
Wakefield Morgan Mine	Gogebic	1923	Iron
Sturgeon Prospect	Dickinson	1925	Iron
Minckler Mine	Iron	1926	Iron

Wauseca-Aronson	Iron	1926	Iron
Lucky Star Reserve	Marquette	1926	Iron
Volunteer (New) Mine	Marquette	1926	Iron
Lucky Star Mine	Marquette	1926	Iron
New Volunteer Mine-Includes Maitl	Marquette	1926	Iron
Richmond Mine (New)	Marquette	1927	Iron
New Richmond Open Pit	Marquette	1927	Iron
Tilden Mine	Marquette	1929	Iron
Blueberry Mine	Marquette	1929	Iron
Blueberry Mine	Marquette	1929	Iron
Dolomite Quarry	Schoolcraft	1930	Dolomite
West Hical Quarry	Schoolcraft	1930	Limestone, General
East Hical Quarry	Mackinac	1930	Limestone, General
Sherwood Mine	Iron	1931	Iron
Brule Mine (Hiawatha #3)	Iron	1931	Iron
Greenwood Mine	Marquette	1932	Iron
Greenwood	Marquette	1932	Iron
Central Exploration	Keweenaw	1934	Copper
Hiawatha Mine #2	Iron	1935	Iron
Hiawatha No. 2	Iron	1935	Iron
Brule	Iron	1936	Iron
Bradley Mine	Dickinson	1937	Iron
Mather Mine	Marquette	1941	Iron
Book Mine	Iron	1942	Iron
Iroquois Mine	Houghton	1942	Copper
Book Mine	Iron	1943	Iron
Sherwood Mine	Iron	1943	Aluminum, Iron, Manganese, Phosphorus
Houghton Conglomerate	Keweenaw	1943	Copper
White Pine Mine	Ontonagon	1945	Copper
Drummond Island Quarry (Dock and Original Quarry)	Chippewa	1945	Dolomite
Drummond Island Quarry (Inland Quarry)	Chippewa	1945	Dolomite
Homer-Wauseca Mine	Iron	1947	Iron
De Grasse Mine	Iron	1950	Iron
Vicar Mine (Wakefield Lease)	Gogebic	1950	Iron
Vicar Mine	Gogebic	1950	Iron

Appendix Table 9: Descriptive table of historical mines in Wisconsin. Table contains the information included in the historical mine GIS shapefile layer. Mines are listed chronologically by year opened. Data provided by USGS Mineral Resource Data System (MRDS) & Mineral Availability System/Mineral Industry Locator System (MAS/MILS).

Name	County	Year Opened	Commodity
Upper Mississippi Valley Zn - Pb Dist. Mines	Lafayette	1750	Zinc
Robarts and Wildcat Mines	Iowa	1830	Zinc
Mason Mine	Iowa	1833	Zinc
Penna-Benton, Expansion	Lafayette	1837	Lead, Zinc
Iron Ridge Mine	Dodge	1849	Iron
Iron Ridge Mine	Dodge	1849	Iron
Etna Mine	Lafayette	1850	Lead, Zinc
Ernest and Meyers Level	Lafayette	1850	Zinc, Lead
Tilden Mound Deposit	Jackson	1856	Iron
Tilden Mound Deposit	Jackson	1856	Iron
Swift and Rooney Mine	Lafayette	1861	Lead, Zinc
Old Occidental Mine	Lafayette	1873	Lead, Zinc
Hoare Mine	Iowa	1875	Zinc
Old Ida-Blende Mine	Lafayette	1880	Lead, Zinc
Commonwealth Group	Florence	1880	Iron
Florence Mine	Florence	1880	Iron
Florence Mine	Florence	1880	Iron
Commonwealth Group	Florence	1880	Iron
Germania Mine	Iron	1885	Iron
Germania Mine	Iron	1885	Iron
Cary Mine	Iron	1886	Iron
Montreal Mine	Iron	1886	Iron
Montreal Mine	Iron	1886	Manganese, Iron
Cary Mine	Iron	1886	Iron
Atlantic Mine	Iron	1887	Iron
Atlantic Mine	Iron	1887	Iron
Hennepin-Snyder Mine	Iron	1888	Iron
Iron Belt Mine	Iron	1888	Iron
Pence Mine	Iron	1888	Iron, Nickel
Hennepin-Snyder	Iron	1888	Iron
Iron Belt Mine	Iron	1888	Iron
Pence Mine	Iron	1888	Iron
Helena-Roachdale Mine	Lafayette	1890	Zinc, Lead
Tyler's Fork Prospect	Iron	1890	Iron
Empress Mine	Lafayette	1891	Lead, Zinc
Lewis Mine	Iowa	1892	Zinc
Mayville Mine	Dodge	1892	Iron, Copper, Lead

Mayville Mine	Dodge	1892	Iron
Centerville Mines	Iowa	1894	Zinc
Blain and Logan Mine	Lafayette	1895	Lead, Zinc
Champion and Eureka Mines	Lafayette	1895	Lead, Zinc
Shores Mine	Iron	1896	Iron
Shores Mine	Iron	1896	Iron
Graham and Stephens	Grant	1897	Zinc
Badger Mine	Lafayette	1900	Lead, Zinc
Bearhole Mine	Lafayette	1900	Zinc
Weiskircher Mine	Lafayette	1900	Zinc
New Occidental Mine	Lafayette	1900	Zinc
Strawberry Blonde Mine	Lafayette	1900	Zinc
Century Mine	Lafayette	1900	Lead, Zinc
Little Grant	Grant	1900	Zinc
Spargo Mine	Iowa	1900	Lead, Zinc
Lampe-Eberle Mine	Iowa	1900	Copper, Lead, Zinc
Jug Handle Mine	Lafayette	1901	Zinc
Milner Mine	Lafayette	1901	Zinc
Glanville Mine	Iowa	1901	Zinc
Sally Waters Mine	Lafayette	1902	Zinc
Jack of Diamonds Mine	Lafayette	1902	Zinc
Capitola	Grant	1902	Zinc
Hazel Green Mine	Grant	1902	Zinc
Empire	Grant	1902	Zinc
Upson Prospect	Iron	1902	Iron
Tylers Fork Mine	Iron	1902	Iron
Murphy Mine	Lafayette	1903	Lead, Zinc
Benton Star Mine	Lafayette	1903	Zinc
Big Dad Mine	Lafayette	1903	Zinc
Jack of Clubs	Lafayette	1903	Lead, Zinc
Jefferson Mine	Grant	1903	Lead, Zinc
Grant County	Grant	1903	Zinc
Silver Dollar Mine	Iowa	1903	Lead, Zinc
McKinley Mine	Iowa	1903	Lead, Zinc
Coughlin Mine	Lafayette	1904	Zinc
B and C Mine	Lafayette	1904	Zinc
Lucky Hit Mine	Lafayette	1904	Zinc, Lead
Whig	Grant	1904	Zinc
Black Hawk	Grant	1904	Zinc
Pengelly Mine	Iowa	1904	Lead, Zinc
Imhoff Mine	Iowa	1904	Zinc
Oxman Mine	Iowa	1904	Lead, Zinc
Illinois Mine	Sauk	1904	Iron
Illinois Mine	Sauk	1904	Iron

Trego	Grant	1905	Zinc
Ross Mine	Iowa	1905	Lead, Zinc
Hazel Patch and Western Mines	Iowa	1905	Lead, Zinc
East Glanville	Iowa	1905	Lead, Zinc
Meloy Fields-Meloy, Robson	Lafayette	1906	Zinc
Fox Mine	Lafayette	1906	Lead, Zinc
West Empire	Grant	1906	Zinc
Milwaukee-Highland Mine	Iowa	1906	Zinc
Red Jacket Mine	Iowa	1906	Lead, Zinc
Milwaukee Mine	Iowa	1906	Lead, Zinc
Acme	Grant	1907	Zinc
Royal	Grant	1907	Zinc
Coor Mine	Lafayette	1908	Lead, Zinc
Klar-Piquette	Grant	1908	Zinc
Columbia	Grant	1908	Zinc
Homestead	Grant	1908	Zinc
Weigle	Grant	1908	Zinc
Kroll Mine	Iowa	1908	Zinc
Harris Mine	Iowa	1908	Copper, Zinc
Rodham Mine	Lafayette	1909	Lead, Zinc
Calvert,Frontier,And Treganza	Lafayette	1909	Zinc
Little Minnie Mine	Lafayette	1909	Zinc
Wilkinson Mine	Lafayette	1909	Lead, Zinc
Old Winskell Mine	Lafayette	1909	Lead, Zinc
Drum Mine	Lafayette	1909	Zinc
Cruson	Grant	1909	Zinc, Lead
Lyght	Grant	1909	Zinc
Mitchell Hollow	Grant	1909	Zinc
Beloit-Elmo	Grant	1909	Lead, Zinc
Imhoff-Egan Mine	Iowa	1909	Zinc
Cleveland Mine	Lafayette	1910	Lead, Zinc
Kearns Mine	Lafayette	1910	Zinc
Hodge	Grant	1910	Zinc
Rajah Mine	Iowa	1910	Zinc
Lucky Twelve Mine	Lafayette	1911	Zinc
Peaceful Valley	Lafayette	1912	Zinc
Plumer Mine	Iron	1912	Iron
Plumer Mine	Iron	1912	Iron
Crawhall Mine	Lafayette	1913	Zinc
Lawrence Mine	Lafayette	1913	Zinc
Bull Moose Mine	Lafayette	1913	Zinc
Martin Mine	Lafayette	1913	Lead, Zinc
M and H	Grant	1913	Zinc
Seitz	Grant	1914	Zinc
Ernst Mine	Florence	1914	Iron

Ernst Mine	Florence	1914	Iron
Hird No.1 Mine	Lafayette	1915	Zinc, Lead
Kittoe Mine	Lafayette	1915	Lead, Zinc
Happy Home Mine	Iowa	1915	Zinc
Optimo No.3 Mine	Iowa	1915	Zinc
Spring Hill Mine	Iowa	1915	Zinc
Blackstone Mine	Lafayette	1916	Zinc
C.A.T.Mine	Lafayette	1916	Zinc
Blockhouse	Grant	1916	Zinc, Lead
Gilman Mine	Iowa	1916	Zinc
Cahoon Mine	Sauk	1916	Iron
Cahoon Mine	Sauk	1916	Iron
Milwaukee-Shullsburg Mine	Lafayette	1917	Lead, Zinc
Old Mulcahy Mine	Lafayette	1917	Zinc
Hird No.2 Mine	Lafayette	1917	Lead, Zinc
Hoskins-Fields Mine	Lafayette	1917	Lead, Zinc
Kistler and Stephens	Grant	1917	Lead, Zinc
Copeland Mine	Lafayette	1918	Zinc
Iowa Mine	Lafayette	1919	Zinc, Lead
Hird No.3 Mine	Lafayette	1919	Zinc
Paquette Mine	Lafayette	1920	Zinc
Nightingale Mine	Lafayette	1921	Zinc
Goke-Blockhouse	Grant	1921	Lead, Zinc
Berkshire Mine	Ashland	1922	Iron
Berkshire Mine	Ashland	1922	Iron
Winrock Mine	Lafayette	1923	Zinc
Optimo No.4 Mine	Iowa	1923	Lead, Zinc
South Rule Mine	Iowa	1923	Lead, Zinc
Monmouth & North Monmouth Mines	Lafayette	1924	Lead, Zinc
Curwen Mine	Lafayette	1924	Zinc
Booty Mine	Lafayette	1924	Zinc
James Ore Body	Lafayette	1925	Lead, Zinc
Birkett Mine	Lafayette	1926	Lead, Zinc
New Longhorn Mine	Lafayette	1926	Lead, Zinc
Dodgeville No.1 Group of Mines	Iowa	1926	Lead, Zinc
Middle Mine	Lafayette	1927	Zinc
Byrnes Mine	Lafayette	1928	Zinc, Lead
New Ida Blende Mine	Lafayette	1930	Zinc
Prairie Mine	Iowa	1930	Lead, Zinc
Trewartha Mine	Lafayette	1932	Lead, Zinc
Crawford Mine	Grant	1932	Zinc, Lead
Vinegar Hill Blockhouse	Grant	1933	Zinc
De Rocher Mine	Lafayette	1935	Lead, Zinc
New Mullen Mine	Lafayette	1937	Lead, Zinc
Wipet Mine	Lafayette	1938	Lead, Zinc

Giles Mine	Lafayette	1938	Zinc
Four S.And B.Mine	Iowa	1939	Lead, Zinc
Farrey Mine	Lafayette	1940	Iron, Zinc
Old D.H.And S.Mine	Iowa	1940	Lead, Zinc
Obrien Mine	Lafayette	1941	Zinc
Lyne Mine	Lafayette	1941	Zinc
Moore Level	Lafayette	1941	Zinc, Lead
B.A.T.Mine	Lafayette	1941	Zinc
Big Jack	Grant	1941	Zinc, Lead
Ewing and Cook Mine	Lafayette	1942	Zinc, Lead
Paul Graber Mine	Lafayette	1942	Lead, Zinc
New Birkett Mine	Lafayette	1942	Zinc
P.M. Mine	Iowa	1942	Zinc
New Mulcahy Mine	Lafayette	1943	Zinc
Andrews Mine	Lafayette	1944	Zinc, Lead
North Star Mine	Lafayette	1944	Zinc
New Hoskins Mine	Lafayette	1944	Lead, Zinc
Pittsburg-Benton Mine	Lafayette	1944	Lead, Zinc
Old Cottingham Mine	Lafayette	1945	Zinc, Lead
Dodgeville No.2 and 3 Mines	Iowa	1945	Zinc, Lead
Consolidated Mine	Lafayette	1946	Zinc
New Cottingham Mine	Lafayette	1946	Lead, Zinc
Annie Walton Mine	Lafayette	1947	Lead, Zinc
Larson Exploration Prospect	Florence	1948	Iron
Calumet and Hecla Mine	Lafayette	1949	Zinc
Vinegar Hill Blackstone Mine	Lafayette	1950	Zinc, Lead

Appendix Table 10: Descriptive table of historical mines in Minnesota. Table contains the information included in the historical mine GIS shapefile layer. Mines are listed chronologically by year opened. Data provided by USGS Mineral Resource Data System (MRDS) & Mineral Availability System/Mineral Industry Locator System (MAS/MILS).

Name	County	Year Opened	Commodity
Chandler Mine-South	St. Louis	1888	Iron
Chandler Mine-North	St. Louis	1891	Iron
Zenith Mine	St. Louis	1892	Iron
Biwabik Mine	St. Louis	1893	Iron
Canton Mine	St. Louis	1893	Iron
Franklin Mine	St. Louis	1893	Iron
Duluth Mine	St. Louis	1893	Iron
Minnewas Mine	St. Louis	1893	Iron
Little America Mine	Koochiching	1894	Gold
Auburn & Great Western Mines	St. Louis	1894	Iron
Burt Mine	St. Louis	1895	Iron
Julia Mine	St. Louis	1895	Iron
Lone Jack Mine	St. Louis	1895	Iron
Williams Mine	St. Louis	1895	Iron
Fayal No.1 Mine	St. Louis	1895	Iron
Ohio Mine	St. Louis	1895	Iron
Genoa Fee Mine	St. Louis	1896	Iron
Genoa-Sparta Mine	St. Louis	1896	Iron
Penobscot Mine	St. Louis	1897	Iron
Sparta Mine	St. Louis	1897	Iron
Emmett Mine	St. Louis	1897	Iron
Elba Mine	St. Louis	1898	Iron
Ajax Mine	St. Louis	1899	Iron
Savoy Mine	St. Louis	1899	Iron
Sibley Mine	St. Louis	1899	Iron
Malta and Malta Annex Mine	St. Louis	1899	Iron
Park Lot No.1 Mine	St. Louis	1899	Iron
Alpena Mine-East	St. Louis	1900	Iron
Clark Mine	St. Louis	1900	Iron
Stevenson Mine	Itasca	1900	Iron
Union Mine	St. Louis	1900	Iron
National Steel Pellet	Itasca	1900	Iron

Corsica Mine	St. Louis	1901	Iron
Bradford Mine	St. Louis	1902	Iron
Croxton-Syme Mine	St. Louis	1902	Iron
Glen Mine	St. Louis	1902	Iron
Jordan Mine	St. Louis	1902	Iron
Laura Mine	St. Louis	1902	Iron
Leetonia Mine	St. Louis	1902	Iron
Pearce Mine	St. Louis	1902	Iron
Labelle Mine	St. Louis	1902	Iron
North Eddy Mine	St. Louis	1902	Iron
Minorca Mine	St. Louis	1902	Iron
Sharon Mine	St. Louis	1902	Iron
Cass Mine	St. Louis	1903	Iron
Kinney Mine	St. Louis	1903	Iron
Pool Mine	St. Louis	1903	Iron
Stephens Mine	St. Louis	1903	Iron
Albany Mine	St. Louis	1903	Iron
La Rue Mine	Itasca	1903	Iron
Aad Mine	St. Louis	1904	Iron
Yates Mine	St. Louis	1904	Iron
Shenango Mine	St. Louis	1904	Iron
Forest Mine	Itasca	1904	Iron
Holland Mine	St. Louis	1905	Iron
Myers Mine	St. Louis	1905	Iron
Webb Mine	St. Louis	1905	Iron
Alexander Mine	Itasca	1905	Iron
Adriatic Mine	St. Louis	1906	Iron
Jennings Mine	St. Louis	1906	Iron
Larkin Mine	St. Louis	1906	Iron
Victoria Mine	St. Louis	1906	Iron
Mayas Mine	St. Louis	1906	Iron
Brunt Mine	St. Louis	1906	Iron
Hoadley Mine	Itasca	1906	Iron
Alberta Mine	St. Louis	1907	Iron
Mariska Mine	St. Louis	1907	Iron
Onondaga Mine	St. Louis	1907	Iron
Siphon Mine	St. Louis	1907	Iron
Yawkey Mine	St. Louis	1907	Iron
McKinley Mine	St. Louis	1907	Iron

Nassau Mine	St. Louis	1907	Iron
Holman-Cliffs Mine	Itasca	1907	Iron
Belgrade Mine	St. Louis	1908	Iron
Hanna Mine	St. Louis	1909	Iron
Knox Mine	St. Louis	1909	Iron
White Iron Mine	St. Louis	1909	Iron
Perkins Mine	St. Louis	1909	Iron
Seville Mine	St. Louis	1909	Iron
Silver Mine	St. Louis	1909	Iron
Embarrass Mine	St. Louis	1909	Iron
Godfrey Mine	St. Louis	1909	Iron
Bray Mine	Itasca	1909	Iron
Elizabeth Mine	St. Louis	1910	Iron
Hudson Mine	St. Louis	1910	Iron
Mace No.1 Mine	Itasca	1910	Iron
Meadow Mine	St. Louis	1910	Iron
North Uno Mineb.N.	St. Louis	1910	Iron
Madeira Mine	St. Louis	1910	Iron
North Uno Mineg.N.	St. Louis	1910	Iron
Hartley-Burt Mine	St. Louis	1910	Iron
Bangor Mine	St. Louis	1910	Iron
Mississippi Mine	Itasca	1910	Iron
Section 30 Mine	Lake	1910	Iron
Cavour Mine	St. Louis	1911	Iron
Cavour Mine	St. Louis	1911	Iron
Fay Mine	St. Louis	1911	Iron
Ruddy Mine	St. Louis	1911	Iron
South Uno Mineg.N.	St. Louis	1911	Iron
Kennedy Mine	Crow Wing	1911	Iron
Robert Mine	Crow Wing	1911	Iron
Grace Mine	St. Louis	1912	Iron
Section 17 Mine	St. Louis	1912	Iron
Majorca Mine	Itasca	1912	Iron
Armour No.2 Mine	Crow Wing	1912	Iron
Cuyuna North Range	Crow Wing	1912	Manganese
Allan Mine	St. Louis	1913	Iron
Eaton Mine	St. Louis	1913	Iron
Helmer Mine	St. Louis	1913	Iron
Vivian Mine	St. Louis	1913	Iron

Bennett Mine	Itasca	1913	Iron
Judd Mine	Itasca	1913	Iron
Delaware #1 & #2	Itasca	1913	Iron
Deacon Mine	St. Louis	1914	Iron
Higgins No.1 Mine	St. Louis	1914	Iron
Kinney Scotch Mine	St. Louis	1914	Iron
Prindle Mine	St. Louis	1914	Iron
Quinn Mine	Itasca	1914	Iron
Harrison Mine	Itasca	1914	Iron
Sullivan Mine	St. Louis	1915	Iron
Thorne Mine	St. Louis	1915	Iron
Weed Mine	St. Louis	1915	Iron
South Eddy Mine	St. Louis	1915	Iron
Chester Mine	St. Louis	1915	Iron
Algoma-Zeno Mine	Crow Wing	1915	Iron, Manganese
Consolidated Vermilion and Extension Mine	St. Louis	1916	Iron
Kerr Mine	St. Louis	1916	Iron
Ordean Mine	St. Louis	1916	Iron
St.James Mine	St. Louis	1916	Iron
Tioga Mine	St. Louis	1916	Iron
Jean Mine	St. Louis	1916	Iron
Butler Taconite	Itasca	1916	Iron
Wearne Mine	Crow Wing	1916	Iron
Hillcrest Mine-South	Crow Wing	1916	Iron
Mccomber Mine	St. Louis	1917	Iron
Midget Mine	St. Louis	1917	Iron
Smith Mine	St. Louis	1917	Iron
Dunwoody Mine	St. Louis	1917	Iron
Patrick-Ann Mine	Itasca	1917	Iron
Arcturus	Itasca	1917	Iron
Joan No.4 Mine	Crow Wing	1917	Iron
Joan No.1 Mine	Crow Wing	1917	Iron
Burns Mine	St. Louis	1918	Iron
Margaret Mine	St. Louis	1918	Iron
Pilot Mine	St. Louis	1919	Iron
Billings Mine	St. Louis	1919	Iron
Carson Lake Reserve H-58	St. Louis	1919	Iron
Draper Mine	Itasca	1919	Iron
Sargent Mine	Itasca	1919	Iron

Feigh Mine	Crow Wing	1919	Iron
Sweeney Mine	St. Louis	1920	Iron
Maroco Mine	Crow Wing	1921	Iron
Armstrong Bay Mine	St. Louis	1923	Iron
Harrison Annex Mine	Itasca	1923	Iron
Helen Mine	Itasca	1924	Iron
Vernon Mine	Itasca	1924	Iron
Wabigon & Wabigon No.2 Mine	St. Louis	1925	Iron
North Harrison Annex Mine	Itasca	1925	Iron
Moose Mine	St. Louis	1926	Iron
Morrow Extension Mine	St. Louis	1927	Iron
Bruce Mine	St. Louis	1927	Iron
South Tener Mine	St. Louis	1928	Iron
Fraser Mine	St. Louis	1928	Iron
Drew Mine	St. Louis	1930	Iron
Wheeling Mine	St. Louis	1931	Iron
Mississippi No.2 Mine	Itasca	1933	Iron
Harrison and Patrick Concentration Plant	Itasca	1934	Iron
Chataco Mine	St. Louis	1937	Iron
Pacific Mine	St. Louis	1937	Iron
Sidney Mine	St. Louis	1937	Iron
Carol Mine	Itasca	1937	Iron
Reed Mine	St. Louis	1940	Iron
Stein Mine	Itasca	1940	Iron
Lind-Greenway Mine	Itasca	1940	Iron
Argonne Mine	Itasca	1941	Iron
Northland Mine	Crow Wing	1941	Iron
Douglas Mine	St. Louis	1942	Iron
Niles	St. Louis	1942	
Iron Chief Mine	St. Louis	1942	Iron
Barbara Mine	Itasca	1942	Iron
Mississippi No.1 Mine	Itasca	1942	Iron
Trojan Mine	Crow Wing	1942	Iron
Rouchleau Group	St. Louis	1943	Iron
Cloquet Annex Reserve X-62	St. Louis	1943	Iron
Draper Annex Mine	Itasca	1943	Iron
Leach Mine	Itasca	1943	Iron
Buckeye Mine	Itasca	1943	Iron
Mississippi No.3 Mine	Itasca	1944	Iron

Snowshoe Mine	Crow Wing	1944	Iron
South Rust Mine	St. Louis	1945	Iron
Section 18 Mine	Itasca	1948	Iron
Sherman Mine	St. Louis	1948	Iron
Virginia Mine	Crow Wing	1948	Iron
Mott Mine	St. Louis	1949	Iron
Forster Mine	St. Louis	1949	Iron
Gordon Annex Reserve	Itasca	1949	Iron
Alworth Mine	St. Louis	1950	Iron
Snively Mine	St. Louis	1950	Iron

7.2 Appendix References

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