The Geospatial Humanities

The Geospatial Humanities

Volume 1, An Introduction to QGIS for Historians

JOSHUA MACFADYEN; BENJAMIN HOY; AND JIM CLIFFORD

CHARLOTTETOWN, PRINCE EDWARD ISLAND

Introduction to Geospatial Humanities Volume 1

Introduction to Volume I of this Project

Welcome to *The Geospatial Humanities*, an open educational resource led by Dr. Joshua MacFadyen, Canada Research Chair (Tier II) in Geospatial Humanities and Director of the lab for Geospatial Research in Atlantic Canadian History (the GeoREACH Lab) at the University of Prince Edward Island. The project is designed to walk humanities students and other scholars through a variety of geospatial tools and research methods. Volume I is an e-textbook by lead author Dr. MacFadyen and co-authors Drs. Benjamin Hoy and Jim Clifford. Dr. Hoy is Director of the Historical GIS Lab at the University of Saskatchewan, and Jim Clifford is Associate Professor in History at the University of Saskatchewan. The GeoREACH Lab and the HGIS Lab are dedicated to training students and supporting scholarship in the broader area of geospatial humanities. Previous collaborations between the groups included GIS lessons for the Programming Historian and historical data development for national and international research projects.[1] Other key contributors to Volume I include D. Bailey Clark, an undergraduate research assistant at the GeoREACH Lab, Kim Mears, a librarian and Open Educational Resource program director, and Megan MacDonald, a student assistant at UPEI's Robertson Library.

Geospatial Humanities Volume I focuses on Geographic Information Systems (GIS) and particularly the open source, multiplatform and free QGIS software. QGIS is a user friendly tool capable of creating publishable maps and analyzing complex datasets . Each chapter provides a hands-on tutorial to guide readers through five of the core GIS exercises that are frequently performed by historians. Those processes include (1) software installation and navigation, (2) choosing the symbology of data , (3) georeferencing primary source maps, (4) digitization – creating new GIS data based on primary sources – and (5) map design and cartography. Each tutorial is designed to build on the one before it, although readers who are already familiar with the basics of GIS may jump ahead to later chapters.

This short introduction to Volume I discusses the concepts and practices of the geospatial humanities, with a focus on historical research and the evolution of the geospatial technology most frequently used by historians – GIS. We offer this brief overview of the interdisciplinary practices of geospatial history in order to prepare students with the background they need to proceed through the lessons in Volume I. Each chapter also includes discussions of the basic theoretical concepts necessary to use GIS with confidence. The chapters also include periodic stories in the sidebars that describe how scholars of varying skill levels have used these tools to answer historical questions.

After this introduction you will find five chapters containing detailed tutorials for five fundamental GIS processes. Chapter 1 will show you how to install and operate QGIS to make your first map. All tutorials will require the use of QGIS, a Free and Open Source Software (FOSS) that is available to all users. Along with the proprietary (i.e., pay-for-use) software ArcGIS, QGIS is one of the most popular GIS programs available to scholars today.

We have focused on QGIS because it is accessible. It is free, available in forty languages, and runs well on Windows, Mac, and Linux operating systems. QGIS is also widely supported. It contains extensive documentation, and a large online community of volunteers respond quickly with friendly advice and solutions to specific problems. When students leave university, they do not lose access to the GIS software.

While this tutorial was designed to be completed on a Windows desktop computer, it is possible to conduct these exercises on a

Mac with minimal differences in the installation process and attention to the differences in how the different operating systems store data.

This e-textbook should be easy to read on any browser or mobile device. All of the images contain detailed alt-text for accessible reading. For those who prefer to read the book as an e-book please return to the book's home page and click the download button for a variety of options. To navigate this e-textbook in a browser, please click on the **Contents** button on the left to see each chapter and its main sections. On mobile devices the contents will usually appear at the top of each page. You may also click the links at the bottom of your browser to move forward to the next section of this introduction. Pressing the right or left keys on your keyboard will perform the same action, for those reading this on a personal computer. For instance, the next section should appear on the bottom right under "Getting Started."

Introduction to Geospatial Humanities

The ubiquity of digital maps and GIS

Geographic Information Systems (GIS) have infiltrated our lives over the past twenty years. On election night we watch the maps change dynamically on television as electoral results are reported. Linking map symbols (electoral districts) with data (election results) is the key feature of GIS software. Most of us have smart phones with digital mapping applications. These are GIS apps that link points, lines and polygons (the three main types of vector data you will learn about) with other types of data such as the website link for a business or the hours of a restaurant. That is GIS. These programs link data together combining locations with other kinds of data, such as names, dates, statistical data, descriptions, textual quotes, photographs, audio recordings and just about anything else. The only difference with QGIS, is you will learn how to build this yourself.

Two decades ago, professors and librarians warned history graduate students to think hard before using GIS in their research projects. The software was cumbersome to install, hard to learn, and was not designed to explore change over time. As we write this in 2022, those warnings are less and less applicable.

GIS software is no more difficult to learn than a common spreadsheet program like Excel. It is easy to create basic maps. In fact, you will be making basic maps within the first chapter of this book. And it is very powerful. Like Excel, the power of GIS goes far beyond the basics introduced here in Volume I. Learning QGIS will set you up to use other GIS software and online cloud platforms. All digital mapping systems use the same basic concepts and approaches. The data you use (and create!) are usually compatible with other systems including ESRI's ArcGIS Pro and StoryMaps. Finally, QGIS is a great gateway to other more advanced digital humanities methods. As you get comfortable with the material in this book, you can start to expand your skills with a programming language like Python or with SQL databases, both of which are working in the background of QGIS.

What is geospatial history/humanities?

Geospatial history is a methodology focused on understanding how events unfold across time as well as across geography. In practice, geospatial history (also referred to as Spatial History or Historical Geographic Information Systems (HGIS)) is a flexible and wide-reaching approach. HGIS has been used to study everything from food gathering strategies, and environmental change, to racism and historic violence.[2]

Geospatial humanities projects are often defined by a series of common characteristics.

1. The projects are digital in focus, often requiring the use of specialized software (spreadsheets, programming languages, data visualization software, etc.) in order to visualize, understand, and interpret the final conclusions. In recent years, this software has become far more accessible. With as little as two weeks of training in QGIS, it is possible to create a simple custom-built map that shows the location of the cities discussed in your article or chapter.
2. The projects often require teamwork. This teamwork may occur directly (team members working alongside one another and sharing technical expertise) or indirectly (a scholar drawing on datasets, scanned historical maps, or other digital assets created by others).
3. The final product often appears, at least in part, as a visualization (a custom-built map) to see patterns that would be otherwise invisible in the data. This is accomplished through the process of combining, layering, manipulating, and omitting data created from different primary sources.[3]
4. The datasets created by a geospatial project operate as both a piece of the evidence and a publishable product. Unlike traditional historical endeavors where only the finished write-up (a book or article) is published, geospatial humanists also publish their underlying datasets. The user guides that accompany large datasets are sometimes longer than the articles that spawned them, emphasizing the importance of high quality documentation when sharing research material. While geospatial historians have not abandoned publishing books or articles, they have also begun to explore alternative (often digital) publishing venues that allow information to be displayed interactively combining both the original dataset and the interpretation in a single place.[4]
5. Because large scale digitization projects are so time consuming

to create, most geospatial historians share their data freely with one another to minimize the need to duplicate efforts.[5] This requires proper citation and credit and we hope overtime scholars will be recognized for the impact of their data as well as they published articles and books.
6. Finally, geospatial projects allow for the exploration of absences and counterfactuals. By mapping the location of key features (eg. industries or officials), it becomes possible to see where they are absent at a glance. This can help clarify problems in the archive or problems in the ways the original information had been collected in ways that are not always possible through textual analysis.

Geospatial tools and approaches are employed across many humanities and social sciences disciplines. Although our lessons are tailored for historians in particular, we recognize that scholars from a wide array of disciplines will benefit from them , so we often use the term "Geospatial Humanities" rather than "geospatial history" to describe the field as a whole.

How has GIS Technology Developed?

The history of geographic information systems is long and complex. Automated computing existed long before the arrival of digital computers. By the 1880s, statisticians and government officials like Francis Amasa Walker were already collecting, tabulating, and mapping millions of data points related to the American censuses.[6] However, they faced enormous challenges with the rapidly growing population, and in 1888 the US Census Bureau invited proposals for a mechanical device that could tabulate census data. The winner was a census employee named Herman Hollerith. He proposed a machine that used punch card techniques similar to the cards used to store and input weaving patterns in Jacquard looms. The data machine was so successful that it was used to help process the 1890 census, and Hollerith founded a company that built similar machines for businesses. By 1924 the company had merged and changed its name to International Business Machines (IBM).[7]

*An early example of the historical maps the American Census Bureau were creating in the 1890s. Together these maps tracked the growth of the American population (excluding Indigenous people) between 1870 (left) and 1890 (right). The darker the color the more people residing in the area***[8]**

In the interwar period, a series of innovations led to the development of new computers. At first they remained analog and then, during the Second World War, they adopted electrical relays and binary data formats. Giant electromechanical computers such as IBM's Harvard Mark I and Alan Turing's "Bombe" in Bletchley Park processed enormous quantities of data for the allied war effort and established the theoretical and mechanical foundations for post-war "mainframe" computers.[9] Universities adopted and used mainframes from the beginning, and humanists such as Father Roberto Busa were early adopters. However, digital computing was so expensive and time consuming that it remained inaccessible to most scholars, and computers were not yet equipped to take tabular data and plot it on maps.

Government and industry continued to process unprecedented quantities of geospatial data in the mid twentieth century, and both cartographers and information scientists searched for ways to leverage these technologies to create maps. In the 1960s, the Canadian Federal government produced the first GIS as part of its much older Canada Land Inventory program dedicated to rationalizing the nation's extensive lands and other natural resources. The program hired geographer and aerial surveyor Roger F. Tomlinson to develop a computerized system that could store and map Canada's land use data. Tomlinson completed his plan in 1962 and named it a geographic information system. With federal resources Tomlinson directed a team from IBM and the Ottawa based Spartan Air Services and completed the Canada GIS in the mid 1960s.[10]

The concepts and computational power for GIS was established by the 1960s, but other digital improvements were required before the technology could come into general use. Computer processing power, data storage, and modeling techniques all improved rapidly in the decades since the first GIS. The rise of personal computers in the 1980s made geospatial analysis possible for a much wider range of scholars, and the rapid expansion of the internet in the 1990s brought together new communities of scholars from across the environmental humanities who were interested in GIS and geospatial methods.[11] Scholars in the social sciences began to explore the technology in earnest in the late 1990s thanks to professional groups such as the Social Science History Association (SSHA).[12] Although these disciplines explored new tools in new communities, many of the geospatial research methods they brought to the table had been established generations earlier. For every humanities scholar dabbling in or dedicated to GIS, there were many more using analog methods in the field of historical geography and related disciplines.

Who were the Scholarly Innovators?

Historical geography predates the advent of desktop GIS software and many of the cartography conventions discussed in this e-textbook were developed using analog methods. Books and historical atlases from the mid-twentieth century included maps visualizing census data or changing land use over time. And whole fields of history focused on geographical issues, including Frederick Jackson Turner's frontier thesis, the Annales school or the wide reaching influence of Harrold Innis's Staples thesis and Donald Creighton's Metropolitan thesis.[13] So it might be tempting to see what some historians call the recent "spatial turn" as simply introducing computers to what historians and geographers were already doing. However, desktop GIS software, introduced in the mid 1990s, did fundamentally change the humanities and social sciences. The ability to explore spatial data during the research process and create visualizations on the fly created dramatic new opportunities for analysis. Instead of creating maps at the end of the project for publication, we can now create maps early in our research and use the results to prompt new questions that require further archival research to answer. GIS software created a new systematic way to read historical maps and layer information from different source material. The iterative nature of this process created the new practice of spatial history. We must now turn to the early innovators to see the importance of HGIS methods that developed during the late 1990s.

William Cronon used a mapping component of a new statistical software in the 1980s to map bankruptcy data from the late nineteenth century to show the primacy of Chicago in the American West.[14] This work predated the early desktop GIS software by a few years, but it demonstrated the new power of using maps to explore quantitative history. In the decade that followed, numerous teams began creating large quantitative databases tracking the Transatlantic Slave Trade[15] and national censuses for large countries including the United States, the United Kingdom, and China.

In Canada, GIS was used by a relatively small group of historians and historical geographers starting in the 1990s. The most notable was the *Montréal, l'avenir du passé* (MAP), a geospatial database that allowed geographer Sherry Olson, historian Robert Sweeny, and other scholars uncover new patterns in the history of Canada's largest city.[16] Anne Kelly Knowles brought researchers together and produced four special issues and edited collections published between 2000 and 2008.[17] The vast majority of this early work focused on GIS software's strengths of and connected quantitative databases with spatial data (census tracks with population data). This often involved large teams with significant funding and it took years of data and infrastructure development before they started publishing results. But this work did result in some major revisionist theories. Our colleague, Geoff Cunfer, for example, amassed data on the Dust Bowl that confirmed a drought was significantly more important than tractors, farmers and capitalism in causing the dust storms. GIS allowed him to broaden the analysis from geographically restricted case studies to the whole southern great plains. At this scale, it was clear there was limited correlation between the percentage of the land under cultivation and the dust storms, while the drought data matched closely with maps of the storms.[18]

What are the Recent Approaches to HGIS?

In the past fifteen years, the use of GIS in history has expanded significantly with a number of important developments when compared with the first generation of scholarship. GIS is no longer limited to big research teams with large budgets. Graduate students have used GIS to explore urban morphology as it relates to a small river, a single map of a Mohawk community, or to identify the spread of post offices across the west in Canada and the United States.[19] Secondly, historians have moved beyond the census and other quantitative sources. They have found many new ways to read and interpret historical maps. Historians have used oral histories to gather spatial information.[20] And a number of projects have used text mining methods to create spatial data out of large collections of digitized historical documents.[21] The internet has also created alternative ways to share research results. Interactive online atlases allow visitors to explore the visualizations, and platforms like StoryMaps allow researchers to create history websites to share their findings with the public. *The American Panorama: An Atlas of United States History* is the best current example.[22] Finally, while the cost of GIS software and the funding opportunities limited most of the work to North America, Western Europe and China, the field has begun to extend to the rest of the world with recent publications from the Global South, including articles focused on India and Nigeria.[23]

The field has grown to the point where it is now difficult to survey the literature, and more and more historians simply use GIS or other digital mapping platforms in their research without publishing standalone articles on their methods. Nevertheless, there are a number of bibliographies that try to maintain lists of historical GIS publications and a growing number of websites with shared historical GIS datasets.[24]

Where are the datasets?

As the tutorials in this volume demonstrate, historical GIS projects rely on a combination of recent geographic reference data and historically-specific geospatial data. Within the latter, scholars use their own specific datasets as well as generic data (eg. spatial boundaries and other geographic features) that could be used by anyone studying one place in a similar historical period. But most projects are made easier and more geographically accurate when historical datasets are used in conjunction with spatially enabled databases that show modern features. For example, accessing a modern GIS boundary file for the province of PEI is a great way to ensure that historical map layers of the island are appearing in the right part of the world, at the right scale, and using map projections that have already been created by skilled cartographers (more on projections in Chapter 3). There's no need to reinvent the wheel.

Modern geographic reference data are typically created by government-employed cartographic teams such as municipalities or census officials. Almost immediately after civic data are created they become of interest to historians, and since many have spatial components they may be analyzed in a historical GIS. Some municipalities have even created historically relevant GIS data, and several Canadian provinces have been very open with their historical data including Ontario and Prince Edward Island.

For the most part, the general-interest historical datasets have been developed at the national levels. Large multi-institution teams of historians, economists, geographers, library scientists and other disciplines came together to seek funding (usually from national agencies) and agree on a methodology and approach for creating these datasets. Some of the earliest examples were the Great Britain Historical GIS (GBHGIS) used by the Visions of Britain project, the US National Historical Geographic System (NHGIS) project, and the China Historical GIS project.[25] Since then, there have been national-level GIS data developed in Germany, France, Poland, and other European countries.

GIS boundary files are often created to align with nationally significant historical data, particularly historical censuses. In Canada the CCRI and the Canadian Peoples Project developed robust and freely available census boundary files that may be linked to decennial censuses in each year from 1851 to 1951.[26] The Canadian Historical GIS web portal allows users to "explore, map, and download statistical information about every place in Canada as the nation expanded through the nineteenth and twentieth centuries. Users can dynamically generate, explore, map, and download data about population, ages, housing, national origin, agriculture, fisheries, and other topics." To read more and to access the maps from 1851-1921 visit https://hgiscanada.usask.ca.

Statistics Canada's boundary files are available from 1981 to 2021. See the "Geospatial data & maps" section for each census year on the University of Toronto Map & Data Library's Census of Canada – general documentationwebsite. Each team faces a range of limitations and challenges, of course, and they make decisions about which periods and sources fall within their scope. As a result, it is important for scholars to discover which periods are covered by historical boundary files, and if they are not (for example, Canada in 1971) is it worth creating new boundary files for your project?

Key Tips: Before you Begin

Keep it Simple

Start simple. While the most basic maps can be built with minimal technical skills and in a short amount of time, large scale projects can take months or years to complete and may require a team of researchers.

Build on Existing Work

Often the hardest part of a mapping project is gathering the initial information. Using existing resources is one of the best ways to start out. This allows you to focus your efforts on the map creation process rather than on digitizing extensive resources.

Build Your Community

The historical GIS community is large, diverse, and welcoming. Many scholars are willing to provide you with tutorials, datasets, and other supports if you describe the challenges you are encountering. Chances are good that other communities are interested in your project, too, either in the exact location or in similar approaches in different locations. Try proposing your work to historical conferences, and watch for the H-GIS network's call for papers for the annual SSHA conference. Tap into listservs and social media networks to see if there are others with similar and complementary project ideas; they may be interested in sharing ideas or even joining you at one of the conferences in a thematic panel you design and propose together.

Conclusion

This introduction has briefly defined the geospatial humanities and summarized some of the key developments in geospatial history. We hope you enjoy the tutorials that follow, and we trust you will soon be a geospatial historian if you aren't already! The rest of this e-textbook contains five extensive chapters, sidebars, key concepts, and many images to guide you through each lesson. Remember to click the **Contents** section on the left to see each chapter and its sections, or click the link at the bottom right of your browser to continue to Chapter 1. It should read "Next: Getting Started."

[1] Dr. Geoff Cunfer founded the HGIS Lab and directed the Sustainable Farm Systems project at the University of Saskatchewan https://hgis.usask.ca/projects/sustainable-farm-systems.php. Drs Cunfer, Clifford, and MacFadyen also collaborated on The Canadian Peoples (TCP), a project that developed and shared robust census boundary files as well as tabular data from historical censuses.

[2] Cheryl Lynn Troupe, "Mapping Métis Stories: Land Use, Gender and Kinship in the Qu'Appelle Valley, 1850-1950," (Ph.D., University of Saskatchewan, 2019), https://harvest.usask.ca/handle/10388/12122; Brian Donahue, "Mapping Husbandry in Concord: GIS as a Tool for Environmental History," in *Placing History: How Maps, Spatial Data, and GIS Are Changing Historical Scholarship*, ed. Anne Kelly Knowles and Amy Hillier (Redlands: ESRI Press, 2008), 151–78; Downs, Gregory P., and Scott Nesbit. *Mapping Occupation: Force, Freedom, and the Army in Reconstruction*, 2015. https://www.mappingoccupation.org/. Robert K. Nelson, LaDale

Winling, Richard Marciano, Nathan Connolly, et al., "Mapping Inequality," American Panorama, ed. Robert K. Nelson and Edward L. Ayers, accessed July 14, 2022, https://dsl.richmond.edu/panorama/redlining/#loc=5/39.1/-94.58.

[3] For similar definitions of spatial history and HGIS see White, Richard. "What Is Spatial History?" *Spatial History Project*, February 1, 2010. https://web.stanford.edu/group/spatialhistory/cgi-bin/site/pub.php?id=29. According to White, spatial history projects (including HGIS projects) differ from other forms of history in 5 important ways. This includes 1) the need for collaboration and interdisciplinary teams 2) the use of visualizations as an integral part of the research process rather than simply as a way to present results 3) a dependence on technology 4) a reliance on open ended tools and datasets that allow the end user to remix the evidence in new ways and to reach conclusions well beyond those laid out by the research 5) a focus on understanding spatial patterns.

[4] For a notable example of the potential for interactive data visualizations combined with a textual narrative see Cameron Blevins, Steven Braun, and Yan Wu. "Gossamer Network," 2021 https://gossamernetwork.com/.

[5] For examples of freely available datasets and documentation guides see Hoy, Benjamin. "Building Borders: Visual Representations of the Canada-United Border 1860-1915," 2019. www.buildingborders.com. This data is also permanently hosted by the University of Saskatchewan: https://harvest.usask.ca/handle/10388/12153.

[6] "1870 Fast Facts," n.d., United States Census Bureau, https://www.census.gov/history/www/through_the_decades/fast_facts/1870_fast_facts.html.

[7] Lynne Billard, "The American Statistical Association and the US Census: A shared history," *Significance* 16, no. 5 (2019): 30-34.

[8] Gannett, Henry, and United States. Census Office. 11th Census. "Distribution of the Population of the United States (Excluding Indians Not Taxed): 1870 & 1880." In *Statistical Atlas of the United States, Based upon the Results of the Eleventh Census*, plate 5. Washington: Govt. print. off., 1898. https://www.loc.gov/item/07019233/. Gannett, Henry, and United States. Census Office. 11th Census. "Distribution of the Population of the United States: 1890." In *Statistical Atlas of the United States, Based upon the Results of the Eleventh Census*, plate 6. Washington: Govt. print. off., 1898. https://www.loc.gov/item/07019233/.

[9] Jon Agar, *The Government Machine: A Revolutionary History of the Computer* (MIT press, 2003).

[10] Michael F. Goodchild, "Reimagining the History of GIS," *Annals of GIS* 24:1 (2018): 1-8, DOI: 10.1080/19475683.2018.1424737

[11] Joshua MacFadyen, "Digital Environmental Humanities," in Serge Noiret, Mark Tebeau and Gerben Zaagsma eds., *Handbook of Digital Public History* (Berlin, Boston: De Gruyter Oldenbourg, 2022), 97-106 https://doi.org/10.1515/9783110430295-008.

[12] Anne Kelly Knowles, "Historical geographic information systems and social science history," *Social Science History* 40, no. 4 (2016): 741-750.

[13] J. M. S. Careless, "Metropolis and Region: The Interplay between City and Region in Canadian History before 1914," *Urban History Review* 7, no. 3–78 (February 1979): 99–118, https://doi.org/10.7202/1019408ar; Harold A. Innis, *Staples, Markets, and Cultural Change: Selected Essays*, ed. Daniel Drache (Montreal ; Buffalo: McGill-Queen's University Press, 1995); Frederick Jackson Turner, *The Frontier in American History* (New York, NY: Digireads.com, 2010).

[14] William Cronon, *Nature's metropolis: Chicago and the Great West*, (New York: Norton, 1991), 263-309.

[15] This project was built on the work of earlier efforts to create databases of the Atlantic slave trade in different national contexts dating back to the 1970s. In the 1990s, these projects came together to build a comprehensive database for the whole Transatlantic Slave Trade. David Eltis, "Trans-Atlantic Slave Trade – Understanding the Database," Slave Voyages, 2018, https://www.slavevoyages.org/voyage/about#methodology/introduction/0/en/.

[16] See https://map.cieq.ca and many publications, including Francois Dufaux and Sherry Olson, "Rebuilding a neighbourhood of Montreal," in Jennifer Bonnell and Marcel Fortin eds., *Historical GIS Research in Canada* (Calgary: University of Calgary Press, 2014): 153-180. https://press.ucalgary.ca/books/9781552387085/

[17] Anne Kelly Knowles, "Introduction," *Social Science History* 24, no. 3 (ed 2000): 451–70, https://doi.org/10.1017/S0145553200010269; Anne Kelly Knowles, ed., *Past Time, Past Place: GIS for History* (Redlands: ESRI Press, 2002); Anne Kelly Knowles, "Emerging Trends in Historical GIS," *Historical Geography* 33 (2005): 7–13; Anne Kelly Knowles and Amy Hillier, eds., *Placing History: How Maps, Spatial Data, and GIS Are Changing Historical Scholarship* (Redlands: ESRI Press, 2008).

[18] Geoff Cunfer, *On the Great Plains: Agriculture and Environment* (College Station: Texas A&M University Press, 2005); Geoff Cunfer, "Scaling the Dust Bowl," *Placing History: How Maps, Spatial Data, and GIS Are Changing Historical Scholarship. ESRI Press, Redlands,* CA, 2008, 95–121.

[19] Daniel Rueck, "Enclosing the Mohawk Commons: A History of Use-Rights, Land-Ownership, and Boundary-Making in Kahnawá:Ke" (Ph.D., Montreal, McGill, 2013), https://escholarship.mcgill.ca/concern/theses/7p88cm05j; Jennifer Bonnell, "Imagined Futures and Unintended Consequences: An Environmental History of Toronto's Don River Valley" (PhD Dissertation, Toronto, University of Toronto, 2010); Gustavo

Velasco, "Natural Resources, State Formation and the Institutions of Settler Capitalism: The Case of Western Canada, 1850-1914" (Ph.D., London, London School of Economics, 2016), http://etheses.lse.ac.uk/3437/1/Velasco_natural_resources.pdf.

[20] Troupe, "Mapping Métis Stories"; Yao-Yi Chiang and Craig A. Knoblock, "Recognizing text in raster maps," *GeoInformatica* 19 (2015): 1-27; Inga Schlegel, "Automated extraction of labels from large-scale historical maps," *AGILE: GIScience Series* 2 (2021): 12. https://doi.org/10.5194/agile-giss-2-12-2021

[21] Catherine Porter, Paul Atkinson, and Ian Gregory, "Geographical Text Analysis: A New Approach to Understanding Nineteenth-Century Mortality," *Health & Place* 36 (November 2015): 25–34, https://doi.org/10.1016/j.healthplace.2015.08.010; Jim Clifford et al., "Geoparsing History: Locating Commodities in Ten Million Pages of Nineteenth-Century Sources," *Historical Methods: A Journal of Quantitative and Interdisciplinary History* 49, no. 3 (July 2, 2016): 115–31, https://doi.org/10.1080/01615440.2015.1116419.

[22] American Panorama https://dsl.richmond.edu/panorama/

[23] Nnamdi Ifeanyi Maduekwe, "A GIS-Based Methodology for Extracting Historical Land Cover Data from Topographical Maps: Illustration with the Nigerian Topographical Map Series," *KN – Journal of Cartography and Geographic Information* 71, no. 2 (June 1, 2021): 105–20, https://doi.org/10.1007/s42489-020-00070-z; Ademide Adelusi-Adeluyi, "'Africa for the Africans?' – Mapmaking, Lagos, and the Colonial Archive," *History in Africa* 47 (June 2020): 275–96, https://doi.org/10.1017/hia.2020.9; K. Dhanaraj and Dasharatha P. Angadi, "A GIS Based Interpretation of the Historical Evolution of Urban Settlements in Mangalore City, India," *Spatial Information Research* 29, no. 4 (August 1, 2021): 615–29, https://doi.org/10.1007/s41324-020-00363-5; Sekido Ippei, "Historical GIS Materials for South Asia Studies in The University of Tokyo," *Journal of Urban and Regional Studies* 5, no. 2 (2019): 5.

[24] HGIS Lab Bibliography; Anteriosis List of HGIS projects http://anterotesis.com/wordpress/dh-gis-projects/

[25] Humphrey Southall, "A vision of Britain through time: online access to 'statistical heritage'." *Significance* 4, no. 2 (2007): 67-70.

[26] The 1851 and 1861 data only covers the Province of Canada (which covered a much small geography than the later provinces of Ontario and Quebec).

SECTION I

CHAPTER 1: AN INTRODUCTION TO QGIS

Getting Started

Overview: What is GIS?

A Geospatial Information System (GIS) is a type of mapping software that allows users to create maps and perform advanced spatial analysis. Users can map quantitative data, such as census demographic statistics, to uncover spatial relationships. Users can also harness the power of a GIS to assign real-world coordinates to digitized maps. Users can then create new features on their maps, for example railway lines, in a process known as digitization. These features contain attribute data, say for example the railway's owner or the date that segment was constructed, that enable the user to create historically relevant maps and other visualizations. If a user already has attribute data in a spreadsheet or other tabular format, he or she can use a GIS to assign it to its real-world geographic location on a digital map. The process of linking data—e.g., quantitative or spatial—with actual geographic locations on Earth is one of the unique features of GIS. By contrast, a user could use a graphics software program to show their data on a digital map, or they could use a database program to crunch the numbers of their quantitative data. However, only a GIS can assign this data a geographic location. This affords a level of spatial analysis that graphics software and databases cannot match.

There are currently two notable GIS programs: ArcGIS and QGIS. ArcGIS is a proprietary (i.e., pay-for-use) product suite of geospatial tools developed by Esri, a company involved in the GIS products market. By contrast, QGIS is a Free and Open Source Software (FOSS), and it is freely available to all users. (If you are interested, you can find the source code for QGIS here.) Volunteers maintain and update QGIS.

This textbook is designed for use with the QGIS software; there is no need to purchase proprietary software to complete any of the steps in this guide. However, ArcGIS is the industry standard, and, in some areas, it may be able to perform tasks that QGIS cannot. If you are a student or faculty member at a university, there is a chance that you already have access to ArcGIS. As the GIS concepts that underlie both QGIS and ArcGIS are very similar, those who have access to ArcGIS will likely find this textbook helpful. They are also encouraged to check out the Geospatial Historian website. The same team behind this textbook developed the site's lessons, which are tailored for ArcGIS.

Example Exercise: Using GIS to Investigate Deforestation

Seeing that GIS is useful for analyzing data by mapping it, let's take a concrete example to demonstrate this. In this chapter, we will get ourselves up and running with QGIS. Then, we will use QGIS to help us visualize a question that relates to Prince Edward Island, Canada's smallest province. Island environmental scientists and historians have studied how the amount of forest cover on PEI has changed over time, and QGIS can help us visualize the extent of forest cover and agricultural settlement in different historical periods.

When British settlers first began to arrive on the Island in the late-eighteenth century, they encountered a land that was very densely forested. In the 1860s, an Island newspaper spoke of the topography of the Island that an elderly Islander had witnessed in his younger days. "In his boyhood he has seen the greater part of the country covered with the primeval forest. From every hilltop landwards nothing met his eye but a vast unbroken sea of foliage so dense as almost to appear solid."[1]

Yet, over a few decades, Island settlers put in the arduous, manual labour required to clear much of the land. They used the cleared land primarily for farming. While environmental scientists and historians today know that a great amount of deforestation has occurred since the settlement period began, they have sought to measure the amount of deforestation and to map where it occurred. As we will show later in this chapter, GIS has given them the capacity to do this research.

1. "Country Life in Prince Edward Island in the Past," Summerside Progress, 21 January 1867.

Part I A: Downloading and Installing QGIS

This section will walk you through how to identify the appropriate version of QGIS, as well as how to download it and install it on your personal computer.

Note that you must have administrative access to install software on your computer. If you own your personal computer, you would likely have administrator access. If you are using a computer at your school, you may need to contact your administrator in order to download QGIS.

- Go to [QGIS.org]() and click the “Download Now” button.

Figure 1.1

QGIS is available for computers running Windows, macOS, Linux and BSD. (There are also Android apps available for mobile devices.)

- Click the [LINK]() to download QGIS for the operating system that you have. In our case, we will click “Download for Windows.”

- This demonstration is being done on a Windows computer, so the following steps will show the process for Windows users to follow.

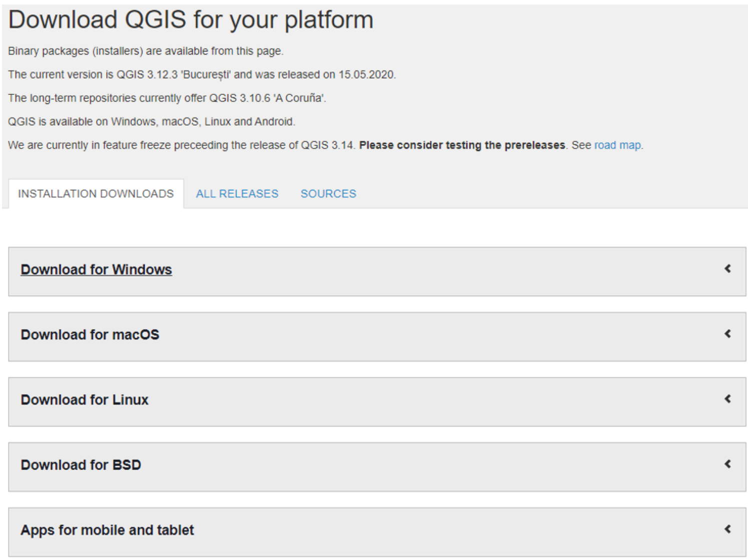


Figure 1.2

When you click "Download for Windows," the box will expand. You have multiple download links to choose from.

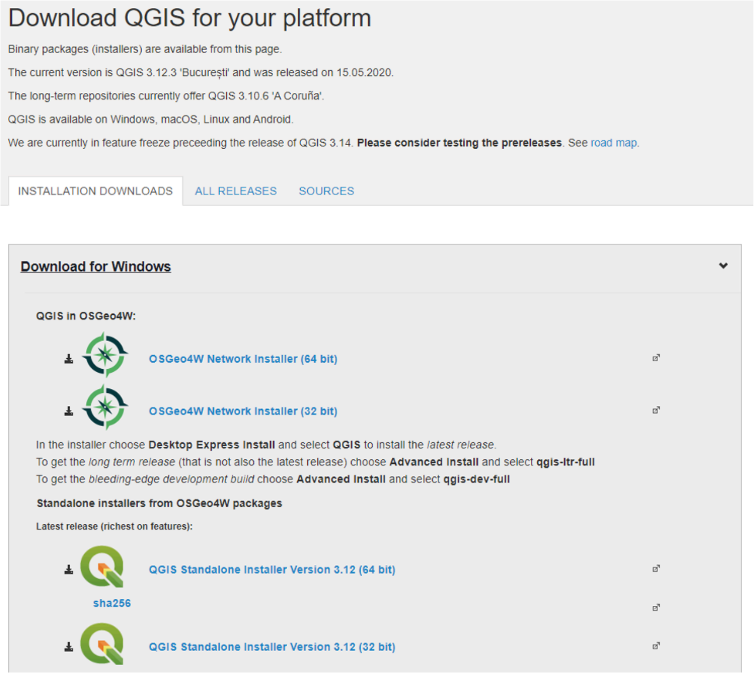


Figure 1.3a (Windows)

We recommend that new users select the "Long term release (most stable)" version (for Mac users at the time we last updated this part of Chapter 1 it was QGIS macOS Installer Version 3.16).

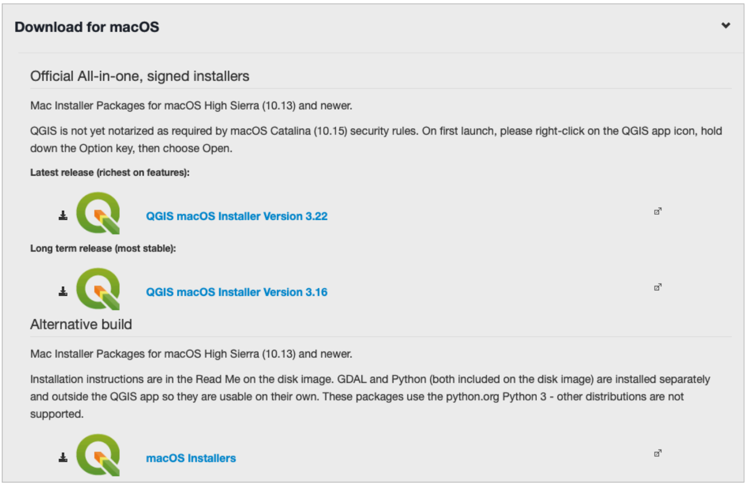


Figure 1.3b (Mac)

The first two links are for Network Installers, which will download a complex package of GIS software. They are designed for advanced users. We will go with the much simpler Standalone Installer, which is listed next and which is better suited for beginners.

> **Note:** make sure to download the Standalone Installer that matches your computer's architecture (64 bit or 32 bit). If you are using a PC that was built after 2005, it most likely has a 64-bit architecture. If you are unsure about your Windows computer's architecture, you can go to your computer's Start menu, then Settings, then System, then About. Under "System Type," it will tell you whether you have a 64-bit operating system.

- Click the “QGIS Standalone Installer” that matches your computer’s architecture. In our case, we will select 64 bit.

Note: QGIS is constantly being updated, so the version number that you see in this guide’s screenshots may no longer be the most up to date by the time you are reading this textbook.

Note: the installer for QGIS is a large file (roughly 400 MB for Windows and 1.2 GB for Mac) and the download may take some time.

- Once the download is complete, double-click the Installer to begin.
- Click Next

Figure 1.4

- Read the License Agreement for QGIS and the components included in QGIS and accept the terms of the agreement to continue.

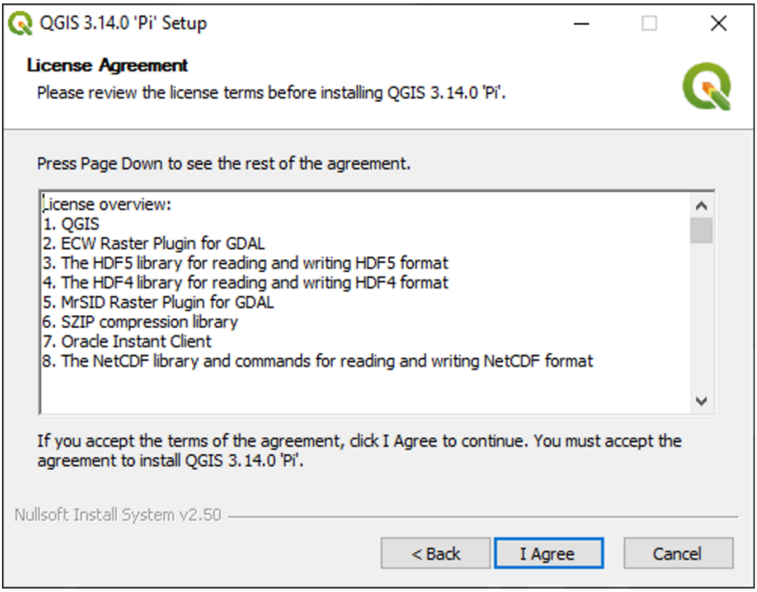


Figure 1.5

- Set the install location for QGIS, or keep the default destination, and click Next.

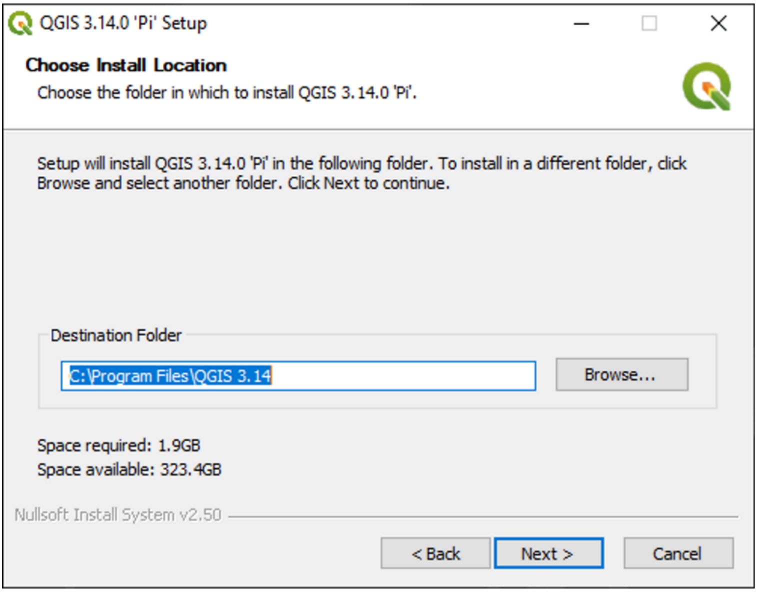


Figure 1.6

The installer also comes equipped with three sets of sample datasets. Uncheck these, for we will work with our own data.

- Click Install.

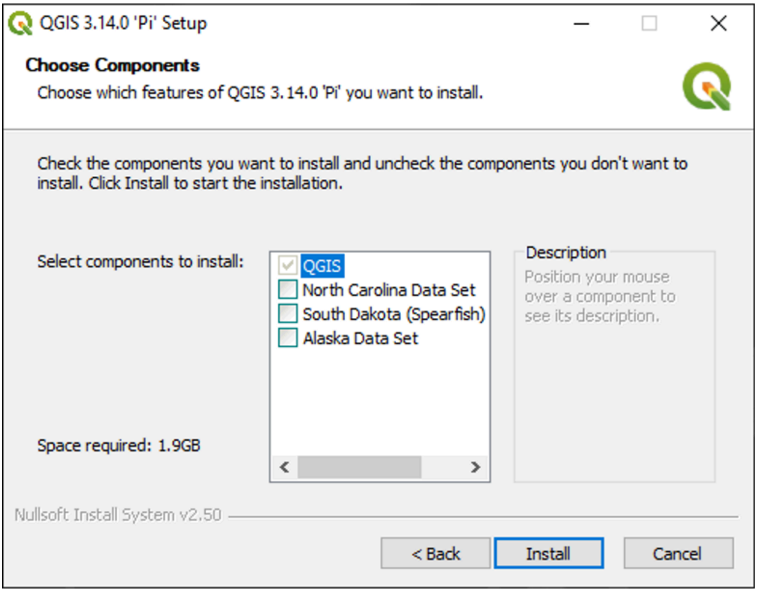


Figure 1.7

The install is in progress and will take a few minutes to complete.

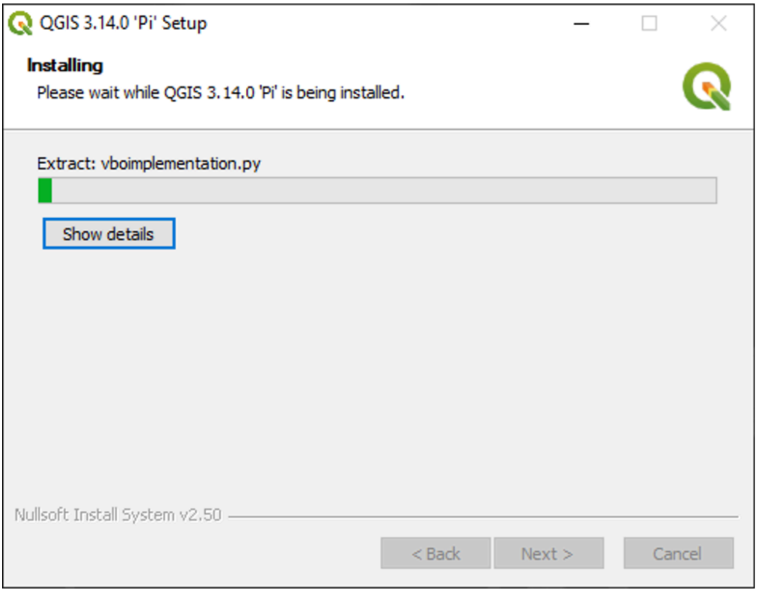


Figure 1.8

- Click Finish when the installation is complete.

Figure 1.9

QGIS is now installed, and we are ready to open it.

Part I B: Opening and Navigating within QGIS

Opening QGIS

By default, a folder called QGIS is created on your Desktop. If you open it, you will see shortcuts to the QGIS application.

- Double-click QGIS Desktop

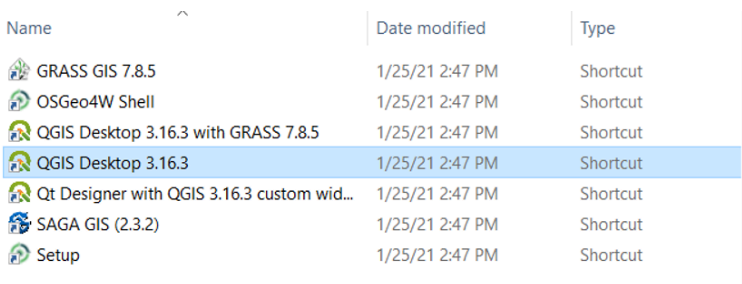


Figure 1.10

While QGIS loads, a splash screen similar to the one below will appear.

Figure 1.11

Once the loading is completed, the splash screen will be replaced with the QGIS program itself.

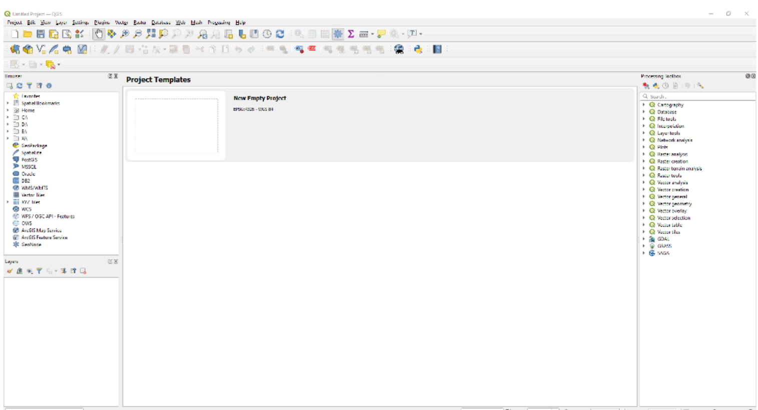


Figure 1.12

Navigating within QGIS

These are the four areas of QGIS where we will spend most of our time. Below, we will go through each of these sections.

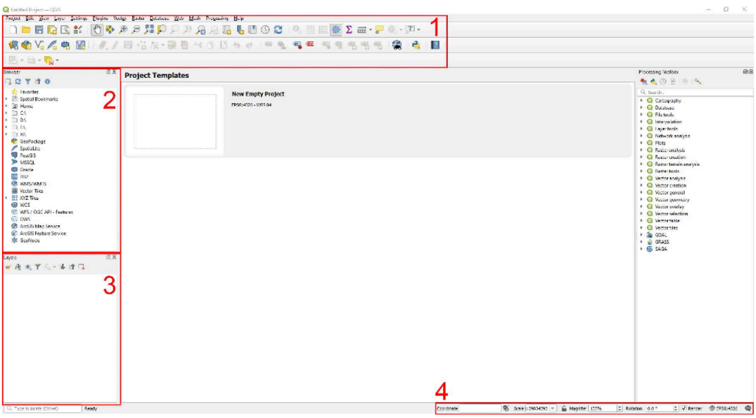


Figure 1.13

Area 1

This area contains all the menus and various icons on the toolbars of QGIS. This section is fully customizable, via drag and drop, as well as using the View menu to change the sections of the toolbars. If you hover over the icons on the toolbars, you will get a pop-up that tells you the name of the tool, and its associated keyboard shortcut keys.

Figure 1.14

Area 2

This is the Browser section of QGIS. This section is where we will get all our layers for our projects. Some will be accessed locally on our computer while others will be accessed through the various additional features of the browser. For example, the XYZ Tiles allows access to the OpenStreetMap layer.

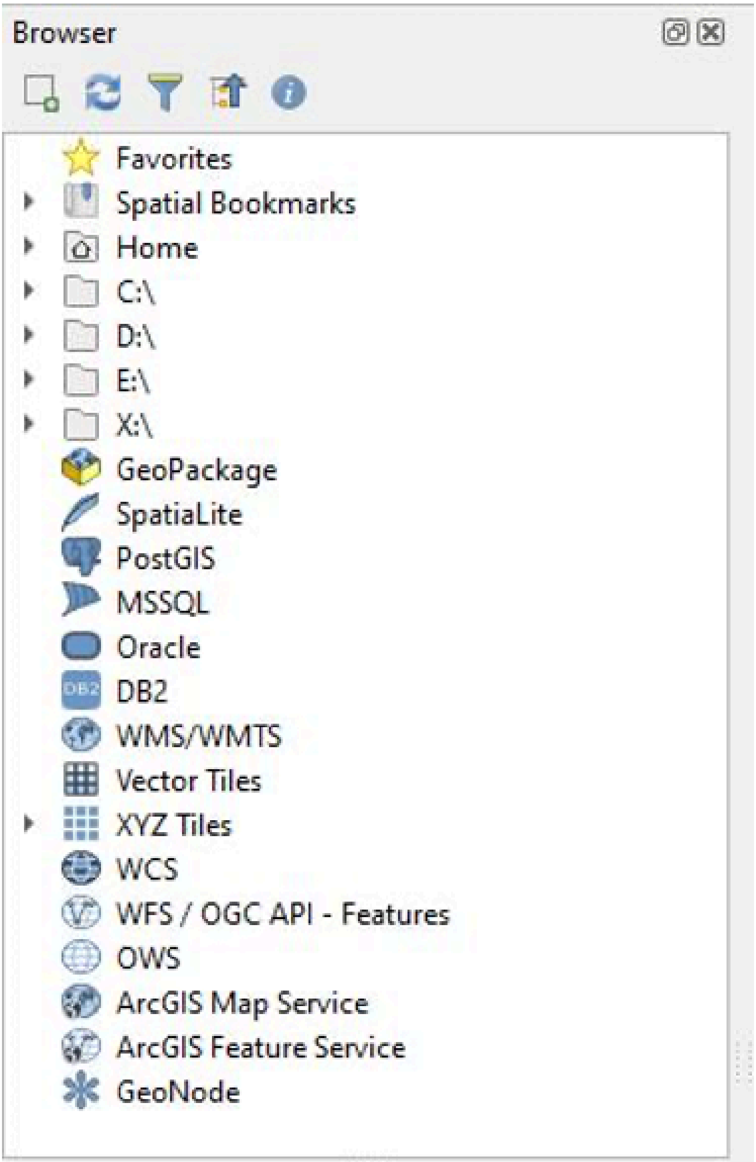

Browser
Favorites
Spatial Bookmarks
Home
C:\
D:\
E:\
X:\
GeoPackage
SpatiaLite
PostGIS
MSSQL
Oracle
DB2
WMS/WMTS
Vector Tiles
XYZ Tiles
WCS
WFS / OGC API - Features
OWS
ArcGIS Map Service
ArcGIS Feature Service
GeoNode

Figure 1.15

Area 3

This is the Layers section, which is sometimes referred to in this book as the table of contents. This is where all active or inactive layers that have been added to the project will be. Here you will be able to change their opacity, colouring, contrast or brightness, along with the hierarchy of your layers.

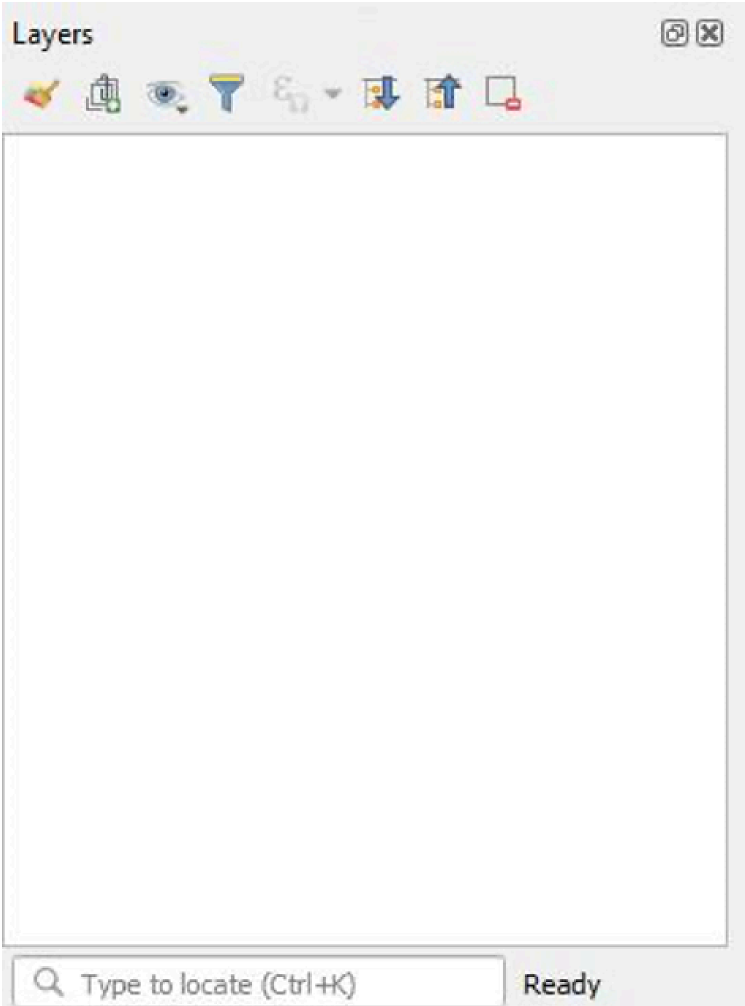


Figure 1.16

Area 4

At the bottom of the screen, we can see the Coordinates for

Geoinformation, the Scale of the map, the Zoom or Magnifier, the Rotation, and the coordinate reference system (CRS). These are useful for navigating your maps and data precisely.

Figure 1.17

> **Tip**: you can drag and drop most elements of the interface in QGIS. For example, you can left-click and hold on the Layers header and, when the Browser view turns blue, drop it over the top of the Browser window.

> **Tip:** if you accidentally close a window panel, you can close/open certain panels any time by navigating to View > Panels > and then selecting the boxes you wish to view.

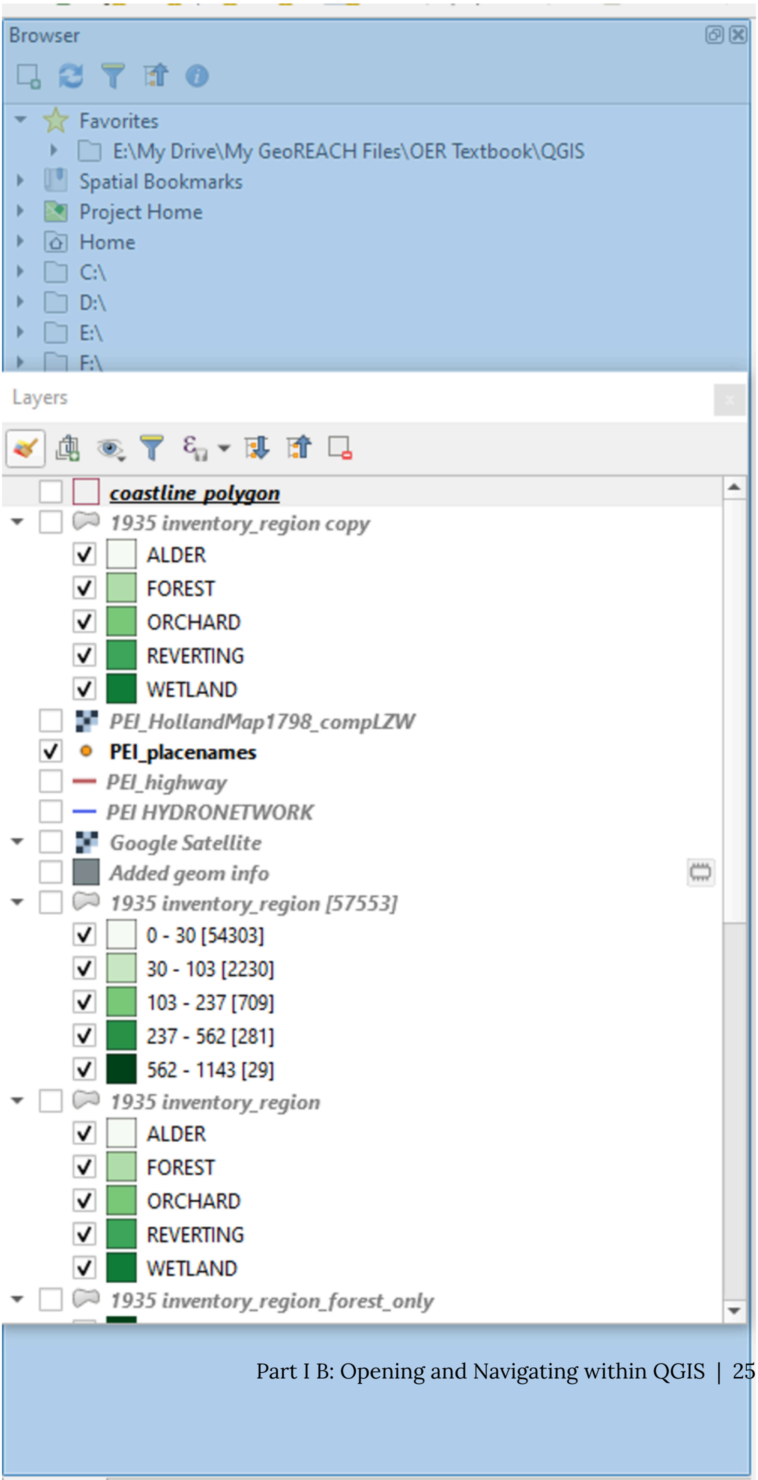

Browser
Favorites
E:\My Drive\My GeoREACH Files\OER Textbook\QGIS
Spatial Bookmarks
Project Home
Home
C:\
D:\
E:\
F:\
Layers
coastline_polygon
1935 inventory_region copy
ALDER
FOREST
ORCHARD
REVERTING
WETLAND
PEI_HollandMap1798_compLZW
PEI_placenames
PEI_highway
PEI HYDRONETWORK
Google Satellite
Added geom info
1935 inventory_region [57553]
0 - 30 [54303]
30 - 103 [2230]
103 - 237 [709]
237 - 562 [281]
562 - 1143 [29]
1935 inventory_region
ALDER
FOREST
ORCHARD
REVERTING
WETLAND
1935 inventory_region_forest_only

Figure 1.18

This will allow you to toggle between the Browser and the Layers table of contents by clicking on their respective tabs in the bottom-left of the QGIS window.

Figure 1.19

If you wish to have the Browser and Layers views viewable at the same time, you can click the undock button.

Figure 1.20

Then, you can drag and drop the Layers view underneath the Browser view again.

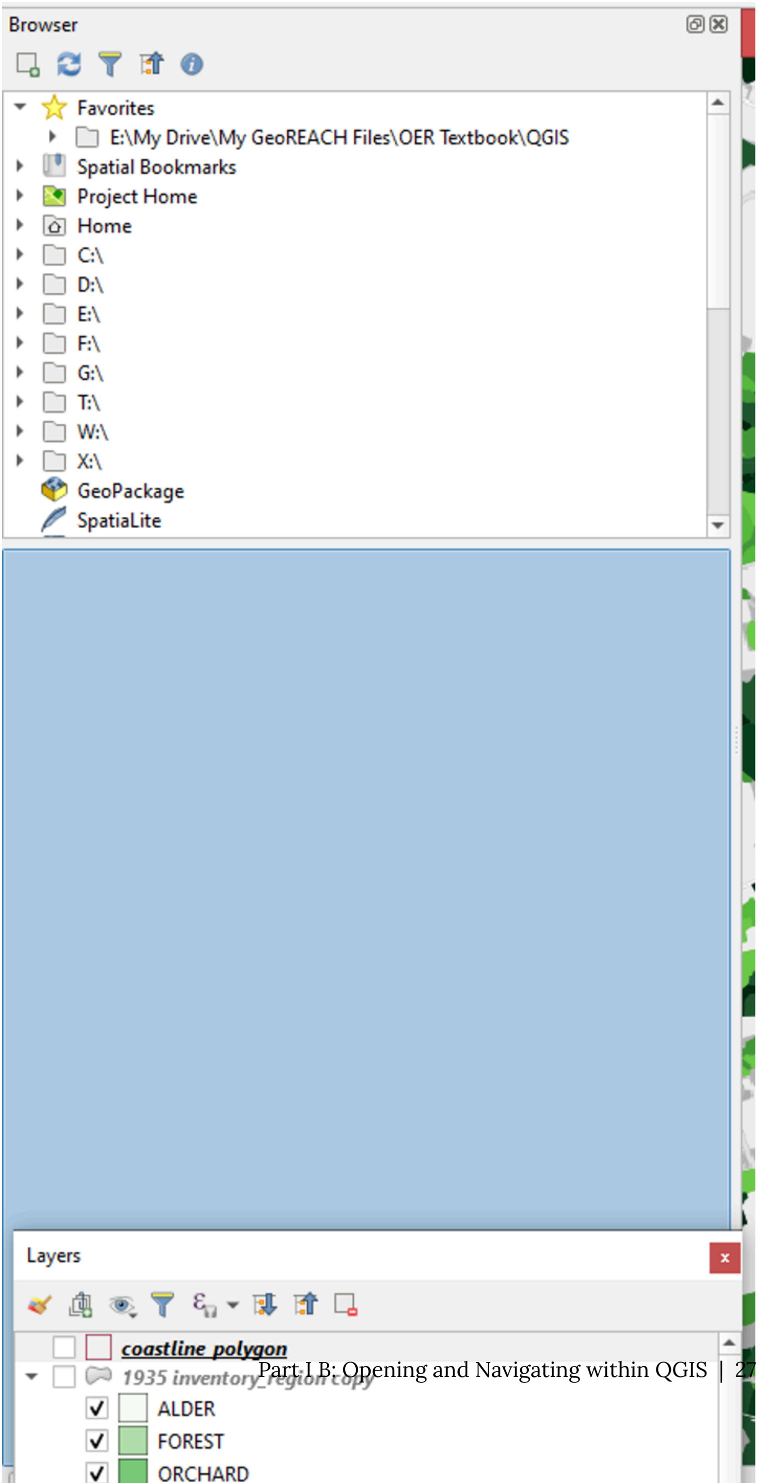

Browser
Favorites
E:\My Drive\My GeoREACH Files\OER Textbook\QGIS
Spatial Bookmarks
Project Home
Home
C:\
D:\
E:\
F:\
G:\
T:\
W:\
X:\
GeoPackage
SpatiaLite
Layers
coastline_polygon
1935 inventory_region copy
ALDER
FOREST
ORCHARD

Figure 1.21

Part I C: Starting Your First GIS Project

We are now ready to start a Project and start getting familiar with the features of QGIS. Our first GIS Project will focus on Prince Edward Island, and we will create a detailed map of the Island with a variety of datasets.

Saving the Project and Creating a Folder Structure

- Click Project
- Click Save As

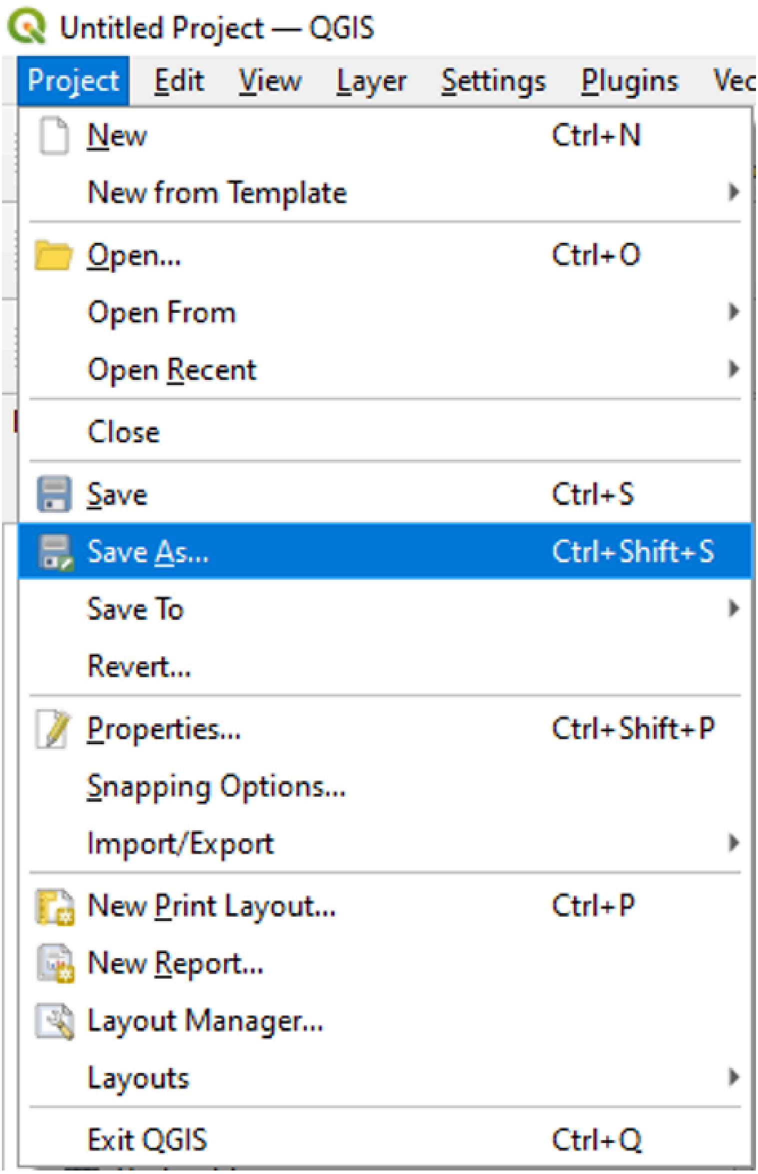

Untitled Project — QGIS
Project
Edit
View
Layer
Settings
Plugins
Vec
New
Ctrl+N
New from Template
Open...
Ctrl+O
Open From
Open Recent
Close
Save
Ctrl+S
Save As...
Ctrl+Shift+S
Save To
Revert...
Properties...
Ctrl+Shift+P
Snapping Options...
Import/Export
New Print Layout...
Ctrl+P
New Report...
Layout Manager...
Layouts
Exit QGIS
Ctrl+Q

Figure 1.22

- Create a new folder in your Documents folder and call it QGIS.
- Create a new folder within the QGIS folder called Chapter1.
- Create a new folder within Chapter1 folder and call it Data.
- Create a new folder within Chapter1 and call it ProjectFiles.
- Save your project in this ProjectFiles folder. Name your project Project1.qgz.

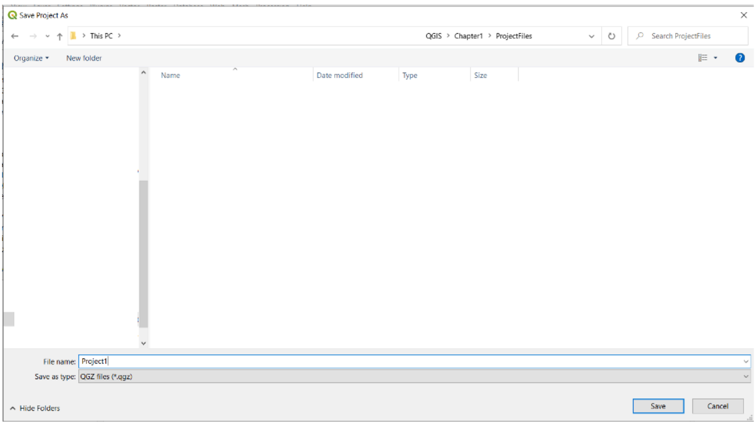


Figure 1.23

Note: as you complete the steps in this textbook, save your work in QGIS early and often to avoid data loss in case the program unexpectedly crashes.

A Note about How a GIS Application Saves Your Work

When you work with a GIS application like QGIS, you are using files in a different way than if you used a program such as Microsoft Word, for example. In Word, when you save a document, a single file is saved, and this contains everything that you wrote. All you need to do to reopen your Word document is to open this one file.

However, QGIS often operates differently. In many cases, the mapping work that you are doing in QGIS is stored in many different files. QGIS allows you to open all of these files simultaneously alongside each other in the same window. This allows you to interact with them all at once. The QGIS project file that we save is essentially a set of instructions that tell QGIS which layers we would like it to open and how we would like them displayed.

Moving Your Work

So, if we wish to move a project from one hard drive to another, we cannot simply migrate the project file. Again, the project file is only a set of instructions. It does not include any layers. When moving a project, we must move the parent folder and everything in it, including the project file and the layer files.

To move a parent folder efficiently, we can zip it and then send it. Before using the folder in its new location, we would unzip it first. We would then be free to open the project file, and QGIS will open all of our layers.

The exception to all of this is what is known as a GeoPackage. This file type allows you to save all of your layers and project file within one GeoPackage file (.gpkg). You can then share the work you have done in QGIS by sending this one file to another hard drive. You do not need to zip and send the entire parent folder. The

GeoPackage offers a promising solution to sharing the work you do in a GIS application, and we will show you how to use it in Part II, Chapter 6: Creating and Sharing a GeoPackage. However, much of the work done in GIS applications is still done by using multiple files, including a project file and layer files, which are stored in a parent folder. So, for now, we will stick to this common practice.

To share the work you have done in QGIS (without using a GeoPackage),

- In Windows Explorer, navigate to the Chapter1 folder that we created earlier.
- Right-click the Chapter1 folder.
- Click Send to
- Click Compressed (zipped) folder

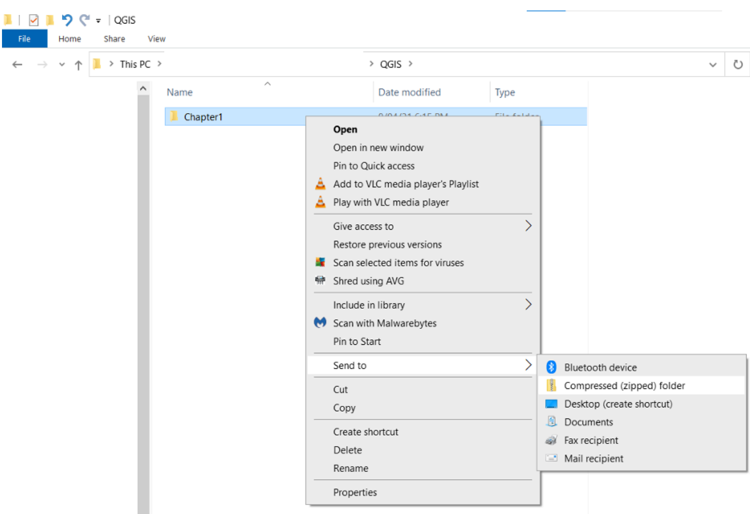


Figure 1.24

A zipped folder with the same name will appear.

Figure 1.25

You can now upload this zipped folder to Google Drive or OneDrive and share it from there. Make sure to instruct the person who will be opening it that they must first download the folder and extract it. Once the folder is extracted, you can open the ProjectFiles folder and double-click the project file called Project1. QGIS will then open all of our layers.

Part II A: Adding a Base Map

Now that we have opened QGIS and begun a project, we can start to add data to it.

The base map is the bottom-layer map over the top of which we will add all of our other layers. It is the map that forms the background map of our project. In many ways, it is the foundation of our GIS project.

- Go to the Browser, and expand the XYZ Tiles option.
- Double-click the OpenStreetMap option. This will automatically add it to your layers.

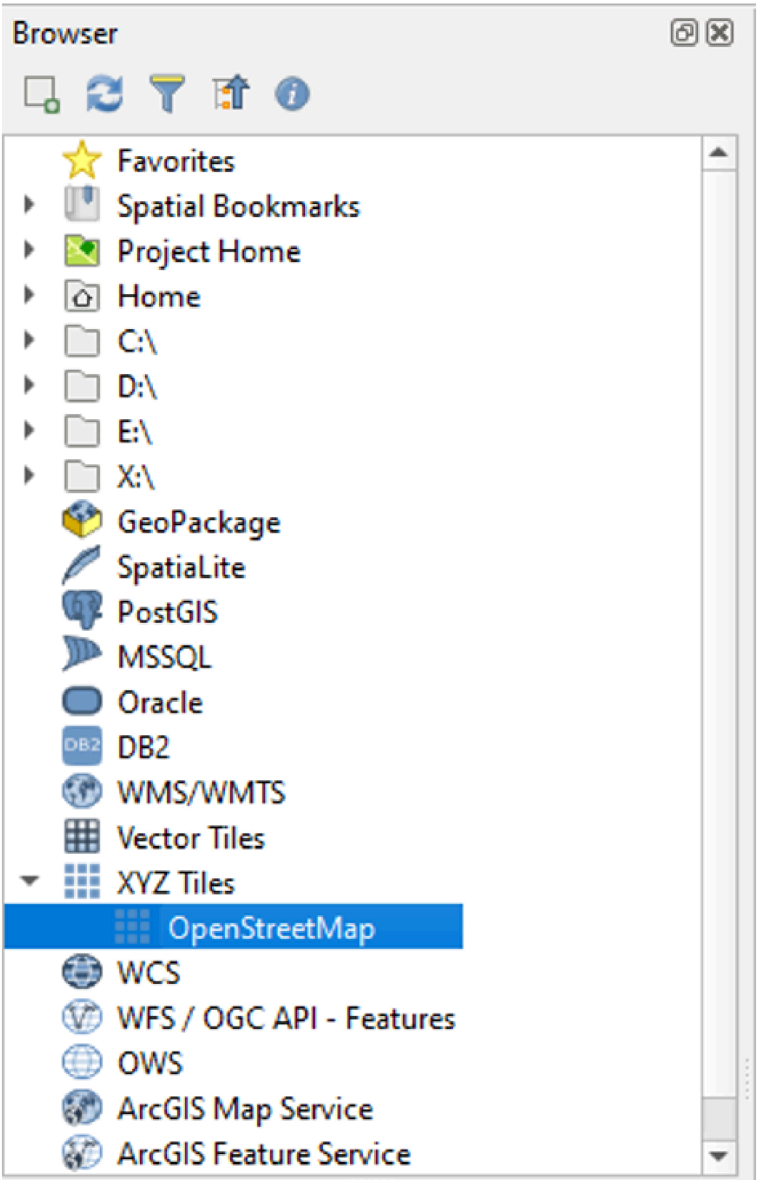

Browser
Favorites
Spatial Bookmarks
Project Home
Home
C:\
D:\
E:\
X:\
GeoPackage
SpatiaLite
PostGIS
MSSQL
Oracle
DB2
WMS/WMTS
Vector Tiles
XYZ Tiles
OpenStreetMap
WCS
WFS / OGC API - Features
OWS
ArcGIS Map Service
ArcGIS Feature Service

Figure 1.26

We can navigate the OpenStreetMap layer with the following tools. These tools allow us to pan around the map at the current zoom, to zoom in and out, and to zoom to a 1:1 ratio of the currently selected layer.

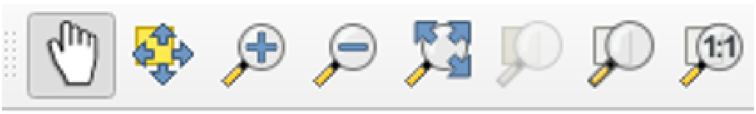


Figure 1.27

Part II B: Setting the Project's Coordinate Reference System

Since Earth is spherical in shape, mapmakers use something called a map projection to flatten the globe onto a flat surface in order to make a map. A Coordinate Reference System (CRS) defines a map projection. So, we choose a CRS, and it sets a map projection for our project.

Perhaps one of the best-known map projections is the Mercator projection, which was developed in the sixteenth century.

Here is our OpenStreetMap layer set to the default CRS—EPSG:3857 WGS 84 / Pseudo-Mercator, which is a Mercator projection.

Figure 1.28

Fact: EPSG stands for European Petroleum Survey Group, which developed the CRS standards in the 1980s while conducting oil exploration in Europe.

While the Mercator projection succeeds in displaying the spherical globe on a flat surface, it distorts the size of the world's landmasses. Areas far away from the equator, such as Canada, are inaccurately enlarged in relation to areas nearer to the equator, which remain accurate.

In the past century or so, mapmakers have been trying to create alternatives to the Mercator projection. The goal is to create ones that avoid some of the distortion that the Mercator projection causes.

We will set the CRS of our project to one that accurately represents Prince Edward Island, for that is our area of focus. If we were mapping another region, such as the contiguous United States, we could set our CRS to one that is specific to that part of the world.

To set our project's Coordinate Reference System:

- Click Project, then Properties, then CRS.

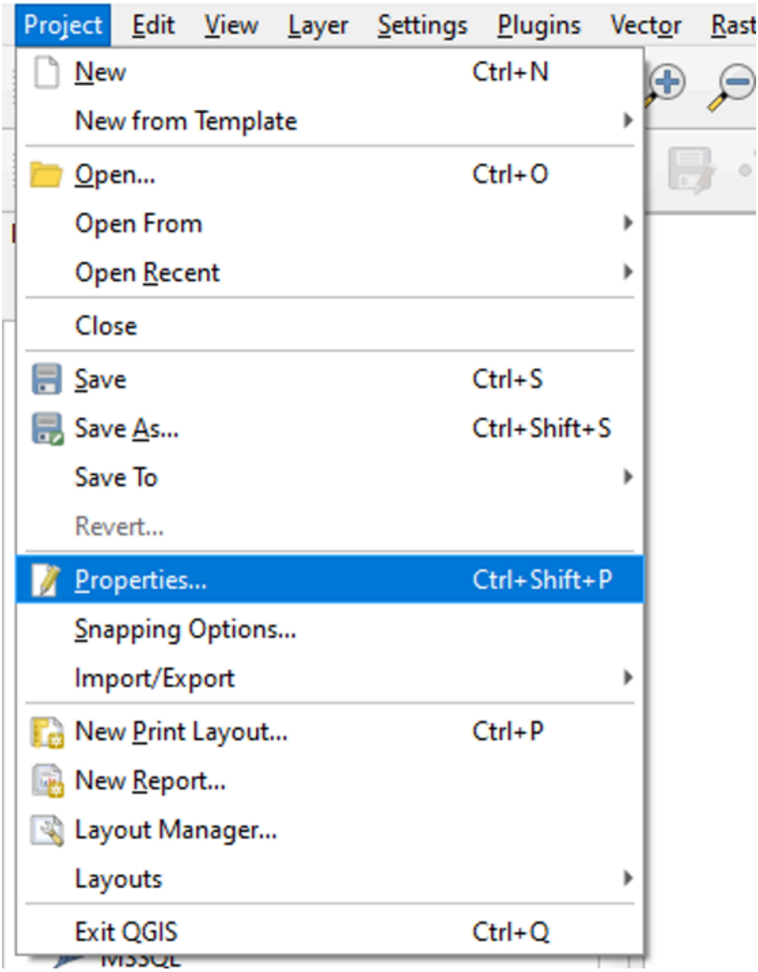

Project
Edit
View
Layer
Settings
Plugins
Vector
Rast
New Ctrl+N
New from Template
Open... Ctrl+O
Open From
Open Recent
Close
Save Ctrl+S
Save As... Ctrl+Shift+S
Save To
Revert...
Properties... Ctrl+Shift+P
Snapping Options...
Import/Export
New Print Layout... Ctrl+P
New Report...
Layout Manager...
Layouts
Exit QGIS Ctrl+Q

Figure 1.29

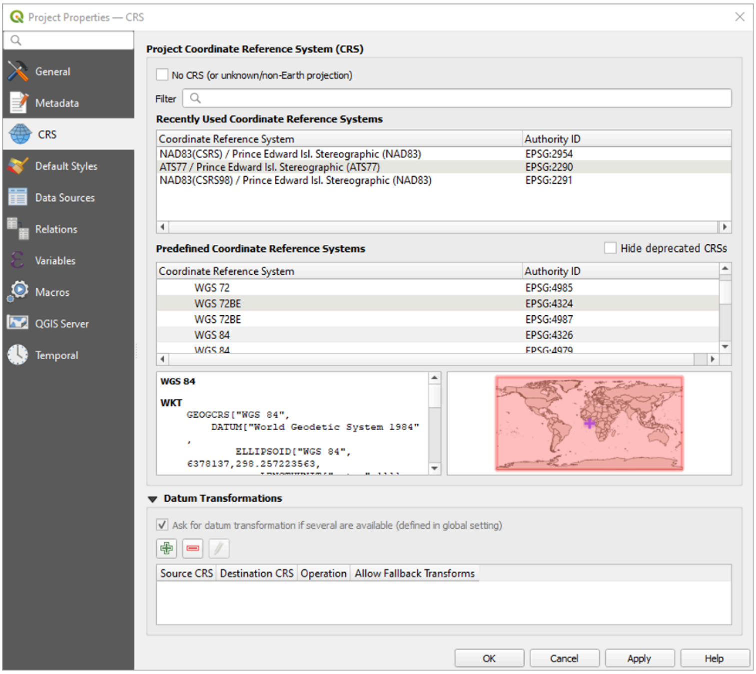


Figure 1.30

QGIS has a small preview screen that shows you to which area your CRS is tailored. Currently, the CRS is set to the default—EPSG:3857 – WGS 84 / Pseudo-Mercator.

- Type 2954 into the Filter search box.
- In the Predefined Reference System area, click to highlight the search result called NAD83(CSRS) / Prince Edward Isl. Stereographic (NAD83). It has the Authority ID called EPSG:2954.
- Click OK.

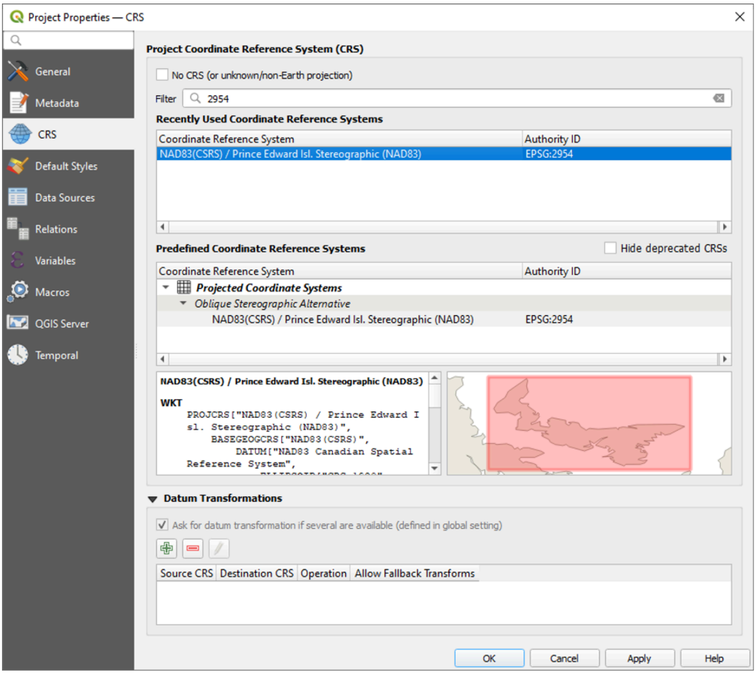


Figure 1.31

The following window will pop up. It asks us to select a transformation.

- Select the first transformation option and click OK.

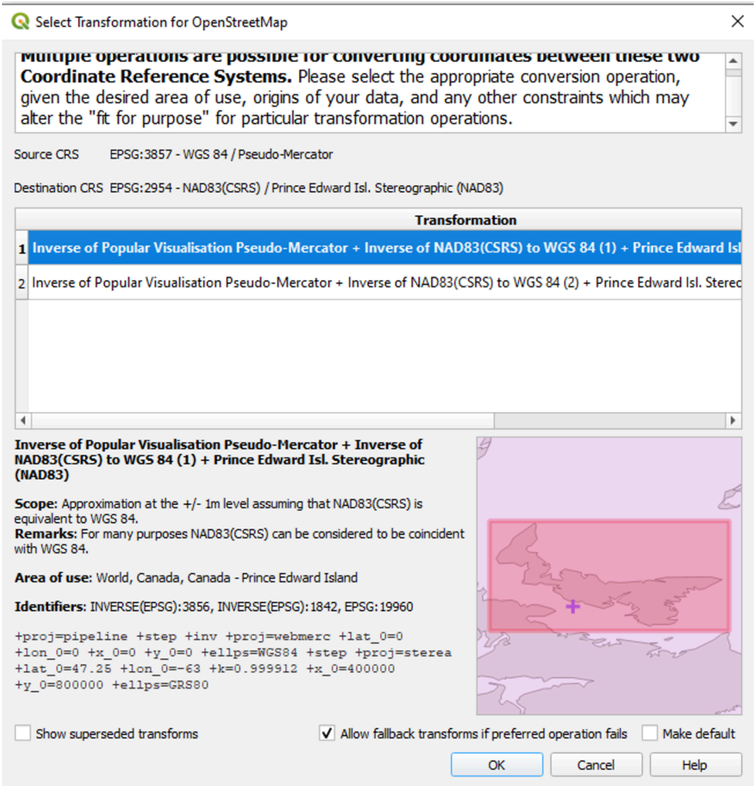


Figure 1.32

We had to choose a transformation because the default CRS of the OpenStreetMap layer is different than EPSG:2954, the one we just set for our project. QGIS will use the transformation setting we just chose to project the OpenStreetMap layer in the project's CRS. In fact, if we add any more map layers that have a CRS different than that of our project's CRS, QGIS will reproject these layers in the project's CRS too. This process has been termed "on-the-fly projection," and it is a strength of GIS software. On-the-fly projection will ensure that, notwithstanding a layer's default CRS, all layers that we add to QGIS will display according to the project's

CRS. This is critical, for it ensures that there is consistency in how all the layers are presented.

Here is the result of setting our project's CRS to EPSG:2954. Canada is much more accurate in size and shape, although the focal point has become Prince Edward Island.

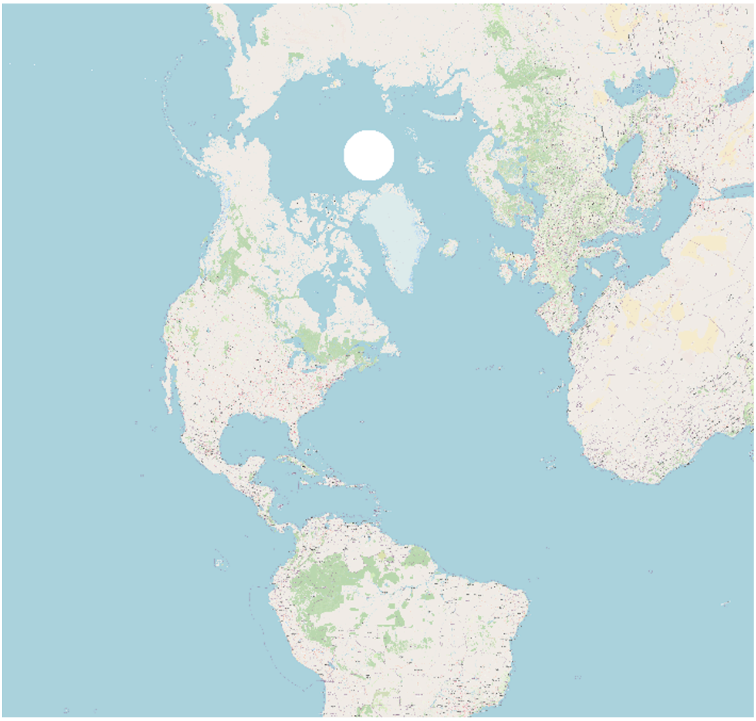


Figure 1.33

Note: you can quickly view your project's CRS by looking to the bottom-right of the QGIS window.

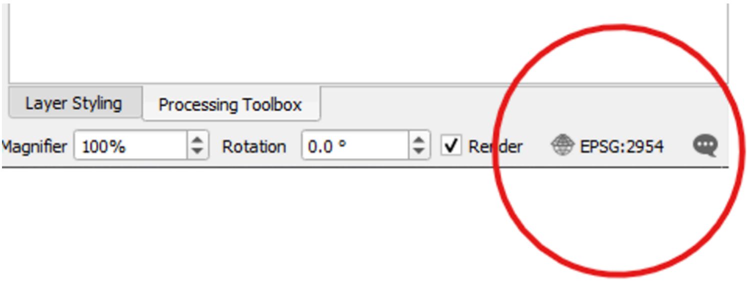

Layer Styling
Processing Toolbox
Magnifier
100%
Rotation
0.0 °
Render
EPSG:2954

Figure 1.34

Part II C: Downloading the Data

Before we continue, we will gather the data that we will analyze later in this chapter.
Please visit the following links from the Government of Prince Edward Island's website for the first five datasets. We can use this data to research the amount of deforestation on PEI.

- On each of these pages, click "Download File." Each of the files will download in a zipped folder. Extract these folders into the Data folder we created within the Chapter1 folder earlier.
    - PEI Coastline Shapefile
    - PEI Lot/Township Shapefile
    - PEI Hydronetwork Shapefile
    - PEI Forest Shapefile
    - PEI National Park Shapefile

Next, click the following download links from the Programming Historian website. Extract these zipped folders into the Data folder within the Chapter1 folder. These datasets are primarily helpful for adding common points of reference to our map. This will make it easier for us to interpret the location of any deforestation that we uncover.

1. PEI Highways
2. PEI Places

A Description of the Data

The coastline data will show us the modern contours of PEI's coasts. The nature of PEI's ever-shifting coasts means that they have changed considerably in some areas between the start of British colonization in the late-eighteenth century and today. Nevertheless, this coastline data provides us with a starting point for imagining what kind of coast the first British settlers to the Island experienced upon arrival.

The Island's river systems have been important to its history. Before British settlers cleared much of the land, the only viable way of traversing the Island was by travelling on its many rivers. So, we will add a data layer that contains PEI's "hydronetwork"—that is, its system of rivers and bodies of water.

As an example of the importance of rivers to the Island's past, consider the Georgetown area. The Three Rivers that flank Georgetown on the Island's eastern edge were critical to the area's development. They were partly responsible for affording Georgetown its excellent capacity as a harbour, and their banks provided many excellent locations for shipbuilding. We will return to studying the historical geography of Georgetown and the Three Rivers community later in the textbook.

Most importantly, we will add a dataset that contains the amount of trees on the Island in 1935 and their location. This is the primary dataset that could be used to determine the amount of deforestation that occurred between the early British colonial period and the twentieth century.

We will also add a dataset that maps PEI's highways. We will be able to see where PEI's roads ended up being placed, after the British settlers had cleared the interior and no longer needed to rely solely on water-based transportation.

Finally, we will add a layer that contains some place names of a few Island communities. These place names will appear on our map and give it some context.

Spatial History

Spatial history is a branch of historical research that encompasses GIS and other forms of digital analysis. It is focused on understanding patterns across both space and time. According to historian Richard White, spatial history projects (including HGIS projects) differ from other forms of history in 5 important ways. This includes:

1. the need for collaboration and interdisciplinary teams
2. the use of visualizations as an integral part of the research process rather than simply as a way to present results
3. a dependence on technology
4. a reliance on open ended tools and datasets that allow the end user to remix the evidence in new ways and to reach conclusions well beyond those laid out by the research
5. a focus on understanding spatial patterns.

White, Richard. [What Is Spatial History?](#) *Spatial History Project*, February 1, 2010.

Part III A: Opening and Symbolizing Vector Data

Vectors are points, lines, and polygons representing data. Vectors can represent borders, roads, and towns along with many other types of data. The key characteristic of GIS is that it assigns geographic coordinates to pieces of vector data. By contrast, a graphics software program can also create points, lines, and polygons, but it will not assign them a geographic location.

All of the data that we just downloaded is vector data. See Chapter 4: Digitization for instructions on how to create your own points, lines, and polygons.

The PEI Coastline Layer

Adding the Layer

Let's start by adding PEI's coastline to our base map.

- On the left-hand side of your screen, in the Browser, navigate to the Chapter1 folder that we created earlier.

> **Tip:** once you have navigated to this folder, right-click it and click Add as Favourite. From now on, you can access it from the Favourites menu.

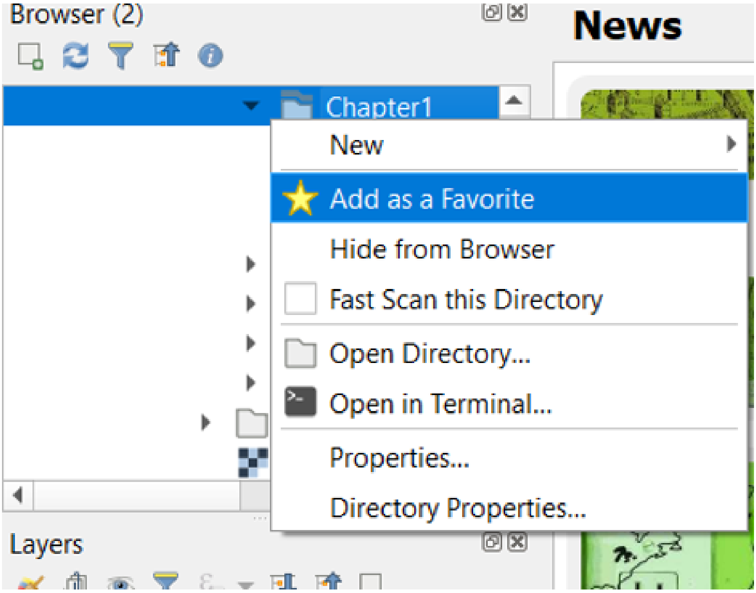


Figure 1.35

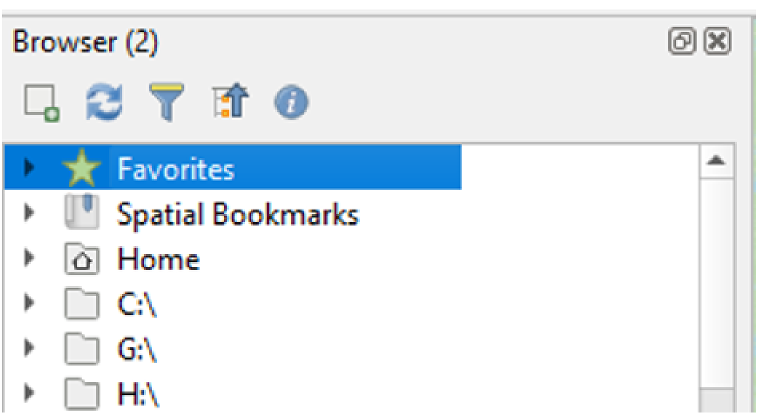


Figure 1.36

- Within the Chapter1 folder, navigate to the Data folder.
- Expand the folder called coastline.SHP.
  - The .shp file extension indicates that it is a shapefile.
- Right-click the layer called coastline_polygon.shp and click Add Layer to Project.

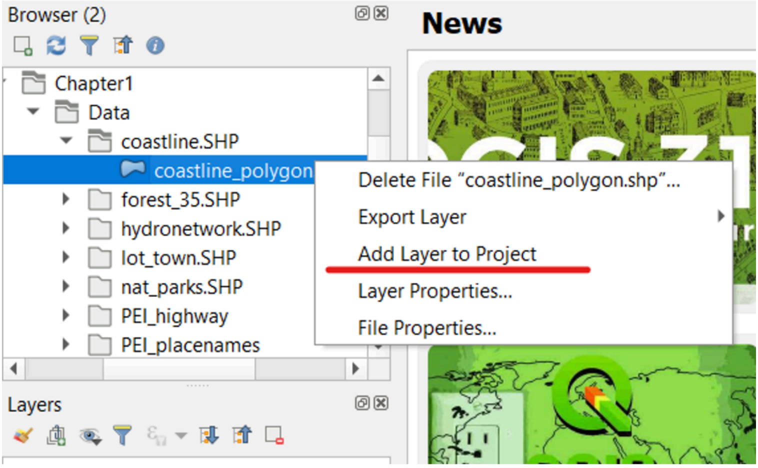


***Figure* 1.37**

- You will now see the coastline_polygon layer in your Layers table of contents.

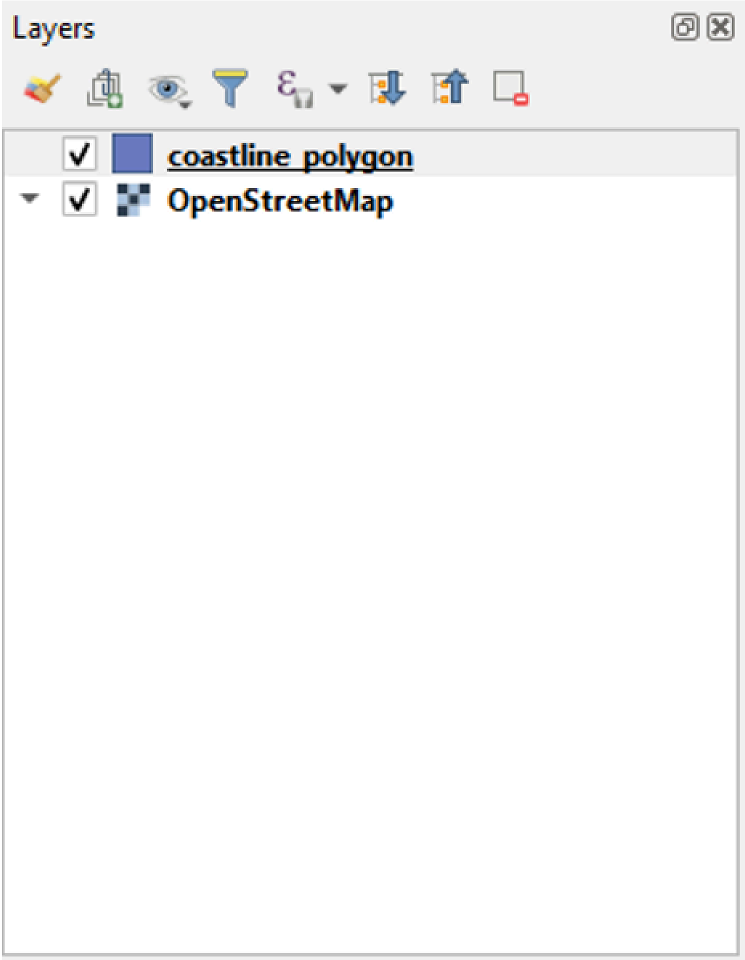


Figure 1.38

Your map will look similar to this now. The coastline file has a fill layer by default, and we can remove this in order to see our base map with the highlighted coastline.

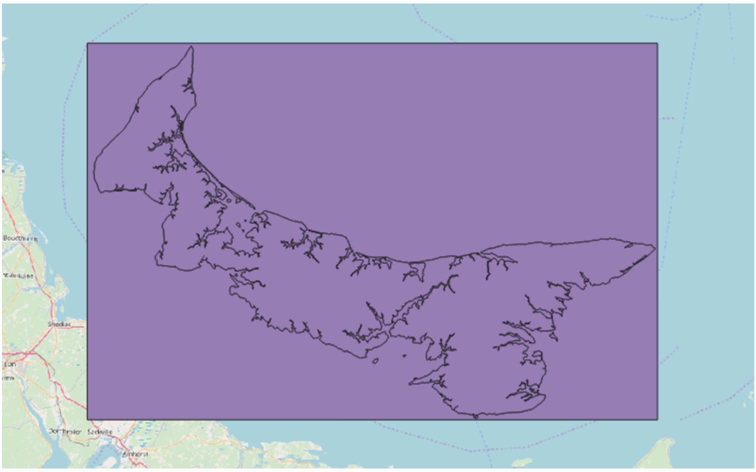


Figure 1.39

Symbolizing the Layer

- Right-click on the coastline_polygon layer and click Properties.
- Click Symbology.

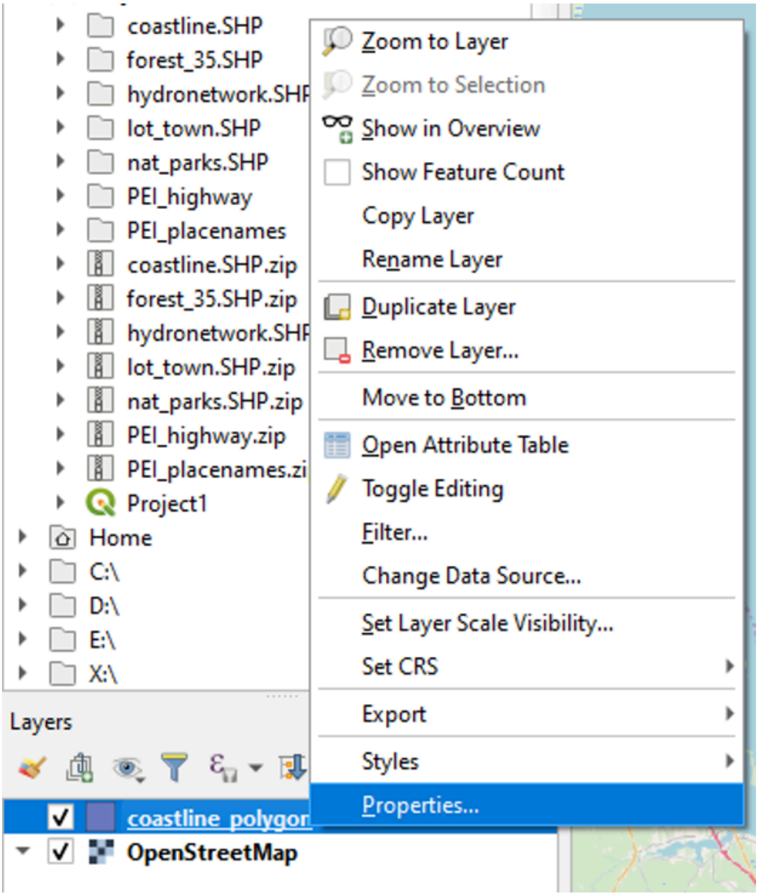


Figure 1.40

- Under Fill, click to select Simple Fill.

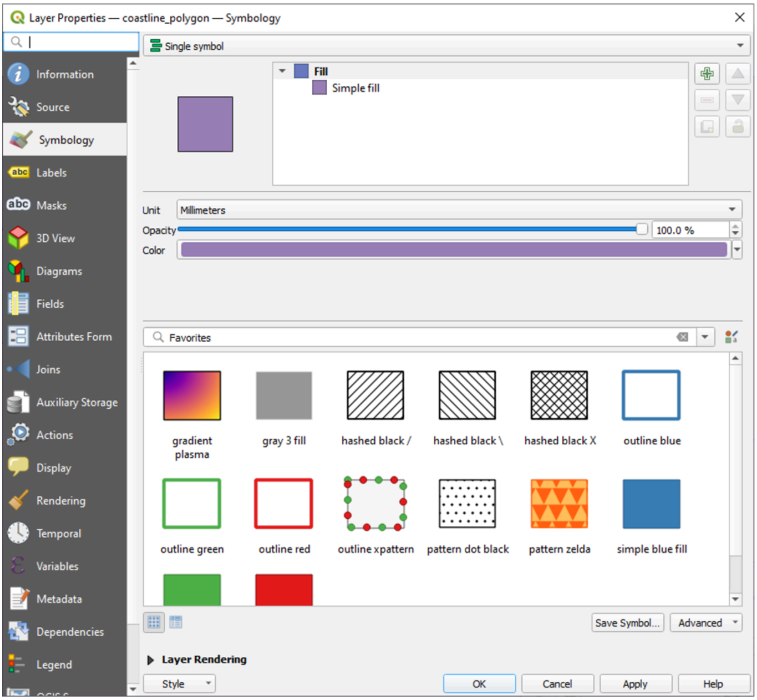


Figure 1.41

- Click Fill style, and select No Brush option. Then click OK.

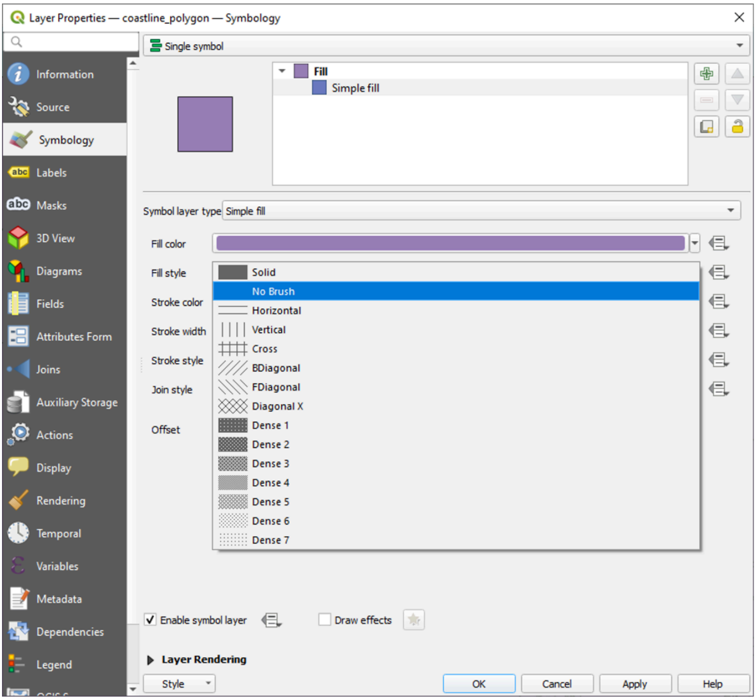


Figure 1.42

Your map will look something like this now.

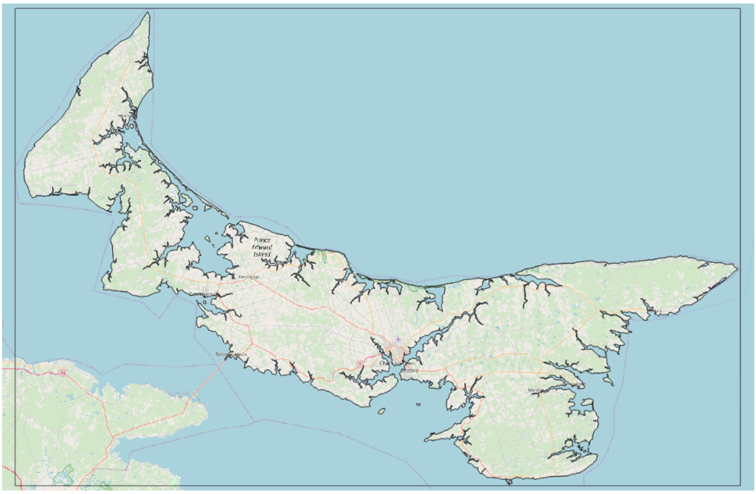


Figure 1.43

The PEI Hydronetwork Layer

Repeat the above steps to add and symbolize the "PEI HYDRONETWORK.shp" layer.

Once added, your layers will look like this.

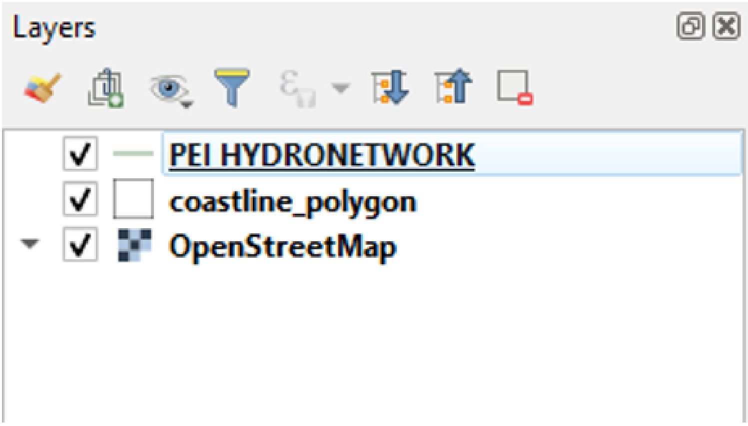


Figure 1.44

And your map will now look something like this.

Figure 1.45

Further Symbolizing the Layer

We want the hydro layer to stand out, so we will change its line colour to blue.

- Right-click the PEI HYDRONETWORK layer, and click Properties.
- Click Symbology.

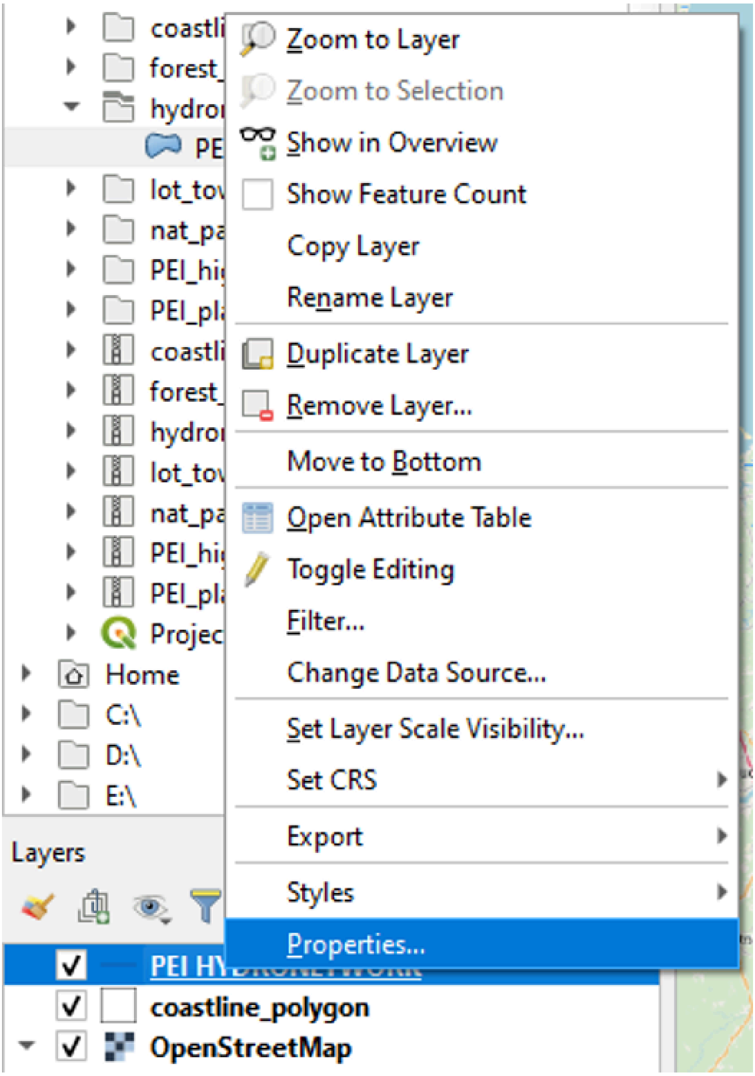


Figure 1.46

- Click to select Simple Line.
- Click Colour and set it to blue. You can use the sliders to

change the colour or set an HTML notation for colour in Hexadecimal.

- Click OK.

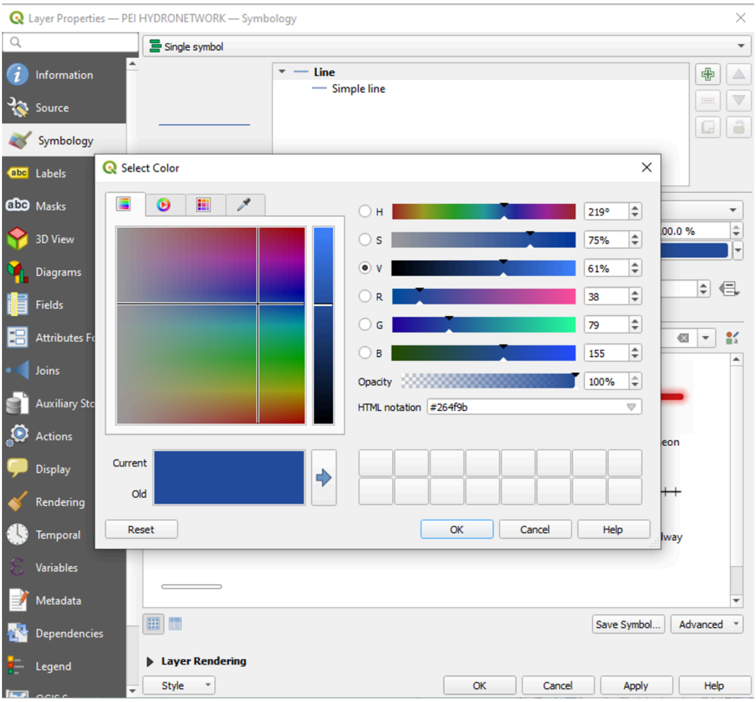


Figure 1.47

Your map will now look something like this.

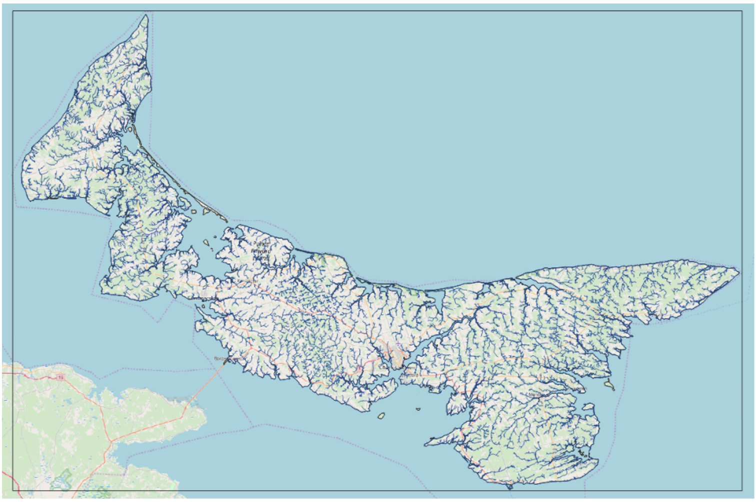


Figure 1.48

The 1935 Forestry Layer

Adding the Layer

- Use the Browser to add “1935 inventory_region.shp” to your layers.

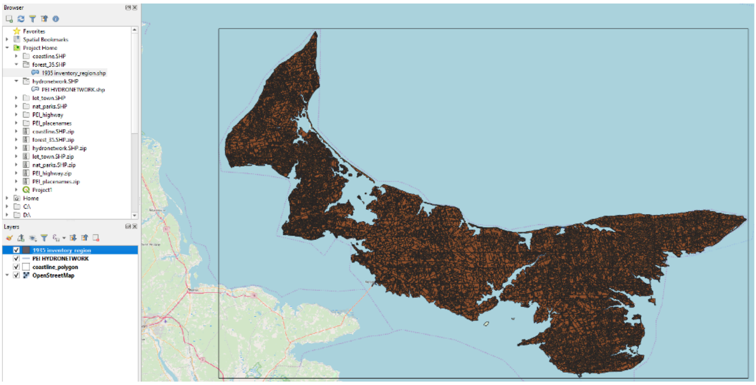


Figure 1.49

Viewing an Attribute Table

Your map will now reflect all four layers. However, the 1935 inventory_region layer is dense and covers the entire island. As mentioned at the start of this section, vectors are made of data. In our case, the data that we are concerned with is the way that the land was used. Canadian censuses recorded this data for many decades. But the important thing about GIS is that it can take this quantitative data and map it as vectors. If we want either to see or edit the data behind the vectors, we can do so by clicking Open Attribute Table.

- Right-click on the 1935 inventory region layer and click Open Attribute Table.

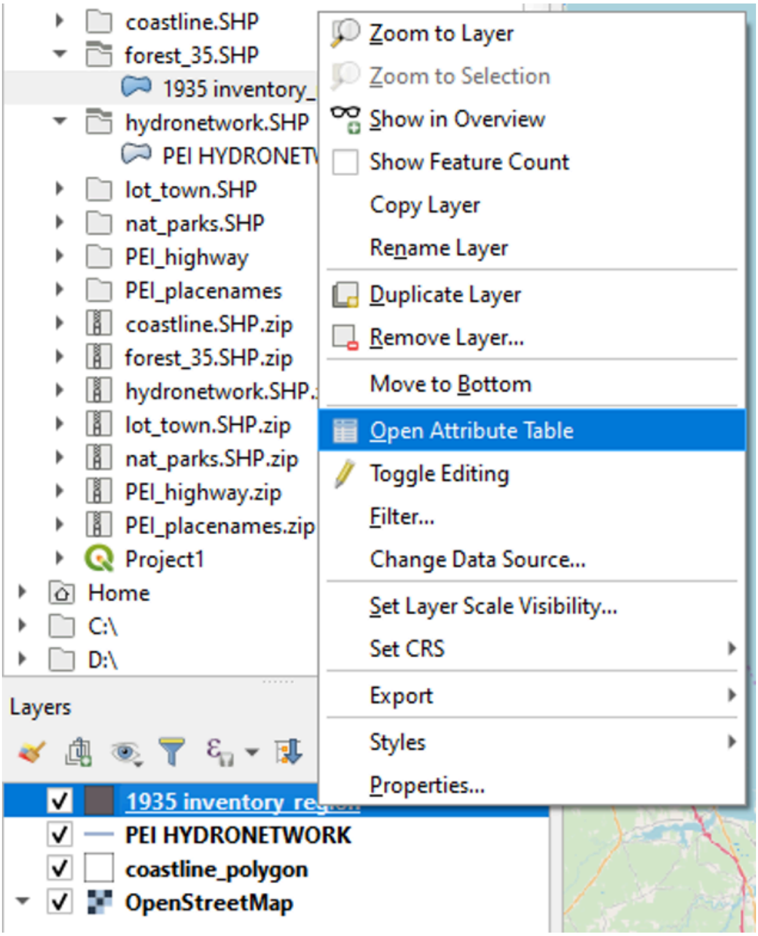
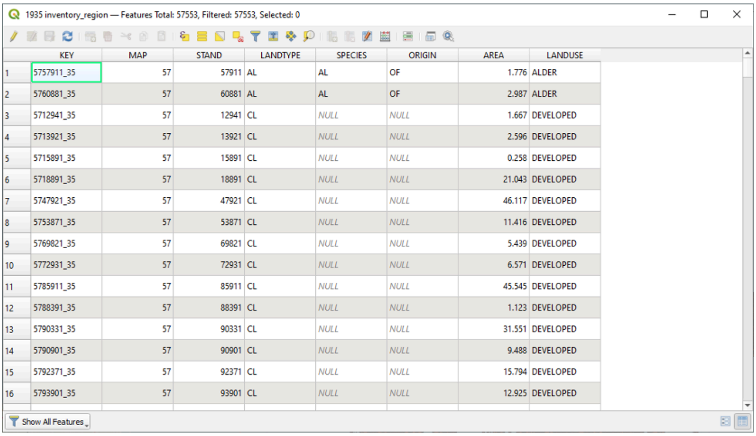


***Figure* 1.50**

Here is the attribute data attached to the 1935 inventory_region. We want to reference the different categories in the LANDUSE column. This is the column that tells us how the land was used in 1935 and whether it was still forested or not.



1935 inventory_region — Features Total: 57553, Filtered: 57553, Selected: 0

	KEY	MAP	STAND	LANDTYPE	SPECIES	ORIGIN	AREA	LANDUSE
1	5757911_35	57	57911	AL	AL	OF	1.776	ALDER
2	5760881_35	57	60881	AL	AL	OF	2.987	ALDER
3	5712941_35	57	12941	CL	NULL	NULL	1.667	DEVELOPED
4	5713921_35	57	13921	CL	NULL	NULL	2.596	DEVELOPED
5	5715891_35	57	15891	CL	NULL	NULL	0.258	DEVELOPED
6	5718891_35	57	18891	CL	NULL	NULL	21.043	DEVELOPED
7	5747921_35	57	47921	CL	NULL	NULL	46.117	DEVELOPED
8	5753871_35	57	53871	CL	NULL	NULL	11.416	DEVELOPED
9	5769821_35	57	69821	CL	NULL	NULL	5.439	DEVELOPED
10	5772931_35	57	72931	CL	NULL	NULL	6.571	DEVELOPED
11	5785911_35	57	85911	CL	NULL	NULL	45.545	DEVELOPED
12	5788391_35	57	88391	CL	NULL	NULL	1.123	DEVELOPED
13	5790331_35	57	90331	CL	NULL	NULL	31.551	DEVELOPED
14	5790901_35	57	90901	CL	NULL	NULL	9.488	DEVELOPED
15	5792371_35	57	92371	CL	NULL	NULL	15.794	DEVELOPED
16	5793901_35	57	93901	CL	NULL	NULL	12.925	DEVELOPED

Show All Features

Figure 1.51

Symbolizing the Layer

We do not want to edit this data; we want to analyze this data visually. So, we can close the Attribute Table window. We want to categorize the layer to see the forestation more clearly, so we will open the properties of the layer.

- Right-click the layer and click Properties.
- Click Symbology.

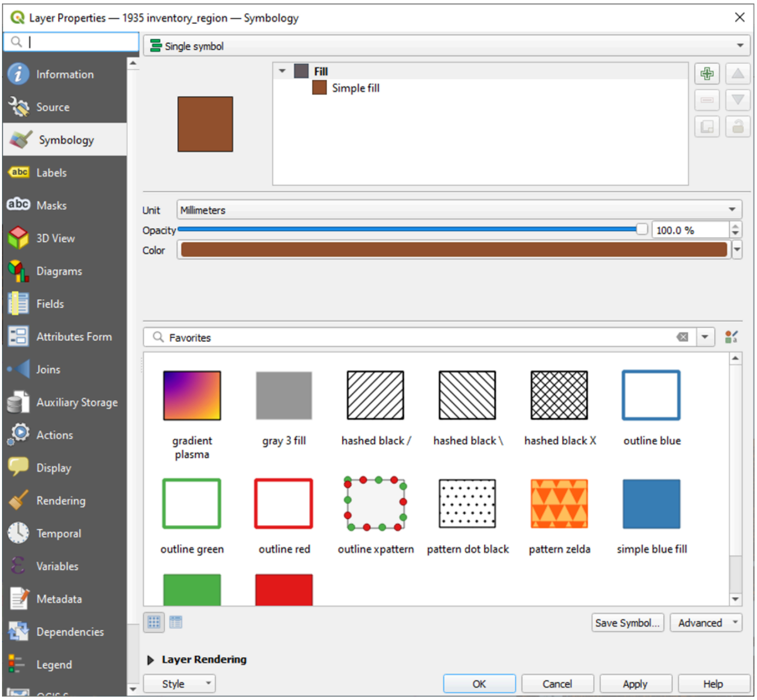


Figure 1.52

- At the very top of the Symbology window, click the dropdown menu where it currently says Single symbol.
- Click Categorized.

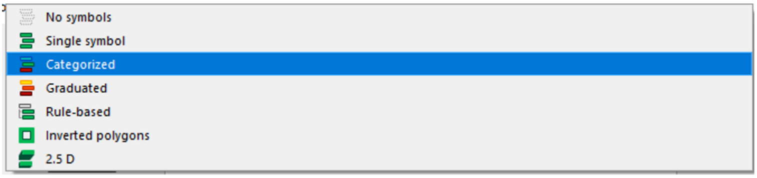


Figure 1.53

Once Categorized has been selected, the Symbology window will change.

- Set the Value to LANDUSE by using the dropdown menu.
- Click the Classify button towards the bottom of the window.
- Click the dropdown arrow next to Color ramp to set it to Greens.
- Click OK.

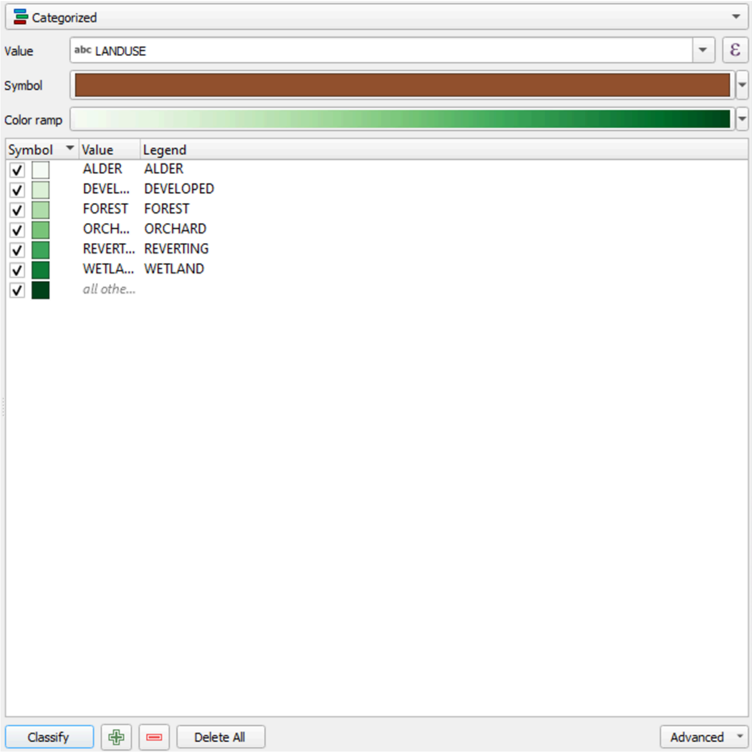


Figure 1.54

This will generate the Symbols, Value and Legend.

The layer will update with sub-layers matching each of the Categories of the LANDUSE column.

If you zoom in on the map now, you will see the various categories of Forests.

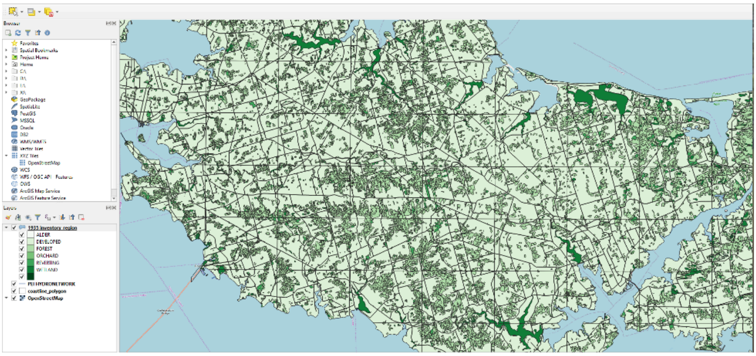


Figure 1.55

- To return to an overall view of Prince Edward Island, right-click the coastline_polygon layer in the Layers pane and click Zoom to Layer.

The PEI Highway Layer

Adding the Layer

- Use the browser to add the PEI_highway.shp file.

During the process of adding PEI_highway.shp file, we encounter the following error:

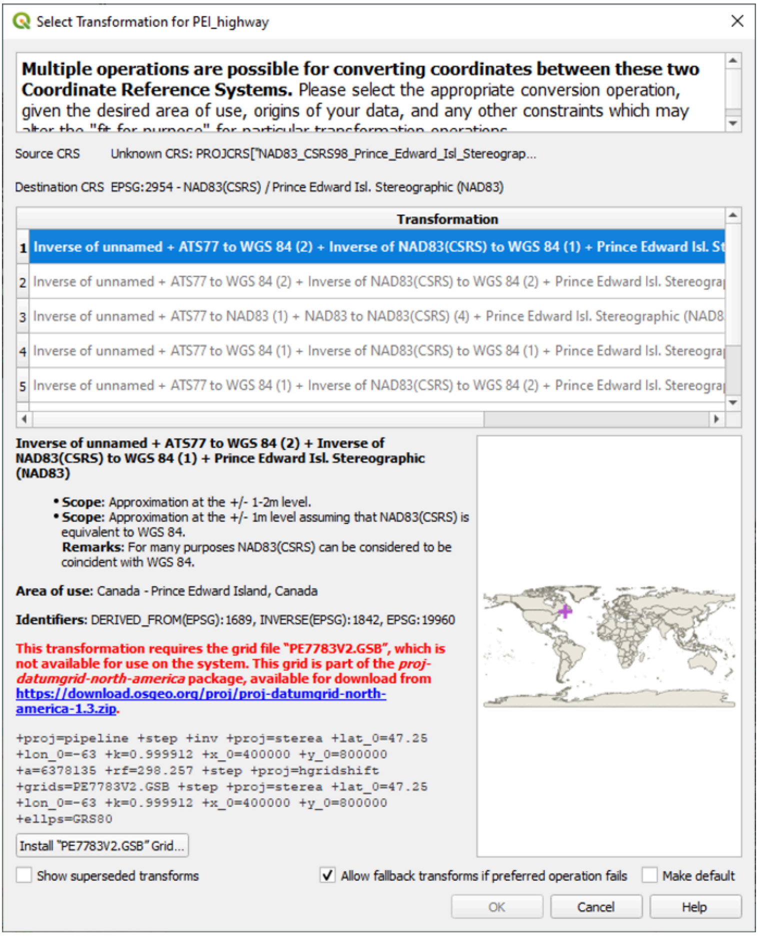


Figure 1.56

We can ignore this by clicking Cancel. QGIS will still render the layer onto our map in accordance with our project's CRS.

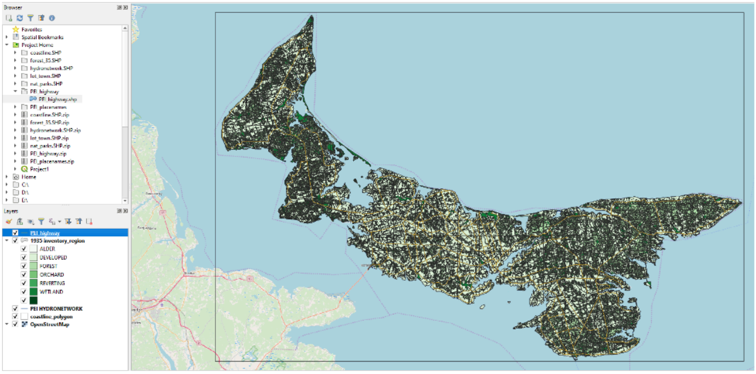


Figure 1.57

Symbolizing the Layer

The roads are a little hard to see among the rest of the data. To remedy this, we will make the roads layer the uppermost layer on the map by moving it above the 1935 inventory in the Layers pane.

- Click and drag the roads layer to the top of the list in the Layers pane.

> Note: the order in which layers appear in the Layers pane determines the order in which they are displayed on the map. So, a layer at the top of the Layers pane list will appear above all other layers on the map.

- Right-click on the PEI_highway layer, and click Properties.

- Note: if the aforementioned error reappears, click Cancel once more.
- Click Symbology.

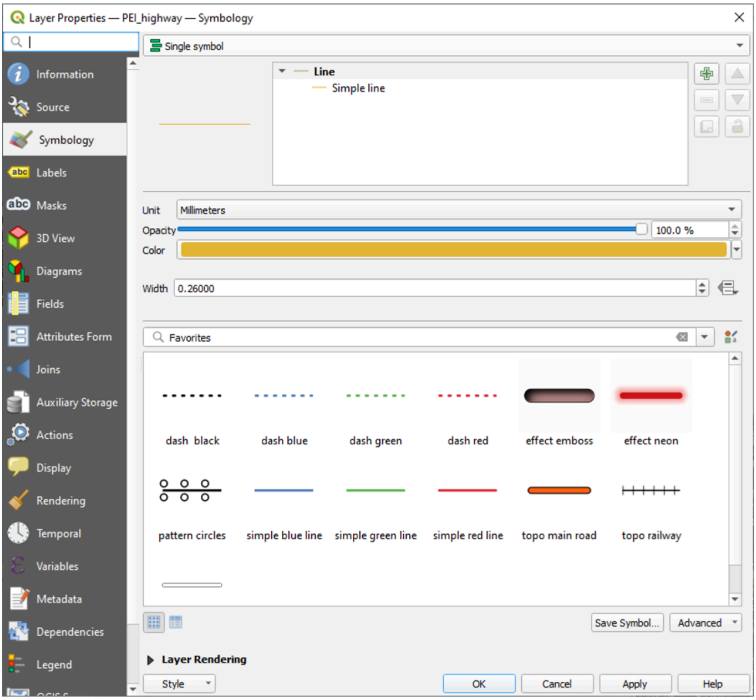


Figure 1.58

- Change the Width from 0.26000 to 0.75, and click OK.

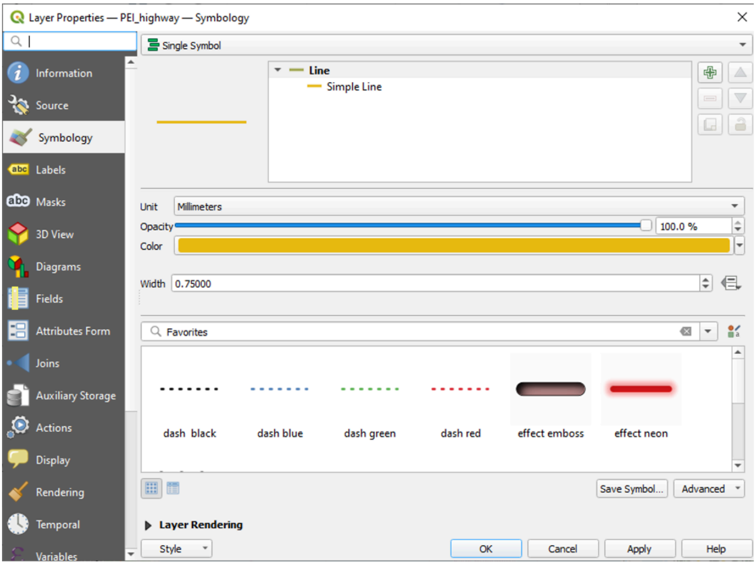


Figure 1.59

The PEI Placenames Layer

Adding the PEI Placenames Layer

- Add the PEI_placenames.shp to our Project and drag this layer to the top of the list in the layers pane.

> Note: a similar error to the one that we encountered for the roads layer will appear. Click Cancel to ignore the error.

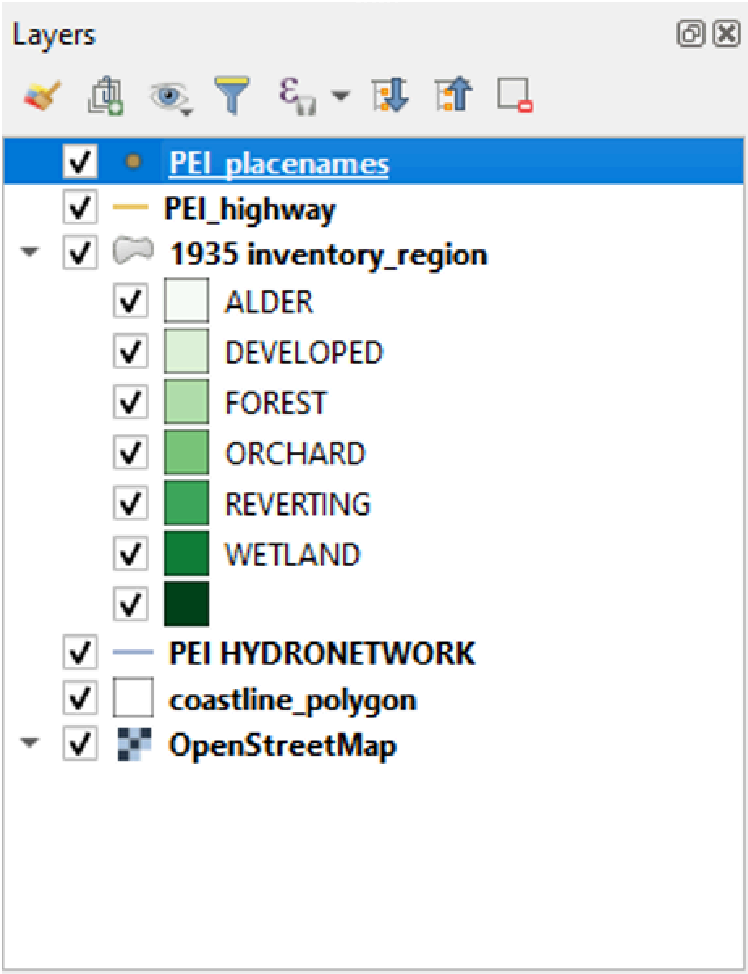


Figure 1.60

Turning on Labels

- Open the properties of the PEI_placenames layer and click

Labels.

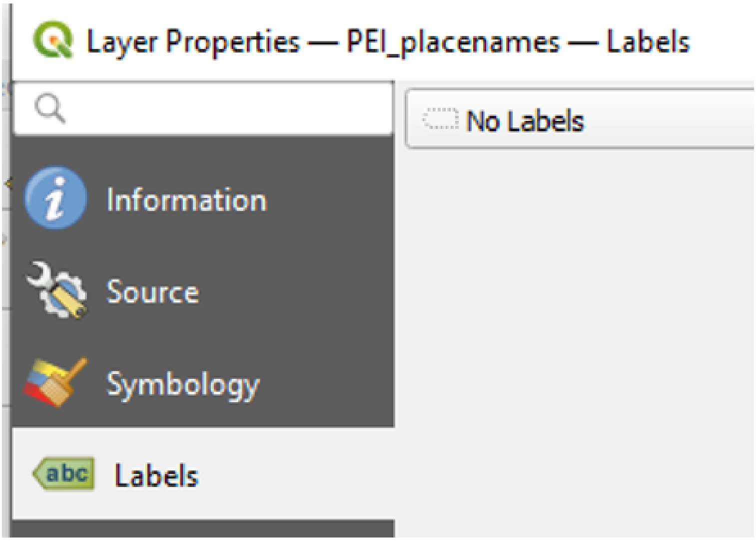


Figure 1.61

- From the dropdown that initially says No Labels, select Single Labels.

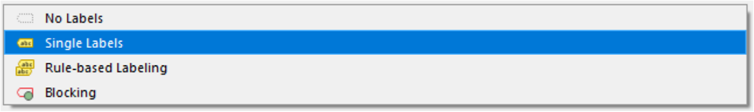


Figure 1.62

You can adjust the visual aspect of the labels using the various options under the Labels menu, including Text, Formatting, Buffer (Outline), Mask, Background, Shadows, and various other features.

- Under the Text tab, change the Colour to white.

- Under the Buffer tab, click the checkbox beside Draw text buffer and then select black as the buffer colour.

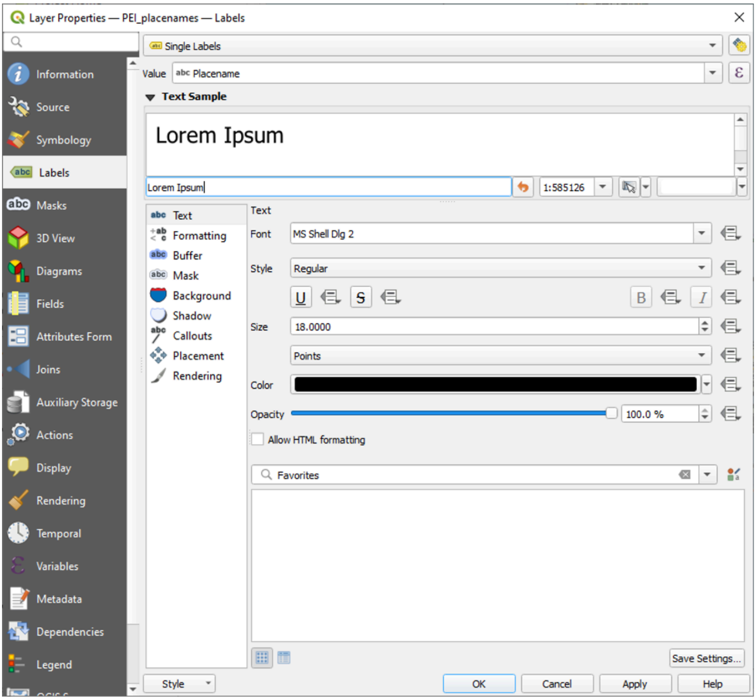


Figure 1.63

Here is the result:

Figure 1.64

Applications of This Vector Data

Historian Douglas Sobey calculated that the number of trees in PEI decreased by two-thirds between the start of the settlement era and 1935, and he used the forest inventory and other historical GIS data to show where exactly this deforestation happened. If you are interested, you can check out his work in chapter four of Time and a Place: An Environmental History of Prince Edward Island.[1]

A GIS such as the one that we set up can also help test whether

1. Douglas Sobey, "The Forests of Prince Edward Island, 1720–1900," in Time and a Place: An Environmental History of Prince Edward Island, ed. Edward MacDonald, Joshua MacFadyen, and Irené Novaczek (Montreal: McGill-Queen's University Press, 2016).

routinely generated sources such as the census are accurate records of historical land use. Historian Joshua MacFadyen and forester William Glen used a GIS to demonstrate that the census was an incomplete record of land clearing. They compared the census of agriculture with inventories created from historical aerial photographs to show the extent of this discrepancy and test the rate at which farmers underreported the amount of cleared land. In the mid- and late-twentieth century, the amount of improved land reported in the census of agriculture was much lower than the amount shown in forest inventories—over 30 percent lower in Kings County in the 1960s and 1970s. This was of course because agriculture represented a decreasing share of land use. However, even in earlier decades, when most rural land use was agricultural, farmers in Kings County reported between 10 and 16 percent less cleared land than the amounts shown by the inventories. MacFadyen and Glen used a historical GIS to determine more accurate estimates of land clearance rates across the twentieth century.[2]

2. Joshua MacFadyen and William Glen, "Top-down history: Delimiting forests, farms, and the census of agriculture on Prince Edward Island using aerial photography, ca.1900-2000," in Historical GIS Research in Canada, ed. J. Bonnell & M. Fortin (Calgary: University of Calgary Press, 2014).

Part III B: Opening Rasters

Now that we have learned about vector data, we can turn our attention to raster data. A raster is a digital image of a map that has accurate coordinates added to it through the process of georeferencing. This textbook will teach you how to georeference in Chapter 3: Georeferencing. For now, we will use a raster that has already been georeferenced.

The raster we will add is a reproduction of the map that British naval captain Samuel Holland produced in the 1760s. Holland produced this map to provide the British, who had just acquired the Island, with a better understanding of PEI (or, as it was known at the time, St. John's Island). Holland surveyed the Island and divided the Island into 67 lots, which were then given out to British owners in the Great Lottery of 1767. This reproduction of Holland's original map was produced in 1798.

Maps like this one show how, at the time, the Island's forests were so dense that they heavily influenced settlement patterns. Settlers could not easily penetrate the forests, so most of the villages on the map are along the coasts or along the navigable rivers.

After we add the 1798 map, we can compare the settlement locations at that time with the ones from the modern OpenStreetMap basemap. We will be able to see how deforestation—along with other factors, such as the construction of Prince Edward Island Railway in the 1870s—allowed Islanders to settle throughout the Island's interior. We can see towns in the Island's interior today, such as Kensington and Hunter River. These towns did not exist in the early settlement period, partly because the dense forest made it difficult to traverse the Island's interior.

Adding a Raster

Let's add the 1798 map to our project.
Click here to download the [1798 map] to your Data folder.

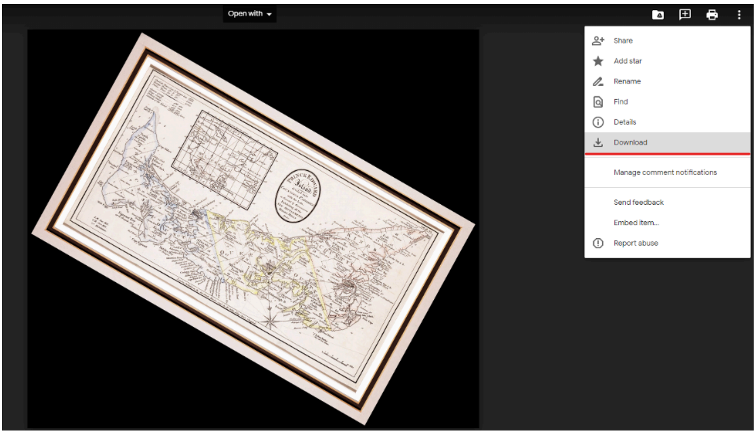


Figure 1.65

We will use this file as the first raster layer we add to our project.

- Use the Browser to add the 1798 map raster to QGIS in the same way that you added vector layers.

Figure 1.66.

Symbolizing the Coastline File over the Top of a Raster

To get a sense of the coastline on which most Islanders settled before the Island's interior was deforested, we can move the coastline layer above the PEI_HollandMap1798_compLZW.

- Drag the coastline layer above the PEI_HollandMap layer.

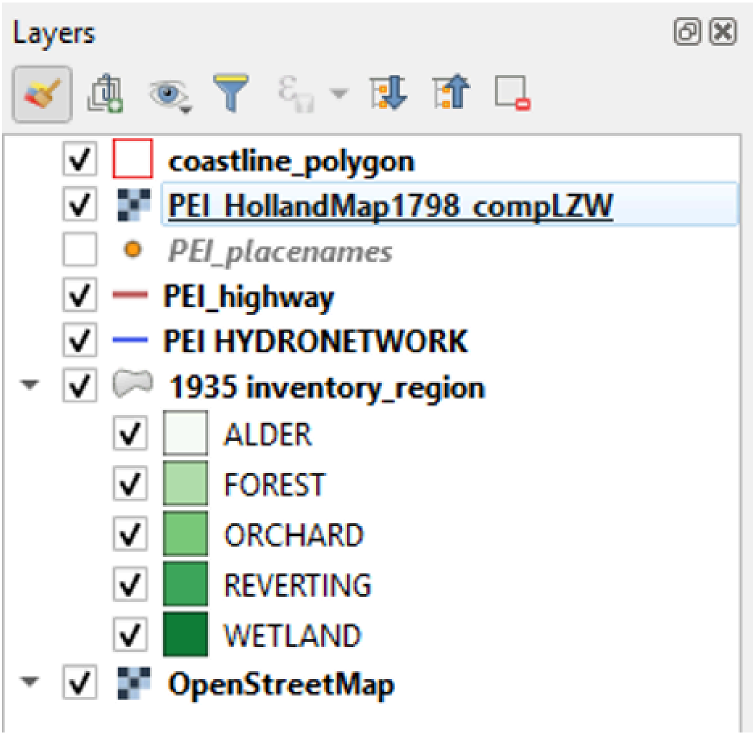


Figure 1.67

Now we will make the coastline overlay have a more pronounced appearance.

- Open the coastline_polygon layer's Properties, click Symbology, and select Simple Fill.
- Click the dropdown arrow next to Fill Color and select Transparent Fill.

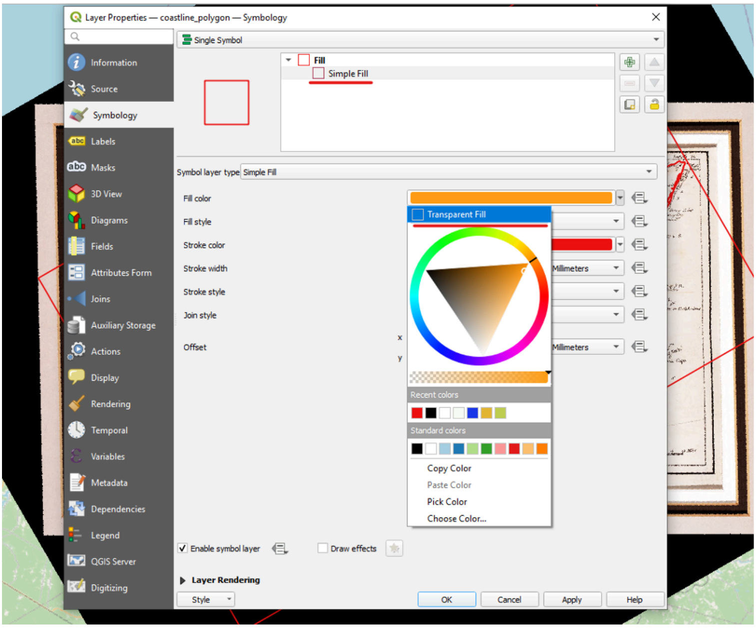
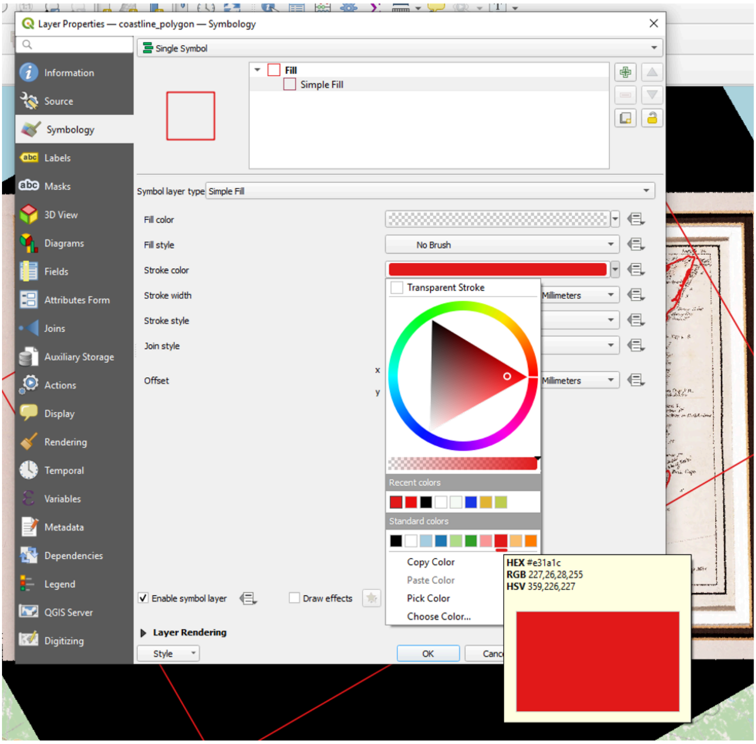


Figure 1.68

- Click the dropdown arrow next to Stroke Color and, under Standard Colors, select red.


Layer Properties — coastline_polygon — Symbology
Information
Source
Symbology
Labels
Masks
3D View
Diagrams
Fields
Attributes Form
Joins
Auxiliary Storage
Actions
Display
Rendering
Temporal
Variables
Metadata
Dependencies
Legend
QGIS Server
Digitizing
Single Symbol
Fill
Simple Fill
Symbol layer type
Simple Fill
Fill color
Fill style
No Brush
Stroke color
Stroke width
Stroke style
Join style
Offset
x
y
Millimeters
Millimeters
Transparent Stroke
Recent colors
Standard colors
Copy Color
Paste Color
Pick Color
Choose Color...
HEX #e31a1c
RGB 227,26,28,255
HSV 359,226,227
Enable symbol layer
Draw effects
Layer Rendering
Style
OK
Figure 1.69

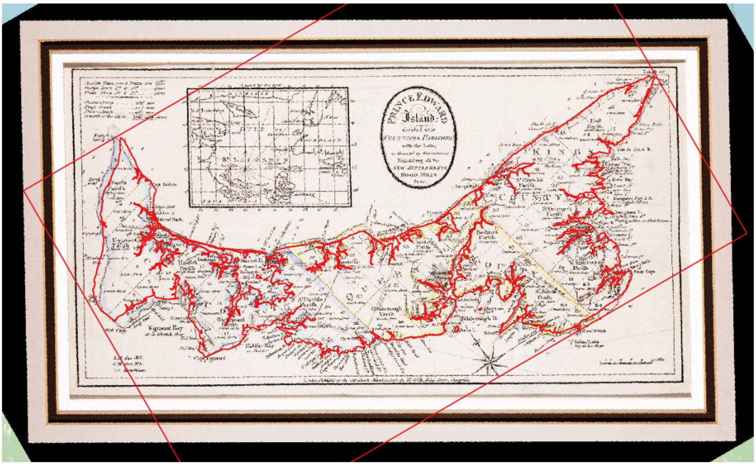


Figure 1.70

We are now able to see clearly the shape of the coastlines, which were the areas of settlement and commercial activity on the Island before deforestation allowed greater access into its interior.

Making the coastlines from today's map visible over the top of the 1798 map is also useful for assessing the older map's accuracy. While Captain Holland and his team produced a remarkably accurate map of PEI at the time, we can see that it has flaws. For example, there are inaccuracies along the coast of Egmont Bay.

Another way that we can assess the accuracy of Holland's map is by adjusting its transparency. We will return to this concept at the end of the next part of the chapter.

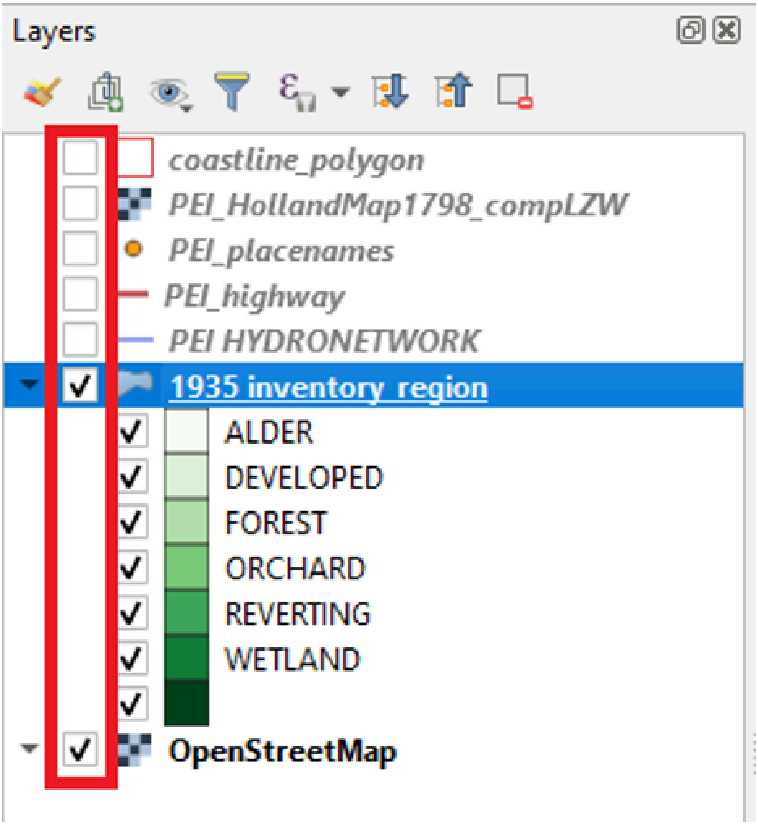
Part IV: Adjusting a Layer's Transparency

Sometimes, we do not want to fully delete a layer but rather adjust its transparency so that we can see "through" it to the layers lying below. We can adjust the transparency of vector and raster data, although the process is slightly different for each.

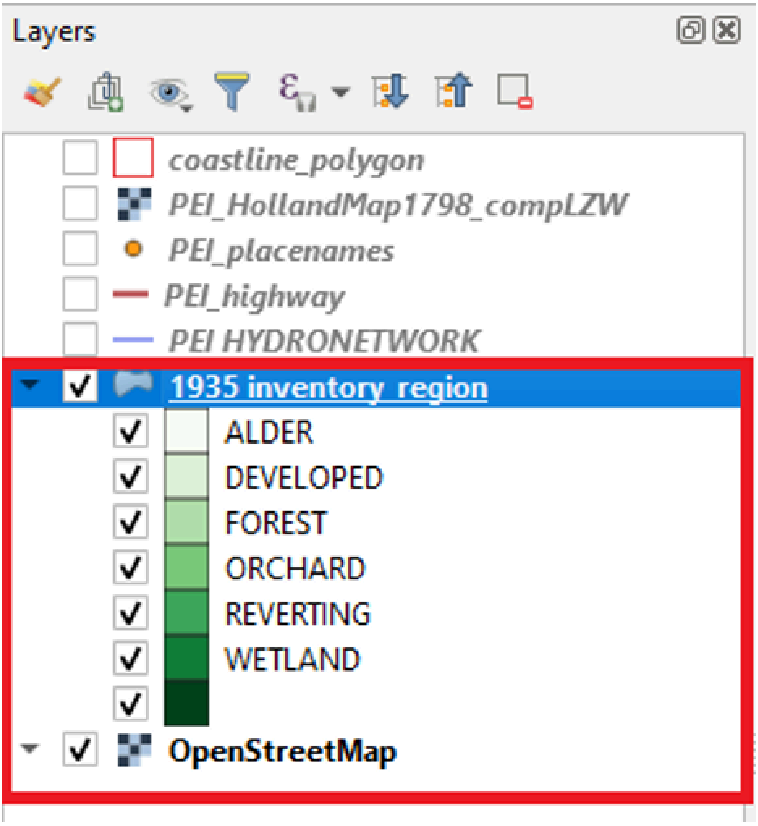
Adjusting the Transparency of Vector Data

Let's return to the idea of the Island's urban communities taking over what were once forested areas.

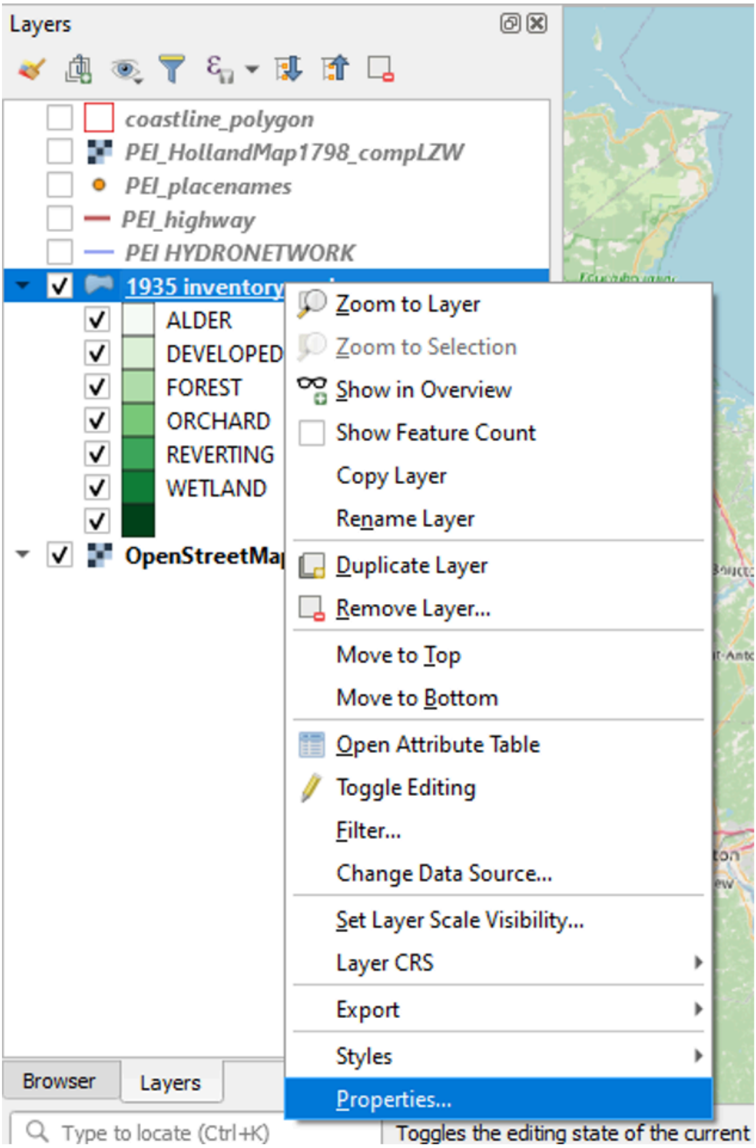
- Uncheck all layers in the table of contents other than the 1935 inventory region layer and the OpenStreetMap layer.



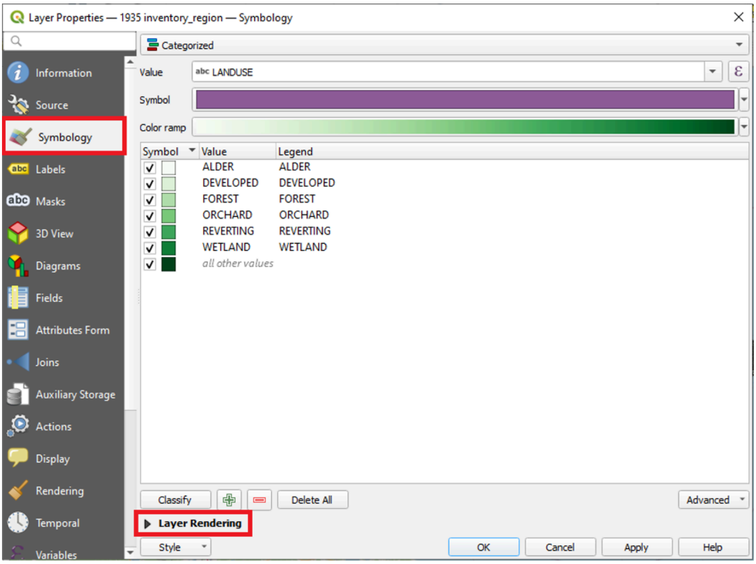
- Make sure the 1935 inventory region layer is above the OpenStreetMap layer in the table of contents.



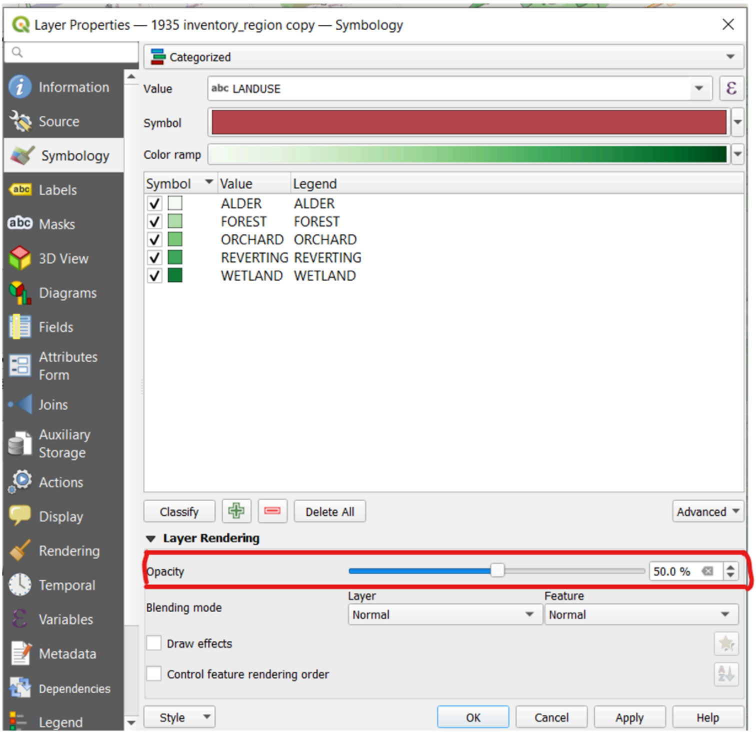
- Right-click the 1935 inventory region layer.
- Click Properties.



- Click Symbology.
- Click Layer Rendering



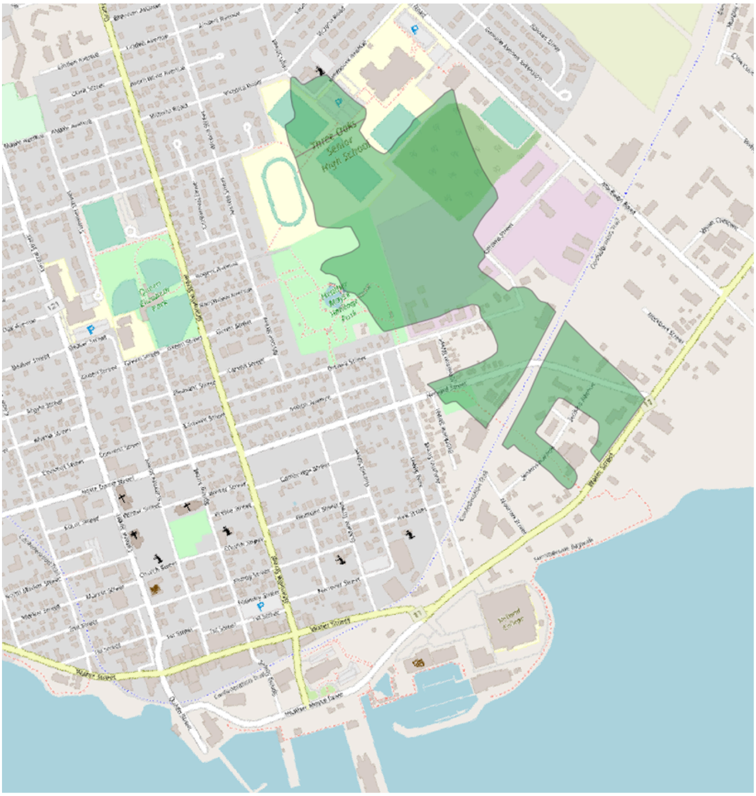
- Adjust the Opacity value to 50.0%. Ignore the other settings in the Layer Rendering menu.



- Click OK.

We can now zoom into any community on PEI and try to see any effects of deforestation.

For example, if we look at the area in Summerside where Three Oaks Senior High School is, we can now see "through" the 1935 forestry map to see the OpenStreetMap beneath it. We can now simultaneously see the forest cover that once existed at that location as well as the modern-day, urban landscape that supplanted it.



Adjusting the Transparency of Raster Data

As you will recall, we added a raster layer to our project in Part III of this chapter. The raster is called “PEI_HollandMap1798.”

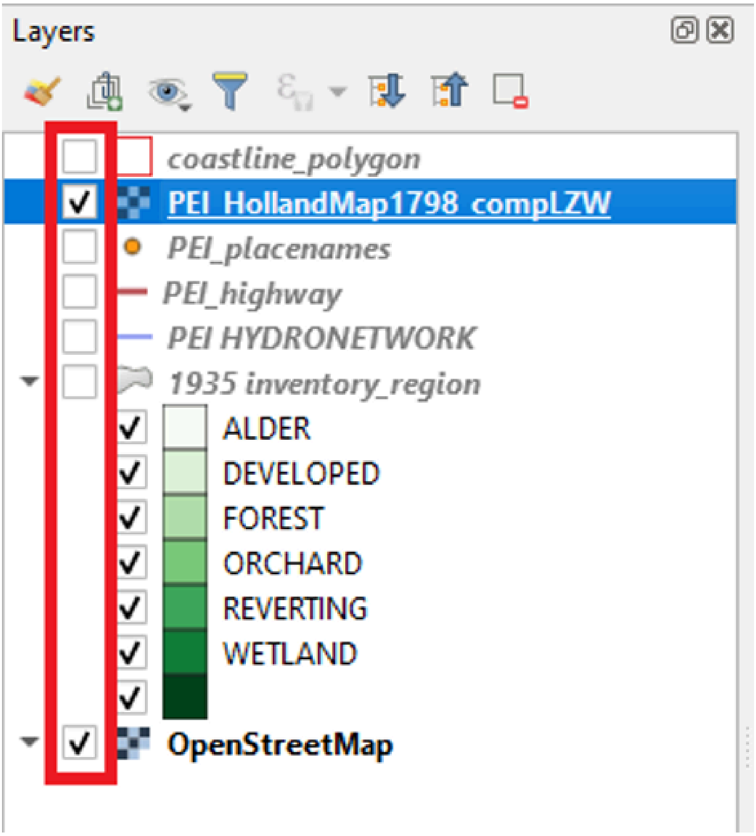
As we said at the end of Part III, Holland’s map is helpful for getting a grasp of how the heavily forested interior of the Island shaped settlement patterns. European newcomers settled and did most of their business around the Island’s coasts and waterways. Holland’s map shows soundings, which were measurements of the water depth in certain critical areas of sea traffic, such as the Hillsborough Bay. Since sea travel was so important to this coast-base settler society, Holland and his team included these soundings.

While Holland's map shows only a few inland settlements, he and his team mapped many coastal settlements. They also went to great lengths to map many smaller islands around PEI.

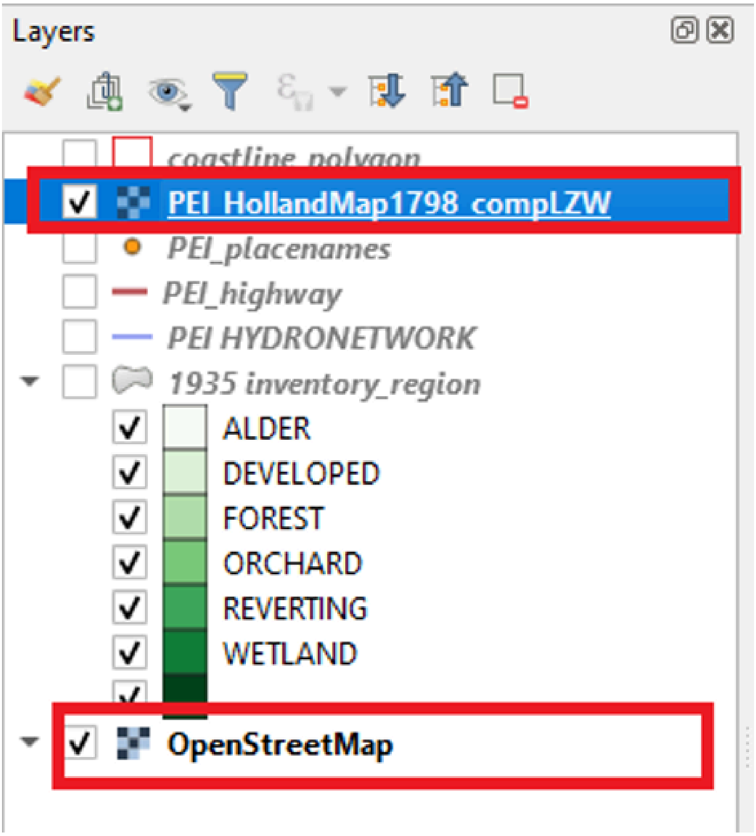
Despite being focused on the Island's coast, the Holland map inaccurately displays certain parts of it. In the last part of this chapter, we could see these errors by adding the coastline layer and laying it over the top of the Holland map layer.

In this section, we will use the transparency tool as another way to assess the map's coastal inaccuracies. We will judge its accuracy in relation to the OpenStreetMap base map that lies beneath it.

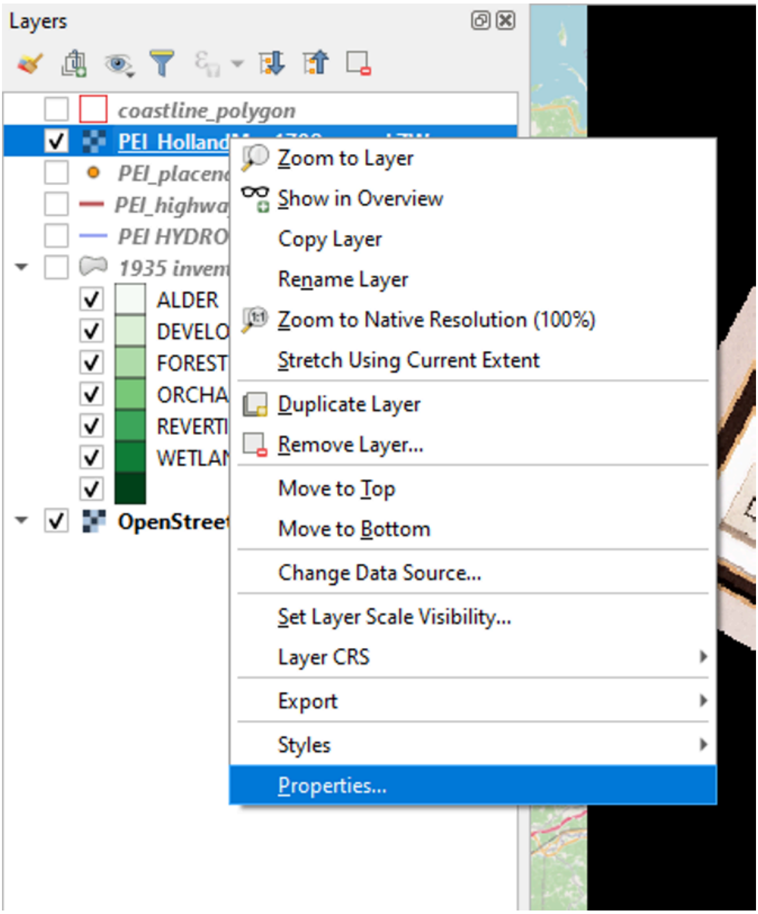
- Uncheck all layers in the table of contents other than the Holland map layer and the OpenStreetMap layer.



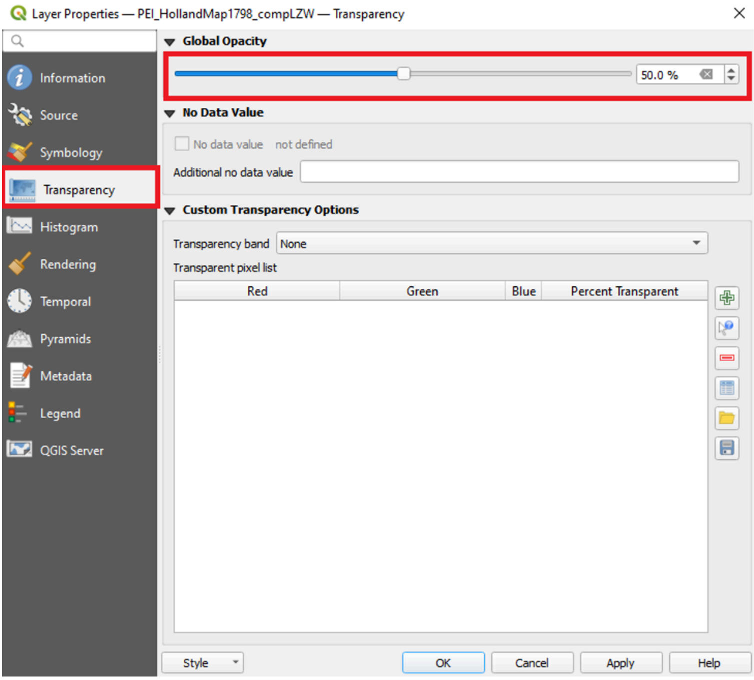
- Make sure the Holland map layer is placed above the OpenStreetMap layer in the table of contents.



- Right-click the Holland map layer in the table of contents.
- Click Properties.



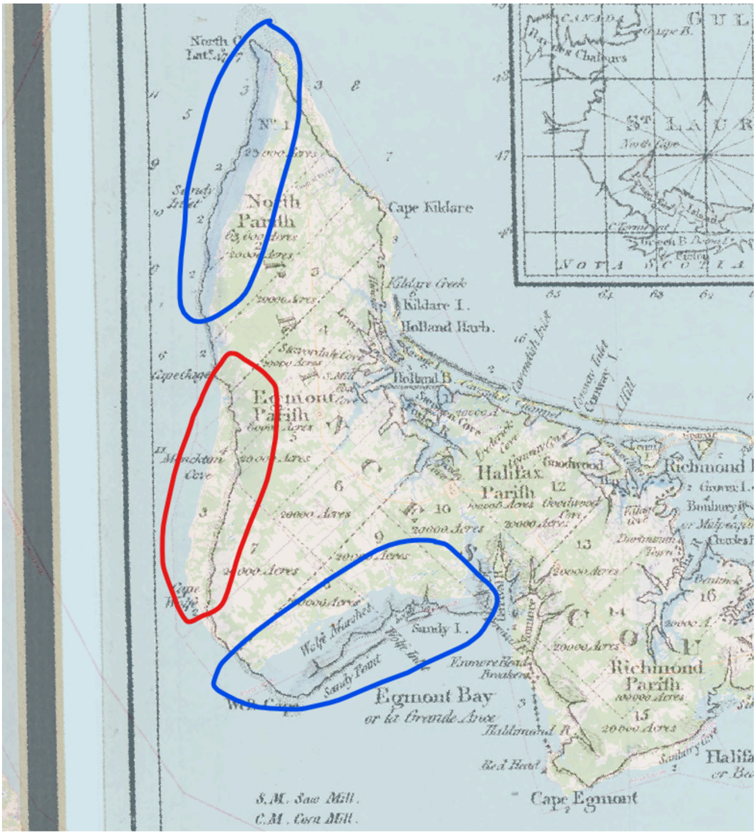
- Click Transparency
- Change the Global Opacity to 50.0%.



- Click OK.

With the Holland map's transparency at 50.0%, we can see the OpenStreetMap layer beneath it. Have a look at the western shore of the Island's Prince County.

There are some areas, shown in blue in the screenshot, that Holland and his team mapped incorrectly. Holland mapped the island boundaries too far inland in some places along the western coast of Prince County (see the area circled in blue). On the other hand, Holland and his team mapped other areas of the Island as though they were in the sea. An example of such an area is shown in red in the screenshot.



Making a raster transparent can help us determine its accuracy. But making a raster transparent can also help us to verify our own accuracy when we are orienting that raster over the top of a base map. This process is known as georeferencing, and we will cover it in the next chapter.

Conclusion to Chapter 1

In this chapter, we have begun our first GIS project. We have learned how to add and change the appearance of (i.e., symbolize) vector and raster data in order to pursue research questions, such as one exploring deforestation on PEI. We will take these concepts a step further in the next chapter.

Further Reading

MacFadyen, Josh, and William Glen. "Top-down history: Delimiting forests, farms, and the census of agriculture on Prince Edward Island using aerial photography, ca.1900-2000." In *Historical GIS Research in Canada*, edited by J. Bonnell & M. Fortin, 197-223. Calgary: University of Calgary Press, 2014. https://press.ucalgary.ca/books/9781552387085/

Robertson Library, Samuel Holland Surveys the Island, IslandImagined.

Sobey, Douglas. "The Forests of Prince Edward Island, 1720–1900." In *Time and a Place: An Environmental History of Prince Edward Island*, edited by Edward MacDonald, Joshua MacFadyen, and Irené Novaczek. Montreal: McGill-Queen's University Press, 2016. https://www.mqup.ca/time-and-a-place-products-9780773546936.php

SECTION II

CHAPTER 2: DATA MANAGEMENT, SYMBOLS, AND STYLES IN QGIS

Getting Started

Overview and Example Exercise

This chapter is divided into two parts, each of which will elaborate on the work you began in Chapter 1. Part I will teach you how to copy a project, which will allow us to build on progress in the previous chapter and not have to start from scratch. It is a similar process to the one used to share your QGIS project, which we discussed in Chapter 1. It teaches data management practices that will enhance the future compatibility and collaboration of your projects.

Part II will teach you more ways to tweak the appearance of your map in order to better present the data you began to map in Chapter 1, in which we tracked deforestation on PEI. At the end of Part II, you will also learn how to reuse the styles that you will have created.

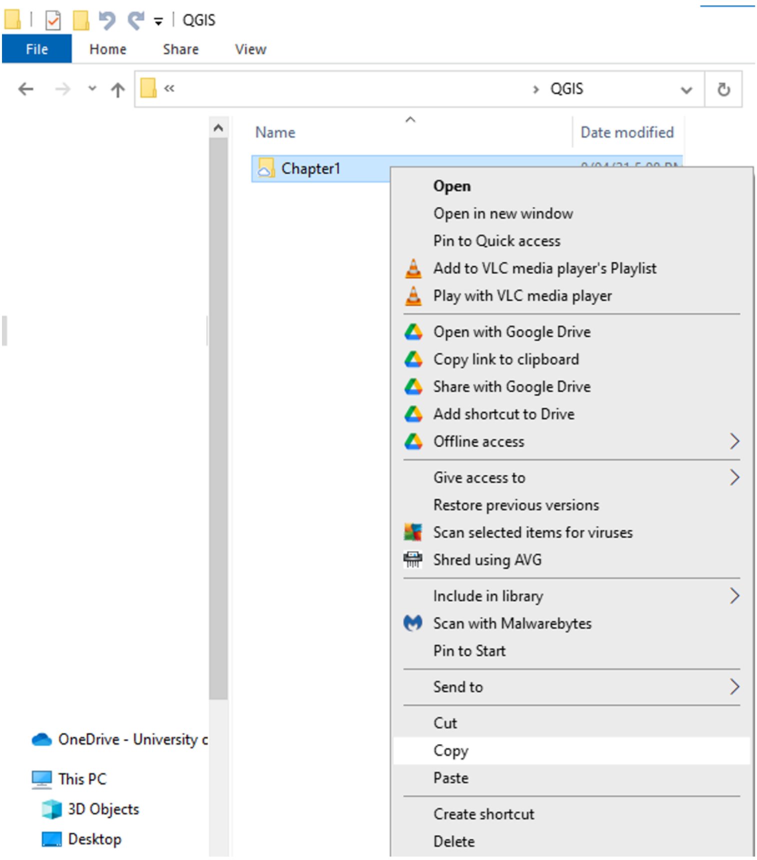
Part I: Copying a Project

Creating a Copy of a Project

We will begin by learning how to copy our project from Chapter 1. This will allow us to build upon the work that we have already done.

Tip: Good digital humanities projects should always keep future compatibility and collaboration in mind. By designing your GIS project with good data management practices, you will be able to find and open your files when you need them, and it will be easier to share your project with collaborators.

- Within the QGIS folder that we created in Chapter 1, there is a folder called Chapter1.
  Using Windows Explorer, right-click the folder called Chapter1.
- Click Copy



QGIS
File
Home
Share
View
QGIS
Name
Date modified
Chapter1
Open
Open in new window
Pin to Quick access
Add to VLC media player's Playlist
Play with VLC media player
Open with Google Drive
Copy link to clipboard
Share with Google Drive
Add shortcut to Drive
Offline access
Give access to
Restore previous versions
Scan selected items for viruses
Shred using AVG
Include in library
Scan with Malwarebytes
Pin to Start
Send to
Cut
Copy
Paste
Create shortcut
Delete
This PC
3D Objects
Desktop

Figure 2.1

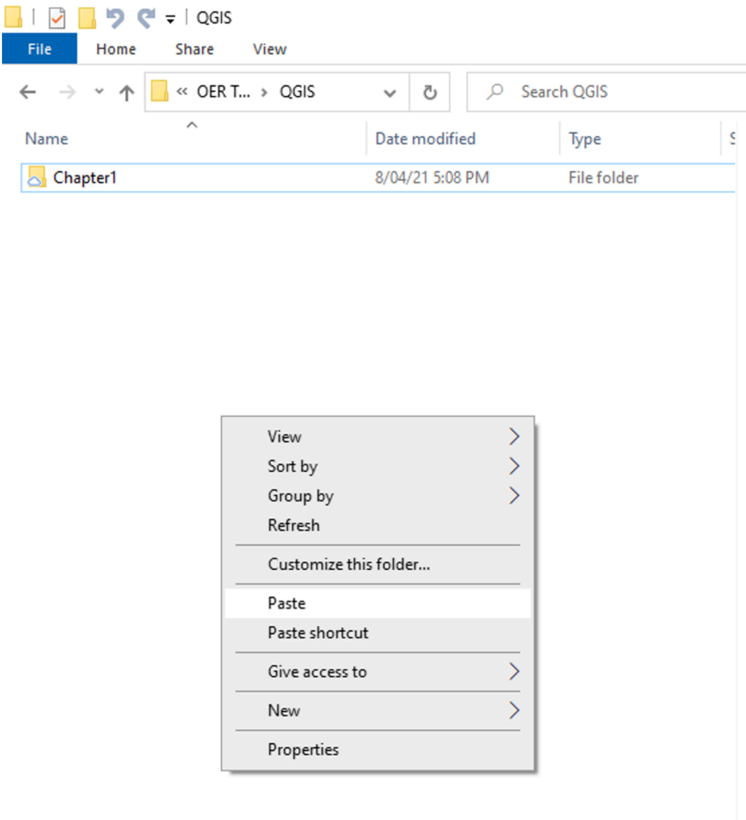


Figure 2.2

This will create a folder called Chapter1 – Copy.

- Right-click the folder called Chapter1 – Copy
- Click Rename
- Type in Chapter2
- Press Enter on your keyboard

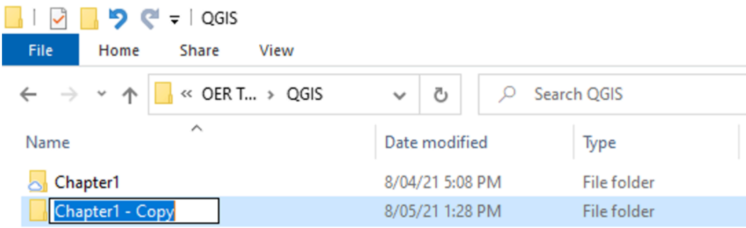


Figure 2.3

We will now open the new Chapter2 folder and rename the project file inside.

- Double-click on the folder called Chapter2
- Double-click on the folder called ProjectFiles
- Right-click on the QGIS project file called Project1
- Click Rename
- Type in Project2
- Press Enter on your keyboard

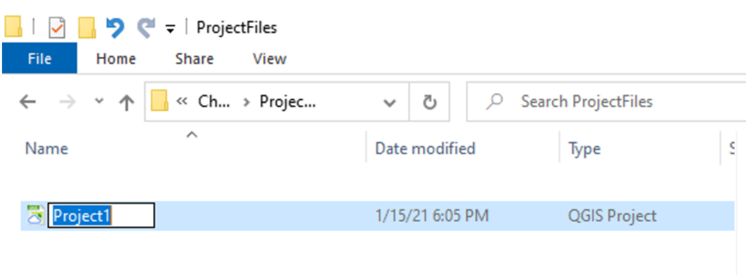


Figure 2.4

Note: if we had simply opened the Project1 project file and used Save As to create a copy of it named Project2, we would only be creating a copy of the project file. We would not be creating duplicate copies of the layer data that the project file references. In fact, this hypothetical Project2 file would reference the layer data of the original Project1 project file from which it was copied. The problem here is that this layer data is stored with the Project1 file and not with the Project2 file. We need all of our data (i.e., layer files and the project file) stored in the same parent folder (e.g., Chapter2) so that we can zip this folder and share it with others. It also is critical to have all of our data in the same folder for another reason: if we ever deleted the Chapter1 folder and then tried to open Project2, it would not work because the layer data that Project2 is trying to open has now been deleted.

Opening a Copied Project

- Double click on the freshly renamed Project2 file to open it in QGIS.

QGIS will now open all of the work you did in Chapter 1. We can reuse some of this work in this chapter so that we do not have to start from scratch.

Note: if you have not completed Chapter 1, you will have to go to that chapter to set up Project1 before you can copy Project1 to create Project2. Chapter 1 shows you how to create Project1. It includes links to download all of the data you need and instructions on how to import it to QGIS.

Part II A: More Symbology

We are going to further expand on the concepts around symbology first explored in Chapter 1.

Principles of Cartography When Using Symbology

Categorized Symbology

We used Categorized symbology for the first time in Chapter 1: Introduction to GIS. Each type of land use on Prince Edward Island was given a unique colour. This exercise was useful for introducing the concept of symbolizing a layer. However, we did not pause to think about which type symbolization would have been best to perform on this layer.

A principle of cartography is that we have to know our map data and the intent of its creators.

It is important that cartographers use a map in the way the mapmaker intended so that the data is displayed appropriately rather than in a misleading or ineffective way. Each map has strengths and weaknesses based on the mapmaker's purpose and focus.

Attributes: Getting to Know Our Data

> Sidebar text for the sidebar here. It's all about attribute table to get to know our data. Once we know the strengths and weaknesses of our data, we can decide the best way to symbolize it. Sidebar text for the sidebar here. It's all about attribute table to get to know our data. Once we know the strengths and weaknesses of our data, we can decide the best way to symbolize it.

We can use the attribute table to get to know our data. Once we know the strengths and weaknesses of our data, we can decide the best way to symbolize it.

- Right-click the 1935 inventory region layer in the table of contents.
- Click Open Attribute Table.

Here, we see a table containing the fields featured in our dataset.

- Click the LANDUSE header to sort the table alphabetically by this field.

Within this field, we can see the following attribute data under the LANDUSE column header: ALDER, DEVELOPED, FOREST, ORCHARD, REVERTING, and WETLAND. We can also see that there are different LANDTYPE attributes associated with each of these LANDUSE attributes. These associations are laid out in the table below.

		LANDUSE	Attributes			
	Alder	Developed	Forest	Orchard	Reverting	Wetland
LANDTYPE	AL	CL	CC	OR	BN	BO
Attributes		RD	FC		RV	WL
		RR	HH			WW
			HS			
			MW			
			SH			
			SS			

We can see that the makers of this map were primarily focused on the Island's forests, for they broke down this LANDUSE category into the most LANDTYPE subcategories.

But what do the LANDTYPE codes mean? As part of the process of getting to know our data, we can consult the metadata that accompanies it. We can view our data's metadata by visiting the same website hosted by the PEI government from which we downloaded the 1935 inventory region shapefile. Instead of clicking on the 1935 inventory region's SHP link, we can click on the Metadata link.

Under the heading called "How does the data set describe geographic features?," under LANDTYPE, there is a web address to the page containing an explanation of the codes. Viewing this page, we can see that the LANDUSE code is a more general descriptor, while the LANDTYPE code is more specific. From this, we can gather that the mapmakers designed this dataset to show both the general and specific ways in which a parcel was used, represented by the LANDUSE and LANDTYPE variables, respectively. Furthermore, it seems that the LANDUSE attribute on which they focused the most was the one called FOREST, for there are the most subcategories for this variable in the LANDTYPE column.

So, it seems that the mapmakers created this land use map principally in order to evaluate the forest cover on PEI. Since the mapmakers focused on the FOREST attribute data and its subcategories, they are perhaps the most accurate data. So, we will focus our maps on this data too.

Filters: Mapping Only the Forested Land

We will filter the 1935 inventory region shapefile map so that our symbolization applies only to FOREST parcels. We will also include the REVERTING value in our filter.

Creating a filter in this way is useful for cases such as ours in which we do not want to permanently delete parts of our shapefile (i.e., the categories called something other than FOREST and REVERTING.) A filter can be a way to temporarily see how our shapefile would look with certain features excluded. Or you can leave a filter on indefinitely.

We will create a copy of our main 1935 inventory region layer in our table of contents. We will apply our filter to the copied version, which will allow us to leave this filter on indefinitely.

- In your table of contents, right-click the layer called 1935 inventory region.
- Click Duplicate Layer

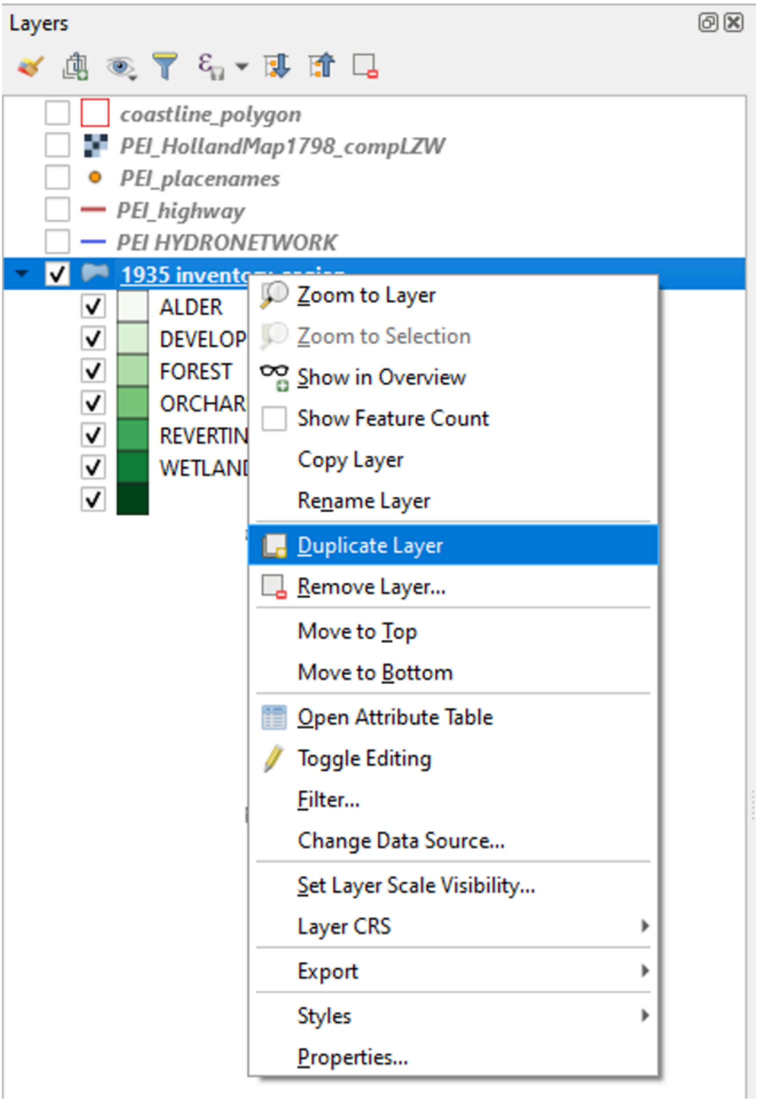


Figure 2.5

This will create a copy of this layer in our table of contents.

> **Note:** when you duplicate a layer in your table of contents, both copies of the layer are still referencing the same shapefile. QGIS alerts us to this fact. So, if we made any permanent changes to the shapefile, such as deleting a feature, the change would be reflected in all layers that are using the same data source. The change would not be limited to only the layer on which we made the change.

Figure 2.6

We now have a layer in our table of contents called "1935 inventory region copy."

- Right-click this layer and click Rename Layer.

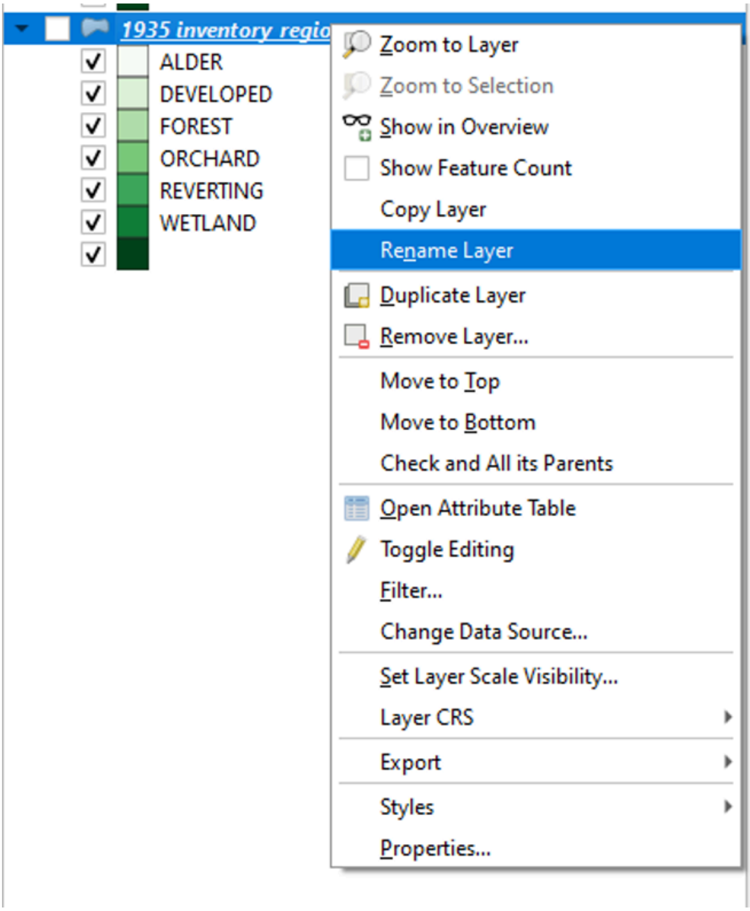


***Figure* 2.7**

- Type in “1935 inventory region filtered” and press Enter on your keyboard.

We are now going to filter our layer so that it only shows the features that contain the FOREST and REVERTING attribute data. We can do this by creating a simple expression.

- Right-click the 1935 inventory region filtered layer.
- Click Filter

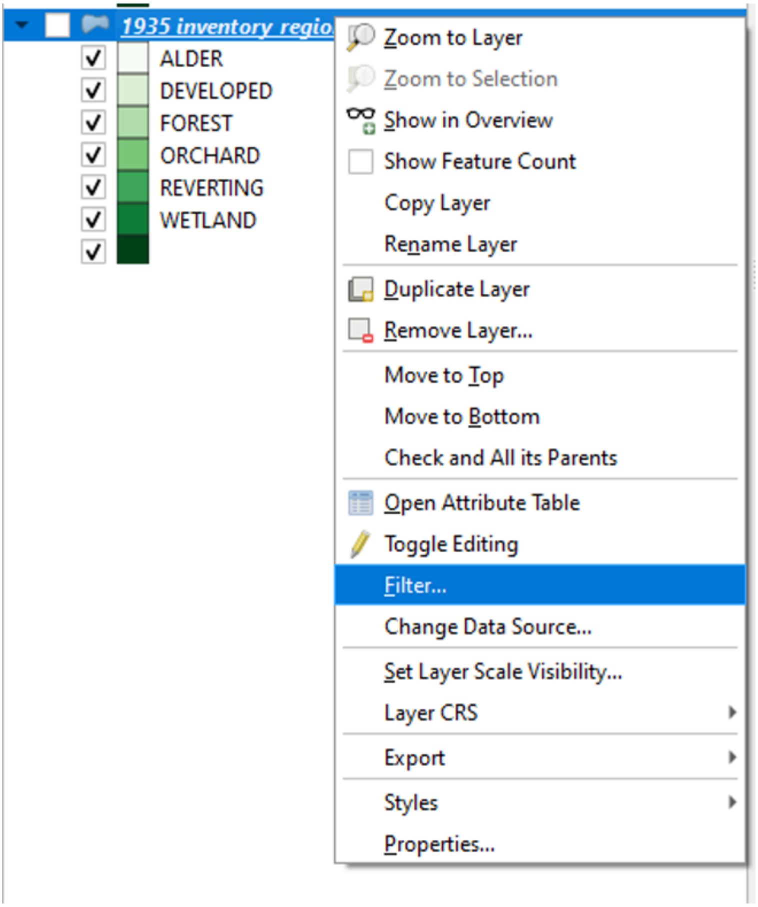


Figure 2.8

The Query Builder window will appear.

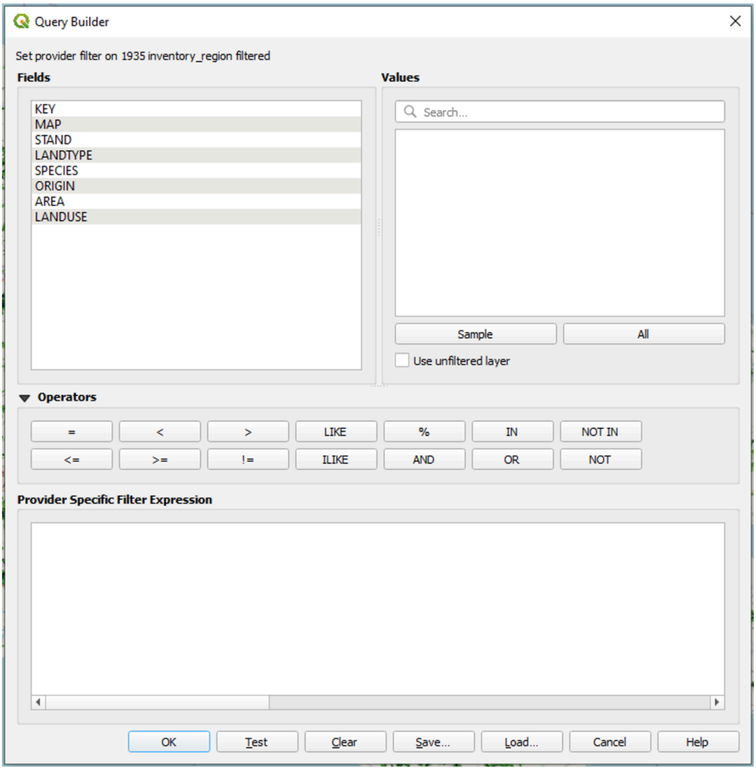


Figure 2.9

- Under Fields, left-click once on the LANDUSE field to select it.
- Under Values, click All.

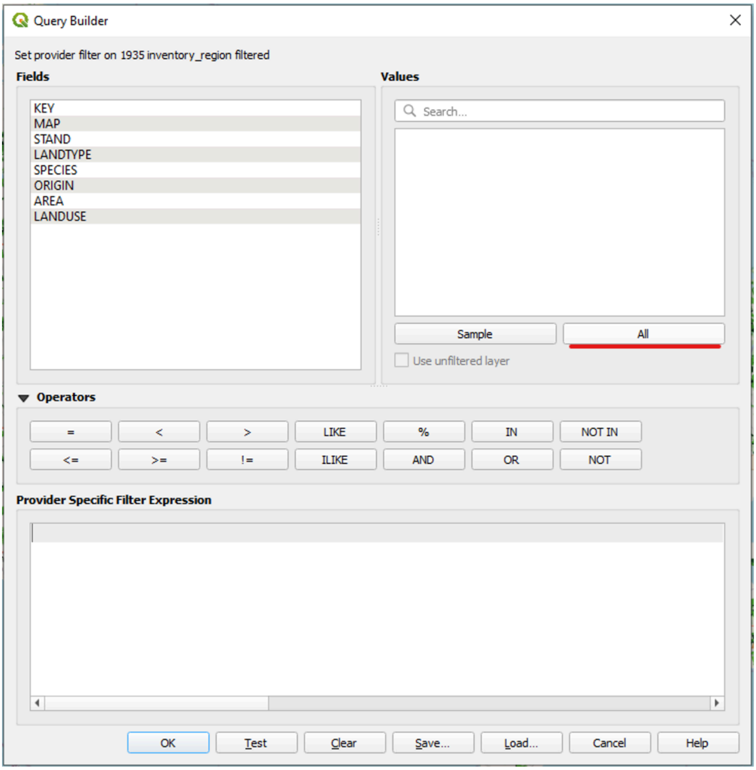


Figure 2.10

Under Values, all of the values associated with that field will appear.

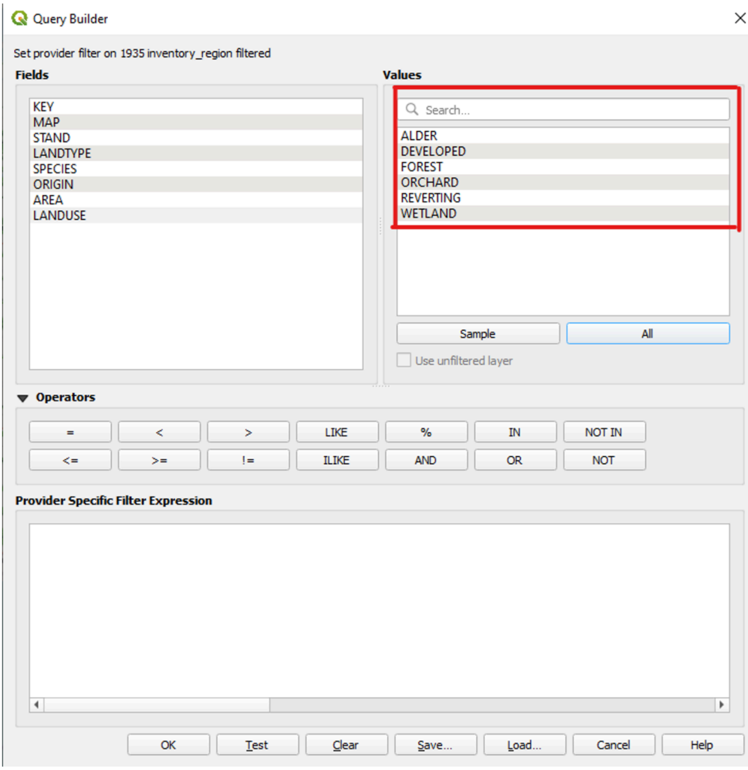


Figure 2.11

We want to include only the FOREST and REVERTING values. To do so,

- Under Fields, double-click on LANDUSE to add it to our expression.

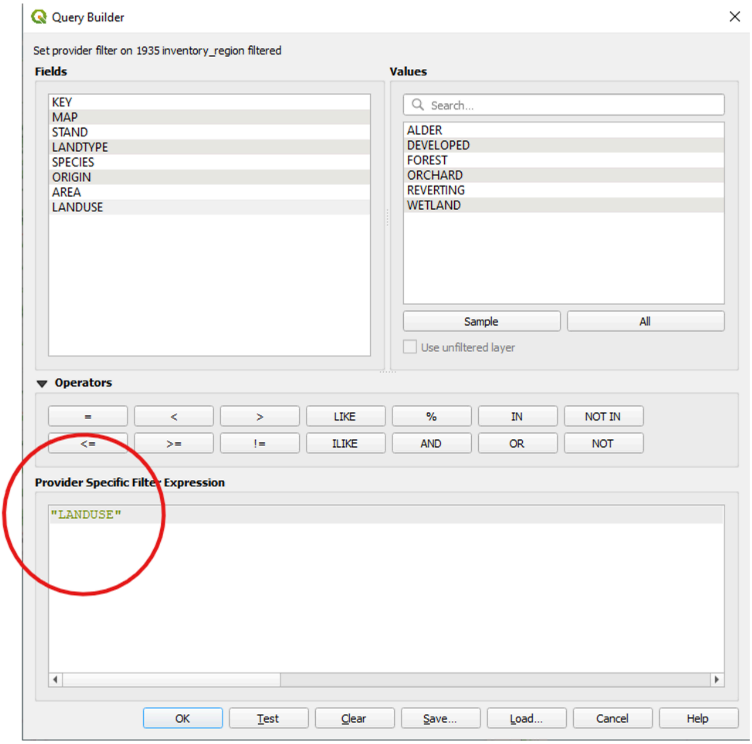


Figure 2.12

We will now tell QGIS that the only two values in the LANDUSE field that we want it to display are the FOREST and REVERTING values. To do so, we will use the operators "=" and "OR."

- Under Operators, click the equals sign (i.e., "=").

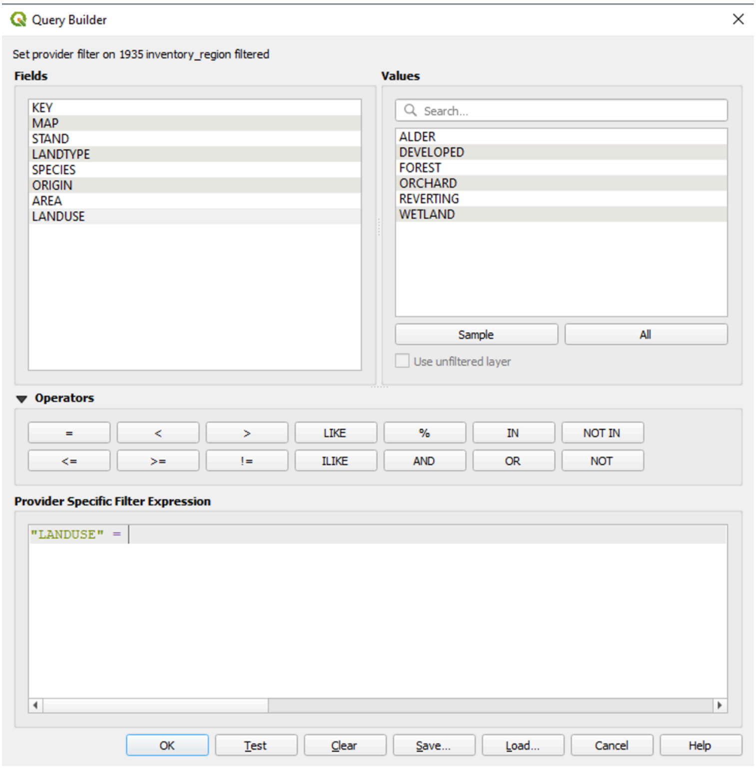


Figure 2.13

- Under Values, double-click FOREST to add it to our expression after the equals sign.

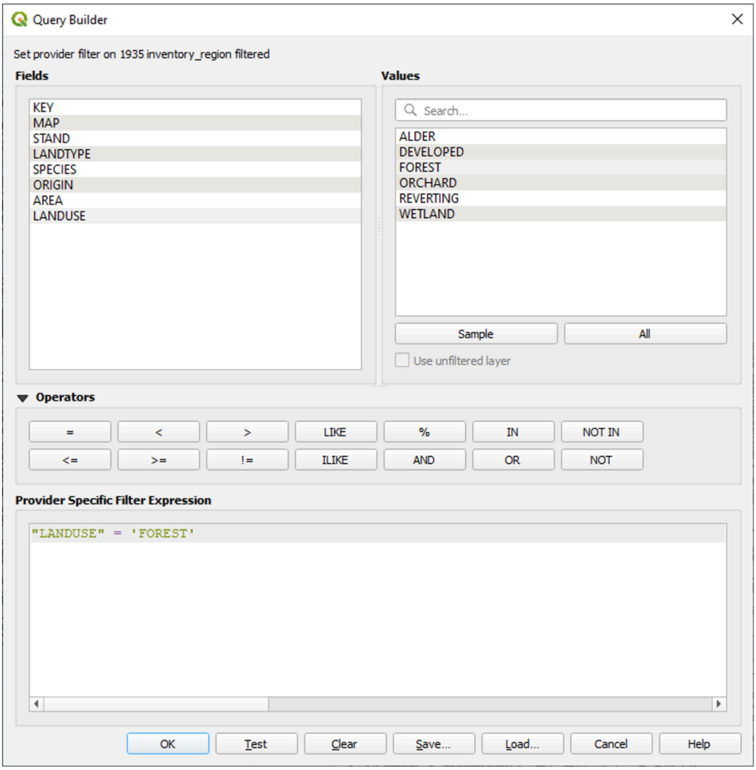


Figure 2.14

We will now use the OR operator to add the REVERTING value to our filter.

- Click the OR operator to add it to our expression after 'FOREST'.

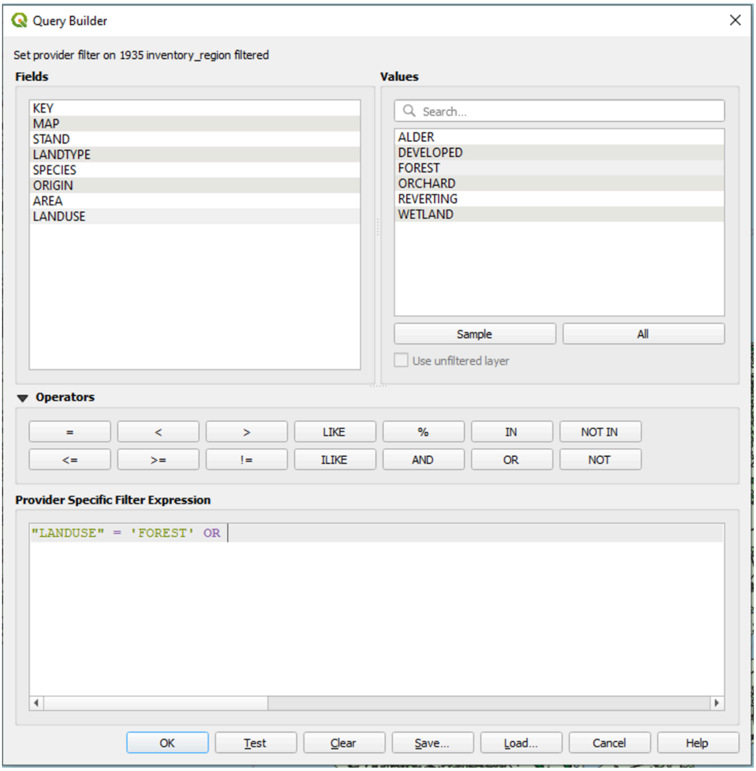


Figure 2.15

● Under Fields, double-click LANDUSE again to add it to our expression after OR.

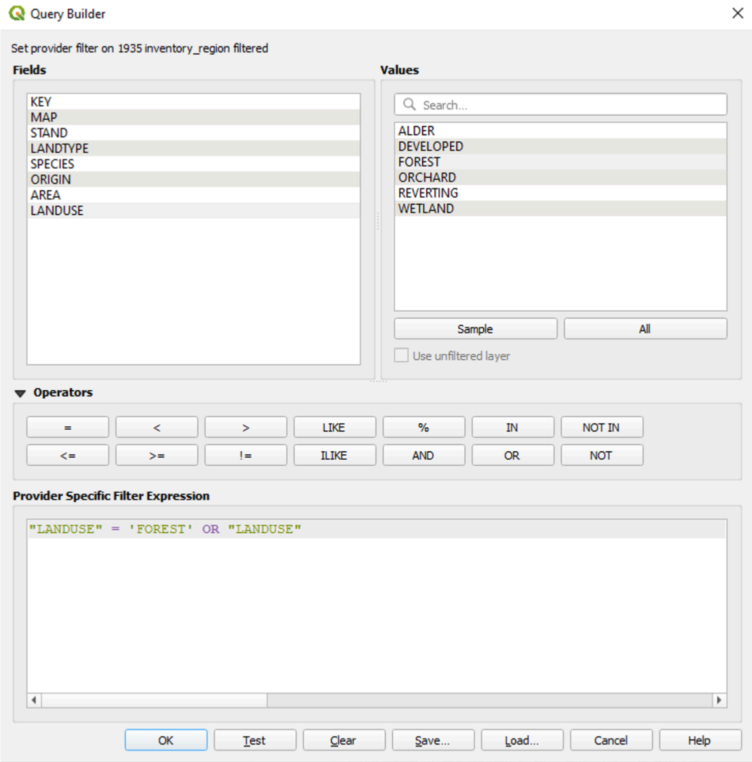


Figure 2.16

- Click the equals sign operator.
- Under Values, double-click REVERTING.

The final expression looks like this:

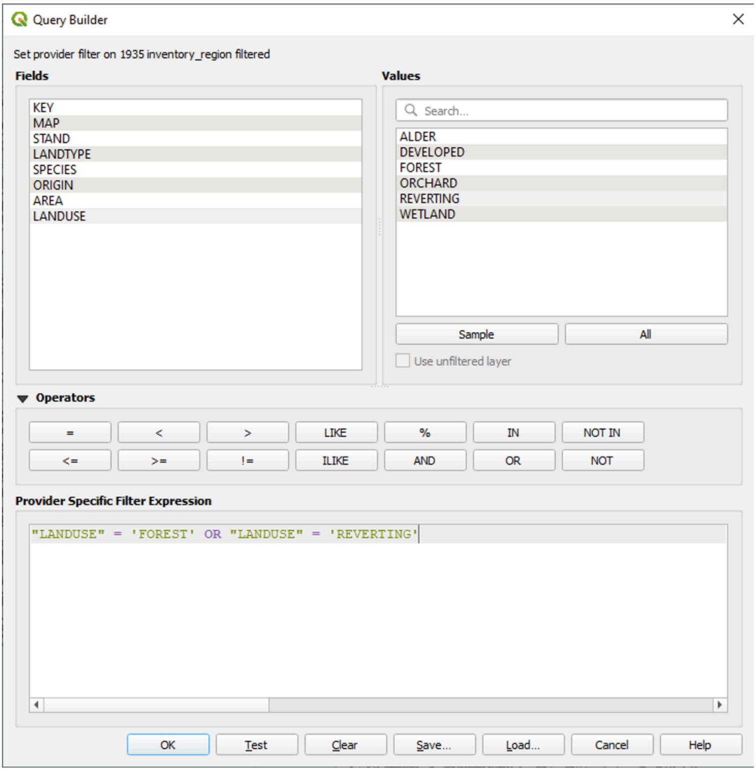


Figure 2.17

With this expression, we are telling QGIS to show only the parts of the 1935 inventory region shapefile whose LANDUSE attribute data is equal to FOREST or REVERTING. QGIS will not display any other parts of the 1935 inventory region shapefile.

- Click OK to close the Query Builder.

Our 1935 inventory region layer will go from looking like this…

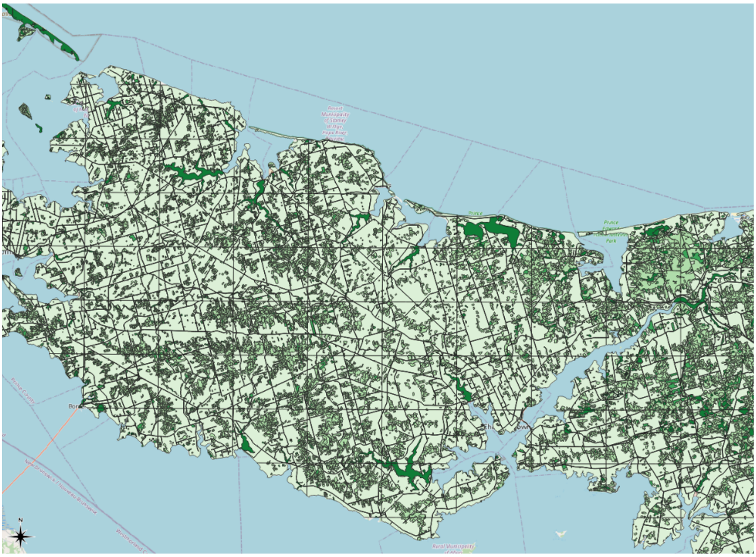


Figure 2.18

…to looking like this.

Figure 2.19

We can also tell that a layer is filtered by looking at the table of contents. There, the layer has a small image of a filter appear next to its name.

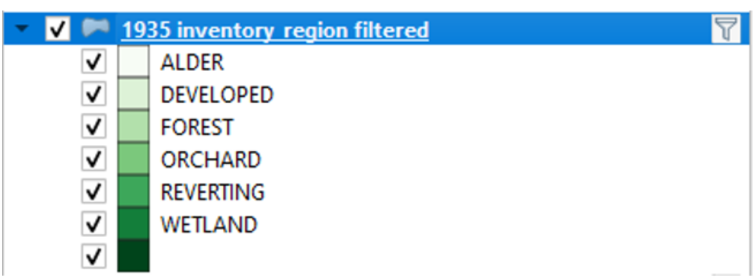


Figure 2.20

We can click on this image of a filter to quickly return to the Query Builder to adjust our filtering settings if needed.

Tip: to unfilter a layer, **click the filter** icon next to a layer's name in the table of contents and, at the bottom of the Query Builder window, **click Clear**. Then, **click OK**.

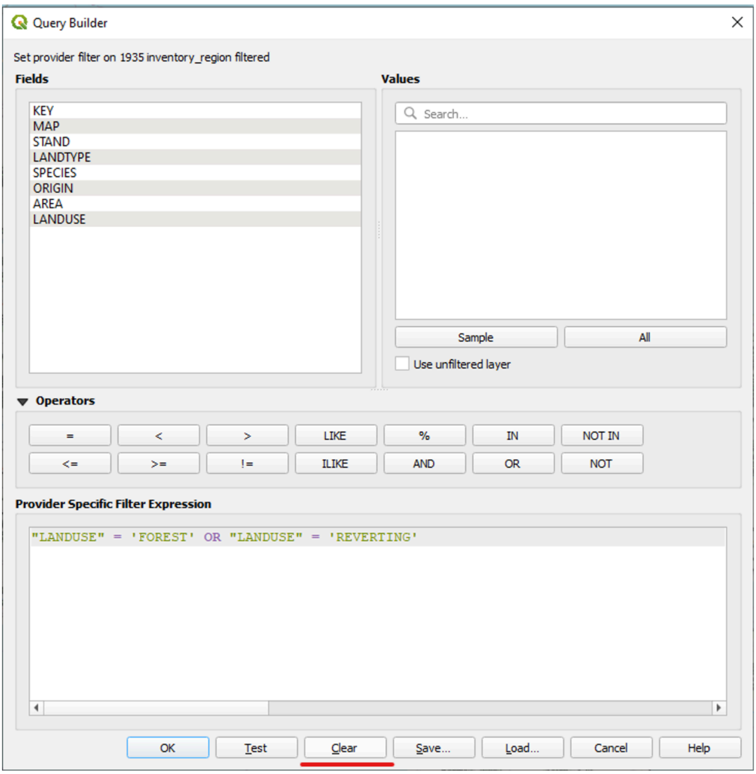


Figure 2.21

If we save and close our QGIS project while the filter is turned on, the layer will remain filtered the next time we open the project.

Symbology: Applying Categorized Symbols to the LANDTYPE Field

We are now going to get even more specific in how we symbolize our 1935 inventory region layer. We are going to symbolize several types of forest, in particular. The types of forest are listed within the LANDTYPE field. The ones with which we are concerned are CC, HH, HS, MW, SH, SS, and RV. We can tell QGIS not to symbolize any other values in the LANDTYPE field.

- Right-click the 1935 inventory region filtered layer.
- Click Properties
- Click Symbology
- From the dropdown menu at the top of the Layer Properties window
- Click Categorized.

Figure 2.22

- In the dropdown menu next to Value, select LANDTYPE.

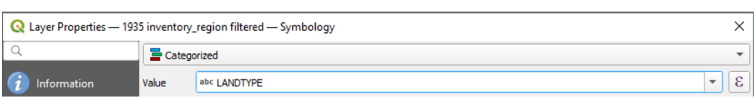


Figure 2.23

- In the dropdown menu next to Colour Ramp, choose Greens.

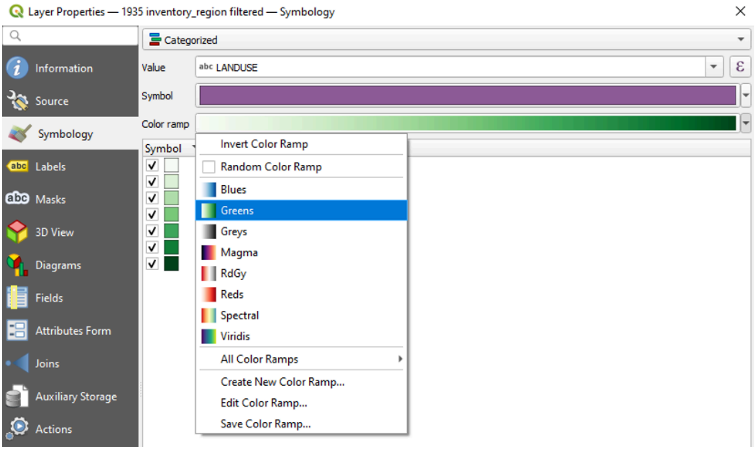


Figure 2.24

- At the bottom of the Layer Properties window, click Classify.

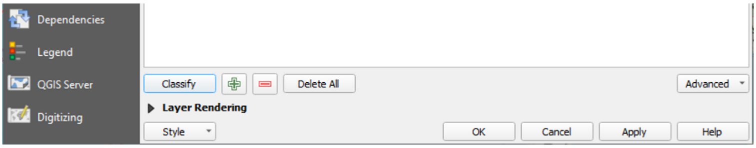


Figure 2.25

Note: if you get the following message after clicking Classify, **click Yes**.

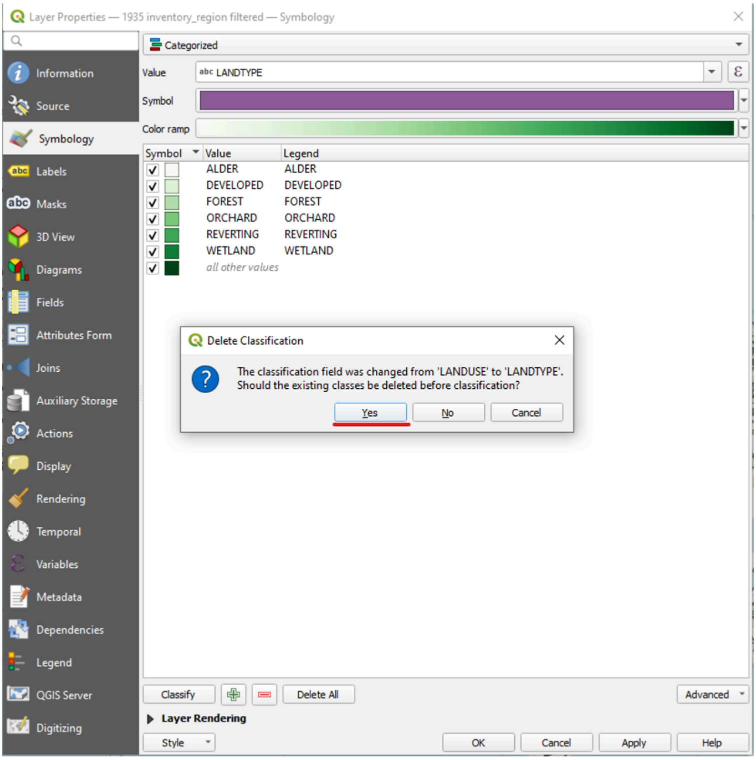


Figure 2.26

We have now symbolized all of the LANDTYPE values. To symbolize only the CC, HH, HS, MW, SH, SS, and RV values, we can select and delete the other values within the Layer Properties window.

- Select all of the values other than CC, HH, HS, MW, SH, SS, and RV. Also select "all other values."

> **Tip:** holding CTRL on your keyboard allows you to

select multiple items at once.
While these values are highlighted, click the red minus button to delete them.

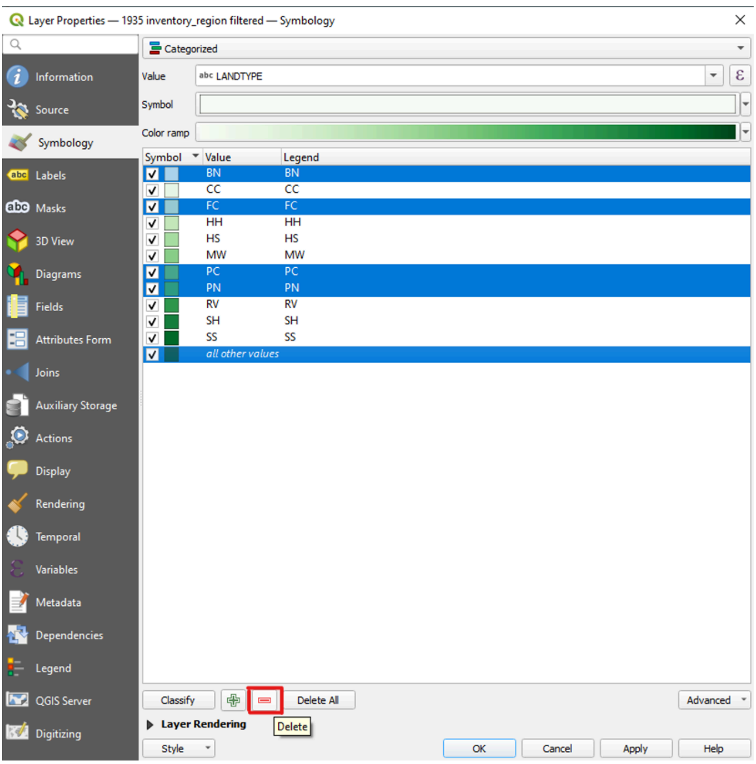


Figure 2.27

We are now left with the seven categories that we wish to map. Before we click OK, we will drag the RV value to the bottom of the list.

- Click and hold the RV value.
- Drag it to the bottom of the list, below SS.
- Release your click.

This is the result:

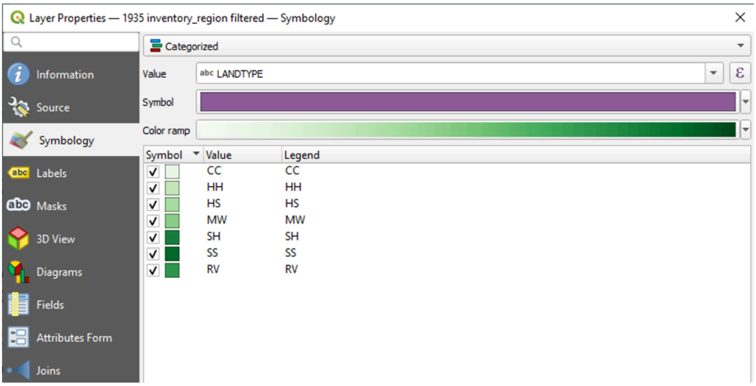


Figure 2.28

You will notice that the colour gradient is now out of order. To remedy this,

- Click the dropdown next to Colour Ramp.
- Click Greens again.

Here is the result:

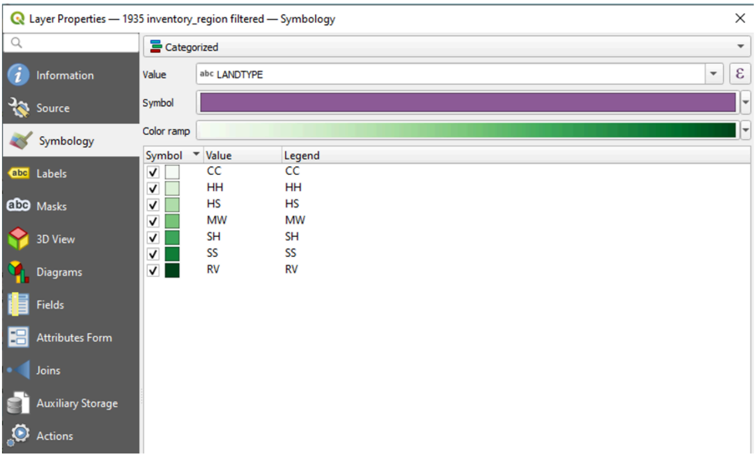


Figure 2.29

- Click OK to close the Layer Properties window.

Our map now looks like this:

Figure 2.30

There are a few changes that we make to improve the visibility of our symbolization.

First, we will remove the black border that accompanies each polygon. This will allow us to zoom out to view the entire Island without the black border overpowering the green symbology that we set, which is what happens now:

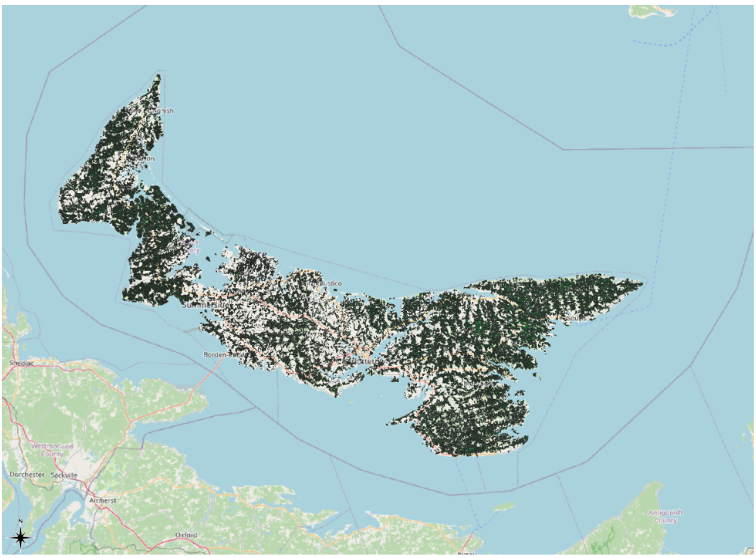


Figure 2.31

To remove the black border from our polygons,

- Right-click the 1935 inventory region filtered layer in the table of contents.
- Click Properties.
- Click Symbology.
- In the dropdown menu next to Symbol,
- Click Configure Symbol.

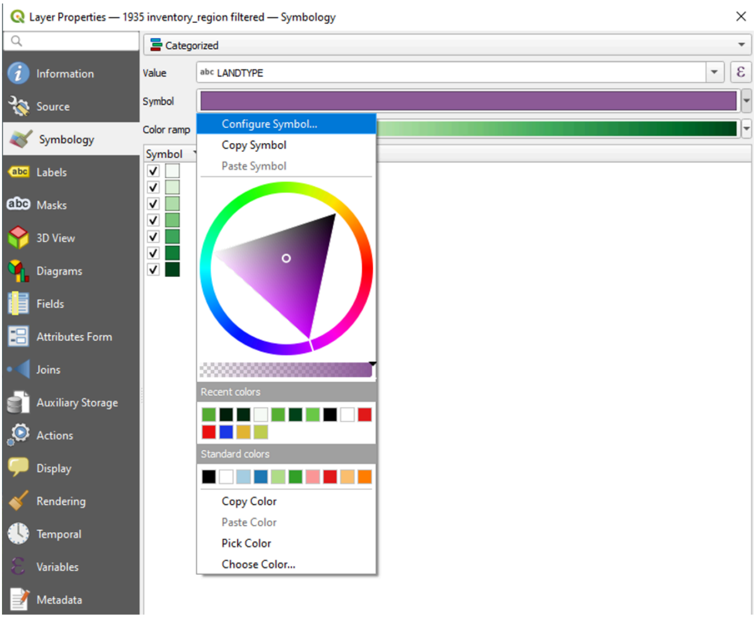


Figure 2.31

- In the Symbol Settings window, click to select Simple Fill.
- In the dropdown menu next to Stroke Colour, choose Transparent Stroke.

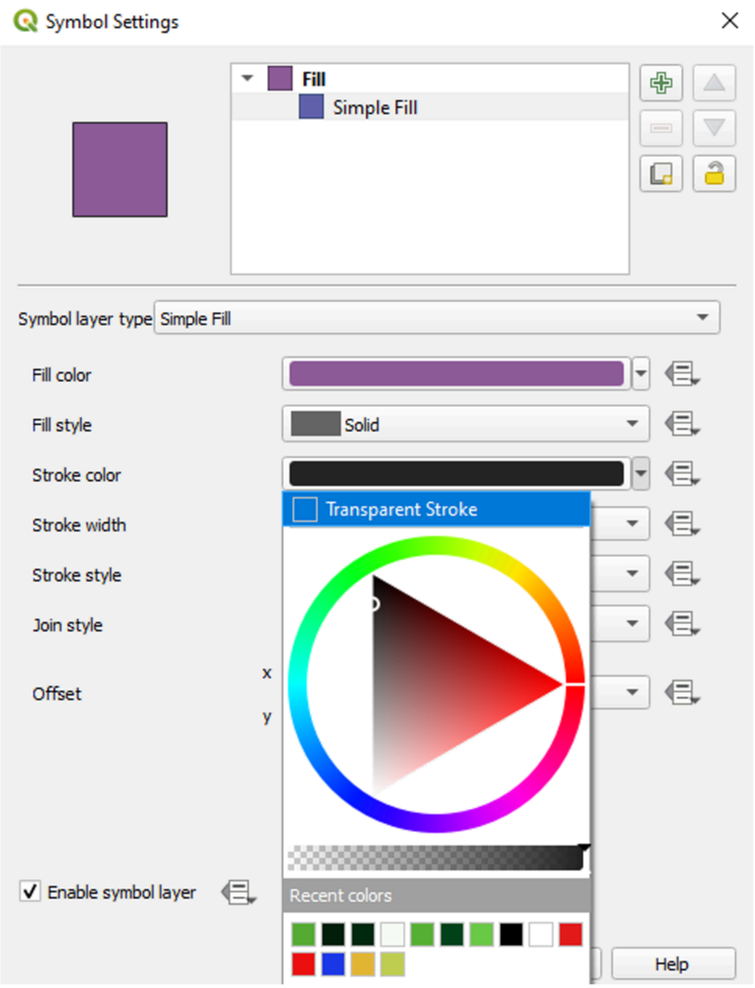


Figure 2.32

- Click OK to close the Symbol Settings window.
- Click OK to close the Layer Properties window.

Here is the result. Without the black borders around the polygons, their green symbolization becomes much easier to see.

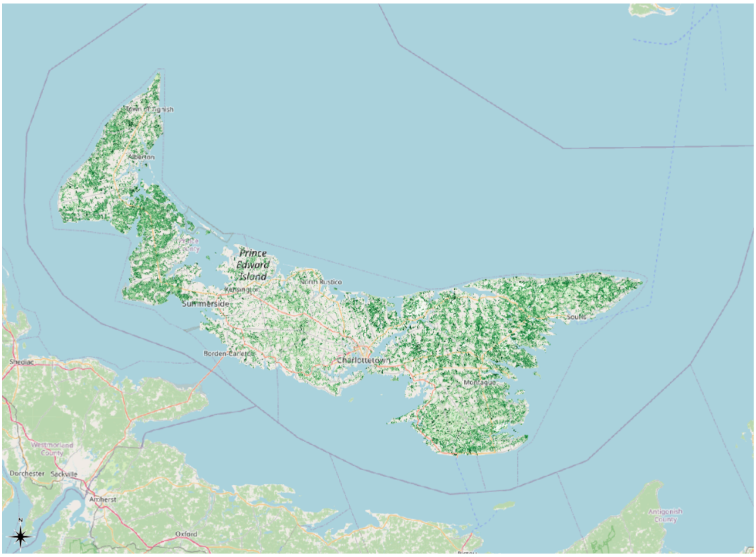


Figure 2.33

We can further augment the visibility of our symbolization.

- Right-click the 1935 region inventory filtered layer.
- Click Properties.
- Click Symbology.
- Click the dropdown arrow next to Colour Ramp and click Invert Colour Ramp.

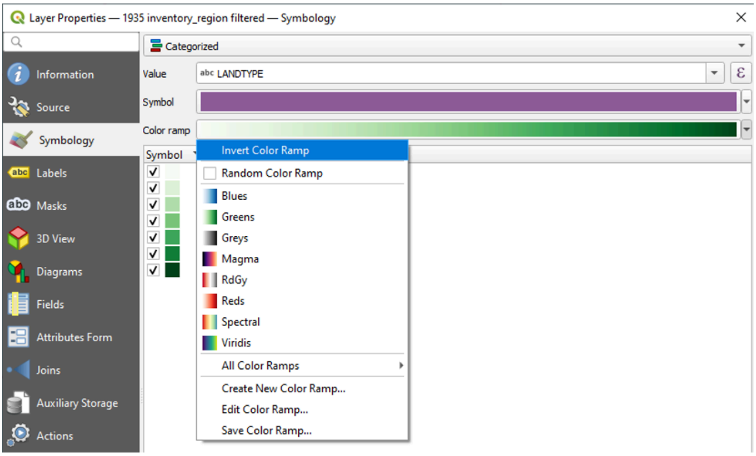


Figure 2.34

Doing this will retain the order of our LANDTYPE values but reverse the order of the green symbology gradient. Now the CC value has the darkest colour. Inverting the colours like this is a key part of knowing our data. In this case, the HH value stands for forested areas that mostly consist of hardwood species. Hardwood species normally take the longest to grow, while softwood species are usually the first type of tree to grow in an area when it is becoming a forest. So, by inverting the colour scheme and making the HH value a darker green, we are drawing more attention to the areas of hardwood tree species that still existed in 1935. In other words, these areas were most likely the ones that avoided deforestation.

While we are in the Layer Properties window, we will also change the colours in the Greens colour ramp so that the lightest shade of green is more visible.

- Right-click the 1935 inventory region filtered layer in the table of contents.
- Click Properties.
- Click Symbology.

- Click the dropdown arrow next to Colour Ramp and click Edit Colour Ramp.

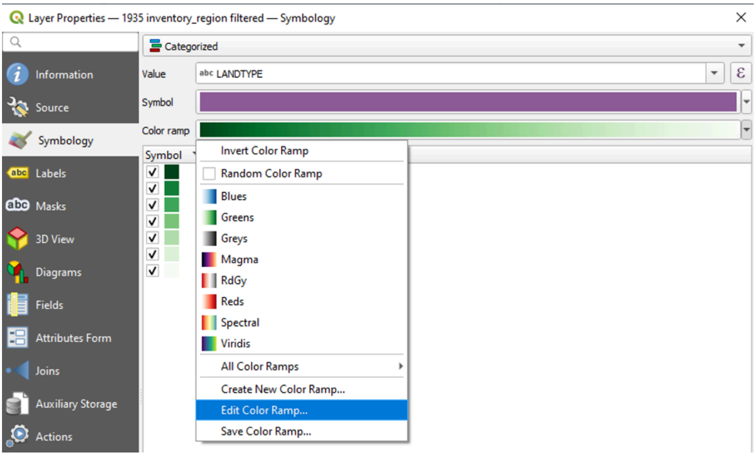


Figure 2.35

- The Select Colour Ramp window will appear.

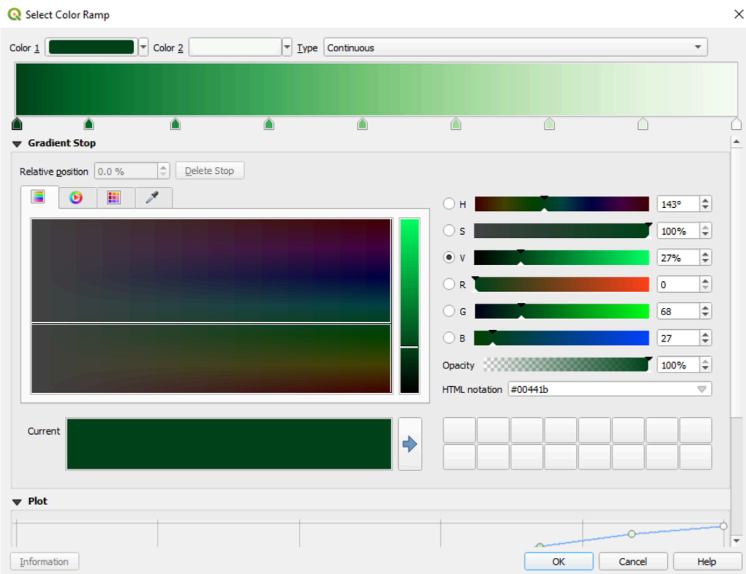


Figure 2.36

- We can see our nine Gradient Stops. We can click on one to open the options for editing it.

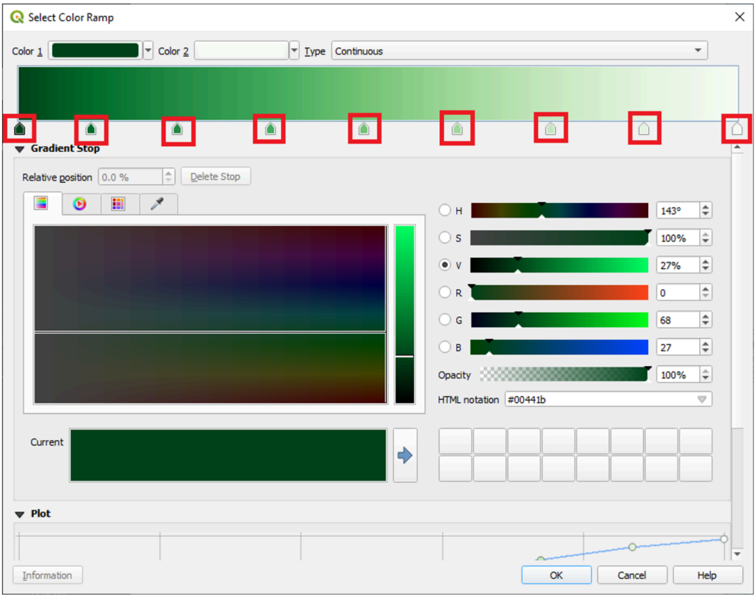


Figure 2.37

With a gradient stop selected, we can alter its colour using the tools found under the Gradient Stop heading.

We can also adjust the colours of the gradient stops under the Plot heading. In this area, we can check Lightness. Then, we can drag the circles (which represent gradient stops) to a higher or lower position on the plot. The higher the position on the plot, the lighter the colour.

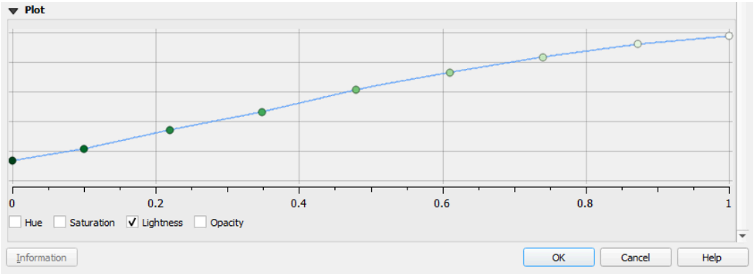


Figure 2.38

To make your gradient stops darker, you can move all of the circles on the plot to a lower location.

Or, if you wish that your colours match the ones created by the authors, you can do the following.

Navigate back to the top of the Select Colour Ramp window.

- Click to select the first gradient stop.

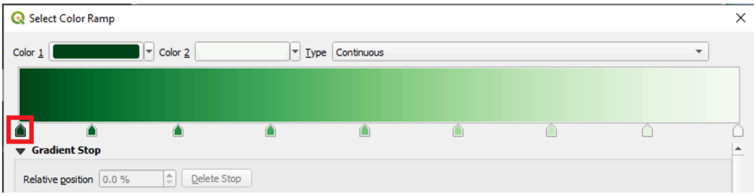


Figure 2.39

Under the Gradient Stop menu, enter the following HTML notation value: #002810

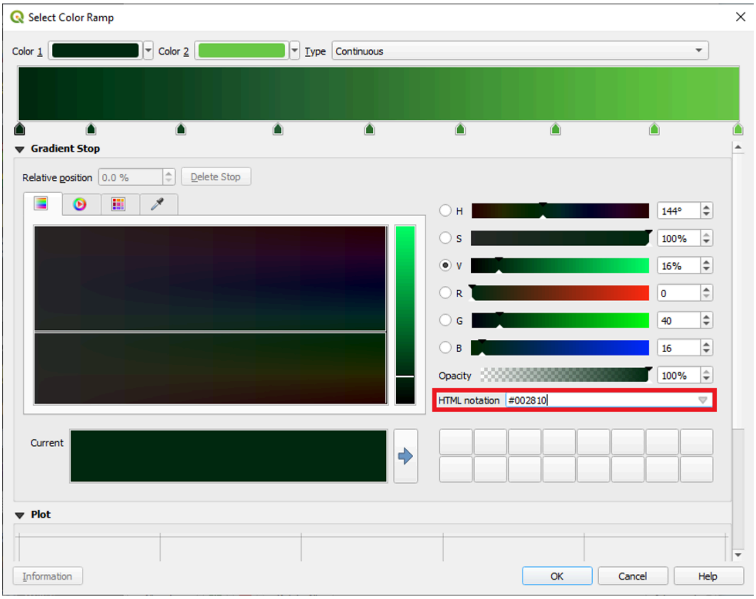


Figure 2.40

Select the second gradient stop and enter the following HTML notation value: #003a17

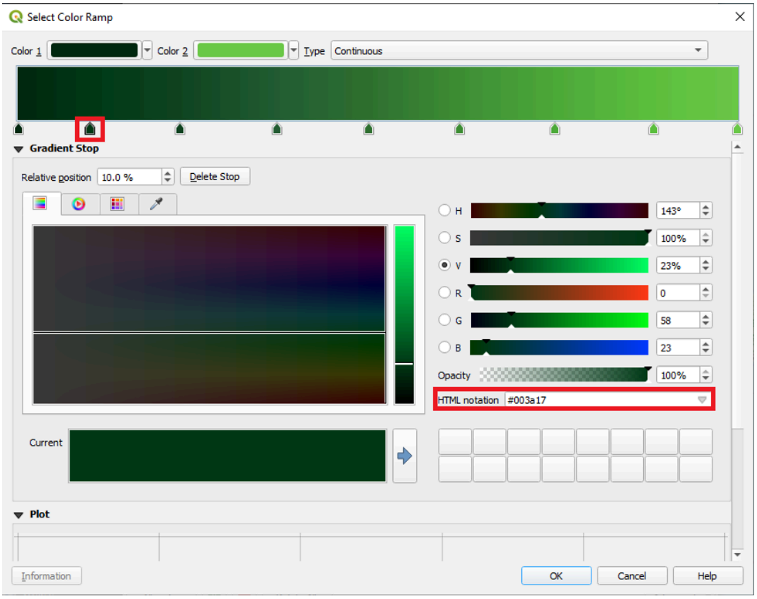


Figure 2.41

Continue this process, adding the following HTML notation values:
Gradient Stop 3: #114522
Gradient Stop 4: #235e33
Gradient Stop 5: #307131
Gradient Stop 6: #3f8f36
Gradient Stop 7: #4eaa3b
Gradient Stop 8: #5ec13f
Gradient Stop 9: #6cc848

Your colour ramp will end up looking like this:

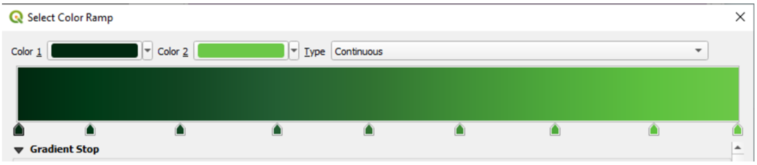


Figure 2.42

- Click OK to close the Select Colour Ramp window.

Tip: to save this newly created custom colour ramp, click the dropdown next to Colour Ramp and click Save Colour Ramp.

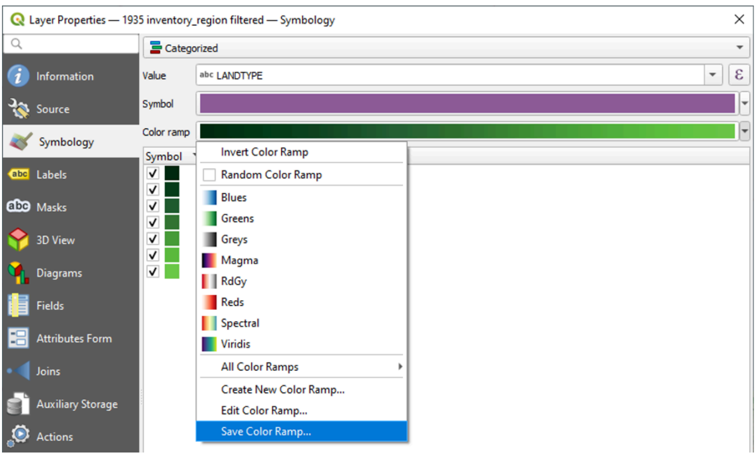


Figure 2.43

- Provide a name (e.g., Dark Greens), check "Add to favourites," and click OK. You will now see your custom colour ramp when you click the dropdown next to Colour Ramp.

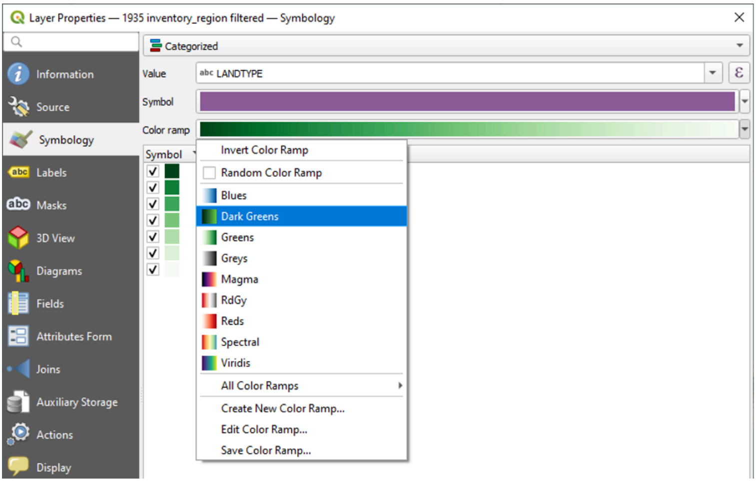


Figure 2.44

Here is the result of our customized symbology. With the customizations that we have made to the symbology, it is very easy for an audience to see the different shades of green, even when the map is zoomed out.

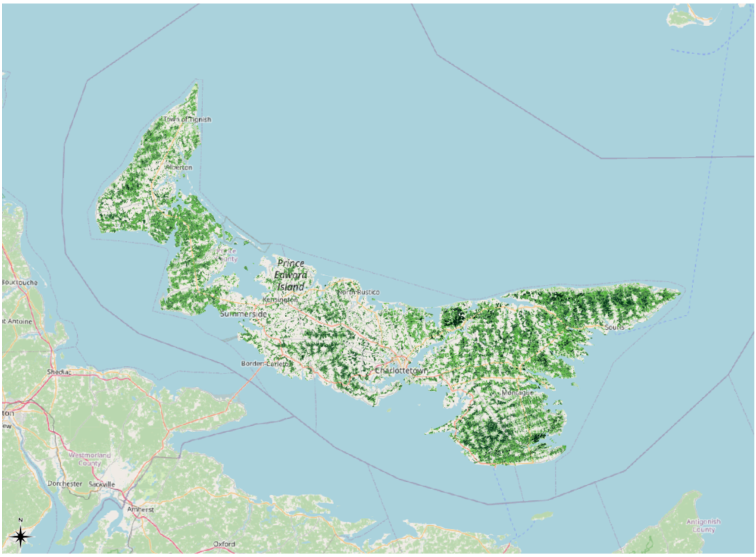


Figure 2.45

Base Maps: Creating a Contrast

A final step that we can take is to add a different base map, one that would contrast better with the green symbolization. There are plenty of open-source base maps available online. A site where we can find some is https://qms.nextgis.com/.

- Go to the above site.
- In the “Search map service” box, type in “gray.”
- Click on the result called “Wmflabs Gray.”

We can see that we are licensed to use this map.

Under TMS Info, copy the URL.

Note: if the Wmflabs Gray map does not appear in a search, search “Gray” instead and select “ESRI Gray (light).”

We will now go back to QGIS and add one of these grayscale base maps as an XYZ Tiles layer.

- In the Browser, right-click XYZ Tiles and click New Connection

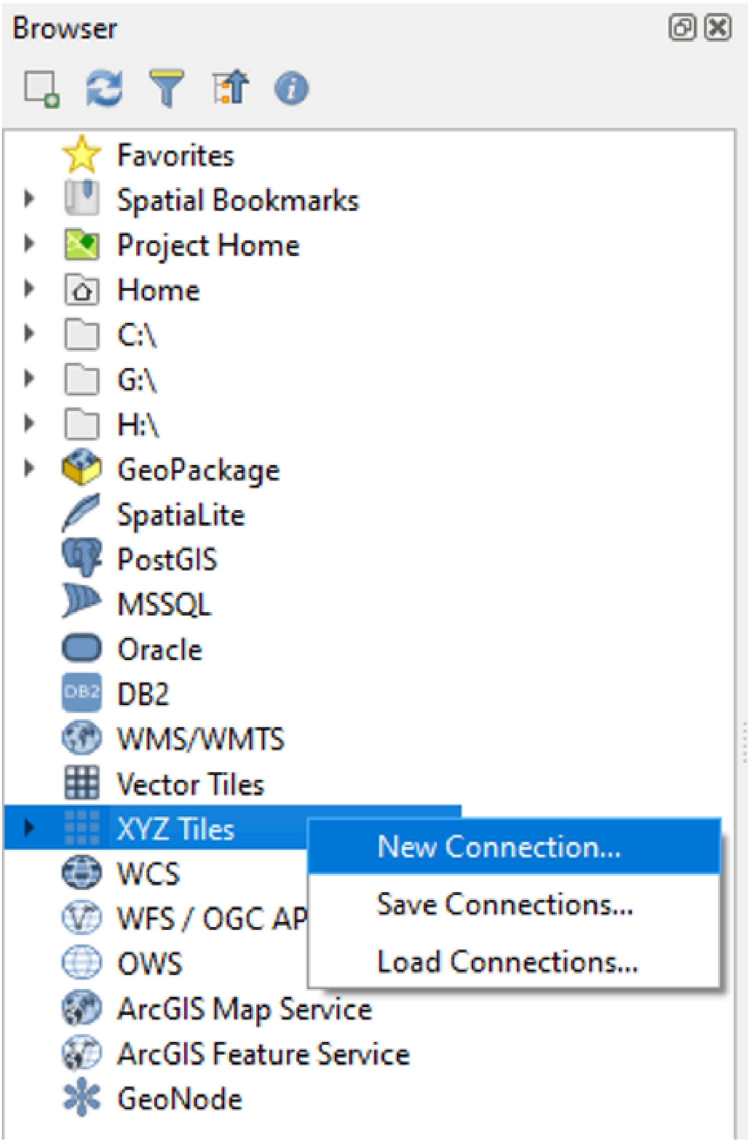


Figure 2.46

- In the Name field, type in “OSM Grayscale”

- In the URL field, paste the URL that we coped from https://qms.nextgis.com/.

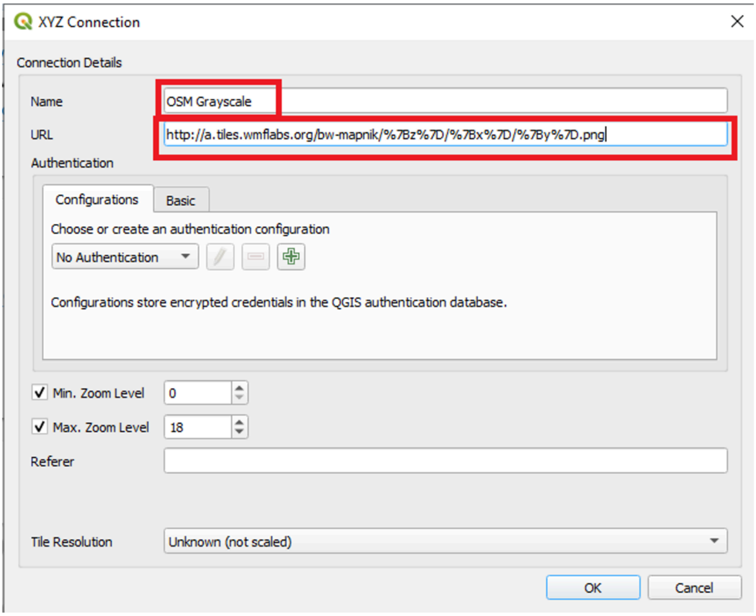


Figure 2.47

- Leave the other settings and click OK.
- In the Browser, under XYZ Tiles, double-click OSM Grayscale to add it to our project.
- In the table of contents, right-click the OSM Grayscale layer and click Move to Bottom.

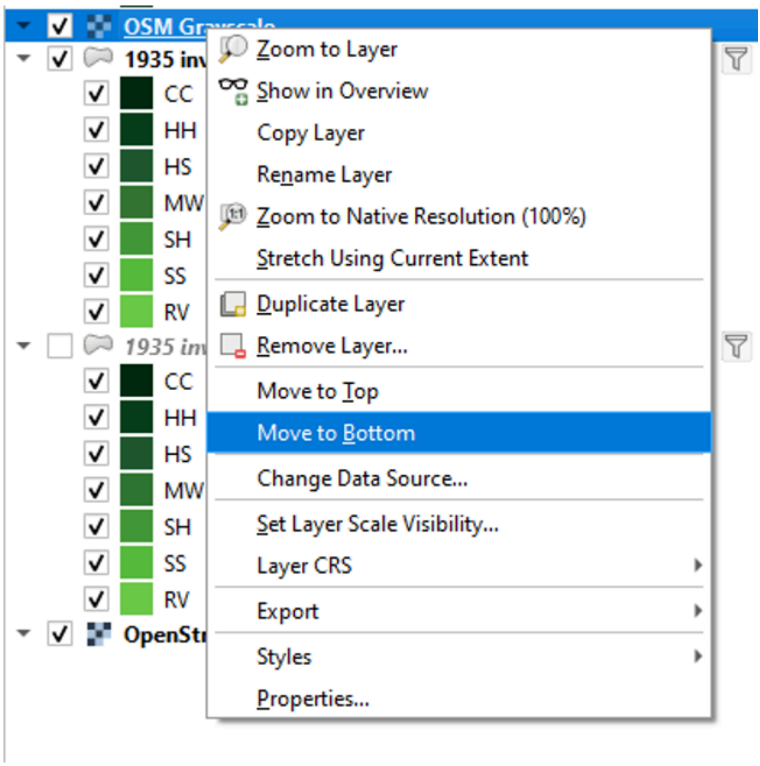


Figure 2.48

- Uncheck the regular OpenStreetMap layer.

Here is the result. The grayscale base map makes the green symbology pop.

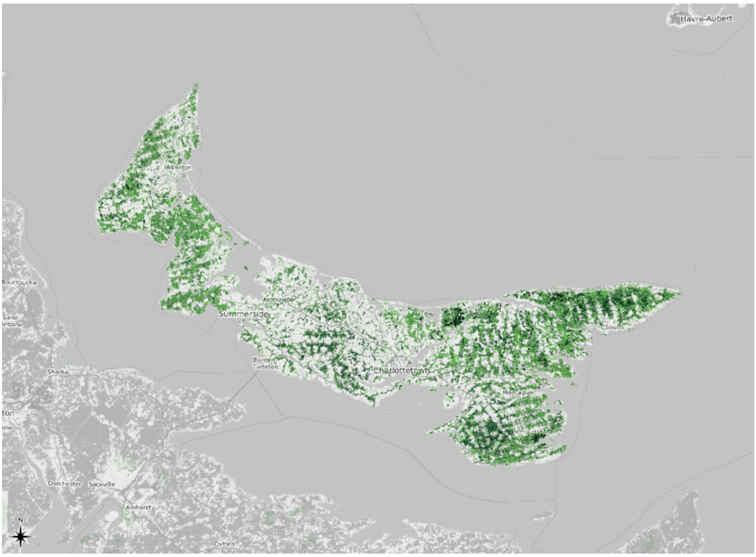


Figure 2.49

Graduated Symbology

What Is Graduated Symbology?

We just used Categorized symbology to show each of the selected LANDTYPE values in a unique colour. Here, we will use a somewhat similar type of symbology called Graduated.

We use the Categorized symbology to give each unique category of data in a field a unique colour on the map. The data that we use with the Categorized symbology can be text-based. It is also best to use the Categorized symbology when you have a limited number of categories. When we used the Categorized symbology earlier in this chapter, we had seven different values selected from the LANDTYPE field, and the field was text-based. Using the Categorized symbology helped us get a sense of the types of forest cover present on the Island in 1935.

Now that we know which types of forest cover were present on the Island in 1935, we are going to use Graduated symbology to assess the area of each type. We use the Graduated symbology with numeric data or, rather, integers. We use a colour ramp of increasingly intense colours to reflect increases in the numeric data. Maps created using the Graduated symbology are sometimes referred to as "choropleth maps" or "heatmaps." In a similar process to that which we used with the Categorized symbology, we choose the value we want to symbolize from the "Value" dropdown menu. The value that we are selecting is a column header in the layer's attribute table.

> **Tip:** symbology depends in large part on the type of data you have and want to display. You should consider whether your data contain discrete variables or continuous variables (to put it in mathematical terms). Categorized symbology is for mapping discrete variables, whereas graduated symbology is for mapping continuous variables.

Identify Features: Exploring Our Data

When performing any sort of symbolization, including Categorized and Graduated, it is important to know the strengths and weaknesses of data with which we are working. It is important to know the purpose and methodology of the data's creators.

In our case, knowing the creators' methodology helps us to see one of our dataset's key flaws. That is, the team of mapmakers behind this project created the shapefile map by interpreting aerial photographs. Each member of the team was assigned an artificially delineated, square section of the Island to interpret. If you turn on the 1935 inventory region layer that we symbolized in Chapter 1, and if you zoom in to a scale of about 1:150000, you will be able to see the square delineations. Here is an example from the Mount Stewart area of PEI, in which one of the grids has been outlined in red:

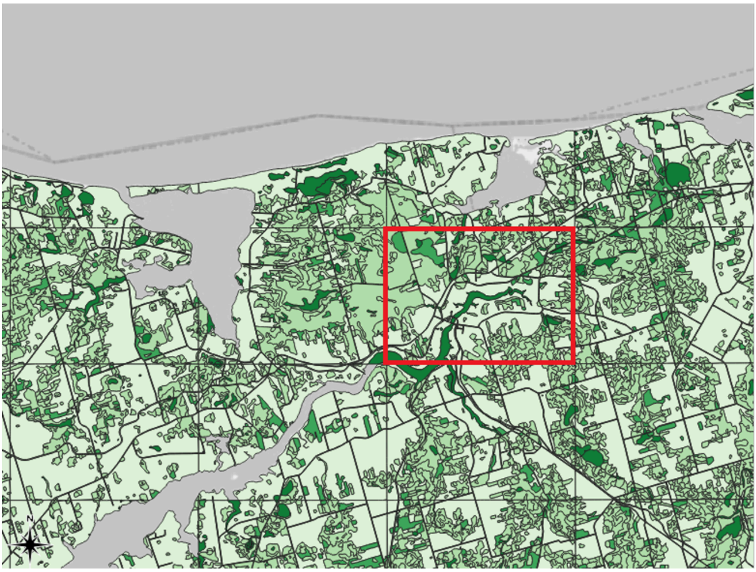


Figure 2.50

The problem with these delineations is that they sometimes separate neighbouring areas into separate shapefile features even though, in the real world, they were likely part of the same continuous land parcel. So, if we create a map that is symbolized based on the areas of the features, we may not be telling an accurate story of the actual sizes of the forested areas in PEI in 1935.

For example, the delineation highlighted in red in the screenshot above divides what was likely one continuous land parcel into two features within the shapefile layer. We can see that this land parcel was arbitrarily divided by using the Identify Features button.

- In one of the toolbars towards the top of your screen, click the Identify Features button.

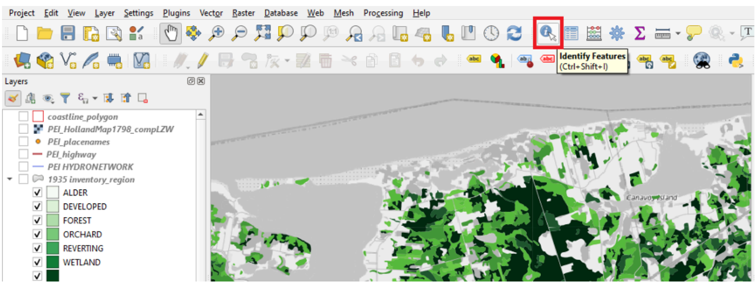


Figure 2.51

- Click on the feature that is selected in the following screenshot of the Mount Stewart area, which was taken at a scale of 1:95000.

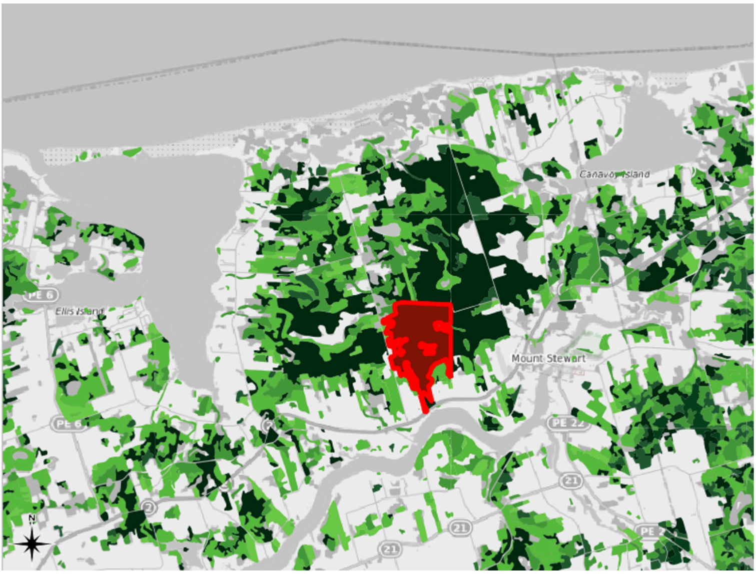


Figure 2.52

The eastern edge of this selected feature seems to have been arbitrarily cut off by one of the delineations that the mapmakers created. The neighbouring feature to the east, which is selected in the following screenshot, was likely part of the same parcel of land in the real world.

- Select the neighbouring feature to the east.

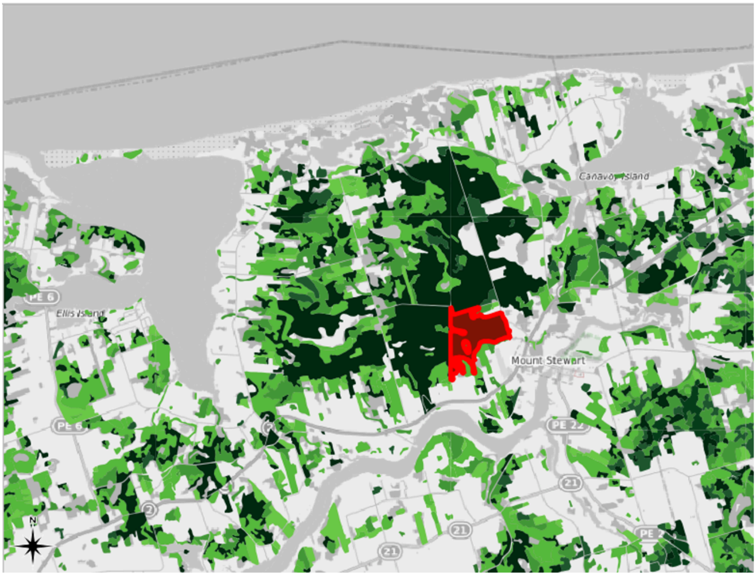


Figure 2.53

When we select an item, the Identify Results pane appears, often to the right of the QGIS window. This pane shows the attribute data associated with a selected feature. For the first selected feature, we can see that the LANDUSE value is FOREST and that the LANDTYPE value is CC. We can also see that the AREA value is 276.240 hectares.

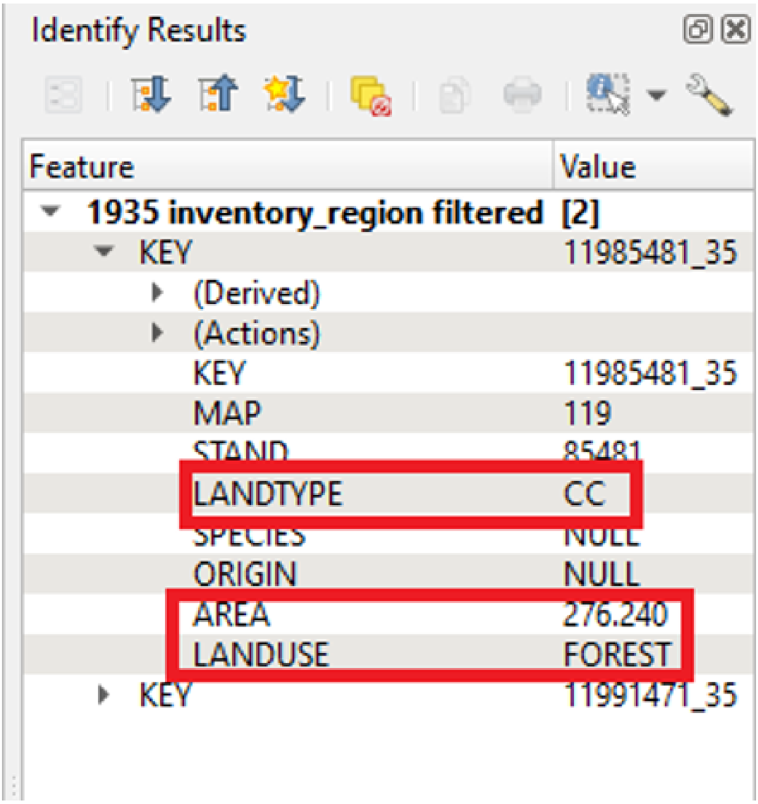


Figure 2.54

The second selected feature has a LANDTYPE value of CC and LANDUSE value of FOREST. So, it is likely that the two of them were part of the same, continuous land parcel in the real world in 1935. The second selected feature's AREA value is 140.115 hectares.

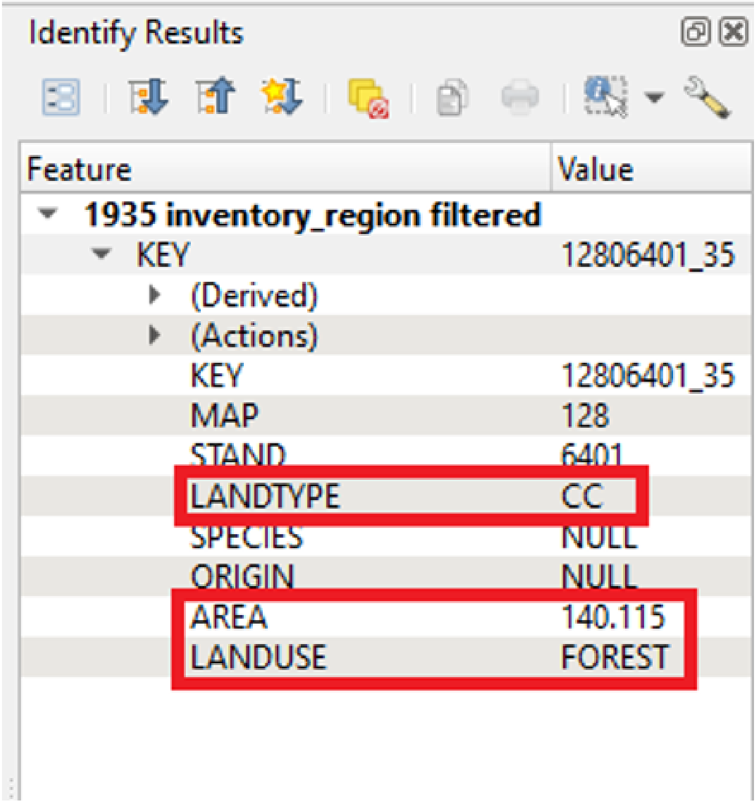


Figure 2.55

If we wished to create a dataset that was as accurate as possible, we could methodically go from grid to grid and merge the features that the mapmakers had arbitrarily divided in two. When merging the features, we would be able to add together the AREA fields of the merged features to get an AREA value for the larger, continuous land parcel. Such a process is a bit too complicated and tedious for right now, but have a look at the following screenshot for an example of what the result would be if we merged the land parcels in the Mount Stewart area that were discussed above. In this example, when the Identify Features button is used, the entire parcel of land can be selected. It is no longer arbitrarily divided into two. The respective AREA values of the two merged features have also been summed to create an area for the continuous land parcel.

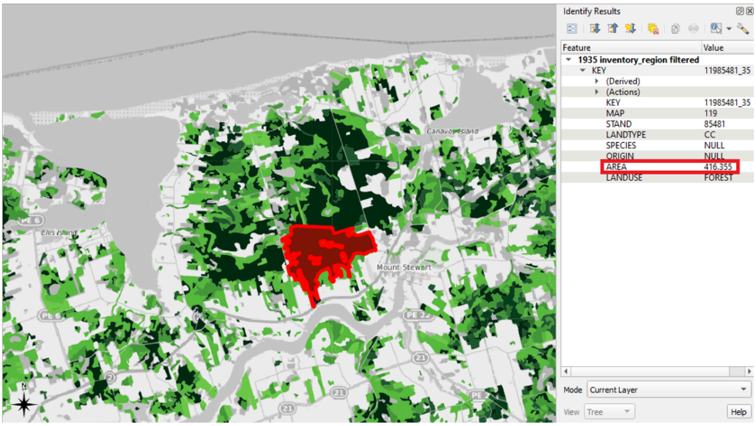


Figure 2.56

This process would involve editing the shapefile itself, and, like some work done with GIS, it would be a bit tedious. However, we would be left with a more accurate map.

For now, we will proceed with applying a Graduated symbology to the features containing either the FOREST or REVERTING attributes as they stand. But we will keep in mind that our choropleth map may be slightly inaccurate in some areas due to the original mapmakers' methodology.

Symbology: Applying Graduated Symbols to the AREA Field

We will first create a duplicate of the layer on which we performed a Categorized symbology earlier in this chapter.

- Right-click the "1935 inventory region filtered" layer and click Duplicate Layer.

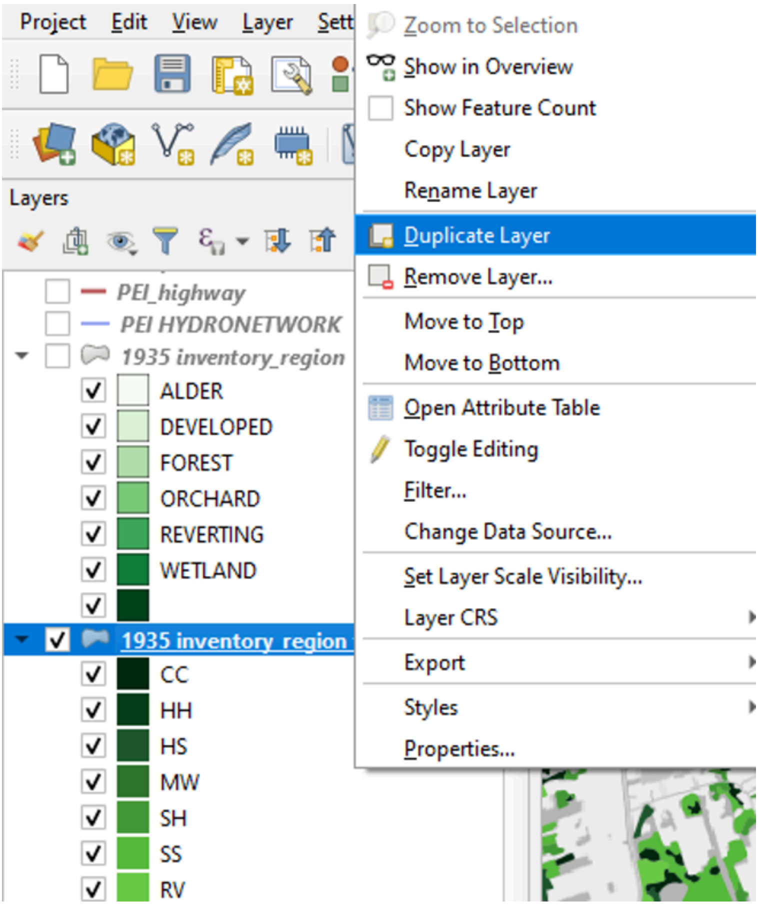


Figure 2.57

Note: remember that the duplicated layer still references the same shapefile as its source data.

Note: since the layer from which we copied was filtered, the duplicate layer that we created from it is also filtered.

- Right-click the duplicated layer and click Rename Layer.
- Type in "1935 inventory region filtered and graduated" and press Enter.

Note: you can now uncheck the 1935 inventory region filtered layer in your table of contents and turn on the 1935 inventory region filtered graduated layer.

We will now symbolize the 1935 inventory region filtered and graduated layer by the AREA field.

- In the table of contents, right-click the 1935 inventory region filtered and graduated layer.
- Click Properties.
- Click Symbology.

- In the dropdown menu at the top of the Layer Properties window, click Graduated.

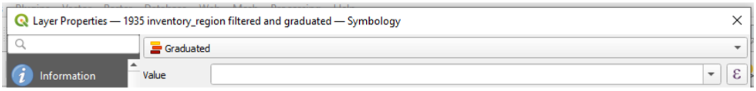


Figure 2.58

- In the Value dropdown menu, choose AREA.

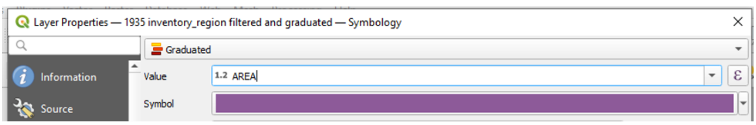


Figure 2.59

Since this layer is a copy of the one in which we created the customized Dark Greens colour ramp, this colour ramp is already in place for us.

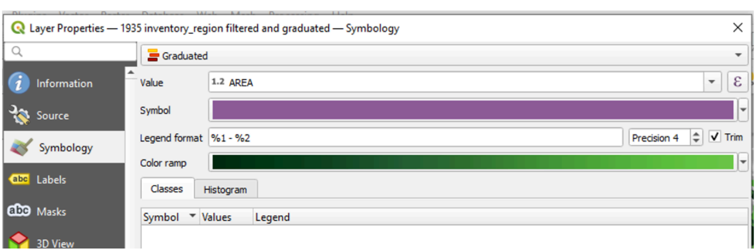


Figure 2.60

Since we are going to be mapping area values, it would perhaps make sense to represent the largest areas with the darkest colour. So, let's invert our colour ramp.

- Click the dropdown arrow next to Colour Ramp.
- Click Invert Colour Ramp.

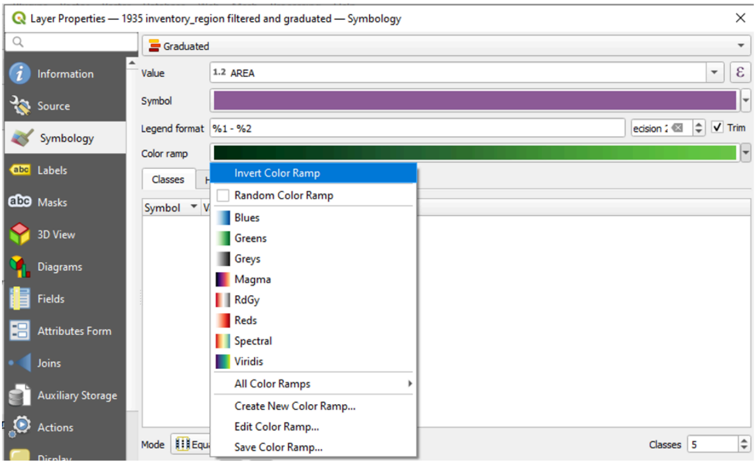


Figure 2.61

We are now able to Classify our data into classes. However, we must first choose which Mode we would like to use to classify our data.

Choosing the Best Graduated Mode to Symbolize Our Dataset

When using the Graduated symbology, we break down our data into classes. We assign each class a different colour. So, for example, the class with the lowest values would have the lightest shade of green, while the class with the highest values would have the darkest shade of green.

We choose the mode that QGIS uses to divide our data into these classes.

To see the list of modes:

- Under the the Classes tab, next to Mode, click the dropdown arrow.

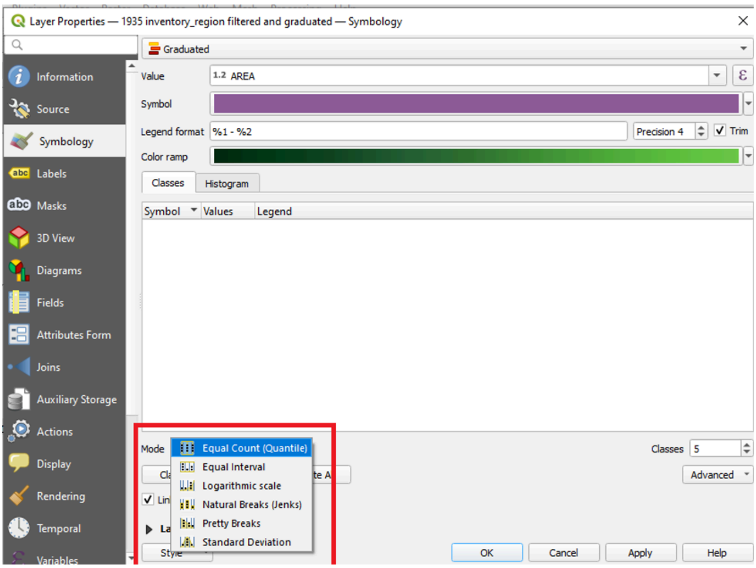


Figure 2.62

The modes available in QGIS are:

1. Equal Count (Quantile)
2. Equal Interval
3. Logarithmic scale
4. Natural Breaks (Jenks)
5. Pretty Breaks
6. Standard Deviation

But how do we decide which mode to select? We try to choose the mode that best suits the data that we are mapping. One way to decide which mode to choose is to first look at a histogram of your dataset.

Viewing a Histogram

From a histogram, you can tell how your data is distributed. A histogram's x-axis will show you a range of values. In our case, it will show us a range of area sizes. A histogram's y-axis will show you a count of the number of data points that have a particular size. Viewing a histogram may help you figure out where to place class breaks so that they best capture the distribution of your data.

There are at least two ways in which to view a histogram of our data in QGIS.

Option 1: Within the Symbology Menu

To view a histogram,

- In the Symbology menu, click on the Histogram tab.
- Click Load Values

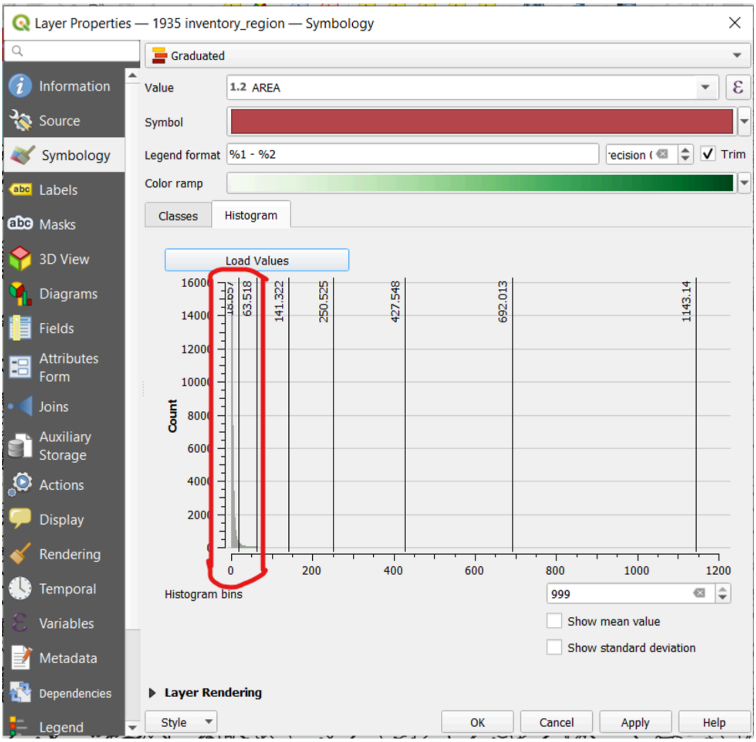


Figure 2.63

The screenshot above is a view of the histogram option within the Symbology menu with the Natural Breaks mode selected. The benefit of this view is that we can see our data alongside the class breaks of the mode we have selected. (Note how the Natural Breaks mode groups most of the data points into the first class break.) The downside is that the histogram itself is difficult to see.

Option 2: Within the Plots Tool

Another way to view a histogram of our data is through the Plots tool.

- Click Processing and then Toolbox

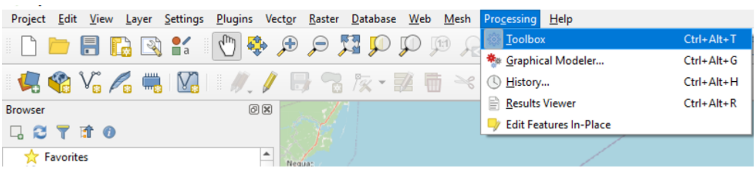


Figure 2.64

- In the Processing Toolbox panel to the right, click Plots and then Vector layer histogram

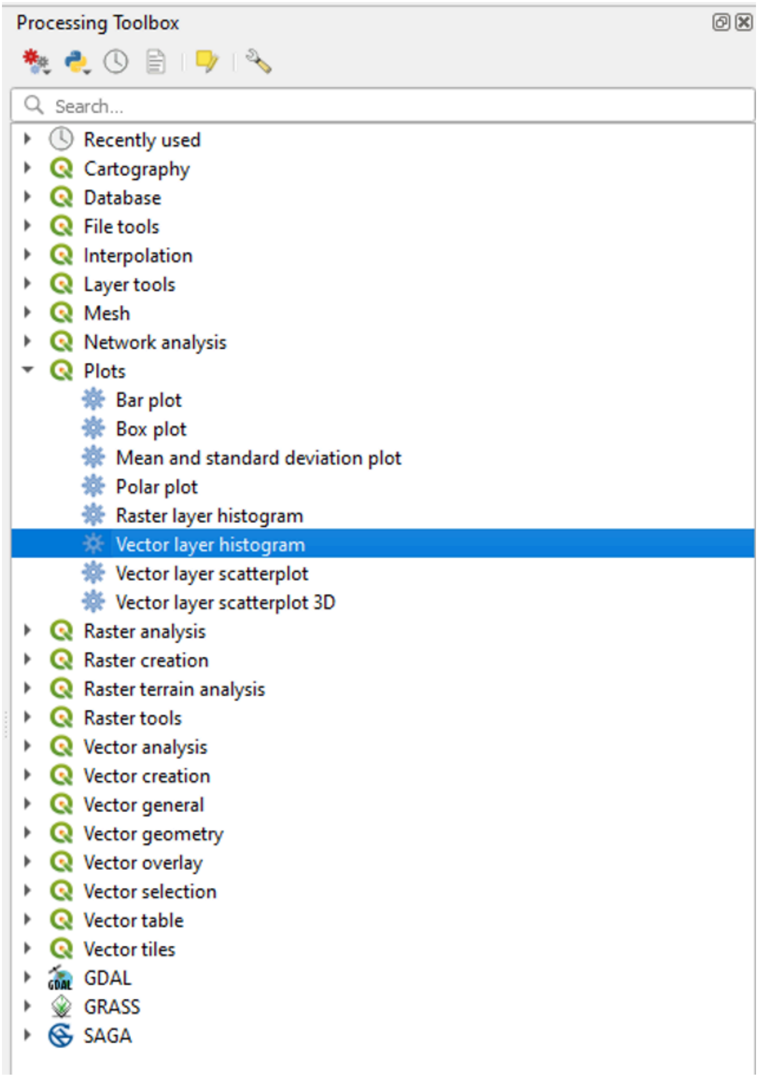


Figure 2.65

- In the Input Layer field, enter “1935 inventory region”
- In the Attribute field, select “Area.”

- Change the number of bins to 999.
- Click Run.

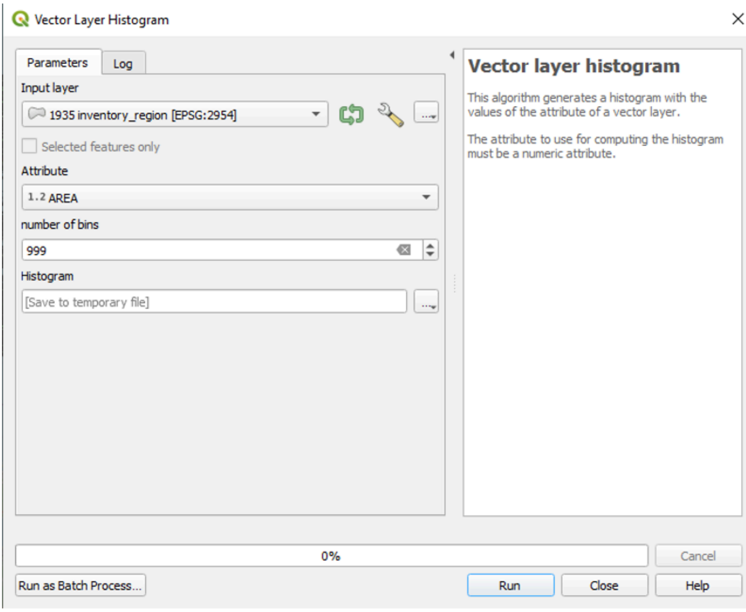


Figure 2.66

A temporary file will be produced.

- At the bottom of the Processing Toolbox, the produced histogram files will appear in the Results Viewer. Double-click the file to open it in your browser.

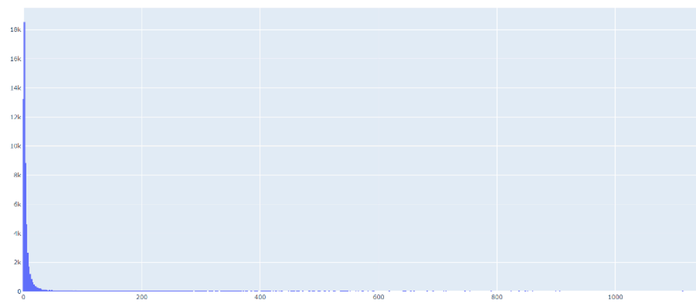


Figure 2.67

Although you cannot see your class breaks in this view, this view is perhaps the best way to analyze your histogram. It is easier to see, and you can pan and zoom in to any area of the histogram to view it in detail.

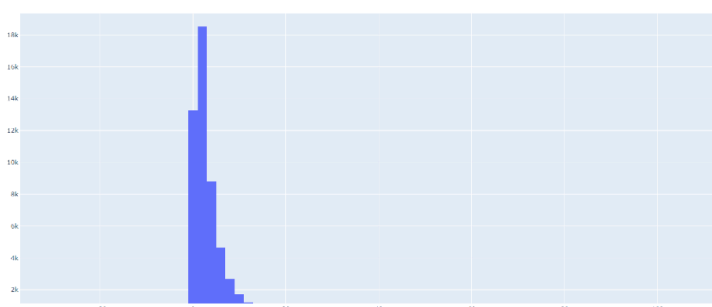


Figure 2.68

Selecting a Mode

After we have viewed a histogram of our data, we can try several different modes to see which one best captures the distribution of our data.

> **Note:** when you change from one mode to another, the number of classes may change. Sometimes, you can override this by inputting a figure for the number of classes. When doing so, keep in mind that maps are perhaps easiest to interpret when they have between three and seven classes.

Here are the modes available in QGIS along with a brief description of how they work.

> **Note:** make sure to invert your colour ramp each time that you change modes so that the class with the largest numbers has the darkest shade of green.

Equal Count (Quantile)

This mode will divide the data so that each class contains the same number of whatever you are mapping (features). For example, if we had 100 features with four variables in our attribute, the Equal Count mode would place 25 features into each class. In our case, each class would contain the same number of land plots. We can see this in action by right-clicking the 1935 inventory region in the table of contents and clicking "Show Feature Count." In the first screenshot, we can see that the number of features, i.e., the number of pieces of data, in each class is roughly the same. This number is shown between square brackets. In the second screenshot, we can see that this mode is not very effective for conveying the differences in the data: most of the map appears in dark green.

The advantage of this approach is it ensures that all colors in your gradient are used evenly, which helps patterns to stand out. The disadvantage is that this approach struggles in maps that contain large clusters of values that are very close to one another. Since the map wants to separate things as evenly as possible, it will sometimes represent similar values with different colors rather than creating its categories around natural breaks in the data.

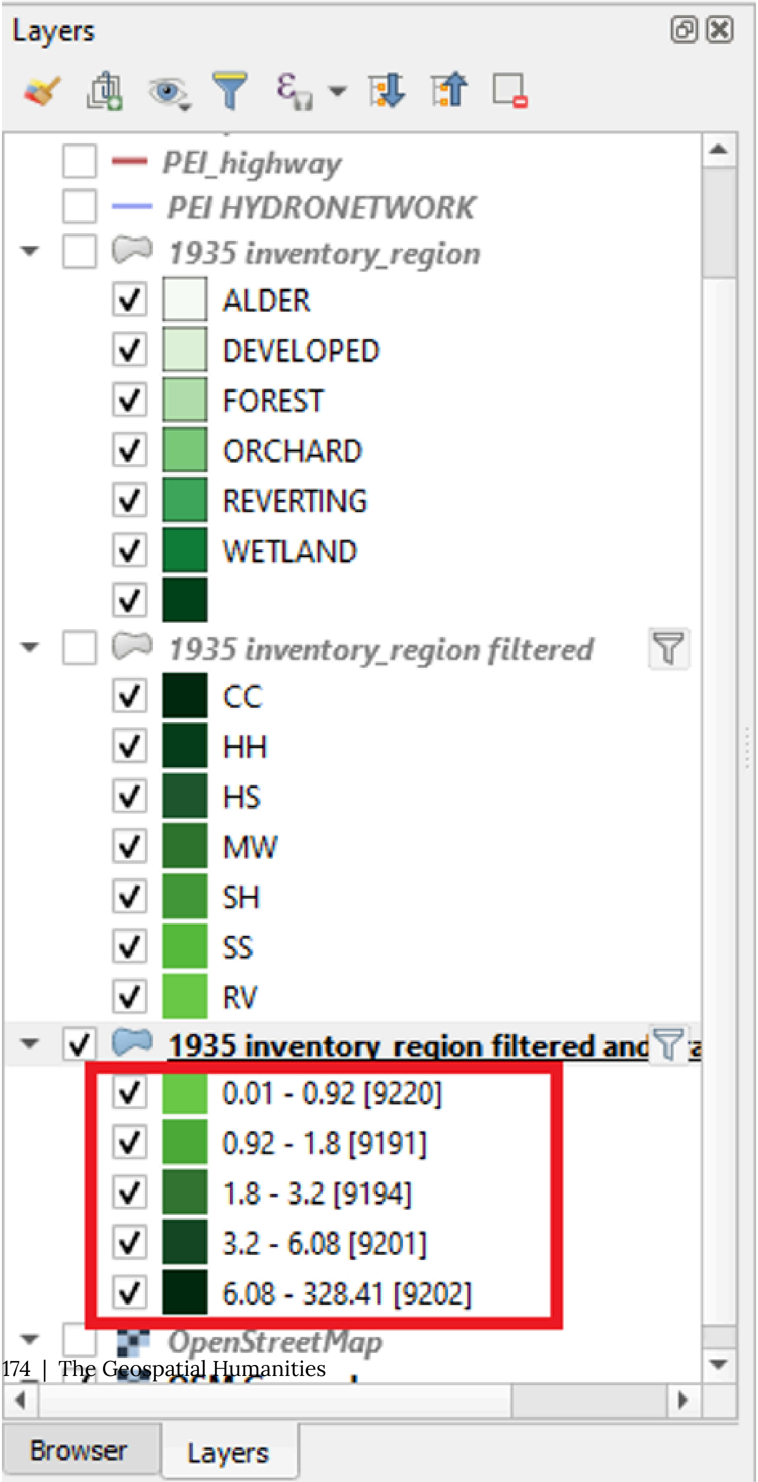

Layers
PEI_highway
PEI HYDRONETWORK
1935 inventory_region
ALDER
DEVELOPED
FOREST
ORCHARD
REVERTING
WETLAND
1935 inventory_region filtered
CC
HH
HS
MW
SH
SS
RV
1935 inventory_region filtered and
0.01 - 0.92 [9220]
0.92 - 1.8 [9191]
1.8 - 3.2 [9194]
3.2 - 6.08 [9201]
6.08 - 328.41 [9202]
OpenStreetMap
Browser
Layers

Figure 2.69

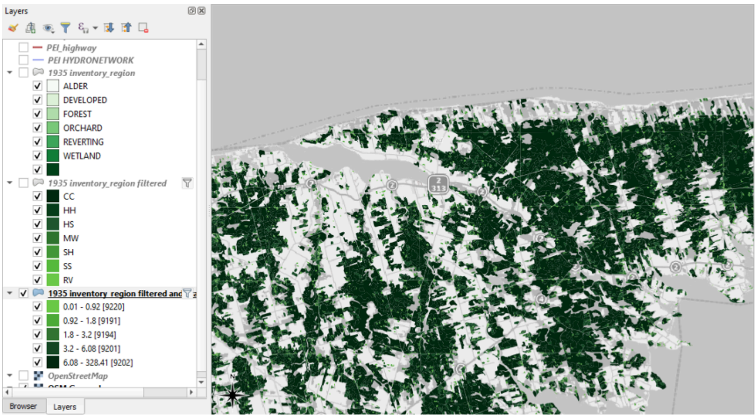


Figure 2.70

Equal Interval

This mode will break up the features so that each class covers an equal range. For example, each of the five classes of land use data would cover about 66 hectares. However, note that the number of features within each class differs greatly, unlike in the Equal Count mode. The second screenshot shows that selecting Equal Interval gives us sort of the opposite problem than the one we had with Equal Count. In this case, most of the map is light green, so it is difficult to discern the differences in the data.

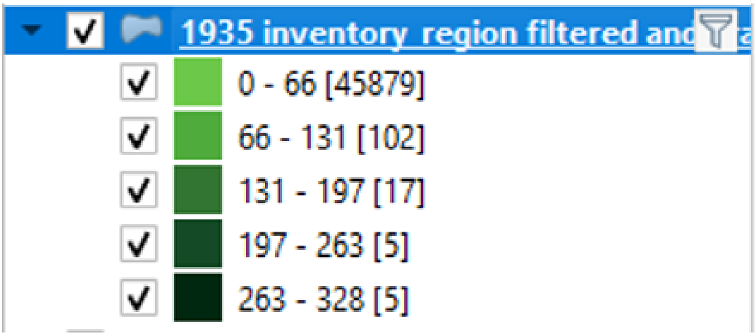


Figure 2.71

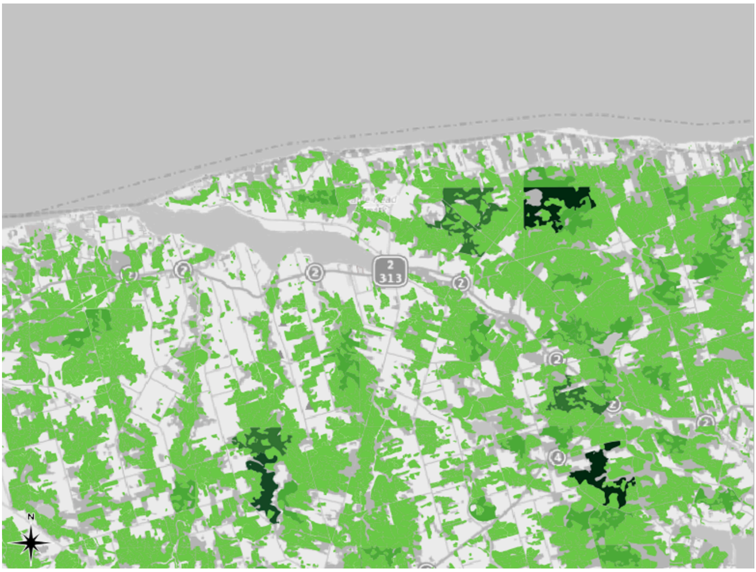


Figure 2.72

Logarithmic Scale

It may be most effective to use this mode when you have data containing a wide range of values. If you select the logarithmic scale in QGIS, each class will grow by a factor of 10. This mode may be a good option for our example, for the "Area" values in our Attribute Table are quite varied. The lowest value is 0.001 and the highest value is 1143.142, and there are many values that lie somewhere in between. We can confirm this by checking our histogram again. We see values spread out along its x-axis.

Figure 2.73

The screenshot from QGIS, below, shows that the Logarithmic Scale varies the colours of the map so that it is not a near-solid green, as it was when we selected the Equal Count mode. However, it is still somewhat difficult to discern the different shades of green.

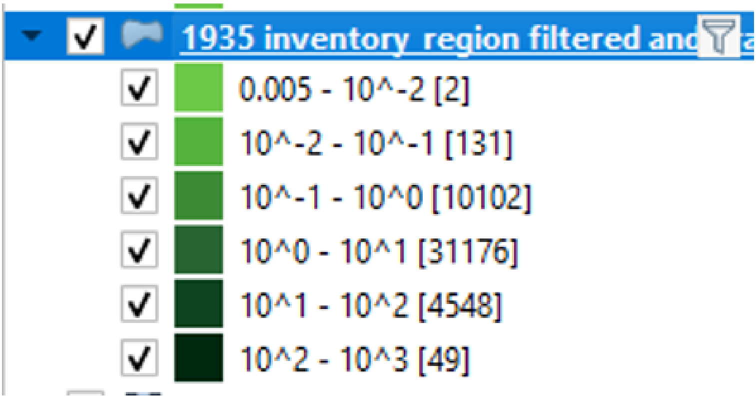


Figure 2.74

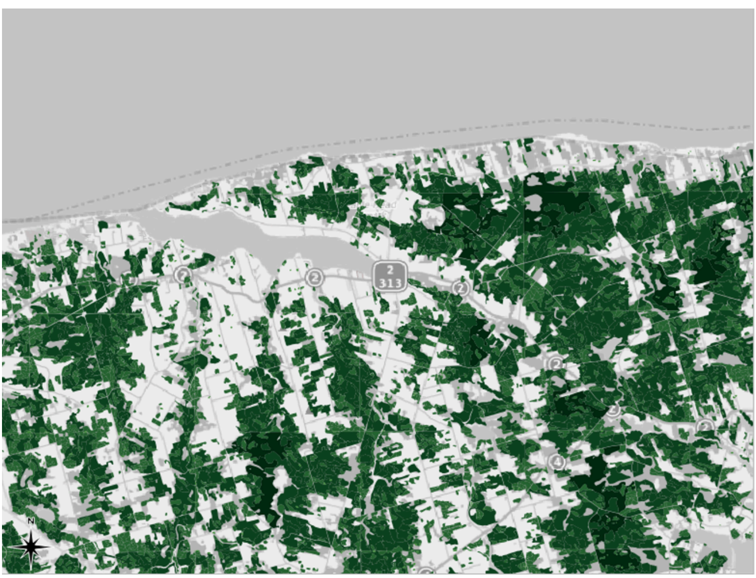


Figure 2.75

Natural Breaks (Jenks)

This mode will group the features into "natural" groupings. That is, this mode will create classes that group features that are most similar. As a result, the features within each class will be very similar to other features in the same class, while the differences among classes will be more pronounced. The following screenshot shows the results for our example.

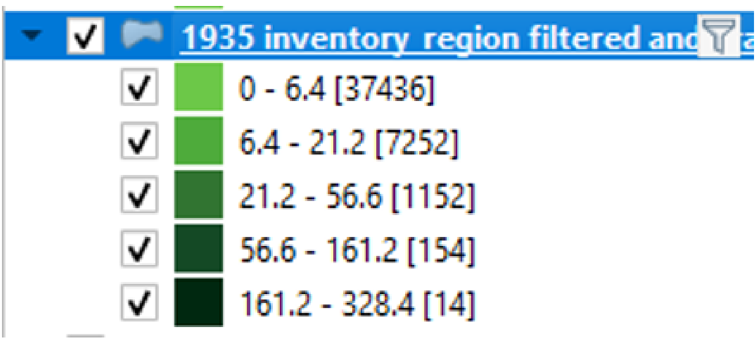


***Figure* 2.76**

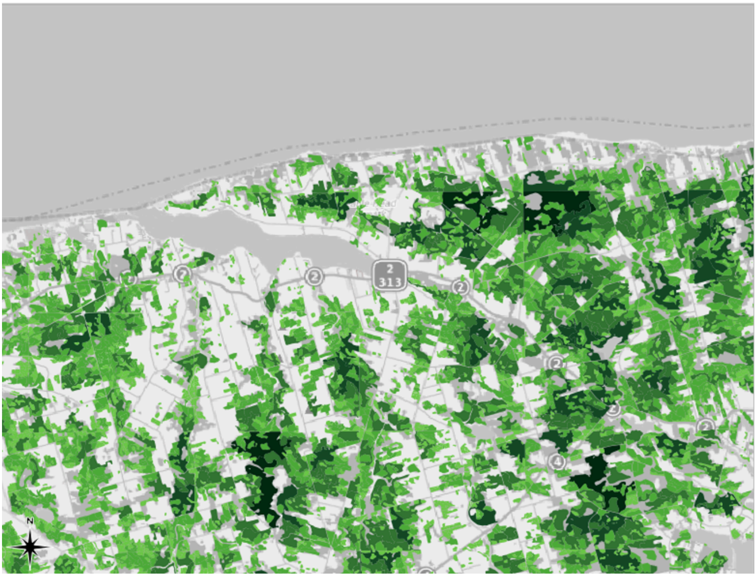


***Figure* 2.77**

There are benefits and drawbacks to using Natural Breaks. The map produced using this mode is perhaps the easiest to read. The map is neither too green nor too white, and there is better contrast than in the map produced using the Logarithmic Scale. However, the Natural Breaks option places the vast majority of our data in the first class, that is, the first one. The map presents this data as though it is all the same, yet, really, there are differences in the data within this class. We lose the ability to discern any differences in the data in this first class.

Pretty Breaks

The Pretty Breaks mode is complicated, but the "pretty" adjective in its name means that it will create classes with round numbers. In our example, it seems to augment the tendencies of Natural Breaks by placing even more data points in the first class.

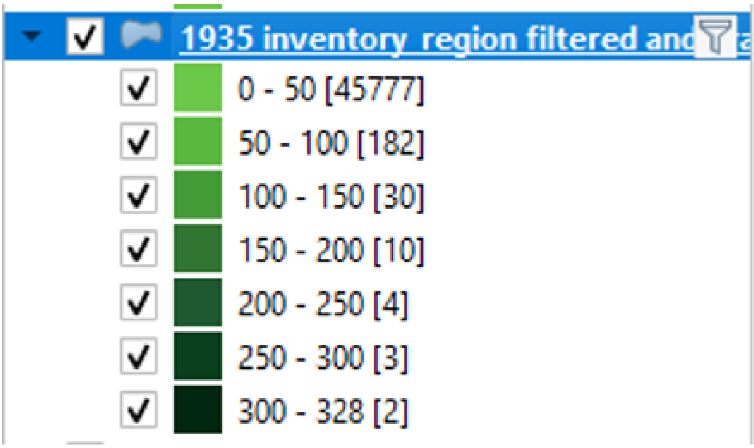


Figure 2.78

Figure 2.79

Standard Deviation

If you view your histogram and see that your data tends to conform to a bell curve, your best option may be to select the Standard Deviation classification mode. Here is our example with the Standard Deviation mode selected. Since our dataset looks nothing like a bell curve, this mode is not very useful to us.

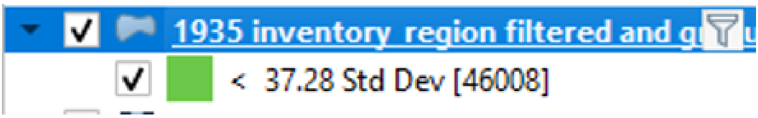


Figure 2.80

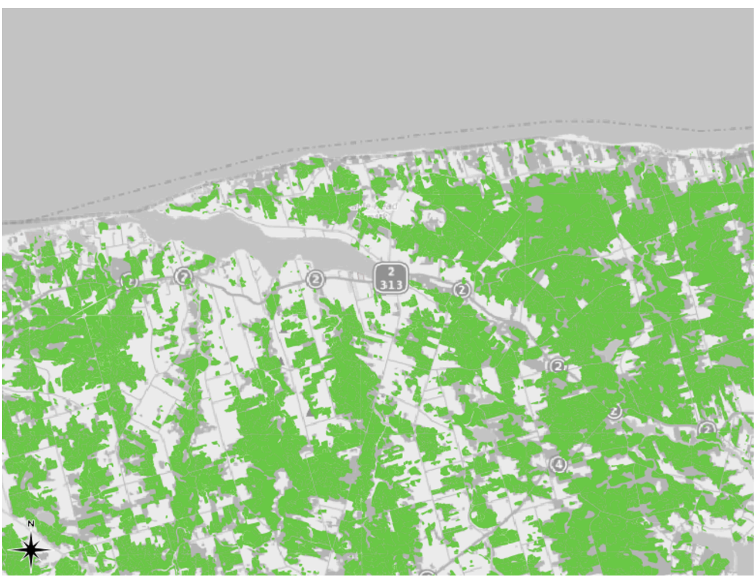


Figure 2.81

It is ultimately up to you to decide which mode of Graduated symbols to use. The logarithmic and Natural Breaks (Jenks) are perhaps the best options in this case. We recommend Natural Breaks. It allows us to put aside what one might call “insignificant” forested areas (i.e., those 6.4 hectares in size or less) in order to focus on the larger forested areas. This is especially important for readability, for there are seemingly countless small polygons representing forested areas of 6.4 hectares or less. Using Natural Breaks allows us to quickly see the largest continuous stands of uniform forest types that remained on the Island in 1935.

Since we started Part II by filtering our layer to include only features with either the FOREST or REVERTING land use attributes, we know that these are all different types of forest parcels. The graduated symology now allows us to identify the largest forest parcels with a quick glance at the chloropleth map.

As we had anticipated, the methodology of those who made the shapefile has resulted in a few inaccuracies with our symbolization. If we return to our example near Mount Stewart with the Natural Breaks symbology enabled, we can see that the western portion of the arbitrarily divided land parcel is large enough to belong within the fifth class, while the eastern portion belongs in the fourth class. In reality, both of them would have been part of the same continuous land parcel, which would have been over 400 hectares in size.

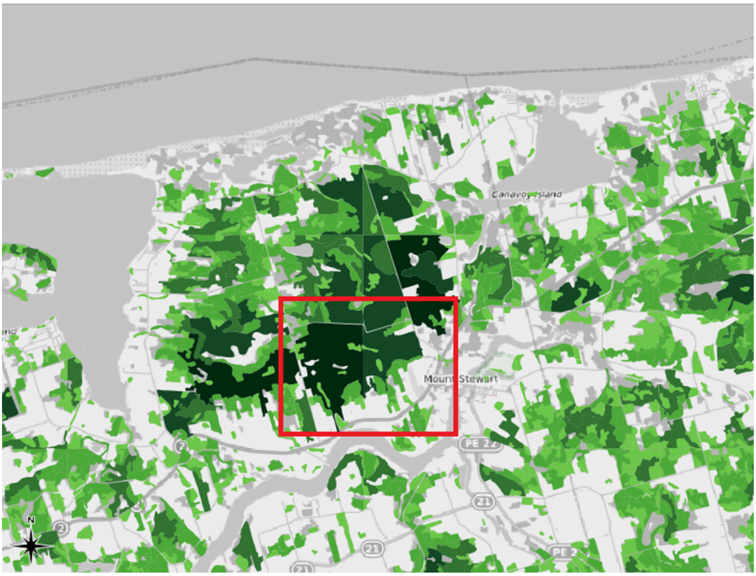


Figure 2.82

Without editing our shapefile to fix up these areas in which continuous land parcels were arbitrarily divided during the original mapmaking process, we can account for this map's limitations by adding an explanatory note in any publication in which this map appears.

Part II B: Labelling

Advanced Label Placement

In this section, our goal is to create a single map that shows both the AREA of the FOREST and REVERTING areas on the one hand and the LANDTYPE on the other. In effect, this one map will accomplish what it took two maps to accomplish earlier in this chapter. To do this, we will add labels to the Graduated map that we just made. However, since the labels in this layer are very dense, and the polygons on which we will place them are irregularly shaped, we are going to alter their positioning and rendering settings so that they are easy to read.

Activation: Turning On the 1935 Forest Map's Labels

- In the table of contents, right-click the layer called 1935 inventory region filtered and graduated.
- Click Properties
- Click Labels
- From the dropdown that initially says No Labels, select Single Labels.

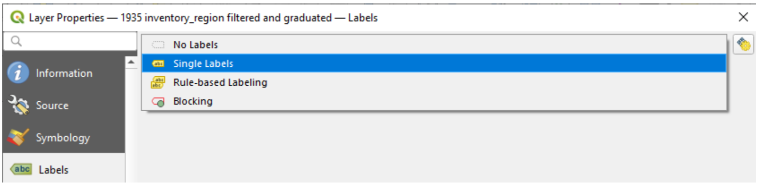


Figure 2.83

- In the dropdown menu next to Value, select LANDTYPE.

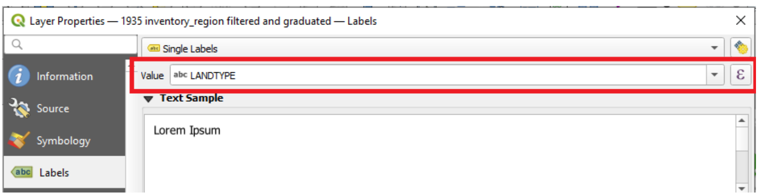


Figure 2.84

Formatting: Symbolizing the 1935 Forest Map's Labels

As in Chapter 1, we are going to alter the appearance of the map's labels so that they are clearer.

- Under the Text menu, change the text colour to white.

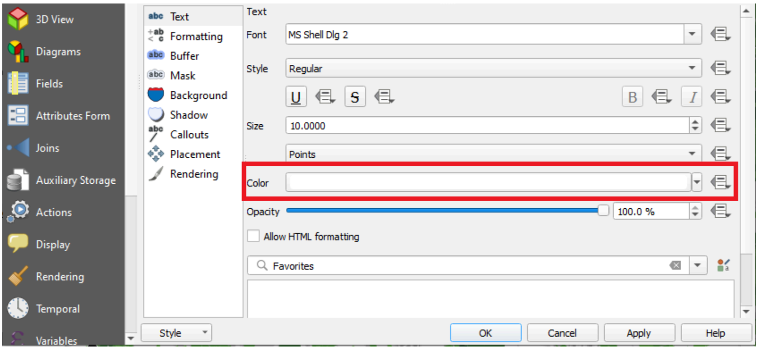


Figure 2.85

- Under the Buffer menu, check Draw text buffer and change its colour to black.

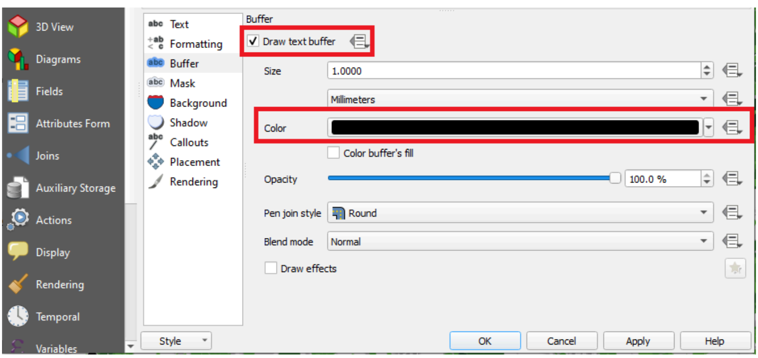


Figure 2.86

Placement: Adjusting the Placement of the 1935 Forest Map's Labels

In Chapter 1, we went with the default Placement Mode, which is called Around Centroid. This mode tries to centre the labels over the top of their corresponding polygons. This mode is fine for regularly shaped polygons. But, since the 1935 inventory region layer contains a dense array of irregularly shaped polygons, the Around Centroid mode may not allow us to easily interpret which label goes with which polygon. So, we will use a different mode, one called Free (Angled).

- In the Placement menu, click the Mode dropdown menu and select Free (Angled).
- Click OK.

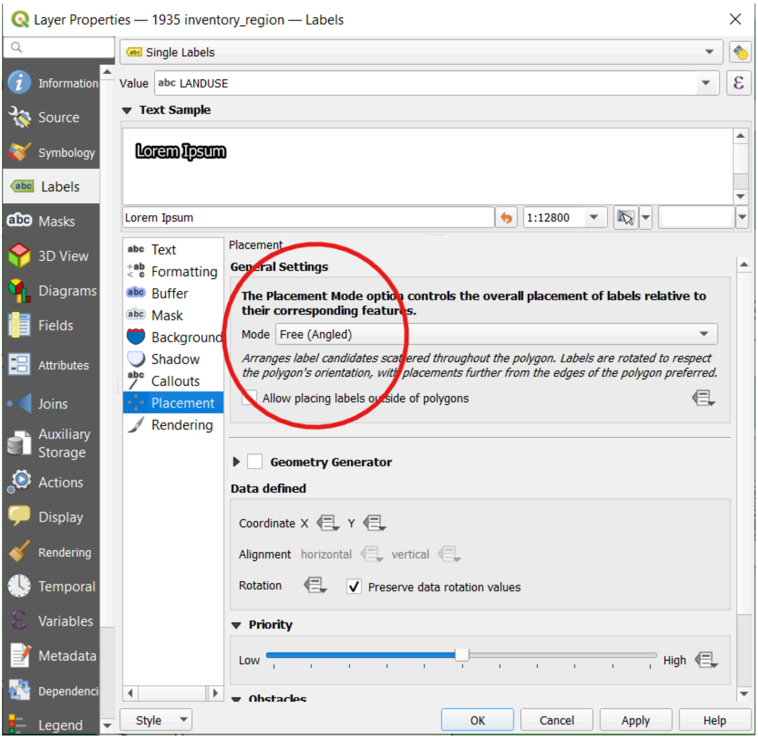


Figure 2.87

As in this example screenshot from northwest of Mount Stewart, you can see that the labels are now free to angle themselves so that they best fit within their corresponding polygons. This can make it easier to tell which label goes with which polygon.

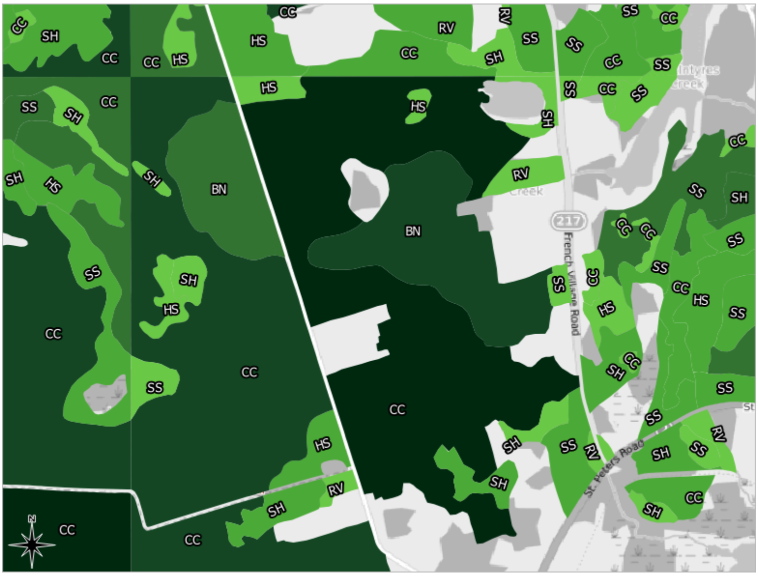


Figure 2.88

Scale Visibility: Rendering the 1935 Forest Map's Labels

In the 1935 inventory region layer, our polygons are dense, irregularly shaped, and often small. So, if we were to turn on labels and then zoom out to view the entire Island, the individual labels would become far too crowded, and they would not correspond to any particular feature on the map. As in the screenshot below, our map would be unreadable. (Moreover, if QGIS has to load all of our labels at all scales, it takes longer to load our map.)

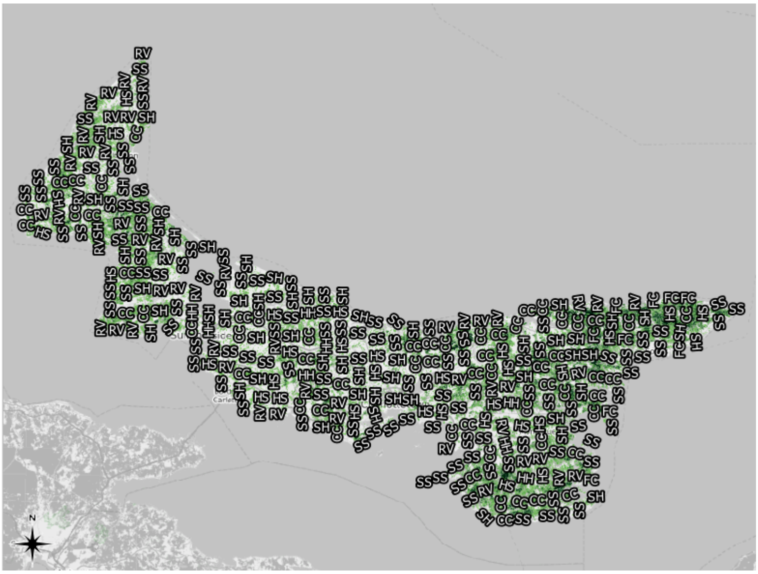


Figure 2.89

To fix this problem, we can tell QGIS to only show labels when we have zoomed in to a certain scale. At this scale, the labels will be readable. Then, when we zoom out, the labels disappear instead of becoming garbled and unintelligible.

- Return to the Labels menu in the Layer Properties window.
- In the Rendering menu, check the box next to Scale dependent visibility.
    - This means that our labels' visibility will be dependent on our map's scale.

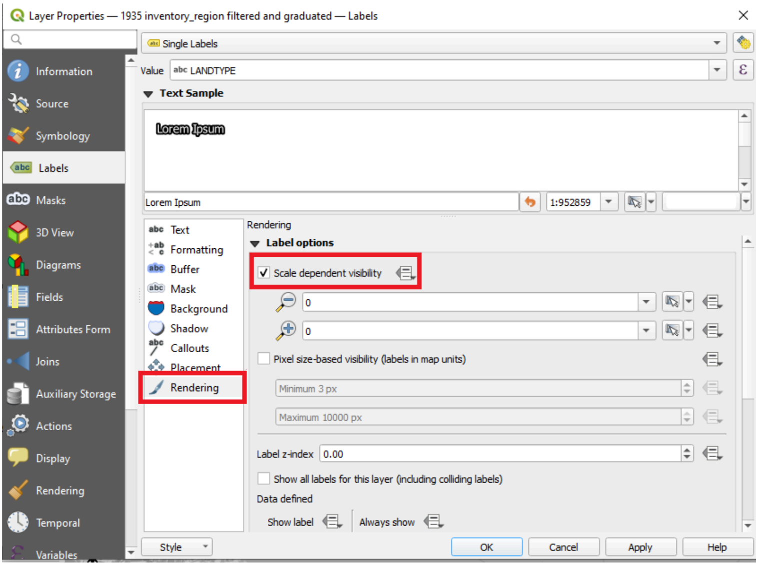


Figure 2.90

Under Scale dependent visibility, there are two boxes to fill out. Next to the first one is a magnifying glass encircling a minus sign. This box is where we set the Minimum Scale.

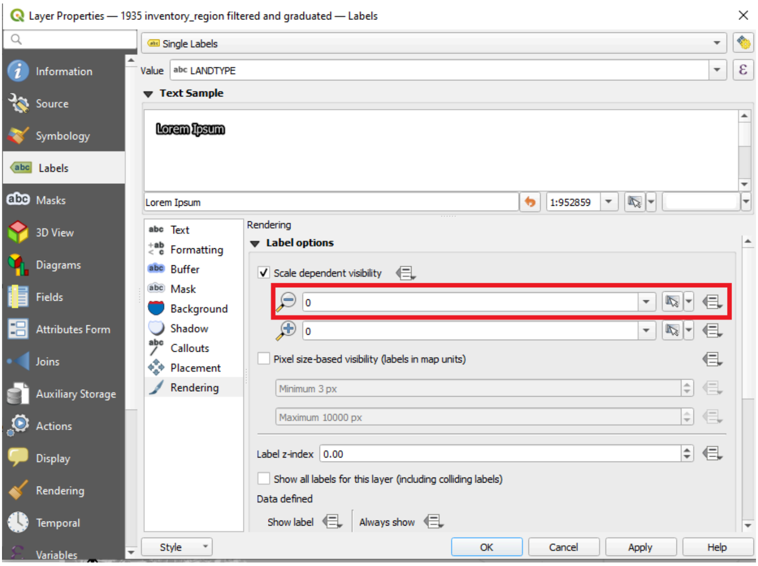


Figure 2.91

In this box, we want to enter the scale at which the labels begin to appear. If the user is at any scale that is smaller than the one that we set, the labels will not appear. So, for example, if we set the first box to 1:50000 and a user zooms to a scale of 1:60000, he or she will not see the labels. Once a user zooms into 1:50000 or beyond, the labels will appear.

The second box, the one featuring a plus sign, is where we set the Maximum Scale.

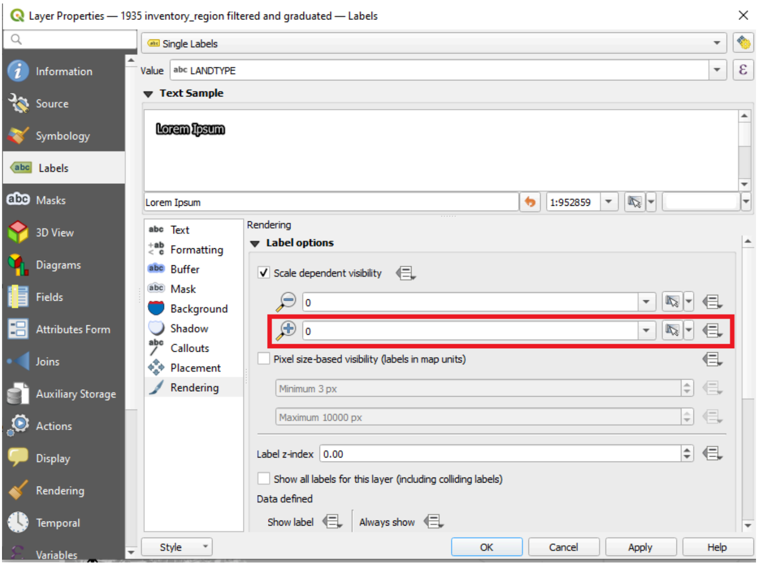


Figure 2.92

In this box, we will enter the scale at which the labels will disappear again. So, let's say that we set the second box to 1:250. If a user zooms to a scale of 1:100, the labels will not be visible.

Used together, the two boxes allow us to define the scales between which a user will be able to see the labels.

- Set the Minimum Scale to 1:50000.
- Set the Maximum Scale to 1:250.

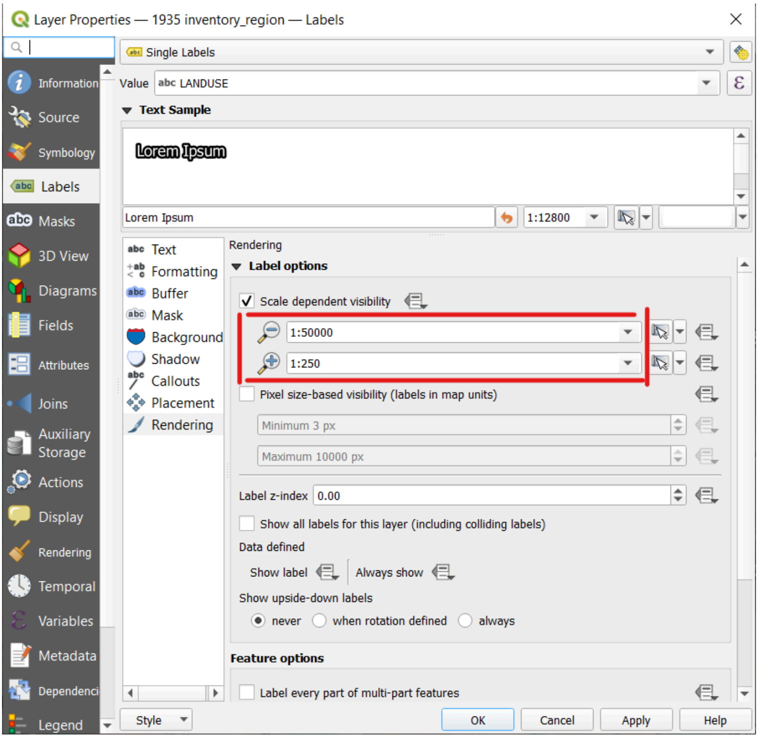


Figure 2.93

Now, when we view the entire Island, we do not see any labels because our scale is too small.

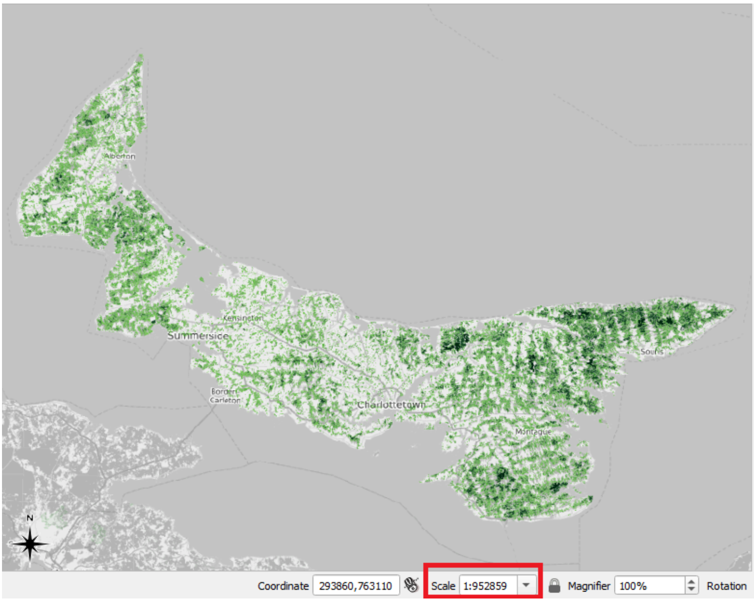


Figure 2.94

Here is the another screenshot of the area around Mount Stewart. Note that the labels are visible because we are at a scale of 1:49000, which lies between the Minimum and Maximum Scales that we set in the Rendering menu.

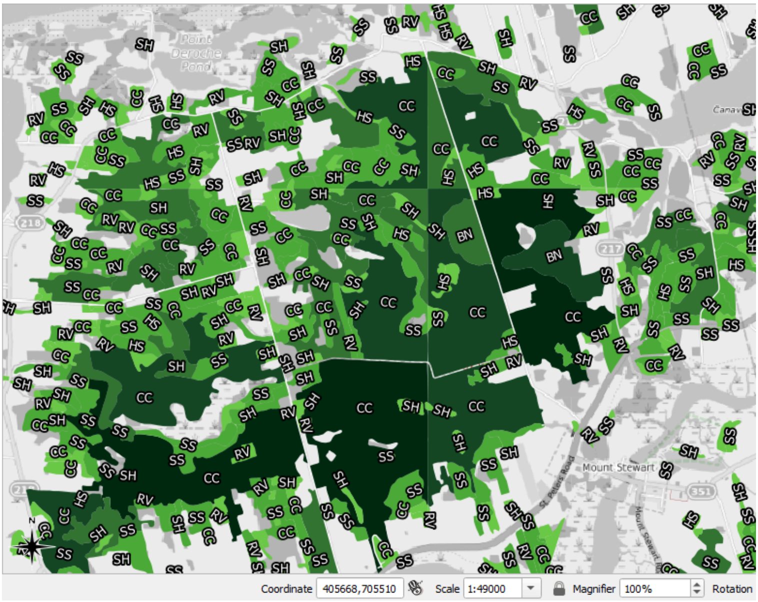


Figure 2.95

We have just learned how to use labels and colouring together to tell two aspects of PEI's forestry story at the same time. Now, we can look at our map and understand two things about the forest environment in 1935: the colour of a polygon tells us the size of a continuous forest stand, and the label of a polygon tells us the type of forest cover that it was.

We can use the map we just produced to continue our assessment of land use in PEI in 1935. Which land use type is most often associated with the darkest colour? It appears as though most of the darkest green areas of the map have a LANDTYPE code of CC or SS, or "clear cut" and "mostly softwood," respectively. Keep in mind that softwoods are usually the first type of tree to grow back in a cleared area once it starts to become a forest again. Thus, the results of our map suggest that a great deal of the trees in this part of PEI had either been recently harvested or they had been harvested earlier and had regrown by 1935. In the 1935 inventory region map, most of these large blocks appear as either “clear cut” or “mostly softwood.”

Attributes for Feature Labels

In Chapter 1, we covered how to turn on labels in the PEI_placenames layer and symbolize them. But there are only a few placenames included in this layer. We will create labels for more communities in PEI in this step. Labelling more Island communities will give our audience added context when they are reading our map.

Some of the communities for which we will create labels, such as Kensington and O’Leary, only emerged once PEI’s interior had been sufficiently cleared of trees.

Adding New Point Features for Labels

Before we can add new labels to the PEI_placenames layer, we must first check this layer’s attribute table in order to know which attributes we can assign to the newly created labels.

- Right-click the PEI_placenames layer in the table of contents.
- Click Open Attribute Table

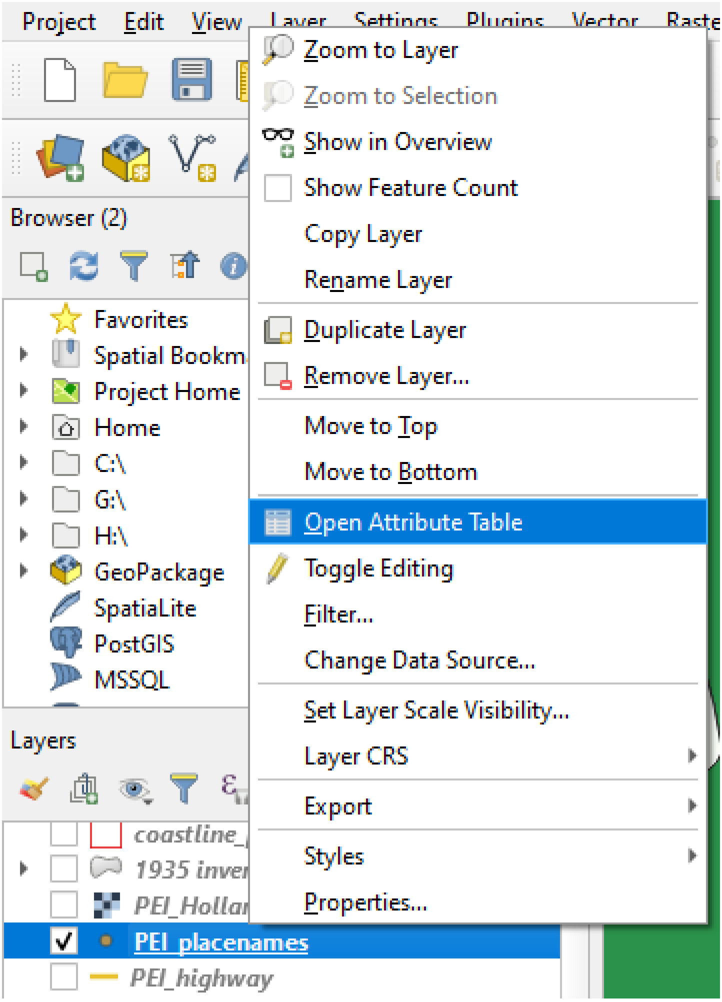


Figure 2.96

The Attribute Table appears.

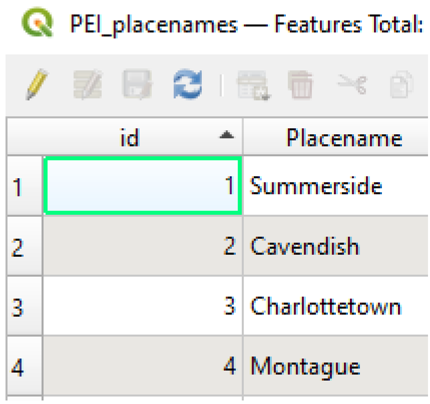


Figure 2.97

In the attribute table, we see that there are four rows of data corresponding to the four places for which a label has already been created. Each place has to have its own unique ID. If we wish to add a fifth label, we would give it an ID number of 5 alongside its name, for the numbers 1through 4 have already been used.

Now that we have checked the attribute table, we can proceed to create some new labels.

- For now, turn off the 1935 inventory region filtered and graduated map.
    - We will use the OpenStreetMap base map as a guide for adding new labels. We can use either the regular one or the black-and-white one.
- Right-click the PEI_placenames layer in the table of contents.
- Click Toggle Editing

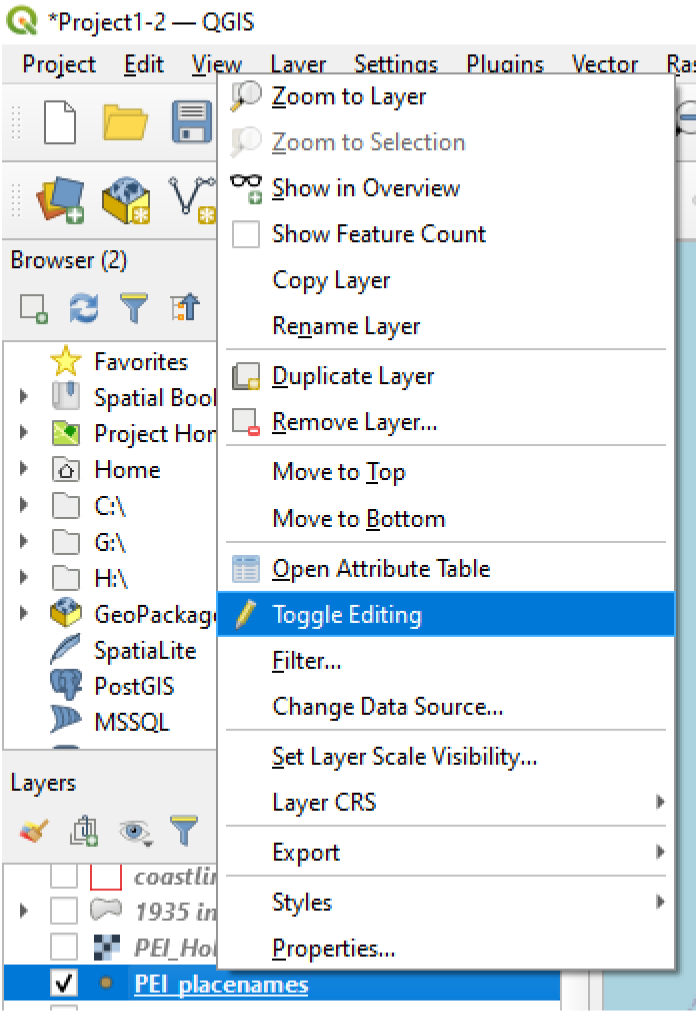


Figure 2.98

- Click on Add Point Feature

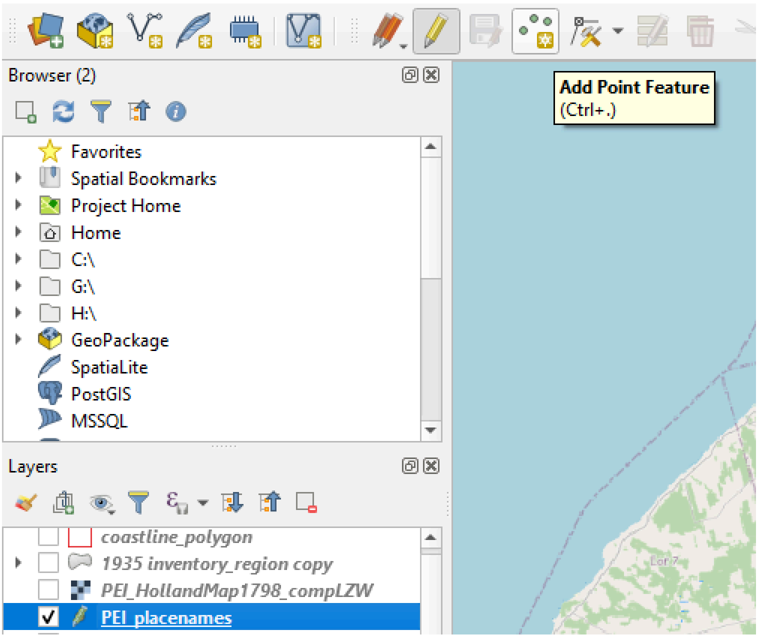


Figure 2.99

- Pan the OpenStreetMap base map to western PEI.
- Click on Alberton to place a point there. (See the screenshot below for its general location.)

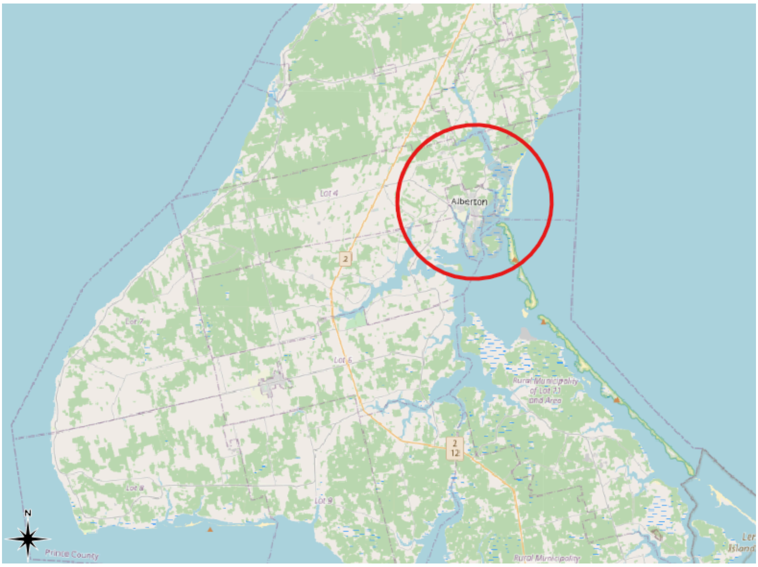


Figure 2.100

After you click to place a label, you will see the following dialogue box:

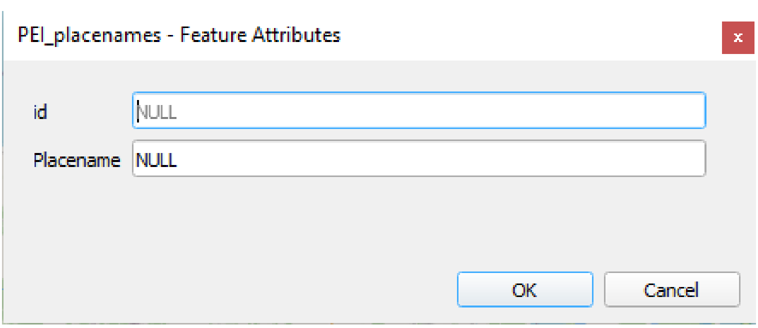


Figure 2.101

- In the ID field, enter 5.

- In the Placename field, enter Alberton.
- Click OK.

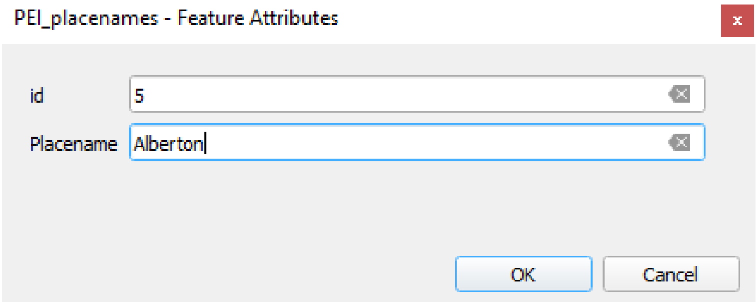


Figure 2.102

Alberton will now be labelled on the map:

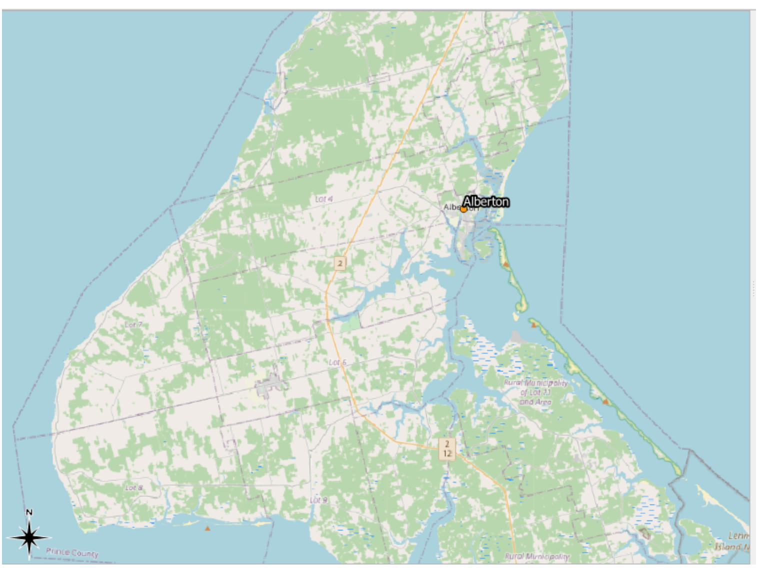


Figure 2.103

- Using the same process, add a label for the town of O'Leary. (See the screenshot below for its general location.)
  - Make sure to provide O'Leary with an ID value of 6.

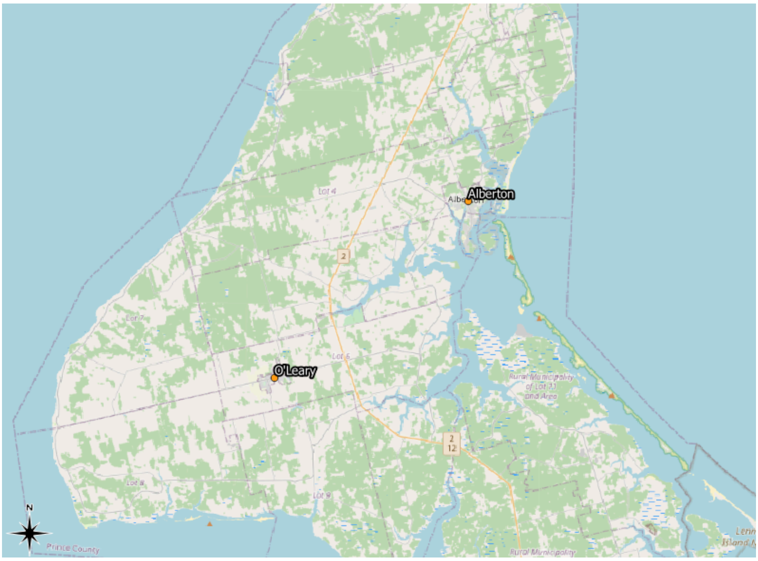


Figure 2.104

- Pan to central PEI and create labels for Kensington, Borden-Carleton, and Hunter River.
  - Make sure to give them the IDs of 7, 8, and 9, respectively.

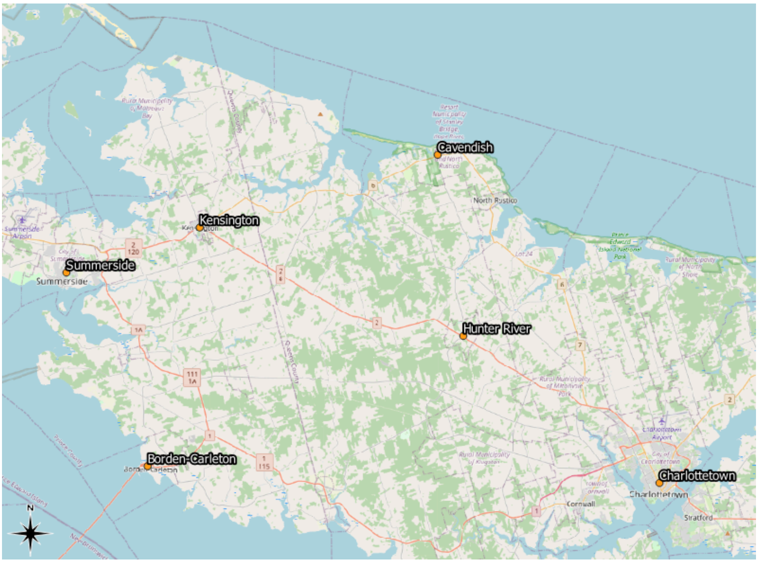


Figure 2.105

- Pan to eastern PEI and create labels for Souris, Georgetown, and Wood Islands. (See the screenshot below for their general locations.)
  - Make sure to give them the IDs of 10, 11, and 12, respectively.

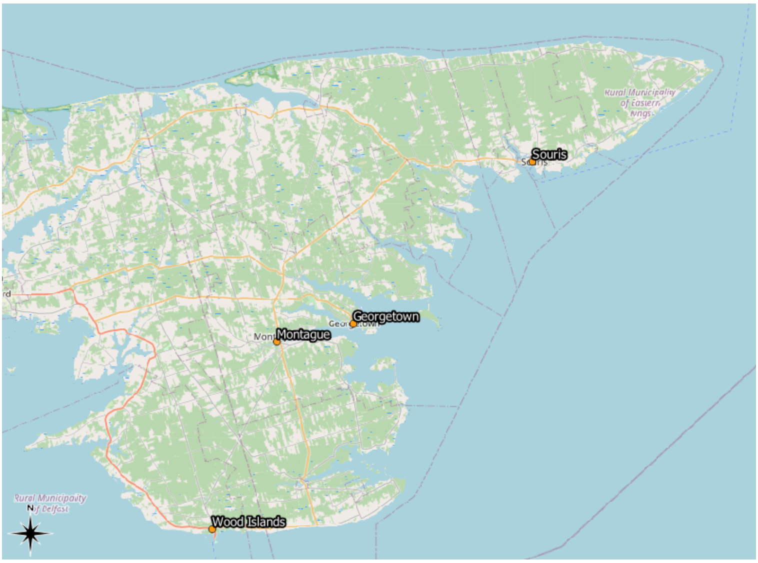


Figure 2.106

Now that we are done adding more labels,

- Click the Save Layer Edits button.

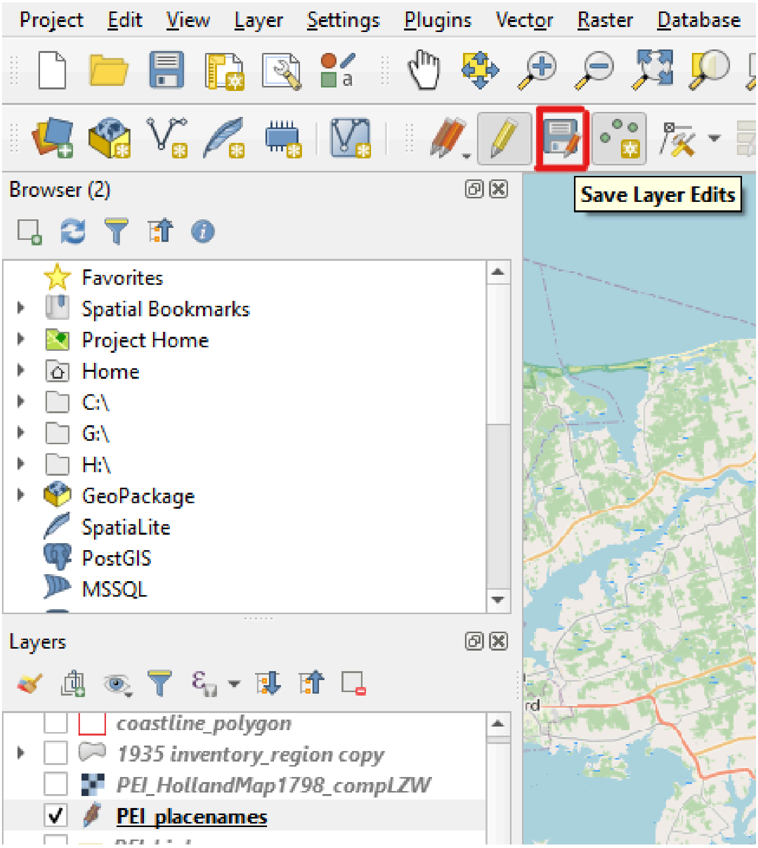


Figure 2.107

- In the table of contents, right-click the PEI_placenames layer and click Toggle Editing.
    - This turns off the editing mode.

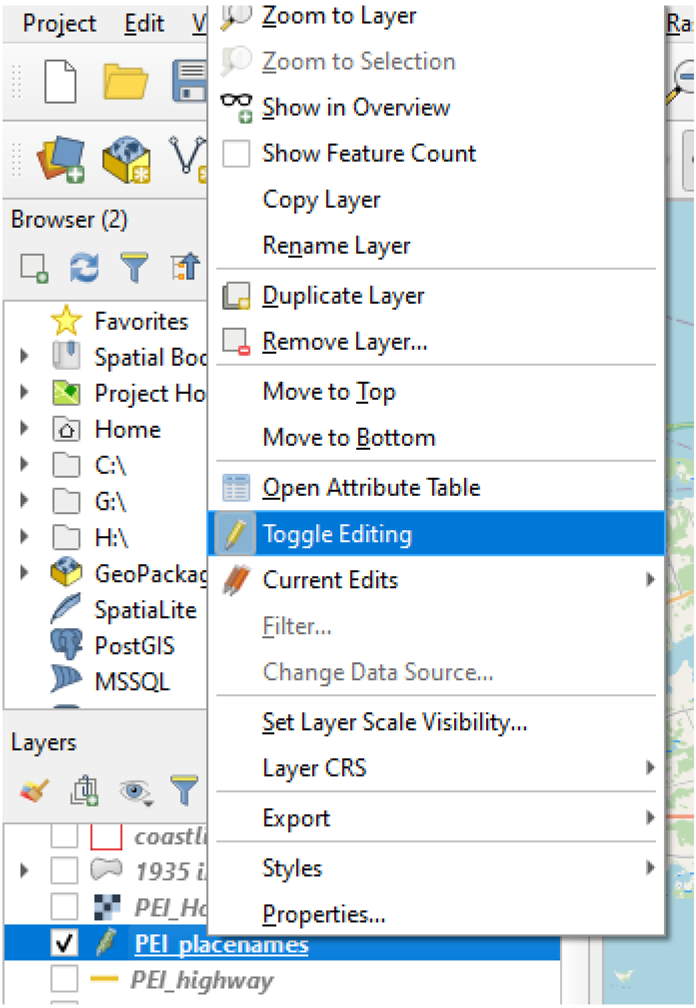


Figure 2.108

- In the table of contents, turn on the 1935 inventory region filtered and graduated layer again.

Part II C: Reusing Layer Styles

After we have customized our layer's symbology and labels, there are a few ways in which we can reuse this styling. Reusing styles is useful for a couple of reasons. First, when we add a shapefile to QGIS, it will not show any symbology; we have to spend time designing its symbology. So, reusing our symbology allows us to quickly symbolize a newly added layer without having to spend time in the layer's Properties menu. Second, a key point of cartography is honesty in presentation of map data. Cartographers strive to present their map data as honestly and accurately as possible. By reusing styles across a series of maps, a cartographer can provide the necessary consistency for telling an honest story with his or her maps.

For example, let's say that we not only had a shapefile containing forestry data for PEI for 1935 but also shapefiles containing forestry data for PEI in 1955, 1975, and 1995. Provided that the shapefiles were all polygons and all had exactly the same headers in their attribute tables, we could apply the same Graduated symbology style we created for the 1935 layer to the others. All of the layers would thus have the same class breaks and colour scheme, making for easy and accurate comparisons across each of the time points. As a bonus, we could also copy our labels to the other layers.

Copying a Style

Since we do not have the hypothetical forestry layers mentioned above, let's say that you would like to copy the styling that we created for the 1935 inventory region layer in this chapter's project file to the same layer in Chapter 1's project file. To quickly do so:

- Make sure that both projects are open. That is, make sure that you have two different windows of QGIS open, one with Chapter 1's project file and one with Chapter 2's project file.
    - On Windows, one good way to open two instances of QGIS is to have one QGIS window open, right-click the QGIS button in the Taskbar, and then click QGIS Desktop. A second instance of QGIS will open, and you can click Project and then Open to open another project, such as Project1.
    - On a Mac, it is more difficult to have two projects open at once. However, you can still copy a layer and then open a different project (note that this will close your other project) and paste that layer into the Layers panel.

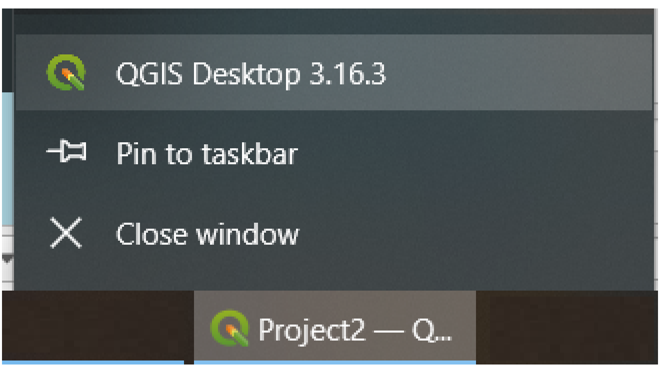


Figure 2.109

- In the QGIS window containing the project that features the layer whose style you would like to copy, right-click this layer and click Styles, and then Copy Styles, and then All Style Categories.

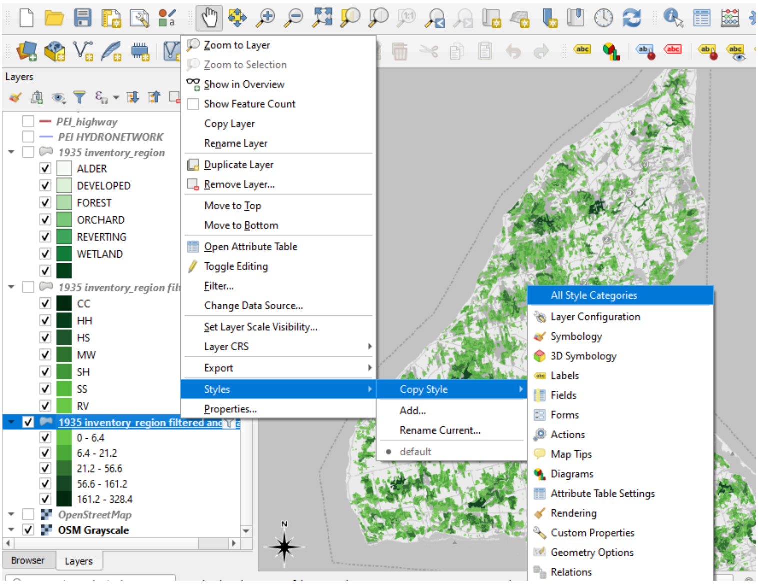


Figure 2.110

- In the QGIS window containing the project that features the layer onto which you would like to copy the style, right-click this layer and click Styles, and then Paste Style, and then All Style Categories.

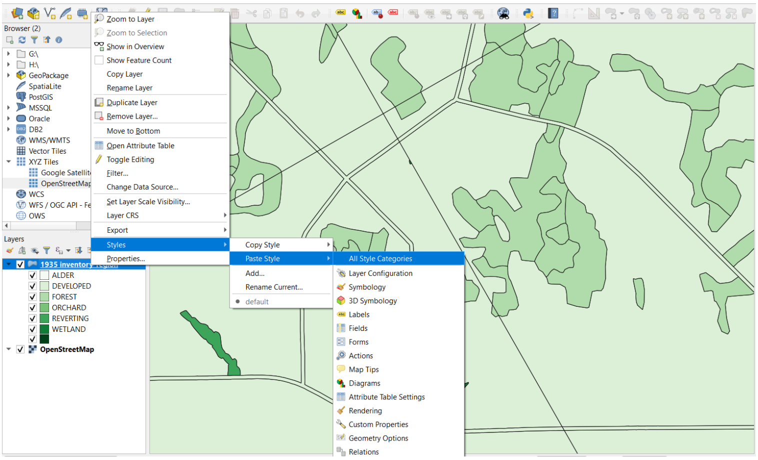


Figure 2.111

Here is the result of the paste:

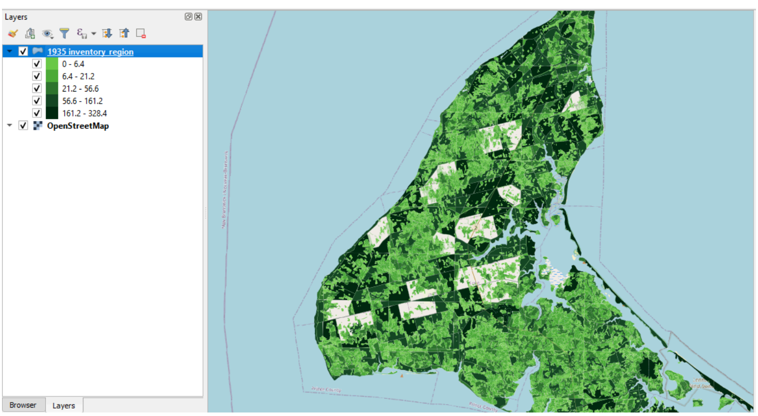


Figure 2.112

Note: when you copy and paste styles between layers in QGIS, it does not copy your filter settings.

Note: you can only copy and paste styles between layers in QGIS. It will not work between QGIS and another GIS application, such as ArcGIS Pro.

Note: if you copy a style, please note that you must apply the style to the same layer (perhaps in a different project file) or to a layer that has the same structure. A different layer of the same structure would be one that is of the same geometry type (i.e., points, lines, or polygons) and that has the same attribute that was originally used for symbolization.

Saving a Style

The process outlined above for copying a style is effective for times when you only need to copy a style once and quickly paste it onto another layer. However, if you wish to save your style permanently, you have a few options.

Saving a QGIS Style File (.qml)

A QGIS Style File (.qml) offers much of the same functionality as the process of copying and pasting symbology, but it allows you to permanently save this symbology instead of temporarily storing it on your clipboard. It also allows you to have a layer's symbology load automatically when the layer is added to a project.

To save a QGIS Style File:

- In the table of contents, right-click the layer whose style you would like to save.
- Click Properties…
- Click Information.
- At the bottom of the Information window, click Style and then Save Style…

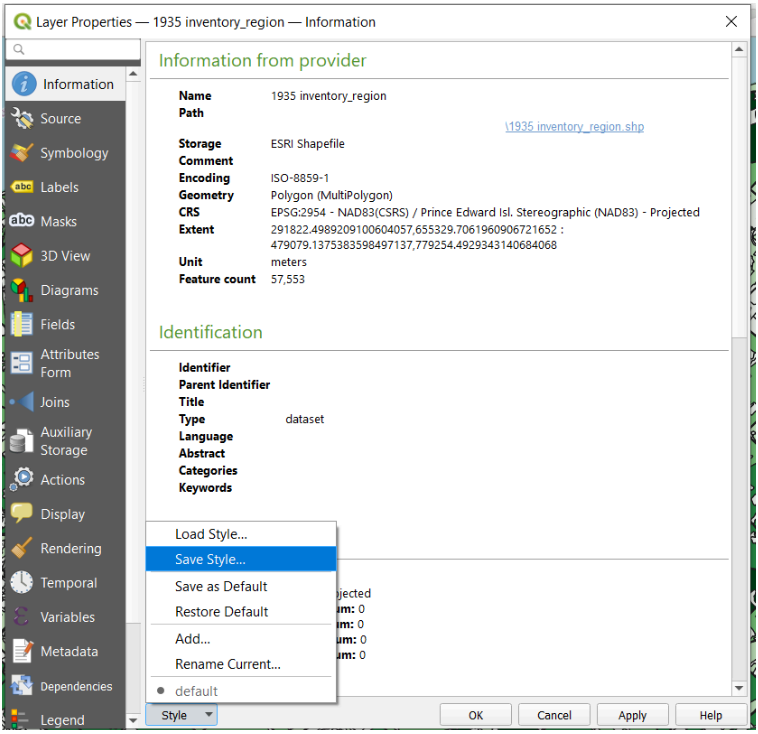


Figure 2.113

- Click Browse

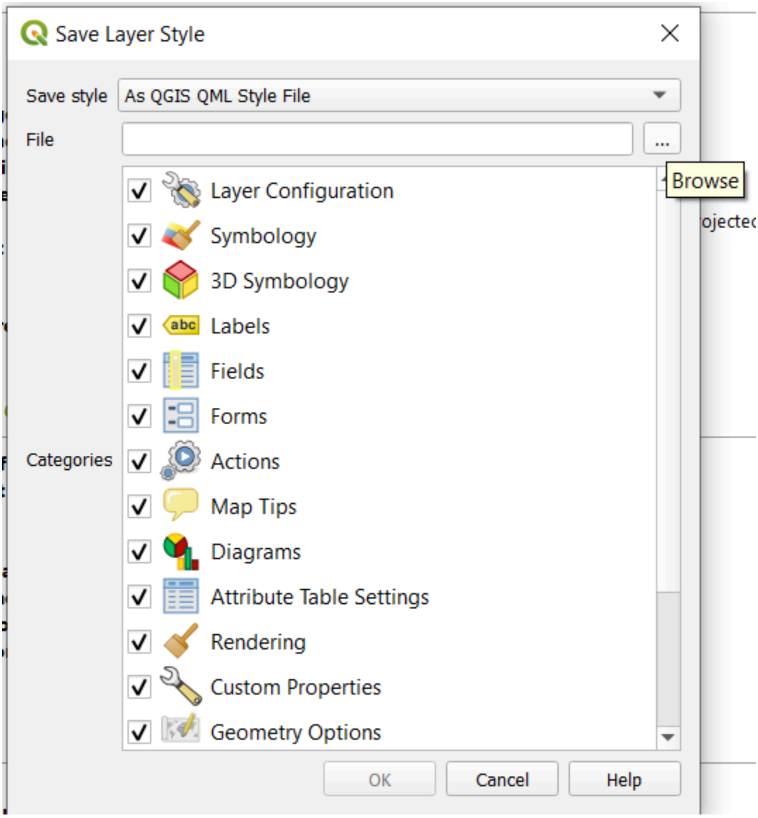


Figure 2.114

- Navigate to the folder in which the layer from which we are saving the style (i.e., the original layer) is stored. In this case, navigate to the folder called Project1\Data\forest_35.SHP.
  - If you need a reminder as to its location, check the "Path" field in the Information window.
- Next to File name, type in the name of the shapefile associated with this style file. We want the original shapefile and the QGIS Style File to have the same name.
  - Although the two files will have the same name, their

extensions will differ. The shapefile will be called 1935 inventory_region.shp while its corresponding QGIS Style File will have the name 1935 inventory_region.qml.

- Click Save

If you open a new project and add the 1935 inventory_region shapefile from the forest_35.SHP folder, it will be automatically symbolized according to the settings stored in the QGIS Style File that we just saved. This is done automatically because the shapefile and QGIS Style Files were stored in the same folder and were given the same name.

Here, we added the shapefile from the forest_35.SHP folder, and QGIS automatically loaded the corresponding QGIS Style File.

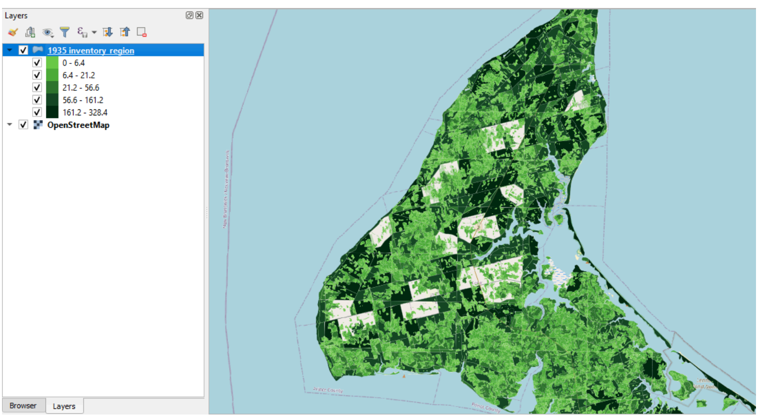


Figure 2.115

> **Note:** your filter settings will not be stored in a QGIS Layer Style File.

If you do not save a shapefile and its corresponding QGIS Style File in the same location, QGIS will not automatically symbolize the shapefile. However, you can manually apply the QGIS Style File to the shapefile.

- In the table of contents, right-click the layer to which you would like to apply the symbology.
- Click Properties
- Click Information
- At the bottom of the window, click Load Style…
- Click Browse
- Navigate to the location where you saved your QGIS Style File and double-click it.
- Click Load Style

Note: If you save a QGIS Layer Style File, please note that you must apply the style to the same layer (perhaps in a different project file) or to a layer that has the same structure. A different layer of the same structure would be one that is of the same geometry type (i.e., points, lines, or polygons) and that has the same attribute that was originally used for symbolization.

Saving a QGIS Layer Definition File (.qlr)

If you would like to create a new file that includes the shapefile and its symbolization, you can export the styled shapefile as a QGIS

Layer Definition File (.qlr). When you add this file to a project, its style settings will automatically appear.

The key difference between a QGIS Layer Definition File and a QGIS Style File is that you can only use a Style File in conjunction with its corresponding shapefile. On the other hand, a Layer Definition File contains both the shapefile and its symbolization settings. QGIS treats it as a map layer unto itself.

To save a QGIS Layer Definition File,

- In the table of contents, right-click the layer whose style you would like to save into a new QGIS Layer Definition File.
- Click Export
- Click Save as Layer Definition File…

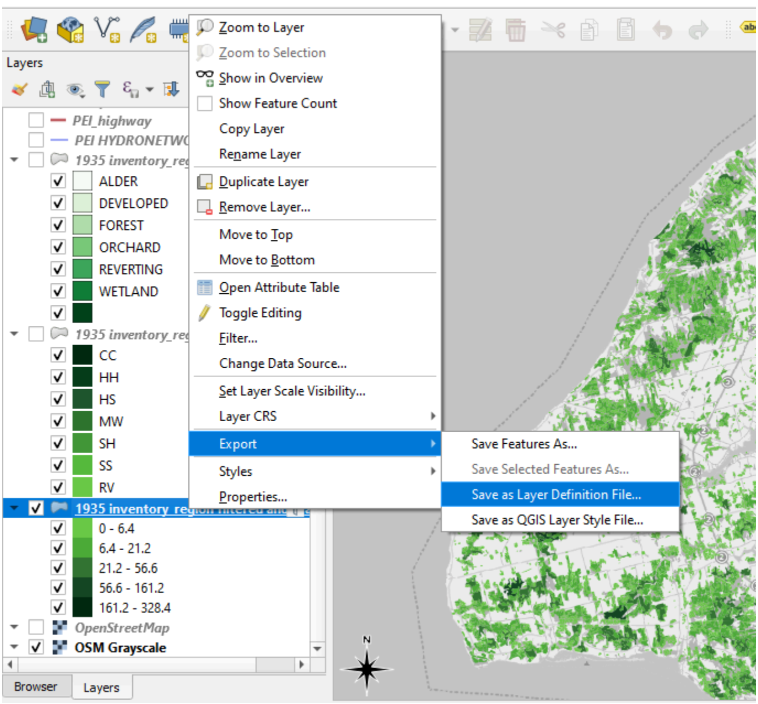


Figure 2.116

- Save the file in an appropriate location, perhaps in a folder alongside any other data you are using for a project.

To load a QGIS Layer Definition File,

- Using the Browser pane, navigate to the location where you saved your QGIS Layer Definition File.
- Double-click the QGIS Layer Definition File to load it into your project.

Here, we saved the 1935 inventory region shapefile that we symbolized earlier in the chapter as a QGIS Layer Definition File and then loaded it into a new, blank project. Note that the symbolization settings and our filter have been retained without having to replicate them manually.

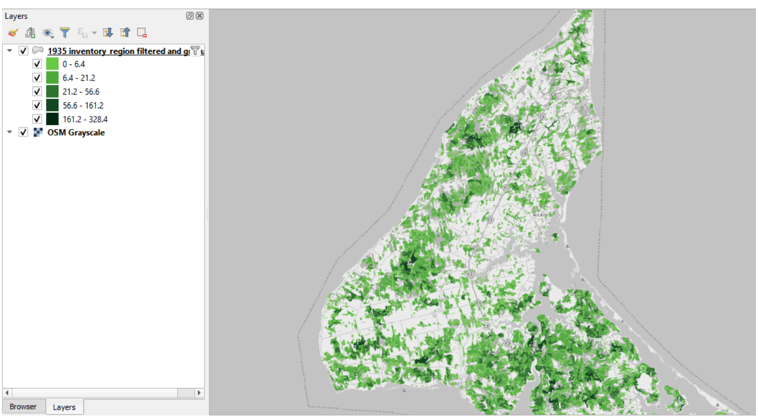


Figure 2.117

Note also that the QGIS Layer Definition File has the same attributes as the original shapefile from which it was created. You can verify this by opening the QGIS Layer Definition File's attribute table.

Note: a QGIS Layer Definition File can only be created and reused in QGIS. It cannot be added to another GIS application, such as ArcGIS Pro.

Watch for a future chapter on Creating and Sharing a GeoPackage for information on how to save styles within a GeoPackage.

Conclusion to Chapter 2

In this chapter, you have learned how to copy a project and practice good data management. You have also learned how to symbolize and label your maps in more complex ways in order to tell more aspects of a story through your cartography. Finally, you have learned how to reuse much of the work you have done with symbology and labelling. With this knowledge, you could extend the story you tell by creating a series of maps.

Throughout the first two chapters, we have used our mapping skills to learn about how European settlement on PEI impacted its existing forests. In the next couple of chapters, our attention will turn to urban history as we explore a project of European settlement on PEI that has foundered in the last century: the town of Georgetown.

SECTION III

CHAPTER 3: GEOREFERENCING IN QGIS

Getting Started

Overview: What Is Georeferencing?

This chapter will teach you how to work with georeferenced maps in QGIS, and it will also teach you how to georeference your own digital copies of historical maps in QGIS.

Georeferencing is a digital mapping process that involves importing a digital copy of a map (usually acquired by scanning a physical map) into the GIS software. That map is then pinned to its correct location on the globe in our GIS. This allows us to use the historical map as a basemap or other layer in reference maps, or we can extract historical information from the digitized map as new vector layers. We may then analyze and symbolize the features in those new layers, or we may simply compare them visually with information from other sources. Historians sometimes use georeferencing to digitize a single feature from a historical map and discard the other features that are not relevant for their research. We may then overlay select features from multiple maps and avoid all of the "noise" that would result from having those maps overlaid in a series of semi-transparent images.

Once a map has been georeferenced, it can be saved as a raster. Raster data is one type of data in GIS. It is a digital image of a map that we have assigned with real-world geographic coordinates through the process of georeferencing.

By saving a map as a raster, we permanently embedding those coordinates to that digital image. So, if you were to open the raster in another GIS project or program, the image would appear in its proper location on the globe in that GIS. In brief, when we georeference, we are anchoring an otherwise positionless digital image to a specific location on our GIS' globe. Once we have georeferenced a map in our GIS, we can analyze and display it in a variety of ways.

Two Streams

This chapter is divided into Stream A and Stream B. You can choose to complete either or both parts. In Stream A, we will download a digital image of a historical map of eastern Prince Edward Island from 1991. This digital map has already been georeferenced and anchored to its correct location in a GIS. So, when we import it into our GIS, it will automatically appear in its proper location on our GIS's globe.

In Stream B, we will then teach you how to georeference a different map of the same area. We will use a scanned image of an 1880 map of Georgetown, PEI. We will assign accurate coordinates to the 1880 map by digitally aligning its geographic features with those of our GIS' globe. Once this georeferencing process is complete, we will be able to analyze the resulting raster.

Any data that we can gain from this raster of Georgetown, such as the number of houses in town in 1880, would be considered vector data. Because vector data is based on georeferenced rasters, users must, as we will in this lesson, turn a digital image of a map into a raster before they may create any vector data from it. We will show you how to create vector data from both the 1991 map and your newly georeferenced 1880 map in Chapter 4: Digitization.

Example Exercises: Two Historical Maps of PEI's Georgetown, "The Town That Time Forgot"

The focus of this chapter is on eastern PEI, in general, and on Georgetown, in particular. Those users who choose to complete both Stream A and B will have the added bonus of getting to analyze this interesting town at two time points: 1880 and 1991.

If you will recall, Samuel Holland was the eighteenth-century British surveyor whom we met in earlier chapters. When he created his map of Prince Edward Island in 1765, he divided the Island into 67 lots. Each lot was about 20,000 acres in size. He then separated these lots into three counties of about 500,000 acres each: Kings County, Queens County, and Prince County. We saw a version of his map of PEI at the end of Chapter 1.

Holland planned one town in each county that he thought would serve as the capital of that county. These capital towns were in areas that Holland thought would be ideal locations for settlement and commerce. He named the counties after the British Royal Family, and he named each county's capital town after a member of the Royal Family. The British king at the time was George III, so Holland named the capital town of Kings County Georgetown. George III's son and heir, the Prince of Wales, was also named George. So, to avoid confusion, Holland gave Prince County's capital city the comparatively generic name of Princetown. Holland honoured George III's wife, Queen Charlotte, by naming Queens County's capital town Charlottetown.

As it turns out, Charlottetown has become the greatest success of the three towns that Holland planned. Now the Island's provincial capital, Charlottetown has an excellent natural harbour. It also lies at the mouths of the North and Hillsborough Rivers, which penetrate deep into the Island's heart. As we saw in the previous chapter, rivers such as these were critical transportation routes during the settlement era, a time when PEI was heavily forested and nearly impenetrable by land. In this chapter, we will focus on Georgetown's rise and fall as a capital town.

During the nineteenth century, it appeared that Georgetown had achieved much of the potential that Holland saw in it. Holland recognized that Georgetown's principal asset was its harbour. It has always been PEI's best natural harbour, and perhaps one of the best in North America. This is partly because two islands that lay off of Georgetown's coast, Panmure Island and Boughton Island, form a sort of breakwater that prevents silt from forming in the Georgetown harbour.[1] We will explore these islands, as well as others off of Georgetown's coast, including Poxy Island, Brudenell Island, and Grave Island, in Part II of the textbook. Like Georgetown, these are places that time has forgotten.

During the nineteenth century, Georgetown prospered as a hub of shipbuilding and commerce. A ferry operated across the Northumberland Strait between Georgetown and Pictou, Nova Scotia. Georgetown was an important gateway between PEI and the mainland. This status was augmented in 1872, when the PEI Railway arrived in Georgetown. Even more passengers and goods now came by rail to Georgetown, where they then got onto the ferry.[2]

However, the twentieth century was not very kind to Georgetown. By this time, the PEI Railway had redirected much of the Island's commerce towards inland areas and overland means of transportation, so Georgetown's excellent harbour became less important. Moreover, in the early-twentieth century, a ferry link between PEI's Borden-Carleton and New Brunswick's Cape Tormentine replaced Georgetown's ferry link with Pictou. The decline in Georgetown's shipbuilding industry siphoned even more life out of the town. As a result of these twentieth-century developments, Georgetown lost "most of its mercantile and professional class of people." Its overall population declined from around 1200 in the nineteenth century to about 750 by the 1970s.[3]

Today, Georgetown remains a "ghost town."[4] At the end of a dead-end road and out of the reach of the Island's circulation of traffic and commerce, Georgetown has seemingly continued to wither since the 1970s. Georgetown is perhaps PEI's version of Staten Island. The glamour of Manhattan and Brooklyn, New York, outshine the geographically isolated Staten Island. In PEI, Georgetown became economically isolated from the prosperity of the Three Rivers Municipality (centered on the nearby town of Montague) and the larger province.

After we have georeferenced the maps from Stream A and B, we will be able to search them for clues as to Georgetown's unfortunate and unforeseen decline. Why did Holland's hopes for Georgetown not pan out?

This study of the georeferenced maps of Georgetown will illustrate the advantages that georeferenced maps offer to urban history and related disciplines. Georeferenced maps such as these can help researchers understand recent changes at the regional or county scale or the changes that occurred in two or three blocks of an urban area.

Saving Your Project

In your computer's Documents folder, there will be a folder named "QGIS" that was put there in Chapter 1.

- Within the QGIS folder, create a new folder called Chapter3.

Stream A

If you plan only to complete Stream A, you can save your new project in the Chapter3 folder.

- Open QGIS and click "new project"

- Click the disc icon or hit Ctrl+S to save the project. Save your project in the Chapter3 folder. Name your project Project3.qgz.

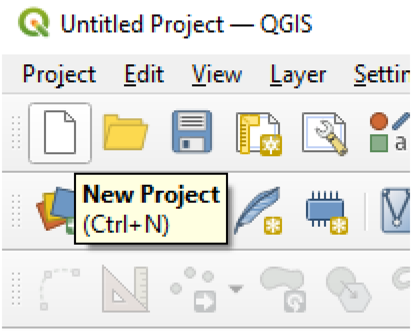


Figure 3.1

Stream B

If you plan to complete this entire chapter, create the following folder structure.

- Within the Chapter3 folder, create subfolders called:
  - ControlPoints
  - ProjectFiles
  - Rasters
  - Rectified
  - ReferenceData
- Open QGIS and click "new project"
- Click the disc icon or hit Ctrl+S to save the project. Save your project in this ProjectFiles folder. Name your project Project3.qgz.

[1] Edward MacDonald, "The French Regime" (Lecture, History 3310, University of Prince Edward Island, September 16, 2020).

[2] Robert C. Tuck, "Georgetown: The Town That Time Forgot," *The Island Magazine* (1978): 24, 27-28. http://vre2.upei.ca/islandmagazine/fedora/repository/vre%3Aislemag-batch2-56/OBJ.

[3] Tuck, 24, 27-28.

[4] Tuck, 22.

Stream A: Downloading a Georeferenced Map from the 1991 National Topographic System

In this step, we will download a National Topographic System (NTS) map from 1991 that has been previously georeferenced by Natural Resources Canada and shared through their Open Government portal. We will show you how to load that map into your mapping project in QGIS. The map is of a section of eastern PEI that includes the towns of Montague, Cardigan, and Georgetown. These three areas now collectively comprise the Municipality of Three Rivers.

If you do not wish to learn how to georeference your own maps at this time, you can complete this process of downloading the georeferenced topographic map and opening it in QGIS. You can use this map to continue on to Chapter 4: Digitization, where you will learn how to create your own features on the map in the form of vector data.

Loading a Base Map

Following the same instructions as Chapter 1, add your OpenStreetMap base map and set the project's coordinate reference system (CRS) to EPSG:2954.

Downloads

- Click here to download the georeferenced copy of the 1991 NTS Georgetown map.
  - To learn more about topographic maps and the NTS map series in Canada please visit the Natural Resources Canada website.
  - The file is a zipped folder containing a GeoTIFF file.
    - The TIFF file format, which has the filename extensions .tif or .tiff, is often used for maps that are going to be georeferenced. If a file is in the GeoTIFF format, it means that the map has already been georeferenced.
    - The zipped folder also contains an xml file for one sheet in the NTS map series. The file we are interested in for this lesson is 011l02_0400_canmatrix_geo.tif. The characters "011l02" are the reference to the NTS sheet also called "Montague."

Stream A

- Unzip the downloaded folder into your Chapter3 folder alongside your Project3 file.

Stream B

- Unzip the downloaded folder into the Rasters subfolder within your Chapter2 folder.

Adding the NTS Map

Other than the base map, the NTS map will be the first layer we add to our project.

- You can add the layer the same way you add Vectors, but instead of choosing the Add Vector Layer on the Layer Menu, choose Add Raster.
    - Or you can drag the .tif file from your computer's File Explorer and drop it onto the map in QGIS.
- Move the new layer to the top of your table of contents by dragging the layer up and dropping it above any other layers.
- Right-click the new layer, which is called "011l02_0400_canmatrix_geo" by default, and click Rename Layer.

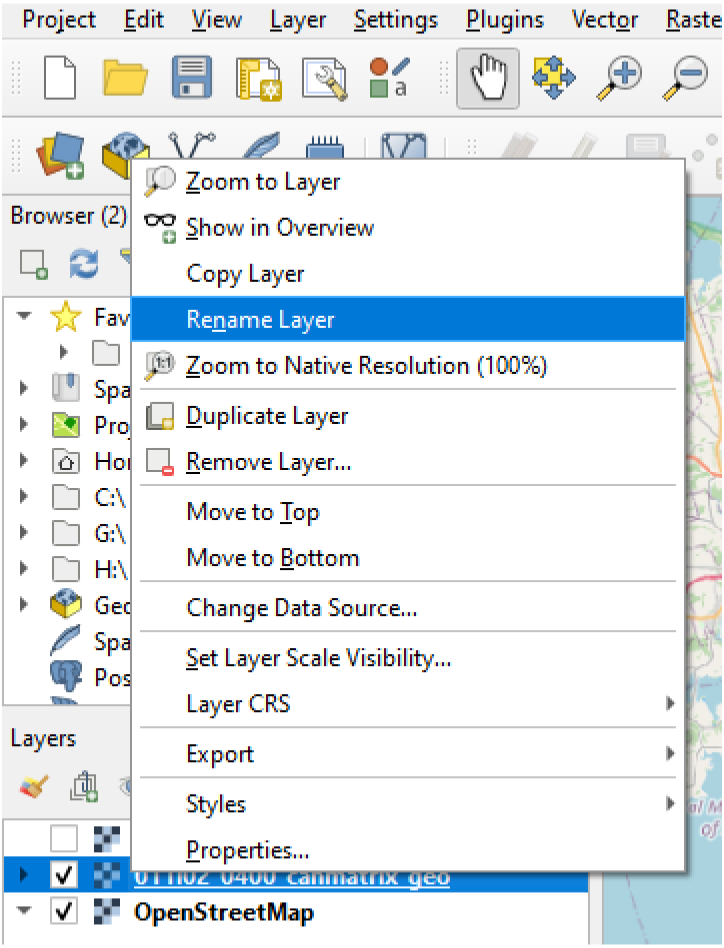


Figure 3.2

- Type in "1991 NTS Georgetown"
- Press Enter on your keyboard.

Note: the NTS map has a CRS of EPSG:26920, which is different than our project's CRS of EPSG:2954. As you will recall from Chapter 1: Introduction, if any layers have a different CRS than that of the project, QGIS reprojects them in the project's CRS "on the fly." So, even though the layers that we are adding in this chapter have different coordinate reference systems, QGIS will reproject them according to the project's CRS. This will ensure consistency in alignment across all the layers.

Checking the Georeferenced Map's Accuracy

In Chapter 2: Copying a Project and Layer Styling, we learned how to adjust a layer's transparency in order to assess its accuracy. This was useful to evaluate the precision of Holland's map. Adjusting a raster's transparency is also very useful to evaluate how well a georeferenced map has been aligned with our base map.

- Right-click the 1991 NTS Georgetown layer in the table of contents.
- Click Properties
- Click Transparency
- Change the Global Opacity to 30%.

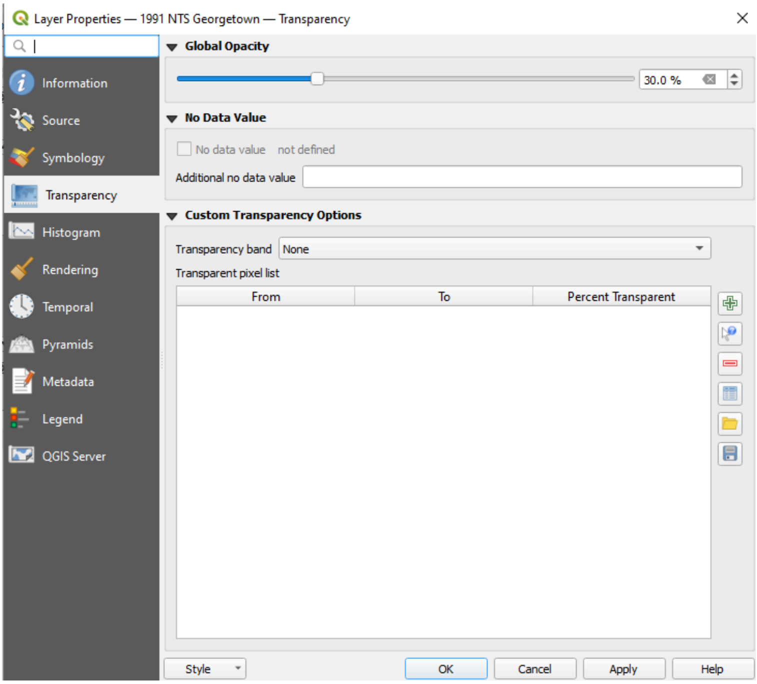


Figure 3.3

- Click OK.
- Zoom into the Georgetown area.
- Compare the streets in the NTS map with those in the underlying OpenStreetMaps base map. How well do they align?

In the screenshot below, we can see that there is a slight misalignment between the streets in the NTS map and those on the base map. For example, on the NTS map, Kent Street is located slightly east and Richmond Street is slightly north of their respective locations on the base map. But, overall, the two maps align well. So, we know that the georeferencing is fairly accurate.

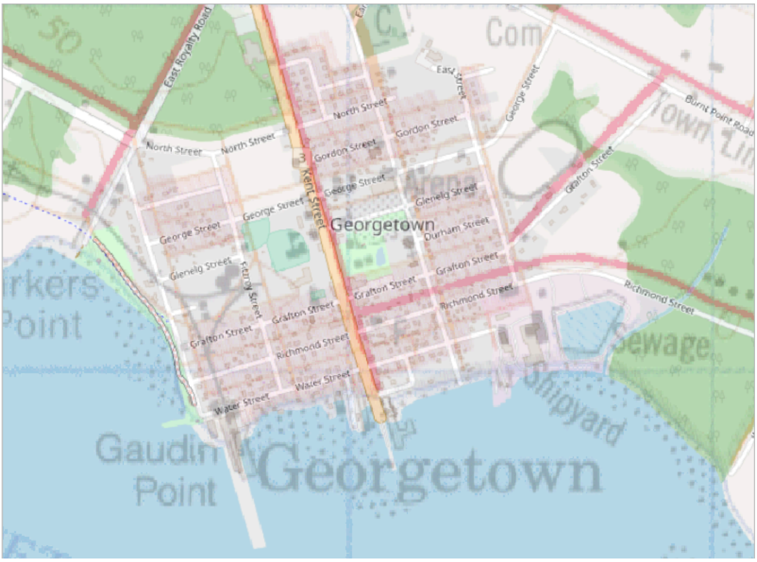


Figure 3.4

Continue to Georeferencing in Stream B or Skip to Chapter 4

If you are only interested in learning how to add a georeferenced map to your GIS at the moment, you can now skip ahead to Chapter 4: Digitization.

Why Is It Helpful to Learn How to Georeference?

You may choose to skip the process of learning how to georeference because you already have access to georeferenced maps. Indeed, many of these can be found online. However, it is very beneficial to learn how to georeference, as it opens up the opportunity to work with many more maps. Of the digital maps out there, the vast majority have not yet been georeferenced. When you learn how to georeference, you will not be constrained to working with the limited number of pre-georeferenced maps. You will be free to take any digital map and georeference it yourself.

As a case in point, consider the georeferenced NTS map provided above. If we limited ourselves to this map, we would have to settle for its scale, which is a little too zoomed out for a detailed study of Georgetown. We would also have to settle for the map's time point, 1991, which is not very historical. But, once we know how to georeference, we can take a digitized map from the 1880 Meacham's Atlas that shows Georgetown at a much closer scale and at a much older time point. Such a map is much more useful to us in our study of how Georgetown's prosperity from this time withered away.

Stream B: Georeferencing a Map of Georgetown from 1880

Downloads

We will acquire the 1880 map of Georgetown from the Island Imagined website. Island Imagined is part of the Island Archives network of websites, which are run in large part by the Island Archives Centre at the University of Prince Edward Island.

- Click here to access the map on the Island Imagined website.
- To download the highest resolution copy of the map, do not zoom in to the map using the “plus” button in the top-left, as shown in this screenshot:

Figure 3.5

- Instead, leave the image zoomed out and click the scissors icon shown in the top right of the screenshot above.
- A new page will load, where you can click Download Image. The image will download as a JPEG.
    - Note: Make sure to download your image to the Rasters subfolder that we created earlier.

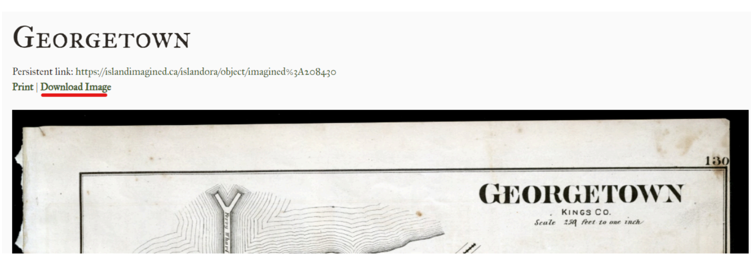


Figure 3.6

Georeferencing

Preparing the GIS for Georeferencing

- Make sure that you have the OpenStreetMap layer added to your QGIS project.
    - Also make sure that it is the only layer that is visible. You may have to uncheck any other layers.
- Make sure your project's coordinate reference system is set to EPSG:2954.

Preparing the Images for Georeferencing

To georeference in QGIS, we will use a tool called the Georeferencer.

- Enter the Georeferencer tool. On Windows this tool can usually be accessed via the **Raster** menu.

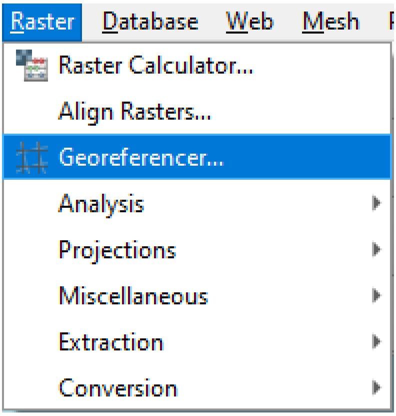


Figure 3.7

- On Mac versions of QGIS 3.22 and older, the Georeferencer tool is under **Raster**, but on some versions, including QGIS 3.23, the Georeferencer tool is found under the **Layer** menu.

This will open the Georeferencer window.

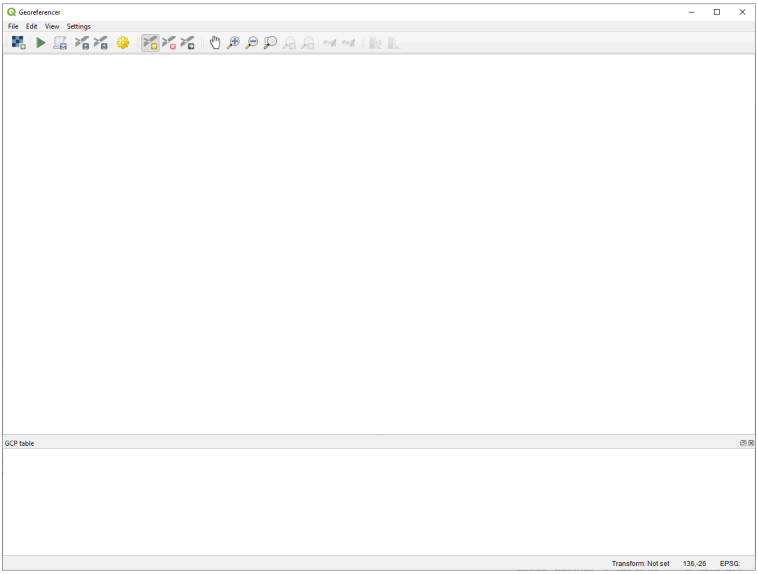


Figure 3.8

Next, we will add the raster of the map we want to georeference.

- Click this symbol to add the raster of Meacham's map of Georgetown.

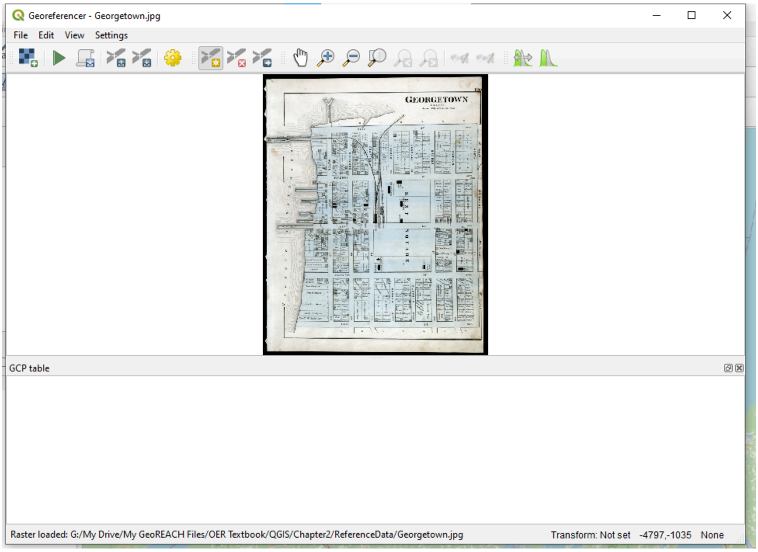


Figure 3.9

- To return to the Main Canvas (where our OpenStreetMap is), click the minimize button on the Georeferencer window.

Preparing the Basemap for Georeferencing

- Zoom in on the OpenStreetMaps layer to Georgetown, Prince Edward Island.

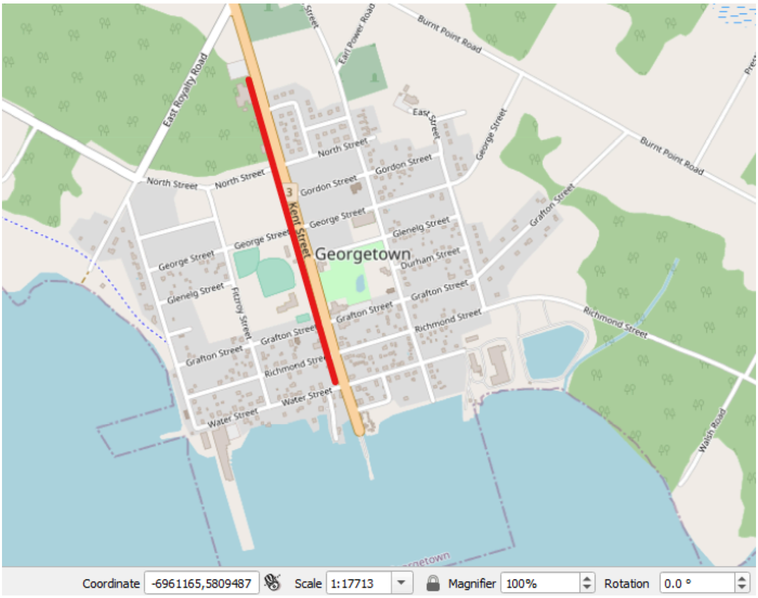


Figure 3.10

In the OpenStreetMaps map, Georgetown's Kent Street is running almost vertically up and down our display. But, in the Meacham's Atlas image, Kent Street is running horizontally.

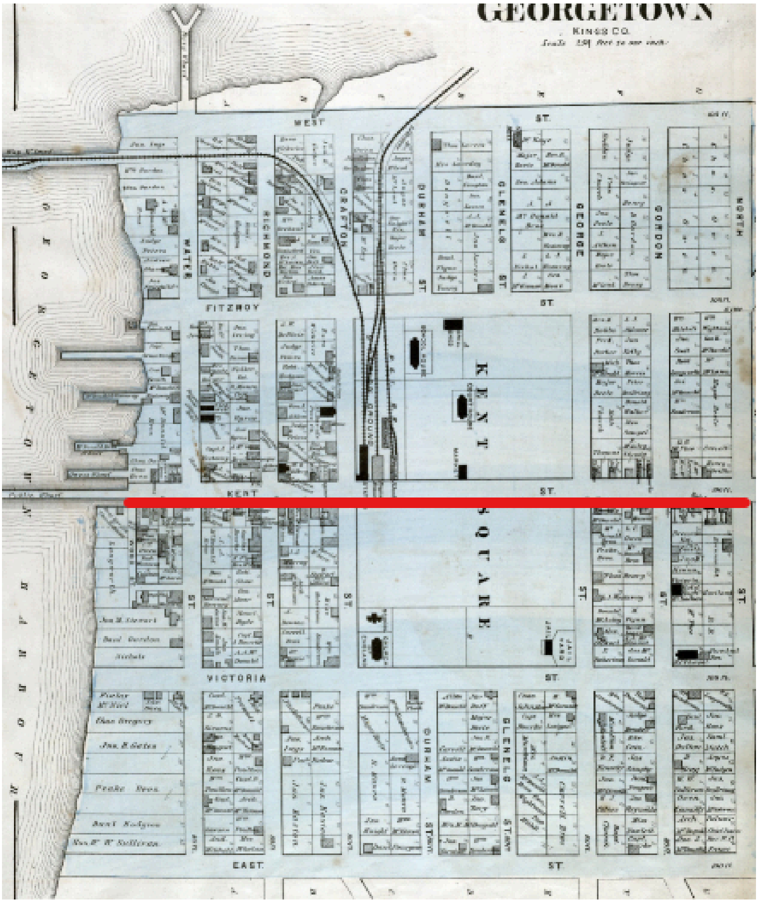


Figure 3.11

It will be easier to identify common elements between the two maps if we reorient the OpenStreetMaps map to match the orientation of the Meacham's Atlas map. To do so:

- Change the Rotation of the OpenStreetMaps map to 105.0°

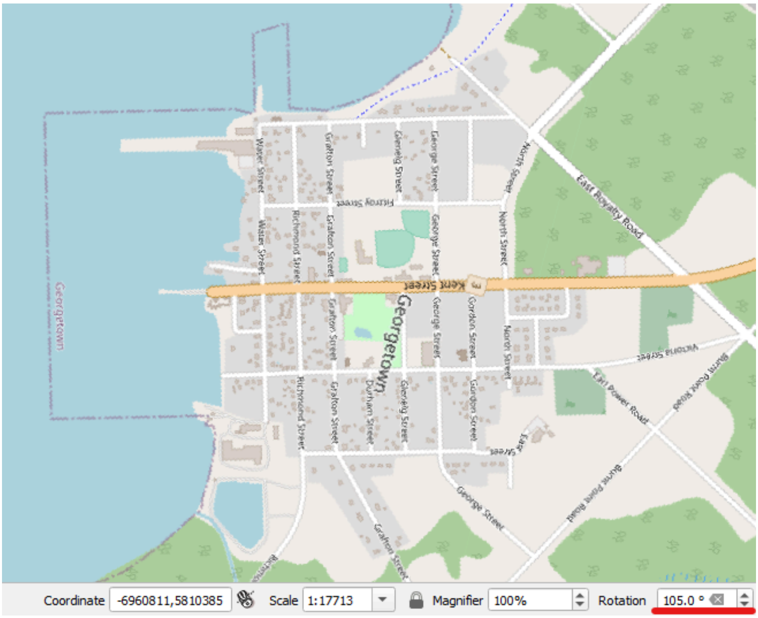


Figure 3.12

Adding Control Points

What Are Control Points?

Now that we have added the map to the Georeferencer tool, we will start adding control points. These control points are points on the historical map that exist on a modern map—in this case, the OpenStreetMaps layer.

Adding control points is the means by which users precisely align the raster map with the reference map. A "control point" is actually made up of two sub-points—one that users place on the raster map and one that they place on the reference map. When you place these two points, you are telling QGIS that these two points represent the same geographic location.

At the end of the georeferencing process, after you have placed your control points, QGIS will know how to align the historical image with the modern-day map. It will align the raster image so that the control sub-point you placed on it is positioned directly above the corresponding control sub-point you placed on the reference map.

QGIS' Control Point Buttons

The following buttons on the toolbar represent, from left to right,

- Add Control Point
- Delete Control Point
- Move Control Point

Adding Control Points

Before we can add control points, we need to look at our map of Georgetown from 1880 and our OpenStreetMap of Georgetown.

- Visually identify the geographic features that are clearly common between these two maps.

These features are often political borders and boundaries, buildings, street intersections, and bridges.

An urban map, the plan of Georgetown focuses on streets, buildings, and town blocks. While some of Georgetown's features have changed between 1880 and today, its distinctive grid-pattern layout has remained largely unaltered. Considering this consistency in street layout between the 1880 and modern-day maps, it seems like using street intersections for control points would produce an accurate georeference.

> **Note**: it would not be a good idea to use historical buildings as the sites of our control points. This map dates back to the 1880s, and it is unlikely that many of those buildings are still standing today. An excellent example of this is the King's County Courthouse. It was built in 1887 and is not in the same place as the courthouse on the 1880 map. Using historical buildings as sites for our control points would require some research prior to georeferencing.

It seems that the intersection between West St. and George St. would be a good spot to place our first control point.

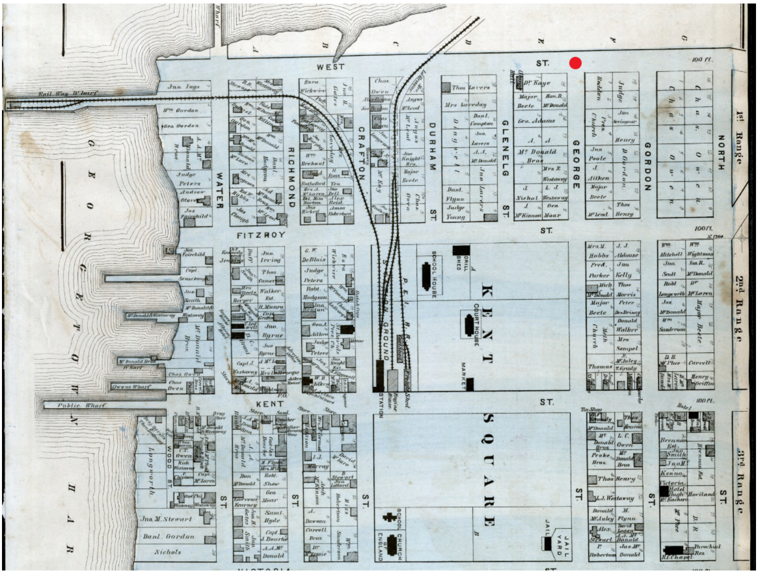


Figure 3.14

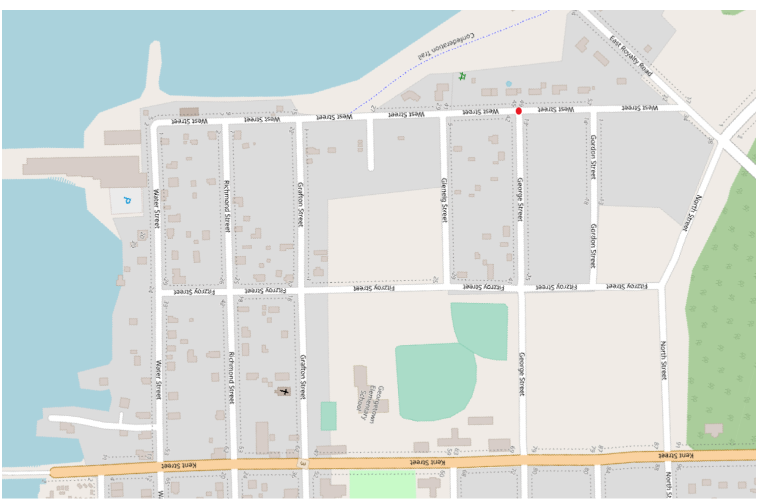


Figure 3.15

Now that we have identified a street intersection that aligns between the 1880 map and the OpenStreetMap,

- In the Georeferencer window, click Add Control Point
    - Your cursor will now turn into crosshairs.
- Click in the very middle of the intersection between West St. and George St. in the 1880 map.

> Tip: There are many different strategies for choosing accurate control point locations in historical GIS. Like all historical research, it helps to use a variety of sources to test the accuracy of the information contained in your historical map. It is also useful to compare different historical maps from the past with features that exist in the real world in the present. In general, it is best to start with more recent maps and work backward. This is because more recent cartography is often more accurate, and because it is easier to identify features that have changed when working in reverse chronological order. All maps are different as well, and as we learned in previous chapters, scholars must consider the mapmaker's original intent, the mapping conventions, and the scale at which the map was considered accurate.

With these principles of control point placement in mind, we must consider the conventions and intentions of the 1880 map. It was an urban map with a focus on street and building locations, and it was intended for use at the town or regional scale. In other words, it was not intended as a property map or as a tool to guide municipal surveyors or developers.

In this case, urban historians usually choose the middle of a street or intersection as the most accurate control point. This is in case there are markings on the historical map that were meant to indicate edge features (eg. sidewalks) that were very likely to change as road infrastructure changed over time.

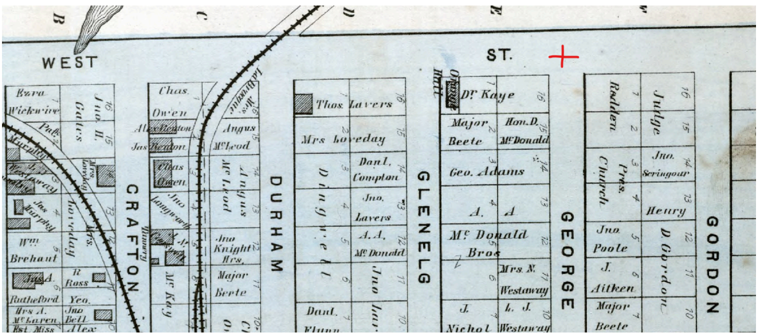


Figure 3.16

> Note: always place the first control sub-point on the raster of the historical map.

Once you place the first control subpoint on the 1880 map, the “Enter Map Coordinates” window will pop up:

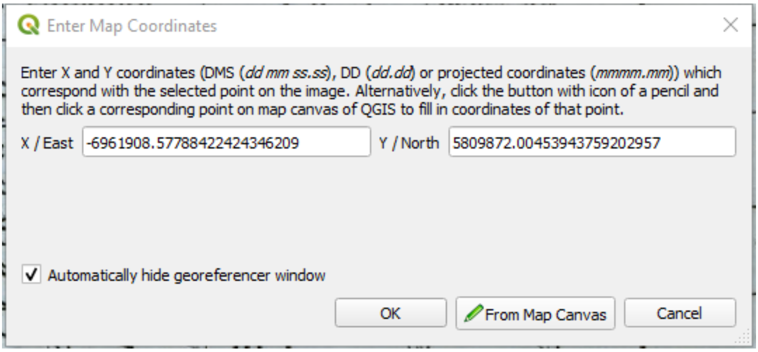


Figure 3.17

- Click “From Map Canvas”

Upon clicking this, the georeferencer window will minimize itself to the bottom-left of your screen underneath your table of contents. If you ever need to reopen the Georeferencer window, you can click its “maximize” button.

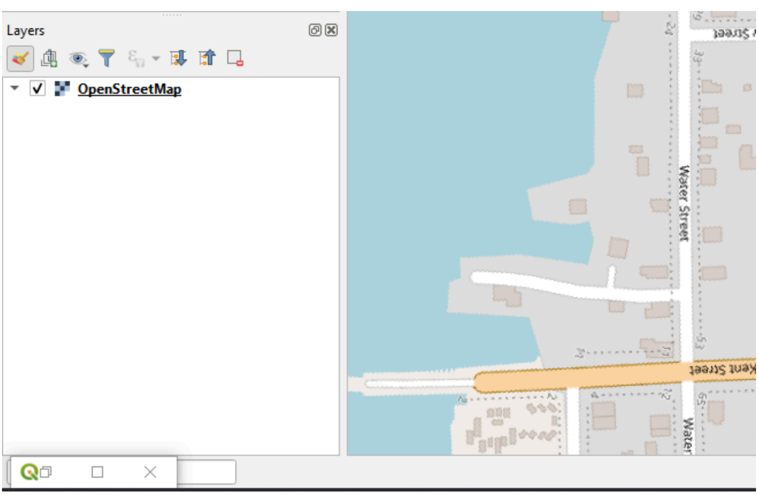


Figure 3.18

In the main QGIS window,

- Click in the very middle of the intersection between West St. and George St. in the OpenStreetMap.

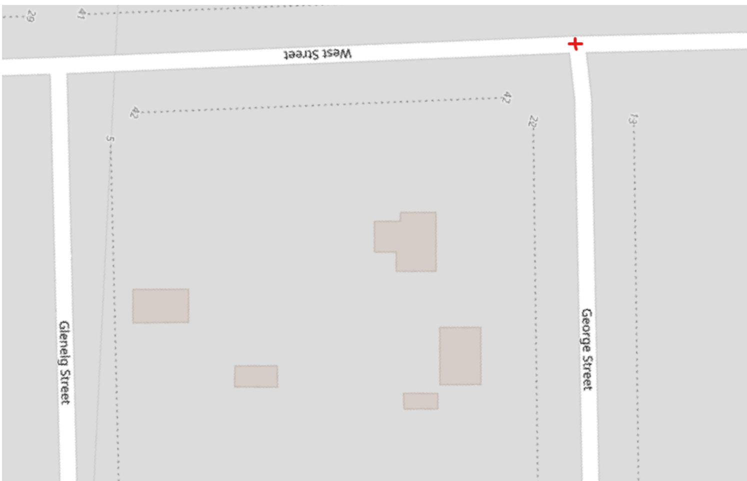


Figure 3.19

After you click on the OpenStreetMap, the “Enter Map Coordinates” window will reappear within the Georeferencer. The X / East and Y / North coordinates will now be filled in.

> Note: For some users, especially on Macs, the Georeferencer or Ener Map Coordinates windows may be maximized but obscured by another window. Try alt-tab (Windows) or cmd-tilde(~) (Mac) to toggle through your open windows.

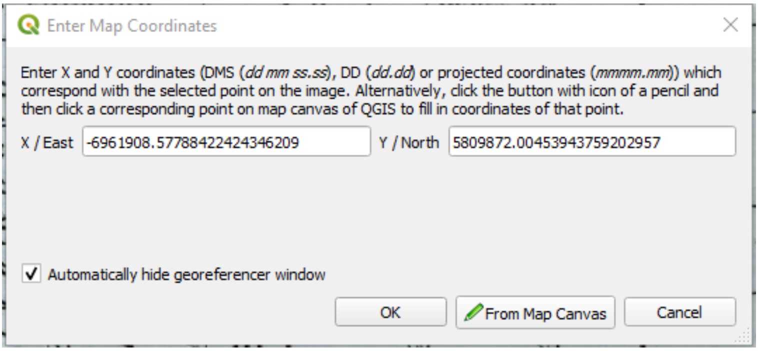


Figure 3.20

- Click OK.

Once you have placed a control point, it will appear as a red dot on the historical map in the Georeferencer window and on the modern-day map in the main QGIS window.

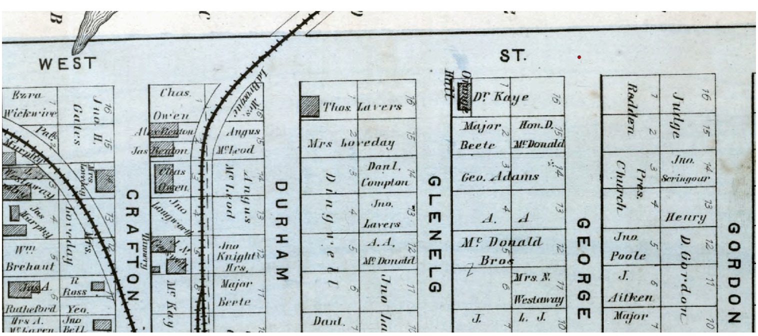


Figure 3.21

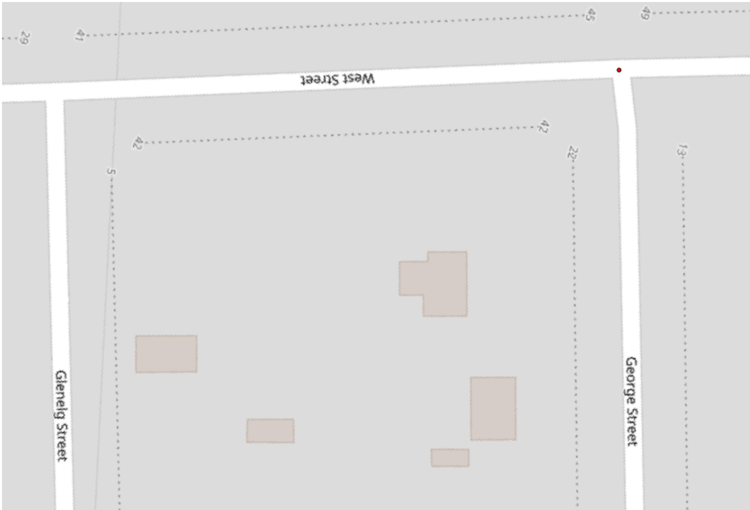


Figure 3.22

If you happen to make a mistake while adding a control point, you can delete it.

- In the Georeferencer window, click Delete Point 
- Your cursor will turn into crosshairs. Click on the red control point you wish to delete, and it will be deleted.

At the bottom of the Georeferencer window, there is a "GCP Table," which lists the control points that you have added. As an alternate way of deleting a control point, you can right-click a control point in this table and click "Remove."

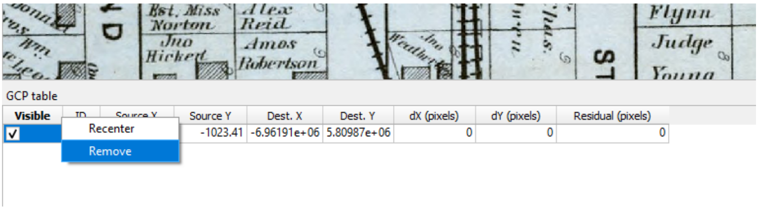


Figure 3.24

You can now repeat the steps in the "Adding Control Points" section until your raster is completely georeferenced. Generally speaking, in order to completely georeference a raster of a historical map, one will usually add a minimum of four and a maximum of ten control points.

It is helpful to spread out your control points across the map, and it is usually best to try to place one control point in each of the corners of the image.

Four control points—especially if placed in the four corners of the historical map—can quickly orient the raster into the correct position in relation to the reference map. Although you may place more than ten control points, after you have placed ten, any further points you place will have an increasingly diminished effect on the orientation of the historical map in relation to the reference map. This Georgetown map from 1880 can be georeferenced fairly accurately with four control points, one on each of its four corners:

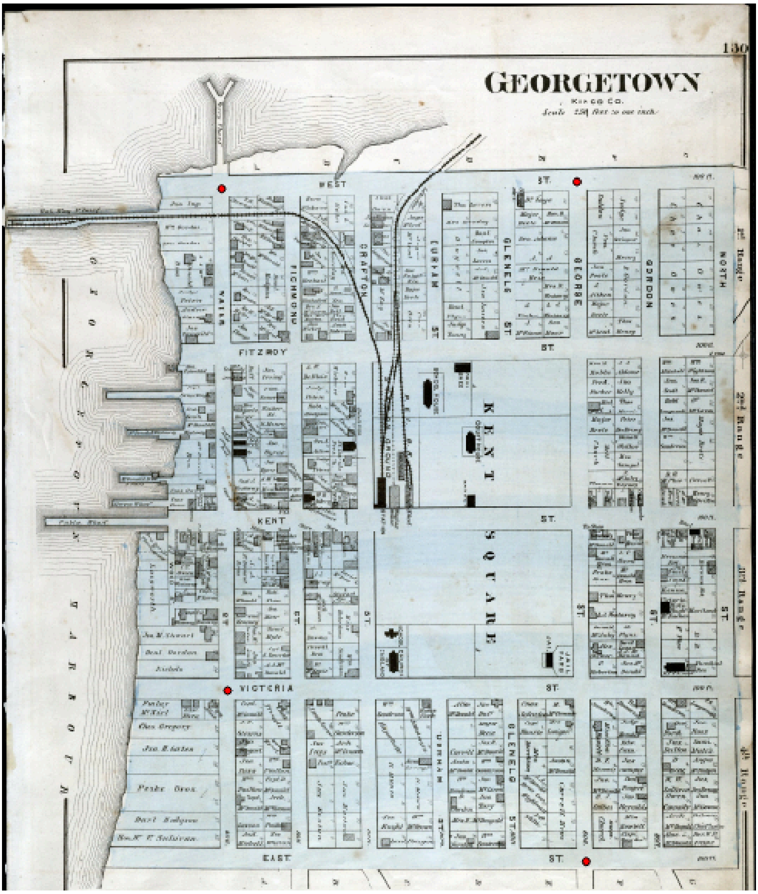

GEORGETOWN
130
WEST
FITZROY
KENT
VICTORIA
EAST
ST.
KENT
SQUARE
RICHMOND
GRAFTON
GLENELG
GEORGE
GORDON
NORTH

Figure 3.25

Figure 3.26

If, during the process of adding control points, your work goes totally askew, you can erase all of your control points, remove the raster, and restart. To do so,

- In the Georeferencer window, click File and then Reset Georeferencer

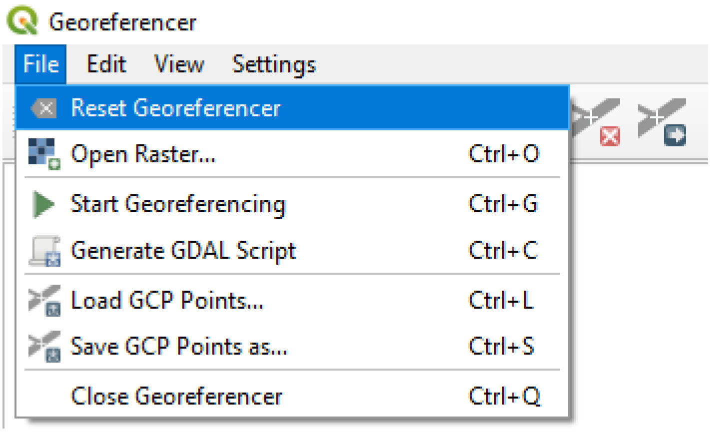


Figure 3.27

Saving Control Points

Before continuing, we can save our control points to a .points file for future use. This can be helpful if we need to re-georeference the same map and we wish to reload our control points. Or we can use these control points again in a different future project.

To save your control points,

- Click Save GCP Points 
- Save your control points in the ControlPoints subfolder within the Chapter3 folder. Name the control points file "GeorgetownControlPoints"

If you ever wish to load control points,

- Click Load GCP Points
  

Transformation Settings

Before we can complete the georeferencing process, we need to select a Transformation type.

> **Caution**: make sure to have saved your control points before selecting any transformation options. QGIS has been known to crash while attempting repeated transformations in a short amount of time, in which case you may lose any unsaved control points.

Transformation is the equation by which QGIS “transforms” the raster to its real map coordinates. Every time you georeference a raster, it goes through a transformation to reach its real-world coordinates. Transformation settings determine how QGIS interprets your control points while georeferencing your raster. The Transformation process affects the scale, rotation, and precision of the map data.

The transformation settings can be viewed and set by clicking the Transformation Settings button in the Georeferencer window:

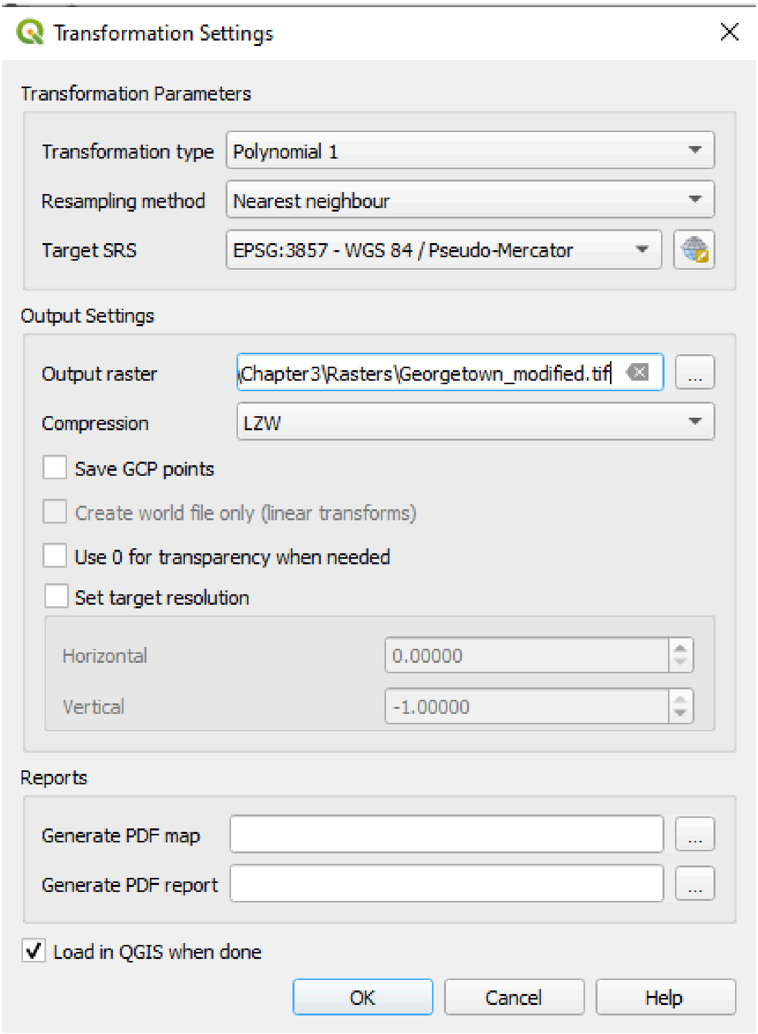


Figure 3.31

We need to specify a Transformation Type, Resampling Method, Target SRS, and Compression. We also need to provide an Output Raster name.

Transformation Types

There are several types of transformations that QGIS uses to place the raster dataset accurately onto its reference map. Listed as least to most complex, these types are Linear, Helmert, three types of Polynomial, Thin Plate Spline, and Projective. Generally, the more complex a transformation type, the more control points that are required.

The **Linear** transformation type is the simplest. It does not alter the raster. **Helmert** will alter the raster by altering its position on the X/Y/Z axes, altering its scale, and altering is rotation.

> Note: a large-scale map is zoomed in and shows a lot of detail for a small area. A small-scale map is zoomed out and shows little detail for a large area.

The **Polynomial** transformations are some of the most commonly used transformations among GIS users. They can warp the raster, which can be key when georeferencing scanned images of old maps that do not always align exactly with the base map. Among the three polynomial transformation options, Polynomial 1 will change the raster the least. Polynomial 1 will keep lines on the raster straight, but it will change the angles between them. It will also adjust the scale and rotation of your raster. Polynomial 2 and Polynomial 3 are used when you need to alter your raster more drastically. Polynomial 2 will begin to bend straight lines, and Polynomial 3 bends them to a greater extent.

Thin Plate Spline is a rather complex transformation. It allows for local areas of an image to have their own independent warping. For example, one part of an image might rotate one direction, while another part of the image might rotate in an entirely different direction. Because they have their own warping, these local areas will be very accurate at the expense of global accuracy.

The **Projective** transformation is useful when georeferencing scanned maps, especially if you are concerned with having accurate local data. The Projective transformation can warp lines to make them straight.

For a more detailed explanation of QGIS' various transformation types, please see Chapter 7: Advanced Georeferencing and Digitization.

Choosing a Transformation Type

We are working with Georgetown, a town built in a square grid. We may not wish to distort these straight lines, so it seems that the Projective transformation option is perhaps the best fit for our project. This transformation type requires four control points, and we have placed four.

- Click Projective in the Transformation Type dropdown menu.

Resampling Method

Resampling is the process of taking an amount of data as a sample and calculating the precision of the data, based on the sample. Smoothing data refers to removing irregularities, such as small sudden spikes, based on the sample.

The following options are available in QGIS for resampling:

- Nearest Neighbour
- Linear
- Cubic

- Cubic Spline
- Lanczos

If you select Nearest Neighbour, few changes will be made to your raster. However, the Lanczos option makes the most changes to your raster to smooth it out as much as possible. Each resampling method between Nearest Neighbour and Lanczos delivers a progressively smoother result.

It does not seem that our project requires a great deal of smoothing out. So, Nearest Neighbour seems to be a good fit.

- Select Nearest Neighbour from the Resampling Method dropdown menu.

Target SRS

The Target SRS should match your Project CRS. If you will recall, our Project CRS is 2954.

- Select EPSG: 2954 from the Target SRS dropdown menu.

Output Raster

Here is where we can choose where we would like to save our georeferenced raster. The default location that QGIS gives is the same location where the original raster was stored. However, we would like to save our georeferenced rasters to the Rectified subfolder within the Chapter3 folder.

- Click Browse.

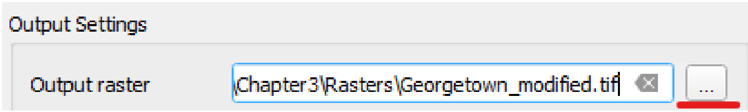


Figure 3.32

- Navigate to the Rectified subfolder within the Chapter3 folder and click Save.

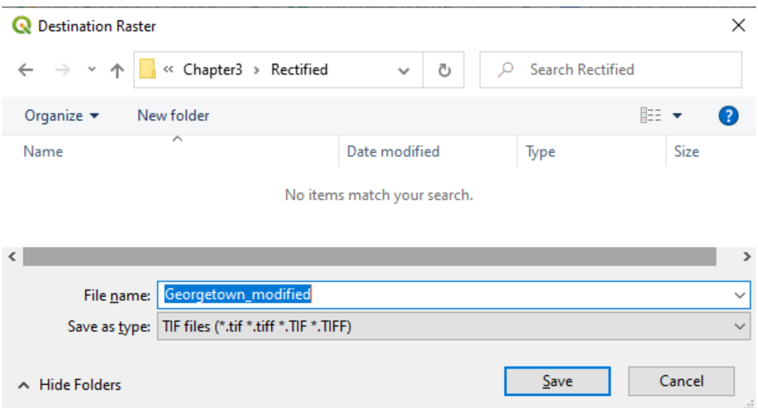


Figure 3.33

QGIS automatically appends "_modified" to the existing raster file's name.

Compression

Compression is heavily dependent on hardware and processing power. The purpose of compression is to make the output file smaller. If a compressed file is "lossless," the compression process has not degraded its quality. By contrast, if a compressed file is "lossy," the compression process has degraded the file's quality in order to significantly reduce the file's size.

The following compression options are available in QGIS:

1. **LZW** (Lempel-Ziv-Welch) is a lossless compression algorithm commonly used for GIFs and TIF files.
2. **PACKBITS** is a fast and simple lossless compression algorithm.
3. **DEFLATE** is a lossless data compression algorithm commonly used in archives.

It seems that LZW will do the trick.

- Select LZW from the Compression dropdown menu.

Load in QGIS When Done

Before clicking OK in the Transformation Settings window, we can select "Load in QGIS when done." When we click this, QGIS will automatically load the georeferenced raster into our project without us having to click Layer and then Add Layer from the top menu in QGIS.

- Check the box in the Transformation Settings window that is called "Load in QGIS when done."

When all of your settings reflect the ones selected in the following screenshot, you can click OK to close the Transformation Settings window:

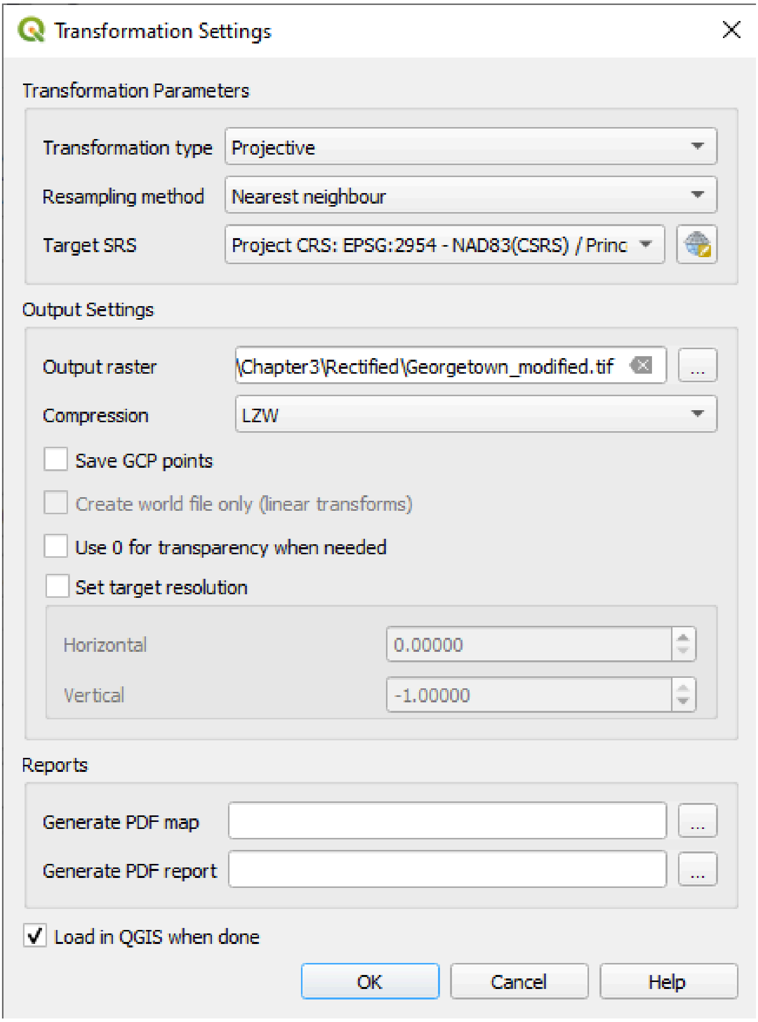
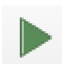

Transformation Settings
Transformation Parameters
Transformation type
Projective
Resampling method
Nearest neighbour
Target SRS
Project CRS: EPSG:2954 - NAD83(CSRS) / Princ
Output Settings
Output raster
\Chapter3\Rectified\Georgetown_modified.tif
Compression
LZW
Save GCP points
Create world file only (linear transforms)
Use 0 for transparency when needed
Set target resolution
Horizontal
0.00000
Vertical
-1.00000
Reports
Generate PDF map
Generate PDF report
Load in QGIS when done
OK
Cancel
Help

Figure 3.34

Completing the Georeferencing Process

Once we have configured our transformation settings, we can complete the georeferencing process. To do so,

- Click the Start Georeference Button



This will open a small Progress Bar that will represent the progress of your georeferencing process. Once it has reached 100%, you will have your georeferenced raster added to your Project and saved in your Rectified folder.

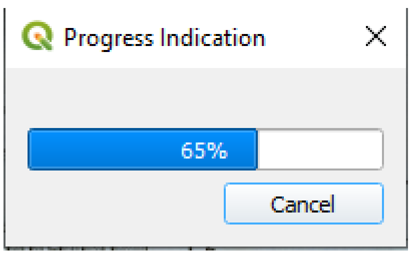


Figure 3.36

Once the georeference is complete, you will receive this message:

Figure 3.37

You can now close the Georeferencer window. Your map has been georeferenced.

Checking the Accuracy of the Georeferenced Map

As we did with the 1991 NTS map of Georgetown, we can adjust the transparency of the 1880 map of Georgetown in order to see how well it aligns with the base map.

- Right-click the 1880 Georgetown map in the table of contents.
- Click Properties
- Click Transparency
- Change the Global Opacity to 50%.
- Click OK.

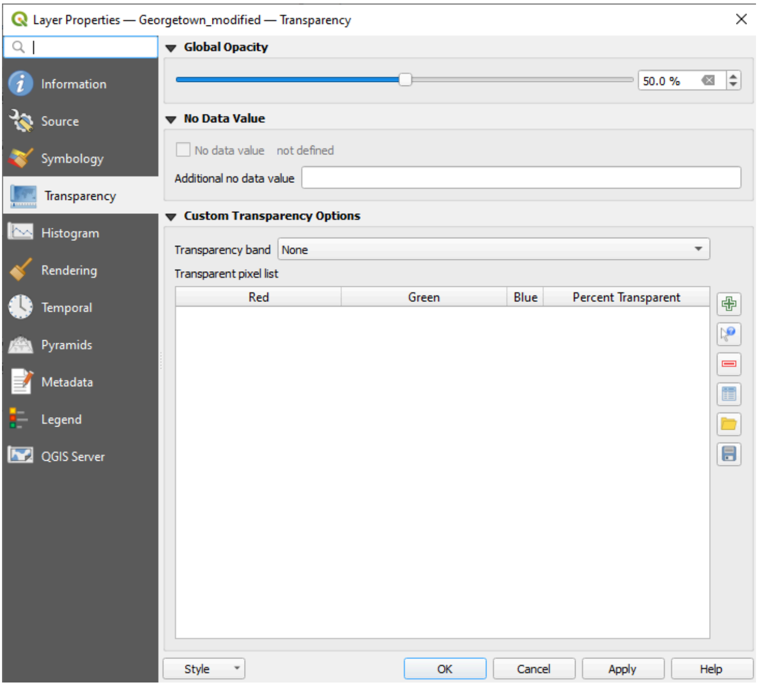


Figure 3.38

- Zoom into the Georgetown area.
- Compare the streets in the 1880 Georgetown map with those in the underlying OpenStreetMaps base map. How well do they align?

As we can see in the screenshot below, the 1880 map of Georgetown and the OpenStreetMaps layer align very well. Almost all of the streets, including Kent Street and Richmond Street, align almost exactly. We can now be confident that our georeferencing is accurate.


George Street
Glenelg Street
K E N T
S Q U A R E
COURT HOUSE
Fitzroy Street
Kent Street
Victoria Street
Grafton Street
Richmond Street
Water Street
East Street
West Street
DURHAM
GLENELG
GRAFTON
RICHMOND
H A R B O U R

Figure 3.39

Conclusion to Chapter 3

Now that we have added some georeferenced maps of Georgetown to QGIS, we will be able to search them for clues as to the decline of the village since the end of the nineteenth century. We will explore and map markers of decline in the next chapter.

Further Reading

Island Communities: Georgetown

SECTION IV

CHAPTER 4: DIGITIZATION IN QGIS

Getting Started

Overview and Background

This chapter is an introduction to the process of adding your own digital content to a map. The process of adding this digital content is called digitizing, and the digital content that you create is called vector data.

Vector data is a type of data within a GIS. Another form of data in GIS is the raster. A vector is digital data that the user creates. Users can create vector data in the form of points, lines, or polygons. GIS users have traditionally created vector data in the form of a shapefile, although more recent formats include the Geodatabases and GeoPackages. The key characteristic of GIS is that it assigns geographic coordinates to this shapefile. By contrast, a graphics software program can also create points, lines, and polygons, but it will not assign them a geographic location.

In cartography, a feature is any representation of a real-world object on a map. Features could include the lines of a historical railway, the patrol routes of an army, the buildings in a town, or the forests, fields, and bodies of water in a nation. Features can be places you know of through personal experience, but, in the humanities, this knowledge is more often what you learn from primary-source research.

The examples in this chapter focus on the historical maps of eastern Prince Edward Island (PEI) that we added to our GIS in Chapter 3: Georeferencing. We will digitize historical boundaries and other features of the town of Georgetown, PEI, using the maps from Chapter 3. No matter if you completed Stream A or Stream B in that lesson, you can still complete this step and start adding your own content to a historical map.

When Is It Best to Digitize?

Using a GIS to annotate a map is relatively straightforward, but it is difficult enough that we might want to pause and ask when it makes sense to use digitization and when you should simply use other graphic design programs. Essentially, you should digitize in a GIS any time you want to add your own digital content to a map, have your content remain interactive, and retain the ability to remove unwanted content. In other words, do this when you need your content to remain graphically dynamic, geographically scalable, and analytically robust. For example, if you simply want to label a map, you can do so with graphic design programs provided that you can find an open-access basemap that suits your needs. However, if you were to label dozens of features, it would be difficult to change the text on those labels all at once. With a GIS, it is possible to alter, concatenate, or even translate the attributes of the content you created, and those attributes may be used to generate dynamic labels and other graphics. Moreover, these graphics are scalable in a GIS. Many scholars need to make multiple versions of their maps at different geographic scales, or create inset maps, or even create scalable and interactive web maps. In a graphic design program, this would require resizing and repositioning those dozens of labels for each output. In a GIS, labels can be set to appear only at certain scales, and their font size will change dynamically as the scholar or the audience zooms in and out on the map. Finally, with dynamic features you retain the ability to show only the features you want to show. It is often difficult to simplify labels and other features using graphic design applications. In a GIS you simply turn off the layers or filter your features (as we did in Chapter 2) so that only certain features are visible on your final map.

Perhaps the most important reason for creating your own content in a GIS is to enhance the analytical characteristics of your research. A GIS is, after all, a spatially enabled database as well as a cartographic tool. As you gather information on your research subjects, you may want to simply map their locations, but you likely also want to analyze the significance of those locations. Why do the spatial characteristics of these subjects matter? What do they tell you about their relationships to each other and to other aspects of the built and natural environments? For instance, the density of those dozens of features you created is often about more than simply the difficulty of fitting the labels onto your map. If those features represent people living in a crowded city, or sharing limited resources in the country, then density mattered to them in important ways. The proximity of your human features to pollutants, threats, infrastructure, and many other features mattered, as well. So also did the time it took people to travel to work or across the country. These are only some of the many spatial questions you can ask of your content once you add them to a GIS. So, if you're ready to give it a try, we hope this chapter will help.

When Is It Best to Use Georeferenced Maps to Digitize?

Not all digital humanities projects require the use of georeferenced historical maps. In fact, you can "digitize" new features in any map, even without historical maps to guide you. The most basic form of digitization involves identifying the location of places that you want featured in your project and clicking on the map to add a digital vector, such as a point, line, or polygon to represent that location. We will do this in the first part of this chapter. In its most basic form, digitizing can be done "by eye" without the help of georeferenced maps that show the location of the features. If the feature still exists today, you can even select from vectors and reuse them (with permission from the content creator, of course). However, when mapping highly detailed features, say a series of historical houses in an urban area, you will quickly find that having a georeferenced map will help with digitization in at least two ways. First, the process of mapping "by eye" will become confusing when dealing with a large number of features. Second, many features have changed substantially over time, and, in the cases of urban homes, many were removed or remodeled so that the modern GIS features are no longer useful as a reference point.

In other cases, historical maps will not be particularly helpful at all. For instance, if you wanted to create a map of the five largest communities in PEI in 1921, you would access the 1921 Census of Canada, record the names of the largest communities (using one of the tables), verify if those names and communities have remained the same, and proceed to make a map showing a single point on each of the five communities. The historical maps of Prince Edward Island would be most helpful if the communities had changed their names, or, less frequently, their locations! Georgetown, PEI, is now part of Three Rivers, but its location has not changed. However, as the town continues to grow and blend into others in the Three Rivers municipality researchers may have to eventually consult historical maps to learn where the town of Georgetown was located as the Census understood it in 1921. At the time we wrote this textbook (2021), Google Maps and other common ways to search the location of towns still showed where Georgetown exists within the larger Three Rivers municipality.

In other types of digital humanities projects, historical maps and modern GIS tools must be used in conjunction with other research. For instance, if you wanted to create a fictional map showing the geographic places that were most likely intended by an author like L.M. Montgomery in her novel, Anne of Green Gables, you would have to compile a list of communities mentioned in the novel, and then another list with the most likely geographic place name. Other scholars have debated this in their works, and it would be helpful to have maps of PEI both from the time that book was published (1908) and more recently. Still others have mapped sites related to Montgomery's own life. Depending on the scale of such projects, and the level of detail used by the author and more recent scholars, it could help to have historical maps that have been georeferenced and overlaid on a modern GIS map.

Example: The Town That Time Forgot?

One of the few urban maps of the Island helps us understand maritime urban development in this period and a good deal about the social life of settler economies. It also helps uncover a historical mystery that has puzzled local heritage communities for 100 years.

As you will recall from Chapter 3: Georeferencing, Georgetown is the capital of Kings County, so selected for its deep water harbour and other transportation features. It became a commercial and shipbuilding capital as well, and, in 1880, it was enjoying what Graeme Wynn calls the industrial ascendancy in the Maritime provinces. That's also when things turned sour.

The map in Meacham's Atlas from 1880 depicts Georgetown at close to its height. The town boasted a bustling merchant quarter, a manufacturing district including shipbuilding and foundries, and a service sector marked by the new PEI railway's eastern terminal, the county's highest court, and its highest high churches, too. And therein lies the mystery. Many of these structures disappeared in the twentieth century, leaving behind several abandoned homes and a hollowed out square. At the beginning of the twentieth century, the town's population was about 1,200 people. Today it is around 555. What was once a centre and a connector has become a margin and, in some ways, the end of the line. Montague has become to Kings County what Summerside is to Prince County (except all of Three Rivers is much smaller than even Summerside).

Through maps, we will be able to see Georgetown's stagnation between 1880 and 1991, which resulted in little new construction or development. We will also see how Georgetown lost much of its commercial activity over the same period, including the losses of a ferry service and a shipbuilding company.

Two Streams

This chapter is divided into two streams. In Stream A, we will digitize features on the 1991 National Topographic Series (NTS) map of Georgetown. We will identify what remained of the once bustling town in 1991, a century after its golden age.

If you made it to the end of Chapter 3: Georeferencing, you will also be able to complete Stream B of this lesson. In Stream B, we will digitize historical content from the earlier and much more detailed historical map of Georgetown, the one found in the 1880 Meacham's Atlas of PEI.

By digitizing features from both 1880 and 1991, we can visually demonstrate how Georgetown declined over this period.

Copying Chapter 3's Files

Streams A and B

As we did in Chapter 2, we will copy the previous chapter's project file and map layers so that we do not have to start from scratch.

Within the QGIS stored in your computer's Documents, there is a folder called Chapter3.

- Using Windows Explorer, right-click the folder called Chapter3.
- Click Copy
- Right-click in a blank space underneath the Chapter3 folder
- Click Paste

This will create a folder called Chapter3 – Copy.

- Right-click the folder called Chapter3 – Copy
- Click Rename
- Type in Chapter4
- Click Enter on your keyboard

We will now open the new Chapter4 folder and rename the project file inside.

- Double-click on the folder called Chapter4
- Double-click on the folder called ProjectFiles
- Right-click on the QGIS project file called Project3
- Click Rename
- Type in Project4
- Click Enter on your keyboard

With the project file and the map layer files copied, we can now proceed.

- Double click on the freshly renamed Project4 file to open it in QGIS.

Note: if you have not completed Chapter 3, you will have to go to that chapter to set up Project3 before you can copy Project3 to create Project4. Chapter 3 shows you how to create Project3. It includes links to download the NTS map and the 1880 Georgetown map, and it shows how to import the NTS map as well as how to import and georeference the map of Georgetown.

Stream A: Creating Vectors from a Basemap and an NTS Map

Mapping a "Ghost Town"

In Stream A, we will create points, lines, and polygons. We will create points for St. David's Presbyterian Church, the Holy Trinity Anglican Church, and the King's Playhouse. By mapping these points, we can show which structures were in place in Georgetown in 1991.

In Stream A, we will also digitize the main road leading into Georgetown (i.e., Kent Street) as a line. We will also digitize Kent Square as a polygon.

By completing Stream A, you will learn how to create all three types of vector data. You will see the few things that Georgetown, a "ghost town," still has to offer.

Creating Vectors: Points, Lines, and Polygons

Points

Creating a New Shapefile Layer

The first type of vector data that we will create is point data. As you will recall from the beginning of this chapter, vector data comes in the form of a shapefile. So, to create our vector data, we will first create a new shapefile layer. To do so,

- Click Layer
- Hover over Create Layer
- Click New Shapefile Layer

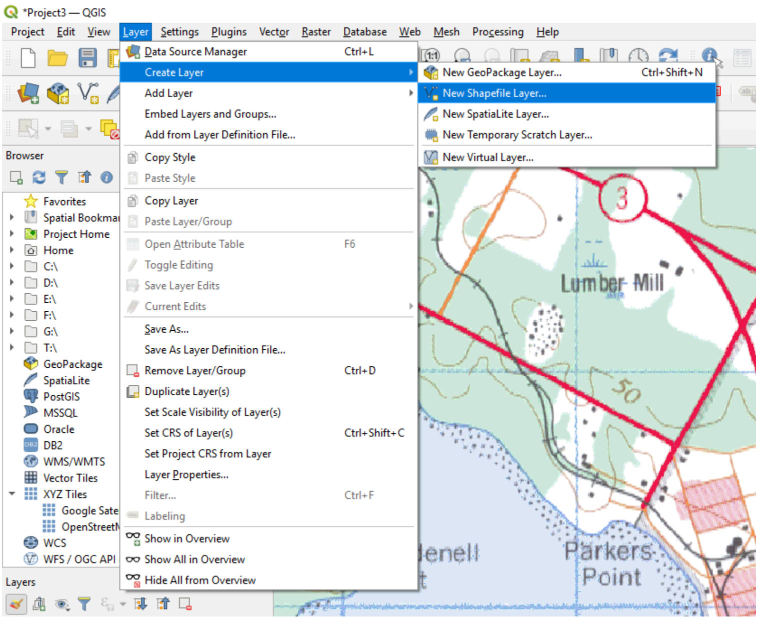


Figure 4.1

Fill out the following information in the dialogue box that appears:
File Name: ...QGIS\Chapter4\Vectors\1991buildings.shp

- First, you will have to create the folder named "Vectors" inside Chapter4. This should **only have to happen once** in this tutorial.
- To create the Vectors folder and save the shapefile in the correct location, click the ellipsis **(. . .)** to the right of the File Name field.
- Navigate to **QGIS\Chapter4** folder.
- Click "New Folder" and name the folder **Vectors**
- Enter **1991buildings** as a File Name, and then click Save.

File Encoding: UTF-8
Geometry Type: Point

Additional Dimensions: None

Underneath Additional Dimensions, we can also make sure the CRS is set to “Project CRS: **EPSG: 2954**.”

Under New Field, we can enter the following information:

- Name: Name
- Type: Text Data

We can leave the other settings.

- Click Add to Fields List.

We are creating this new field so that we can keep track of the names of the places for which we are creating points.

- Click OK

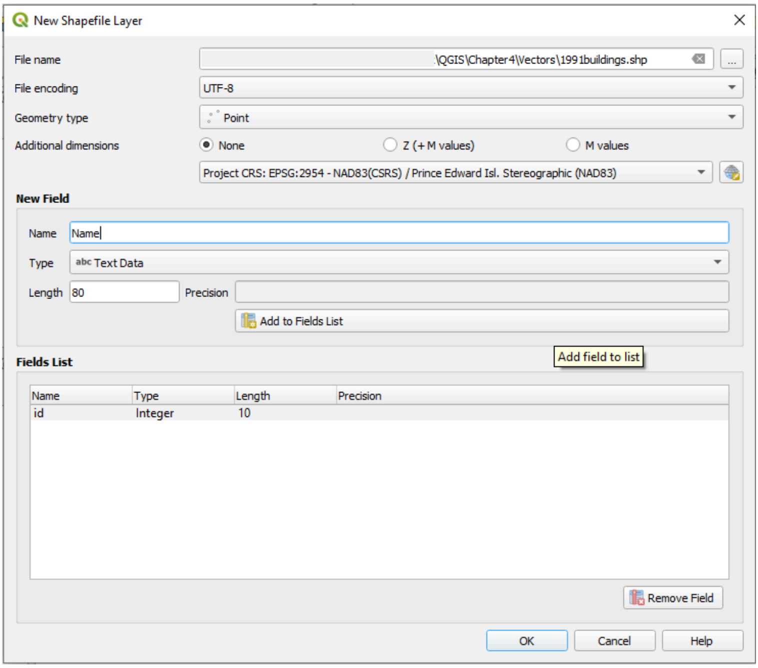

New Shapefile Layer
File name
\QGIS\Chapter4\Vectors\1991buildings.shp
File encoding
UTF-8
Geometry type
Point
Additional dimensions
None
Z (+ M values)
M values
Project CRS: EPSG:2954 - NAD83(CSRS) / Prince Edward Isl. Stereographic (NAD83)
New Field
Name
Name
Type
abc Text Data
Length
80
Precision
Add to Fields List
Add field to list
Fields List
Name
Type
Length
Precision
id
Integer
10
Remove Field
OK
Cancel
Help

Figure 4.2

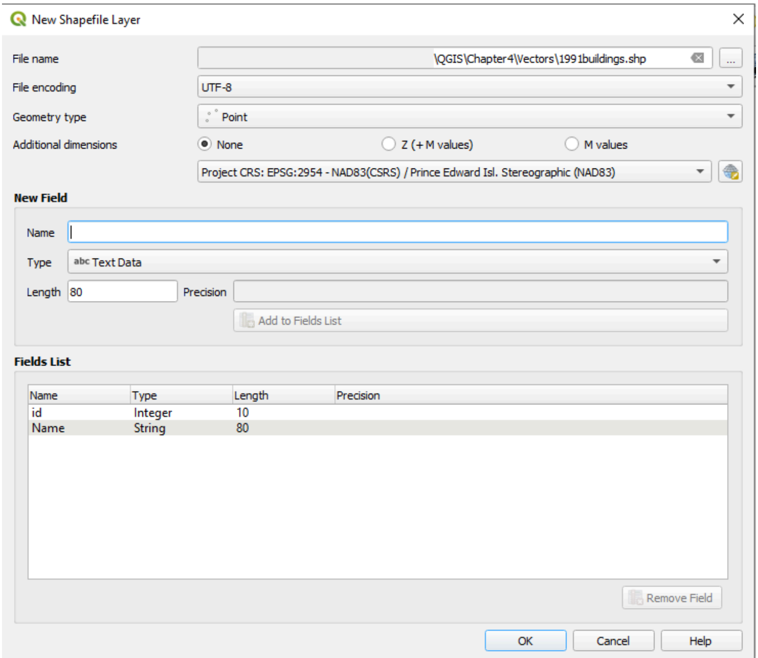


Figure 4.3

Adding Points to the Reference Map

An Important Note about Scale

Before we add our points, we must take a moment to think about the scale of the NTS map. A point's accuracy decreases as the scale of the map decreases. The NTS map of Georgetown to which we will be adding our points was created to show the region around Georgetown and not to show Georgetown itself. In other words, it is a small-scale map, and it is not an urban map. When you add a point to a small-scale map, it will not be as accurate as if you added a point to a large-scale map.

In all forms of historical research, there are limitations. In our case, the scale of the NTS map limits us. We can use the NTS map to see a fairly accurate indication of where we should place a point, but we will have to use the modern-day basemap in conjunction with the NTS map to verify the point's proper location.

To do this, we first must be sure that the object that we are trying to represent with a point—e.g., a building—is still there on the basemap and has not changed location. We then identify the building on the NTS map. Before we commit to placing our point on the building's location on the NTS map, we verify the location of the point on the basemap. So, in other words, the NTS map is indicating to us a building's general location, and the basemap, which is set at a larger scale, is confirming the building's precise location. We will make our final decision as to where to place our point based on the location of the building on the basemap.

The small scale of the NTS map is important to keep in mind when working with it alone, as we are doing in Stream A. We want to use the basemap to make sure that the points we are adding are accurate. But the NTS map's scale is doubly important for users who will be completing Stream B. In Stream B, we work with the 1880 Meacham's Map of Georgetown, which is at a much larger scale. It is an urban map. So, in order to accurately compare points between the 1991 and 1880 maps, we must make sure that we used the same scale when mapping each.

Adding the Points

Now that we have our new shapefile created and we have the scale of the NTS map in mind, we can start to add our points to our 1991 map of Georgetown.

- Click Toggle Editing

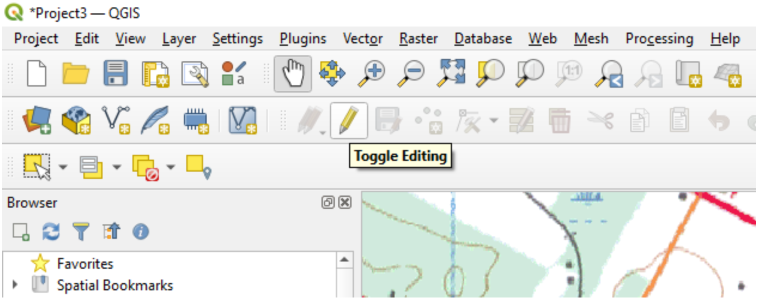


Figure 4.4

- Click Add Point Feature

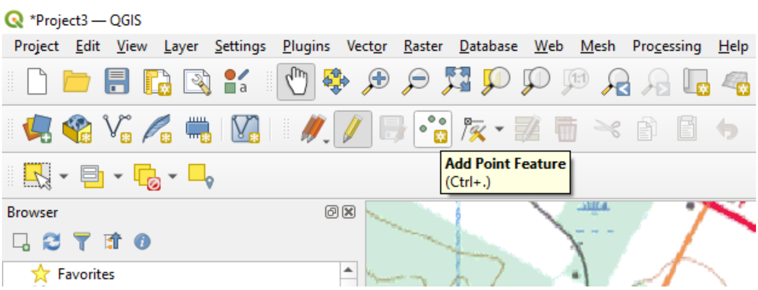


Figure 4.5

Adding a Point for St. David's Presbyterian Church

- Identify St. David's Presbyterian Church. It is not named in the NTS map, but you will likely be able to find it by looking at the screenshot below. Its icon is drawn with a cross, and it is circled in blue in the screenshot.

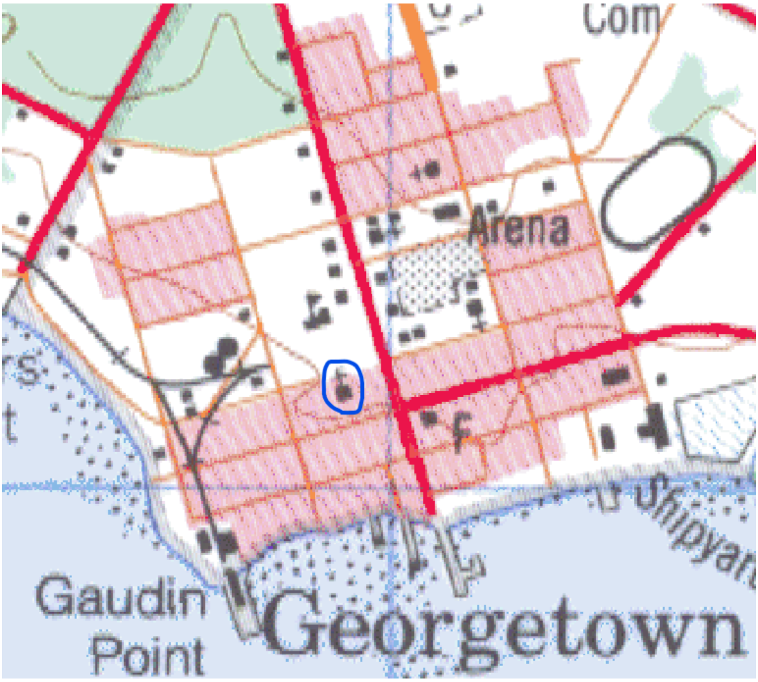


Figure 4.6

- Before you place a point on this location on the NTS map, turn off the NTS map in QGIS' Table of Contents and turn on the OpenStreetMaps basemap. Use the basemap to verify the church's location. The church is represented on the basemap with a cross as well.
    - You might have to zoom in a little to see the OpenStreetMap clearly. But this is a good thing, for, by making our scale larger, we are ensuring the point's accuracy.

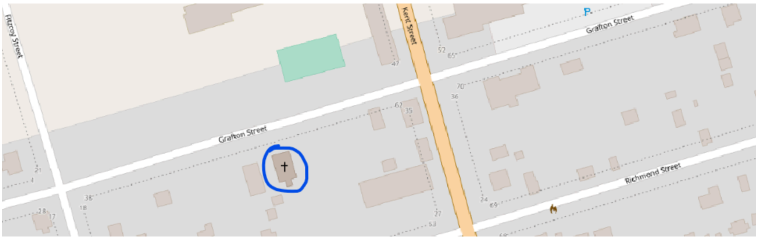


Figure 4.7

- Click on the location of the church on the OpenStreetMap to place our point.
- In the Feature Attributes dialogue box that appears, type in the following details:
    - ID: 01
        - As we add more points to the 1991buildings layer, we will give each new point a unique ID number.
    - Name: St. David's Presbyterian Church
- Click OK.

You will now see a point appear where St. David's Presbyterian Church is on the basemap. In my case, the point is green.

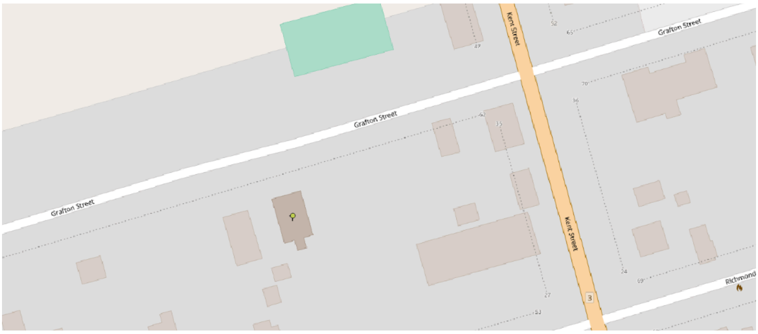


Figure 4.8

Note: you can change the colour of your point by using the Layer Styling panel to the right of your screen. Under Color, you can click the dropdown arrow to access other colours. If you do not see the Layer Styling panel, you can open it by clicking "Open the Layer Styling Panel" or clicking F7 on your keyboard.

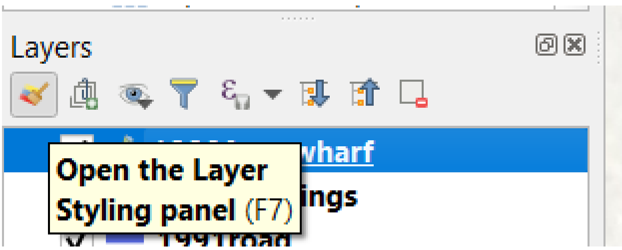
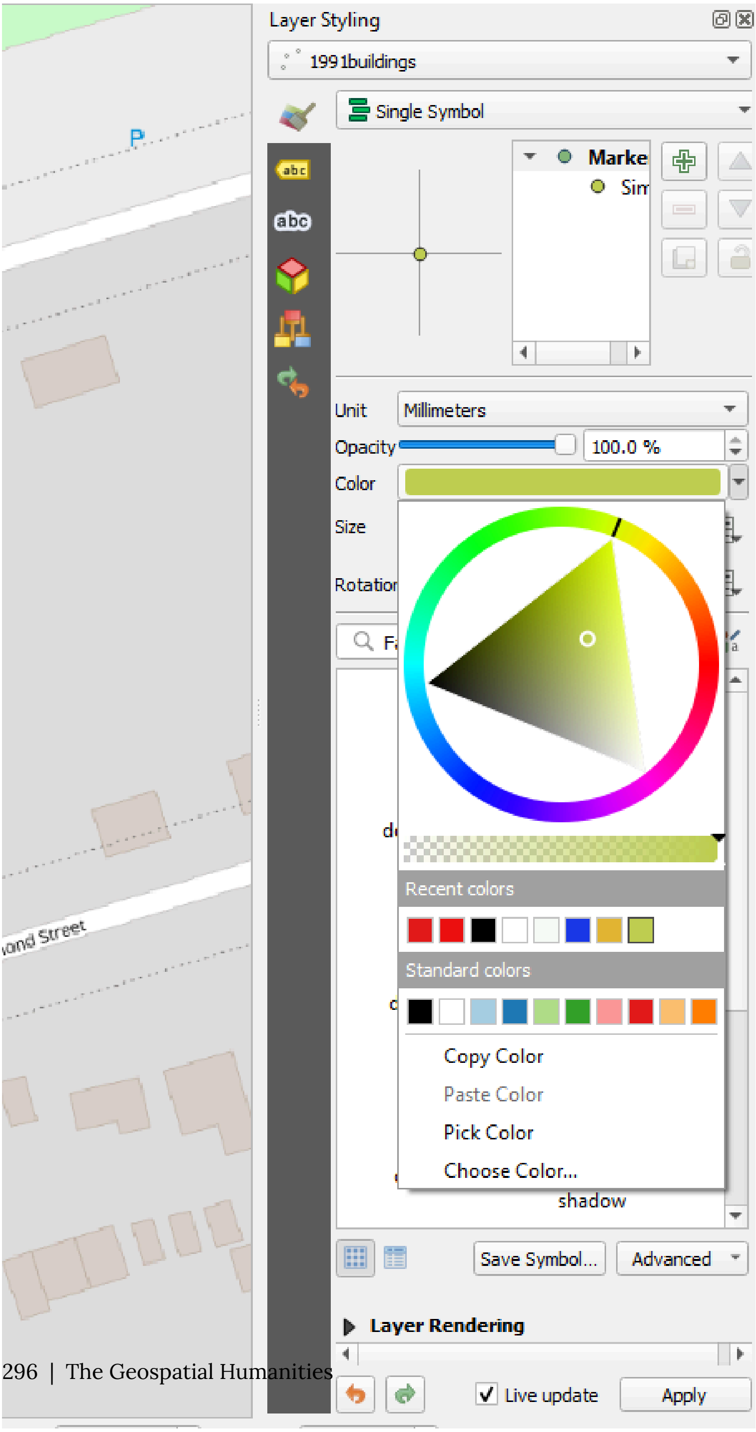


Figure 4.9



P
ond Street
Layer Styling
1991buildings
Single Symbol
Marke
Sim
Unit
Millimeters
Opacity
100.0 %
Color
Size
Rotation
Recent colors
Standard colors
Copy Color
Paste Color
Pick Color
Choose Color...
shadow
Save Symbol...
Advanced
Layer Rendering
Live update
Apply

Figure 4.10

Since we used the basemap to decide the final location of the point, let's have a look at the location of the church on the NTS map to see how much more accurate we made our point's location by using the basemap.

As we can see in the following screenshot, the small scale of the NTS map makes its representation of the church's location a bit inaccurate. We ensured that our point was as accurate as possible by using the basemap.

Figure 4.11

Adding a Point for the Holy Trinity Anglican Church

- As we did when mapping St. David's Presbyterian Church, we will first identify the Holy Trinity Anglican Church on the NTS map. It is not named, but you will likely be able to locate it based on the screenshot below. It is represented with a cross.

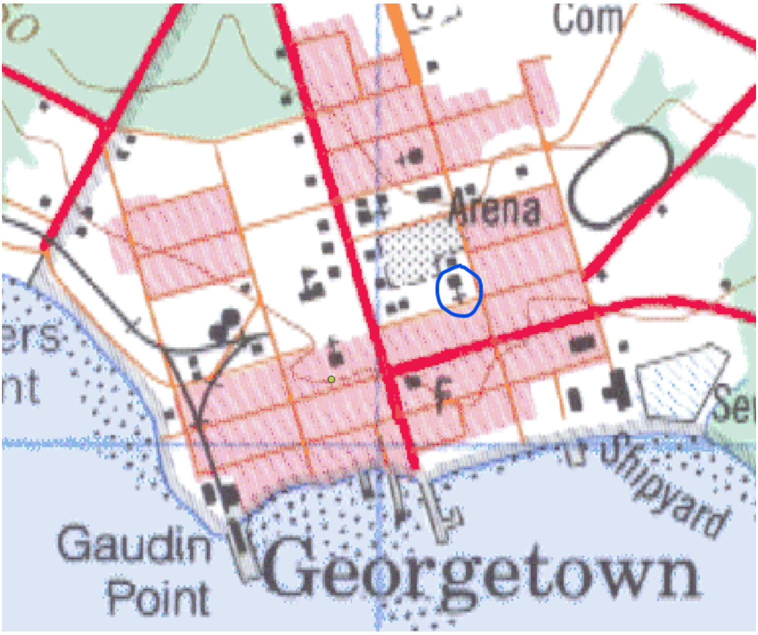


Figure 4.12

- Turn off the NTS map layer, and look at the basemap. Verify the church's location on the basemap. It is represented on the basemap with a cross.

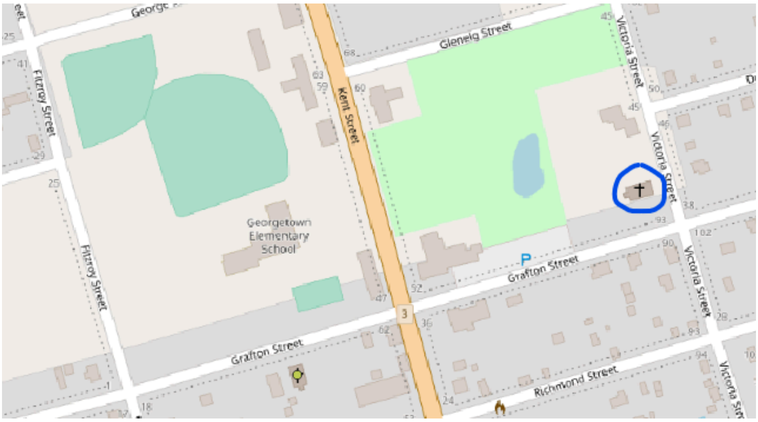


Figure 4.13

- Click on the location of the church on the OpenStreetMap to place our point.
- In the Feature Attributes dialogue box that appears, type in the following details:
    - ID: 02
    - Name: Holy Trinity Anglican Church
- Click OK.

You will now see a point appear where the Holy Trinity Anglican Church is on the basemap.

Figure 4.14

Adding a Point for the King's Playhouse

- As we did when mapping the two churches, we will first identify the King's Playhouse on the NTS map. It is not named, but you will likely be able to locate it based on the screenshot below. There are two squares on the corner of Kent Street and Grafton Street. The King's Playhouse is the one the furthest to the left.

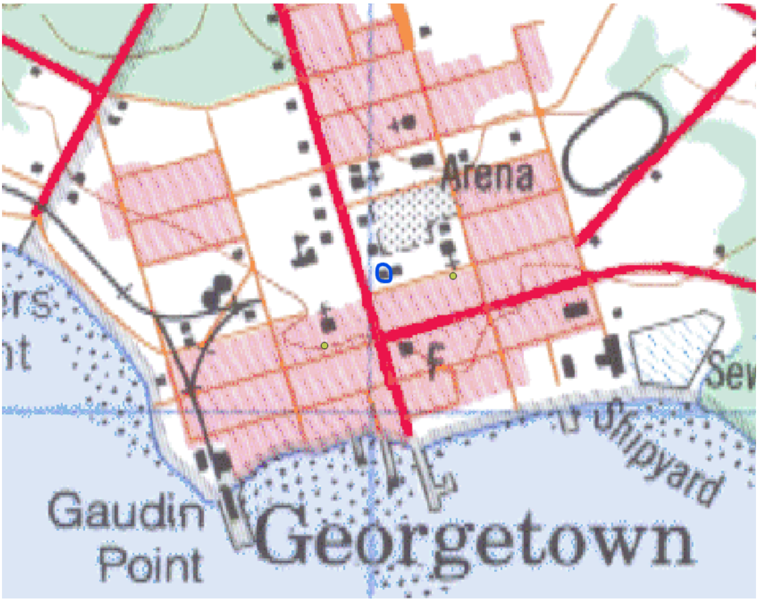


Figure 4.15

- Turn off the NTS map layer, and look at the basemap. Verify the King's Playhouse location on the basemap. You will be able to see the Playhouse's large footprint on the corner of Kent Street and Grafton Street.

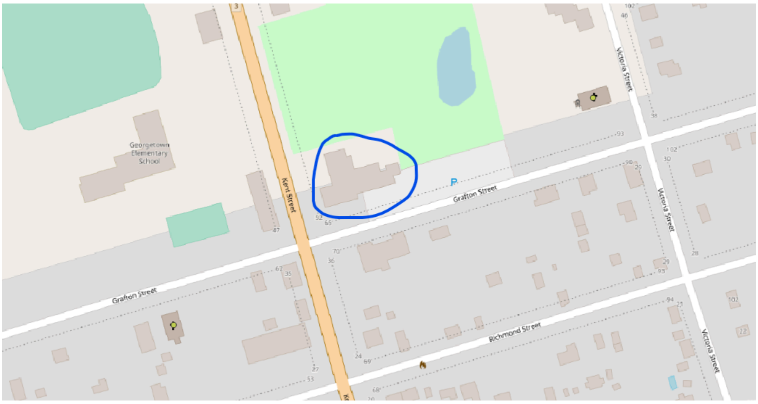


Figure 4.16

- Click on the location of the Playhouse on the OpenStreetMap to place our point.
- In the Feature Attributes dialogue box that appears, type in the following details:
  - ID: 03
  - Name: King's Playhouse
- Click OK.

You will now see a point appear where the King's Playhouse is on the basemap.

Figure 4.17

Saving the Vector Data

After we have created some vector data, we need to save it. Saving vector data is a separate process from saving the QGIS project itself. While it is also a good idea to continuously click Project > Save, after adding some vector data, we will also click the "Save Layer Edits" button.

- Click the "Save Layer Edits" button.


Figure 4.18

Line

Creating a New Shapefile Layer

Once again, we will first create a new shapefile:

- Click Layer
- Hover over Create Layer
- Click New Shapefile Layer

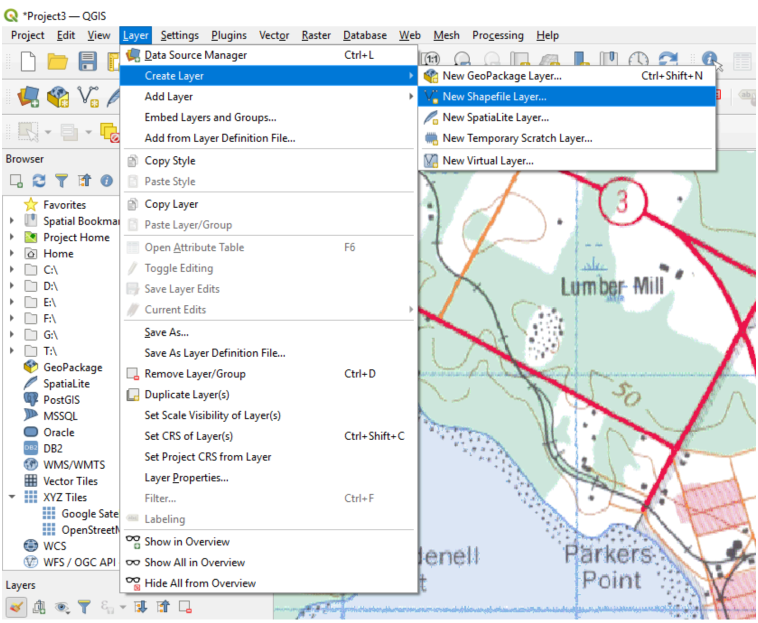


Figure 4.19

Fill out the following information in the dialogue box that appears:

File Name: ...QGIS\Chapter4\Vectors\1991road.shp

- To save our shapefile in the correct location, click the ellipsis to the right of the File Name field. Navigate to QGIS\Chapter4\Vectors. **Enter 1991road** as the File Name, and then click Save.

File Encoding: UTF-8

Geometry Type: Line

Additional Dimensions: None

Underneath Additional Dimensions, we can also make sure the CRS is set to "Project CRS: **EPSG: 2954**."

Under New Field, we can enter the following information:

- Name: Name
- Type: Text Data

We can leave the other settings.

- Click Add to Fields List.

We are creating this new field so that we can keep track of the names of the places for which we are creating lines.

- Click OK

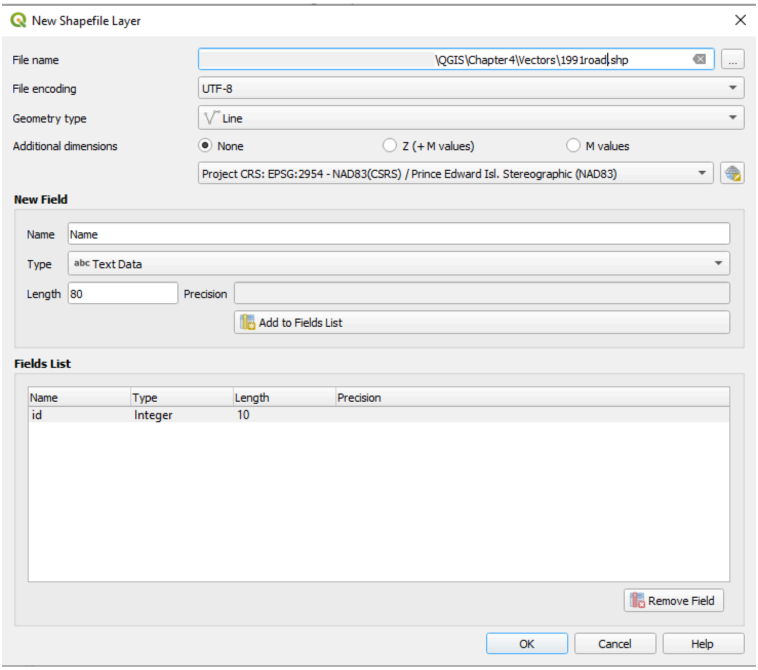

New Shapefile Layer
File name
\QGIS\Chapter4\Vectors\1991road.shp
File encoding
UTF-8
Geometry type
Line
Additional dimensions
None
Z (+ M values)
M values
Project CRS: EPSG:2954 - NAD83(CSRS) / Prince Edward Isl. Stereographic (NAD83)
New Field
Name
Name
Type
abc Text Data
Length
80
Precision
Add to Fields List
Fields List
Name
Type
Length
Precision
id
Integer
10
Remove Field
OK
Cancel
Help

Figure 4.20

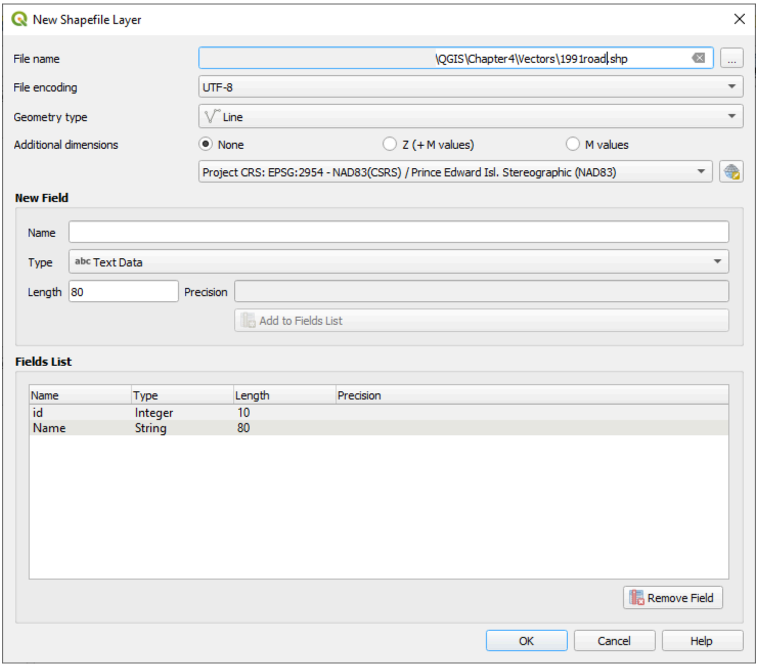


Figure 4.21

Adding a Line to the Reference Map

An Important Note about Scale

As we did when we added the points, we must consider the small scale of the NTS map when we add our line in this step. We will first identify the road for which we want to create a line on the NTS map. We will then turn off the NTS map and check the location of the same road on the basemap.

Adding the Line

- Click Toggle Editing

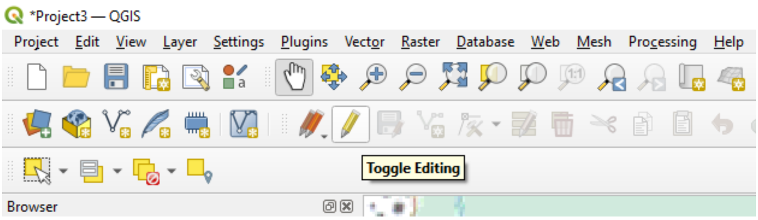


Figure 4.22

- Click Add Line Feature

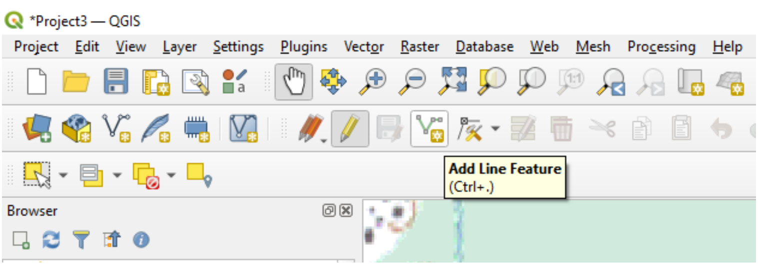


Figure 4.23

Adding a Line for Kent Street

- Identify where Kent Street and North Street intersect on the NTS map.

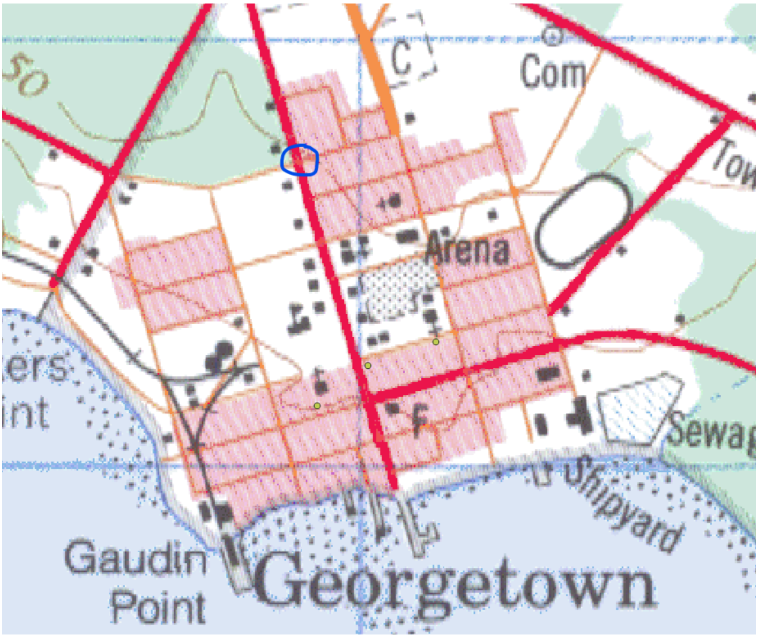


Figure 4.24

- Identify where Kent Street and Water Street intersect on the NTS map.

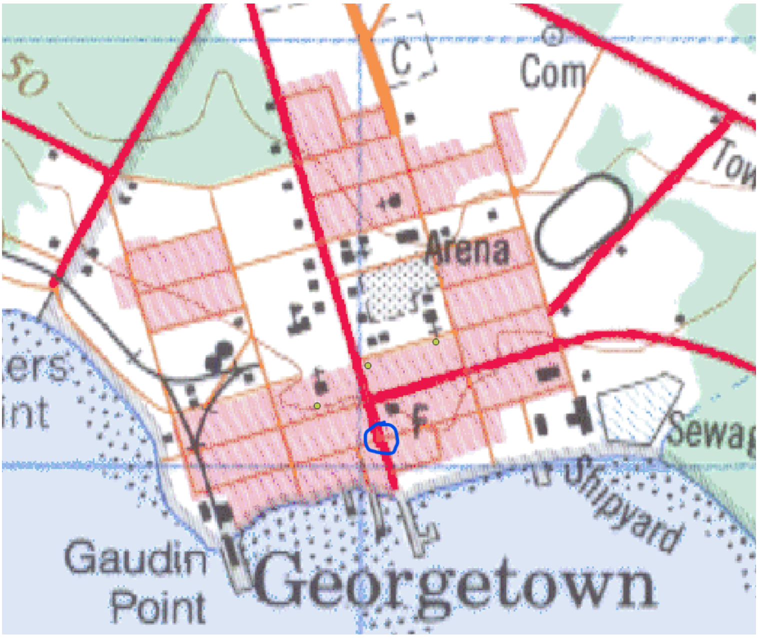


Figure 4.25

- Turn off the NTS layer and look at the base map. Identify the same two points on the base map.

Figure 4.26

- Left-click once at the intersection of Kent Street and North Street.
- Move your mouse to the intersection of Kent Street and Water Street and left-click again.
    - Although it is not necessary in this case, you could continue to left-click at various other points to add extra segments to your line.
- Right-click to complete the line.
- In the Feature Attributes dialogue box that appears, type in the following details:
    - ID: 01
    - Name: Kent Street
- Click OK.

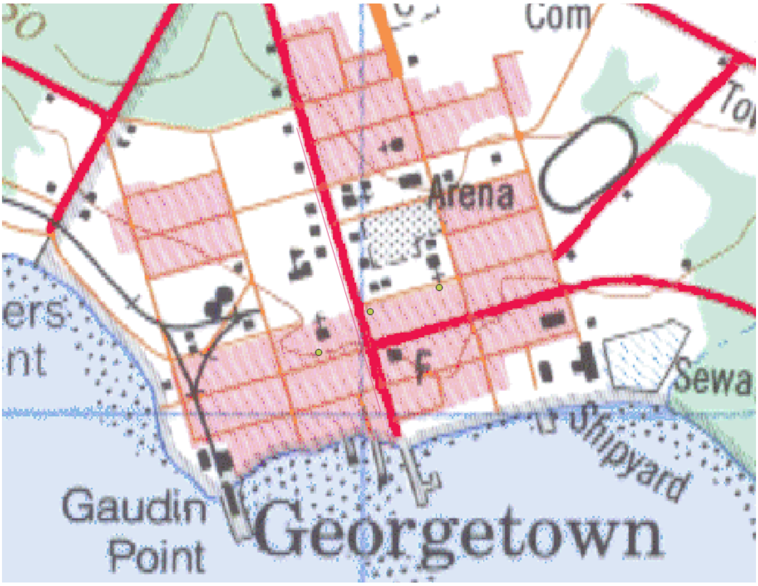


Figure 4.27

The red colour of the line we just created renders it difficult to see among the red in the NTS map.

- In the Layer Styling panel to the right of your screen, click the Color dropdown menu and change the line's colour to a purple or blue.
- Change the line's Width to 1.0 as well.
- Click Apply

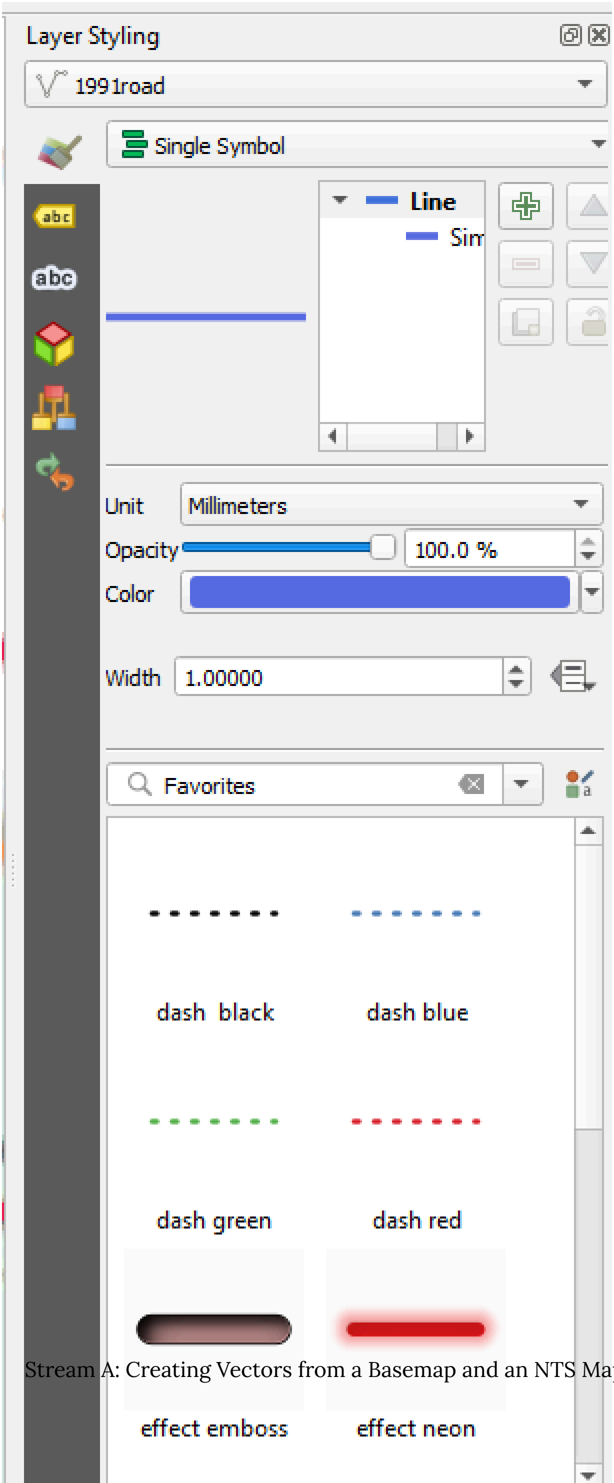

Layer Styling
1991road
Single Symbol
Line
Sim
Unit
Millimeters
Opacity
100.0 %
Color
Width
1.00000
Favorites
dash black
dash blue
dash green
dash red
effect emboss
effect neon

Figure 4.28

The resulting line is much easier to see:

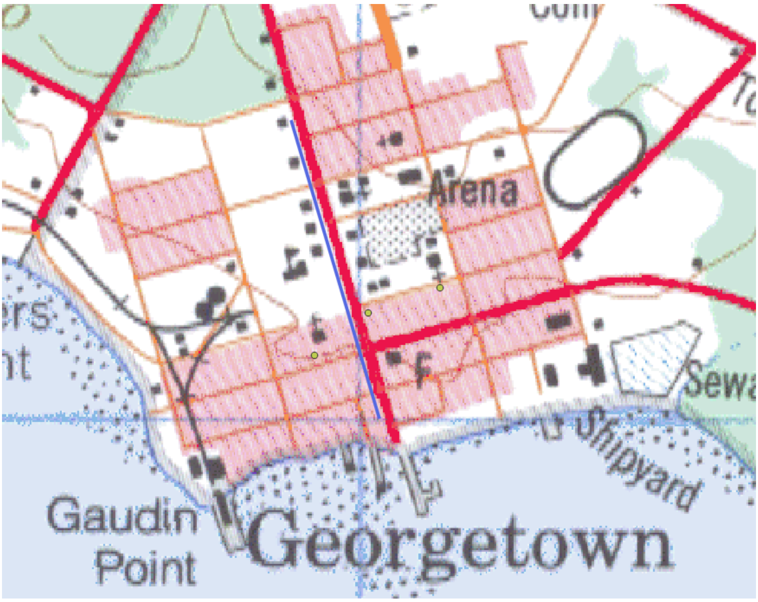


Figure 4.29

Looking at our line with the NTS layer turned on proves once again that we were able to add more accurate vector data by using the larger-scale basemap than the NTS map.

Saving the Vector Data

As always, let's save the vector data that we just created.

- Click the "Save Layer Edits" button.

Figure 4.30

Polygon

Creating a New Shapefile

Once again, we will first create a new shapefile:

- Click Layer
- Hover over Create Layer
- Click New Shapefile Layer

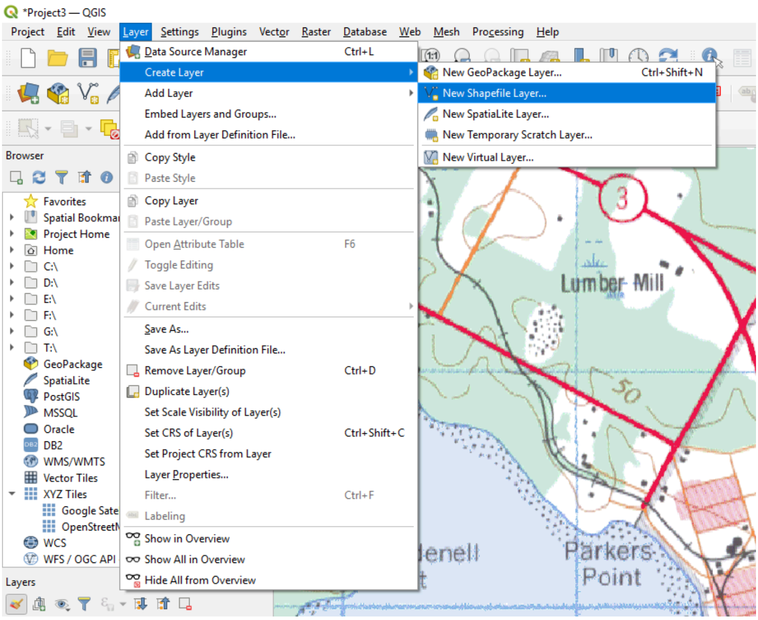


Figure 4.31

Fill out the following information in the dialogue box that appears:
File Name: ...QGIS\Chapter4\Vectors\1991kentsquare.shp

- To save our shapefile in the correct location, click the ellipsis to the right of the File Name field. Navigate to QGIS\Chapter4\Vectors. Enter **1991kentsquare** as the File Name, and then click Save.

File Encoding: UTF-8

Geometry Type: Polygon

Additional Dimensions: None

Underneath Additional Dimensions, we can also make sure the CRS is set to “Project CRS: **EPSG: 2954**.”

Under New Field, we can enter the following information:

- Name: Name
- Type: Text Data

We can leave the other settings.

- Click Add to Fields List.

We are creating this new field so that we can keep track of the names of the places for which we are creating polygons.

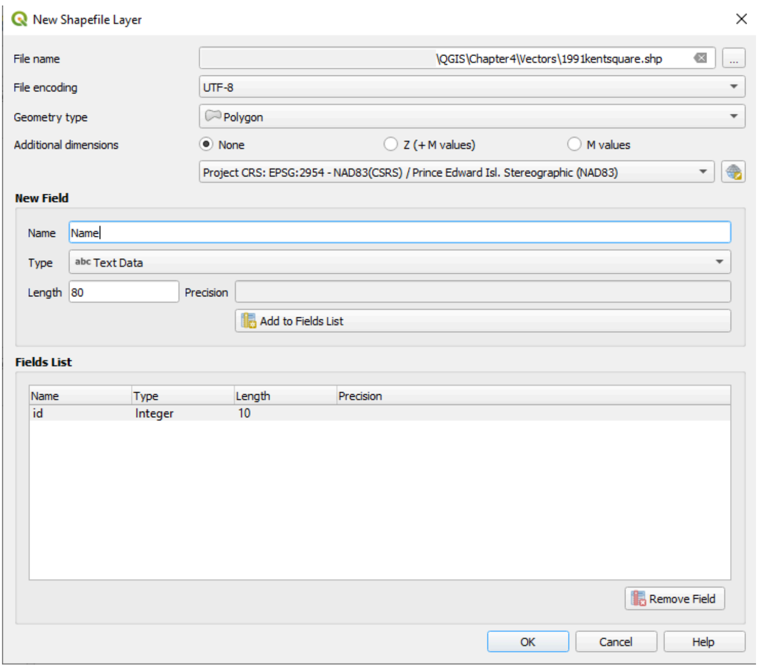


Figure 4.32

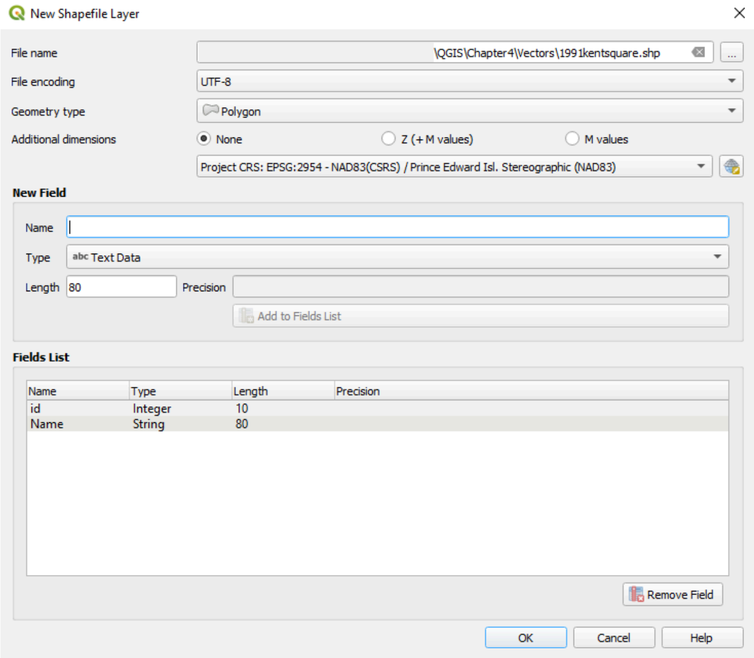


Figure 4.33

- Click OK

Adding a Polygon to the Reference Map

An Important Note about Scale

As we did when we added the points and the line, we must consider the small scale of the NTS map when we add our polygon in this step. We will first identify the area for which we want to create a polygon on the NTS map. We will then turn off the NTS map and check the location of the same area on the basemap.

Adding the Polygon

- Click Toggle Editing

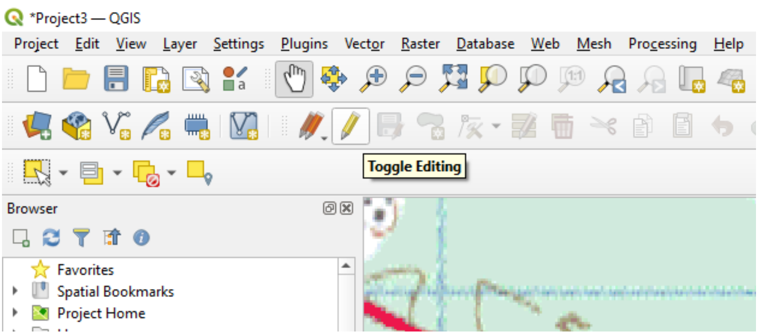


Figure 4.34

- Click Add Polygon Feature

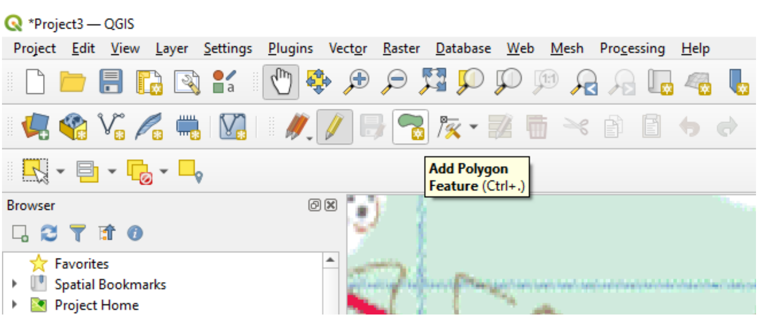


Figure 4.35

Adding a Polygon for Kent Square

- Identify Kent Square on the NTS map.

Figure 4.36. Kent Square on the NTS map is shown with a blue box around the perimeter.

- Turn off the NTS layer and identify Kent Square on the basemap.

Figure 4.37

- Left-click once at the corner of George Street and Fitzroy Street.
- Move your mouse to the corner of George Street and Victoria Street and left-click again.
- Move your mouse to the corner of Victoria Street and Grafton Street and left-click again.
- Move your mouse to the corner of Grafton Street and Fitzroy Street and left-click again.
- Right-click to complete the line.
- In the Feature Attributes dialogue box that appears, type in the following details:
    - ID: 01
    - Name: Kent Square
- Click OK.

The resulting polygon hides part of the road and buildings layers that we previously created.

- In the Table of Contents, drag the 1991kentsquare layer

beneath the 1991buildings layer.

- In the Layer Styling panel to the right of your screen, change the Opacity to 50.0%.

Here is the result:

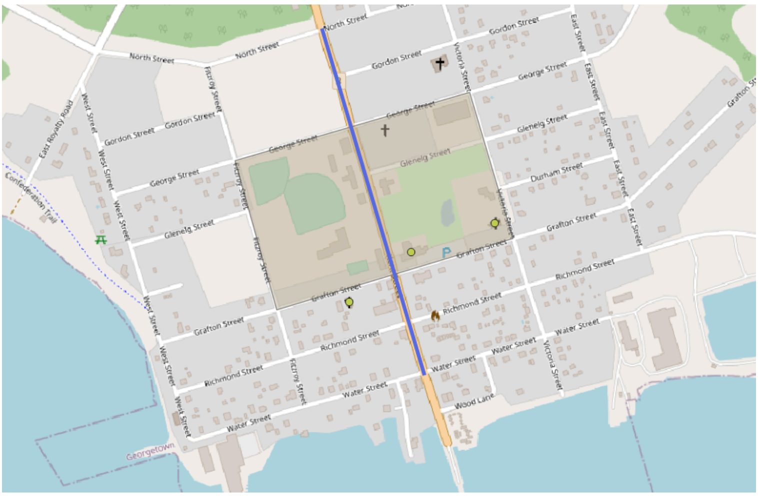


Figure 4.38

If we turn on the NTS map, we can see that we placed the polygon in a much more accurate position by using the basemap.

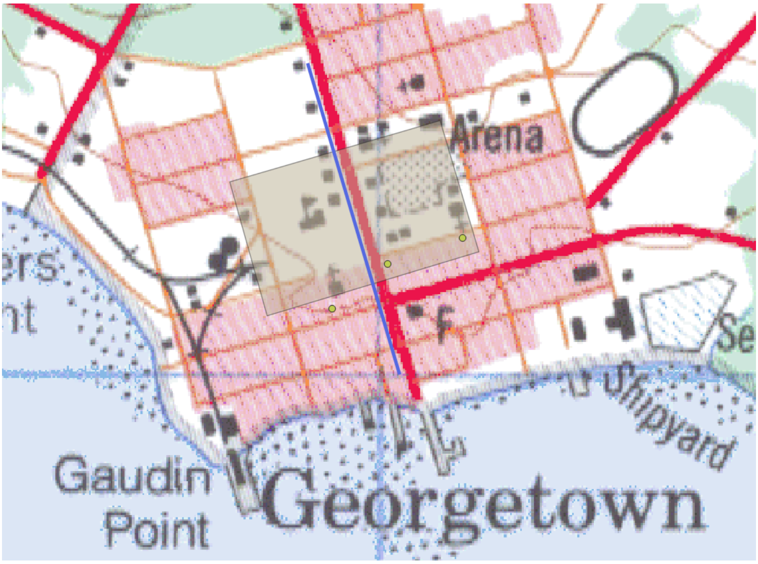


Figure 4.39

Saving the Vector Data

As always, let's save the vector data that we just created.

- Click the "Save Layer Edits" button.

Figure 4.40

Stream B: Creating Vectors from Your Georeferenced Map

Mapping Georgetown's Decline

In Stream B, you will get to see how some elements of Georgetown remained the same while others changed between 1880 and 1991. By seeing these continuity and change over a century, you will begin to visually see the effects Georgetown's decline.

Continuity as a Sign of Decline

- Turn off the NTS layer and turn on the Georgetown_modified layer of Georgetown in 1880.
- See how the points, line, and polygon we added in Stream A align with the data in and around Kent Square.

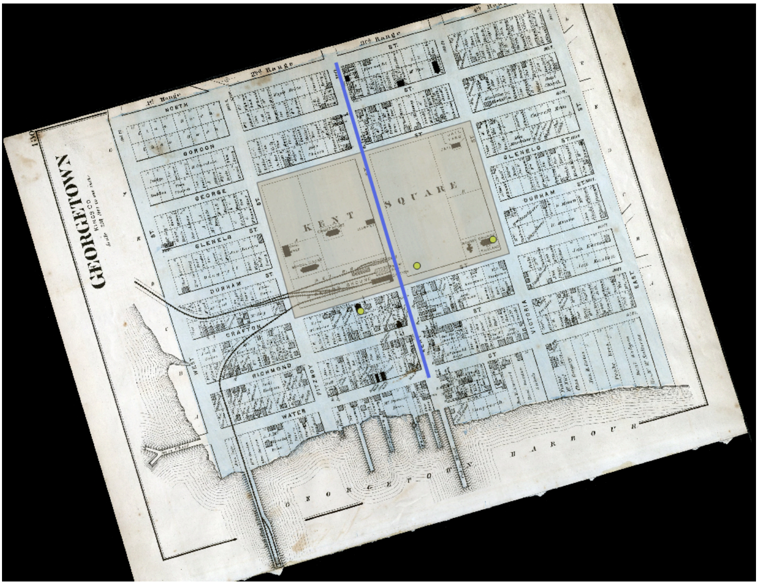


Figure 4.41

We can see how the town has changed very little between 1880 and 1991 and how this lack of change is indicative of the town's stagnation.

The two churches are still in their same locations. Often, when a town's population expands, more churches are built to accommodate the newcomers. In Georgetown, it seems that the demand for churches remained the same between 1880 and 1991, which perhaps suggests a stagnation. The only new feature that we can see between 1880 and 1991 is the King's Playhouse.

Between 1880 and 1991, there was no additional road built with which to enter Georgetown. Kent Street has remained the only way into the town. This shows that Georgetown's settlement and commercial activity has only ever required one main entrance into the town. By contrast, there are many roads by which to enter the Island's major towns, Summerside and Charlottetown.

There was very little change to Kent Square between 1880 and

1991. This shows that, despite over 100 years passing, the heart of the town remained largely the same between 1880 and 1991. That settlers' homes and merchants' buildings never really encroached on the square over a period of 100 years shows that Georgetown's development had stagnated.

Change as a Sign of Decline

We will now digitize features that existed in Georgetown in 1880 but had disappeared by 1991. This loss of features will perhaps reveal more aspects of Georgetown's decline.

To start with, we will digitize Georgetown's railway station, its customs house, and shipbuilder Benjamin Davies' shipyard as points. We will also digitize Georgetown's ferry wharf as a line and its railway wharf as a polygon.

The railway came to Georgetown in 1872, and it augmented the town's status as a port of trade. Passengers and goods were shipped into the port, from which the railway could take them inland. To facilitate this process, Georgetown's railway station and railway wharf were built.

That Georgetown had a customs house further shows that the town was a key port of entry in 1880.

Benjamin Davies, a significant Island shipbuilder of the late nineteenth century, presumably built ships in Georgetown as part of Georgetown's booming shipbuilding industry in the late nineteenth century.

The ferry connection between Georgetown and Pictou was a key driver of Georgetown's prosperity in the nineteenth century, before it was replaced by the ferry link between Borden-Carleton and Cape Tormentine in the twentieth century. The ferry wharf for which we will create vector data was the place at which the ferry docked in Georgetown.

All of the above features were part of Georgetown in 1880 and were keys to its prosperity. So, their disappearance by 1991 is indicative of the town's decline.

Creating Vectors: Points, Lines, and Polygons

An Important Note about Scale

Unlike the 1991 topographic map, the Georgetown map from Meacham's Atlas (1880) is an urban map at a large scale. So, we do not have to consult the basemap to verify the locations of our points, lines, and polygons on the Georgetown map. Since we used the basemap and made sure that we mapped the vector data on the NTS map at a larger scale, we are able to make accurate comparisons between the 1880 and 1991 maps.

Points

Creating a New Shapefile

To create our vector data, we will first create a new shapefile layer. To do so,

- Click Layer
- Hover over Create Layer
- Click New Shapefile Layer

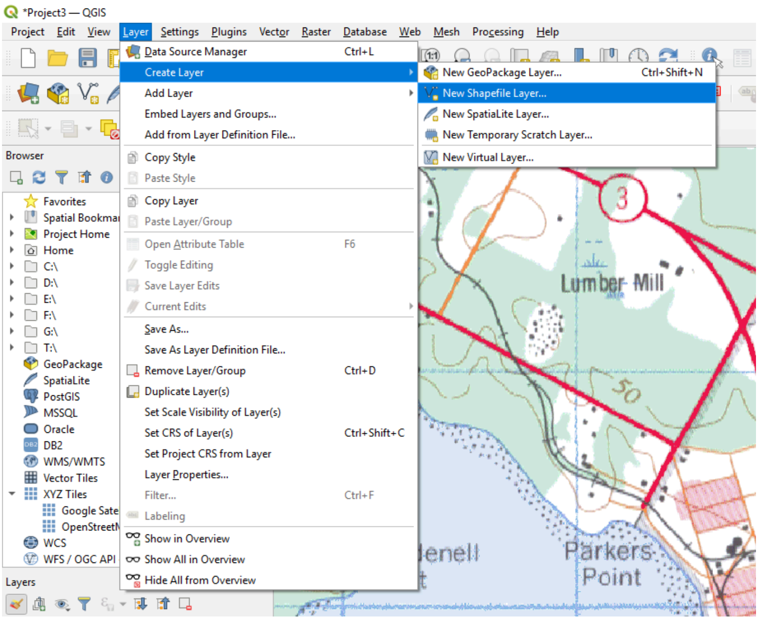


Figure 4.42

Fill out the following information in the dialogue box that appears:

File Name: ...QGIS\Chapter4\Vectors\1880buildings.shp

- To save our shapefile in the correct location, click the ellipsis to the right of the File Name field. Navigate to QGIS\Chapter4\Vectors. Enter **1880buildings** as a File Name, and then click Save.

File Encoding: UTF-8

Geometry Type: Point

Additional Dimensions: None

Underneath Additional Dimensions, we can also make sure the CRS is set to “Project CRS: **EPSG: 2954.**”

Under New Field, we can enter the following information:

- Name: Name
- Type: Text Data

We can leave the other settings.

- Click Add to Fields List.

We are creating this new field so that we can keep track of the names of the places for which we are creating points.

- Click OK

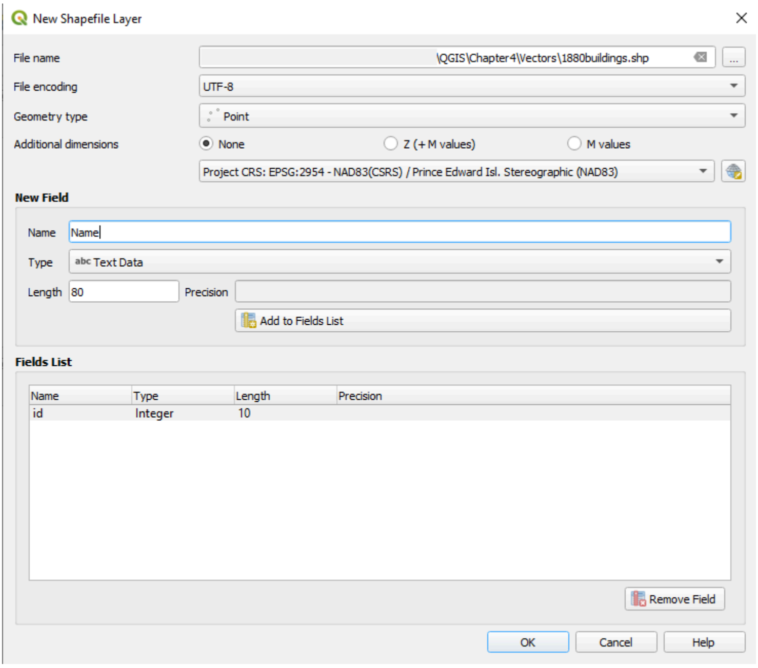


Figure 4.43

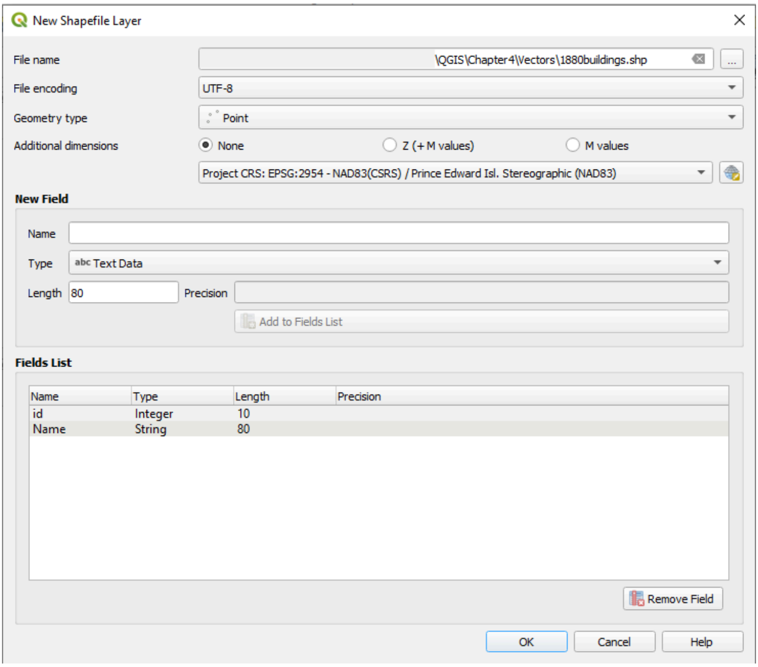


Figure 4.44

Adding Points to the Reference Map

Now that we have our new shapefile created, we can start to add our points to our 1880 map of Georgetown.

- Click Toggle Editing

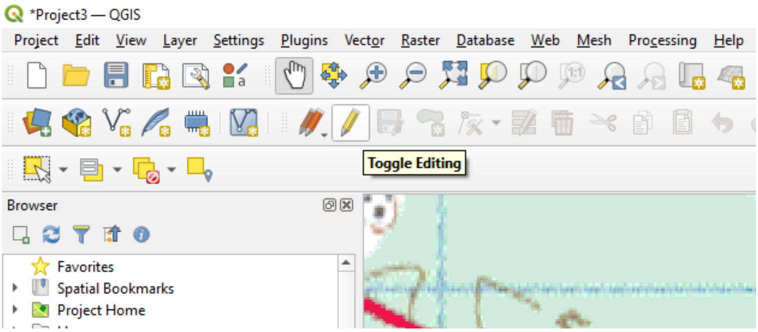


Figure 4.45

- Click Add Point Feature

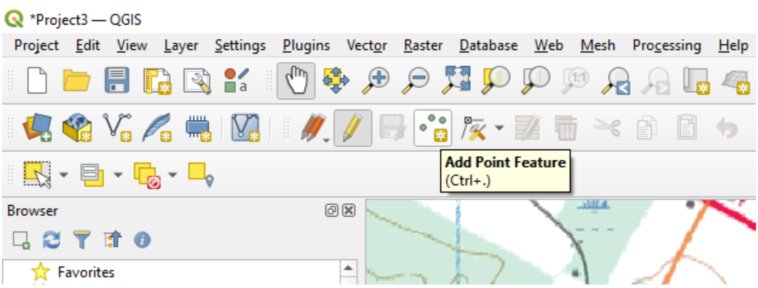


Figure 4.46

Adding a Point for Georgetown's Railway Station

- Identify the railway station in the 1880 map of Georgetown. There are multiple buildings on the railway station ground, but the one we are interested in is the one circled in pink in the following screenshot:

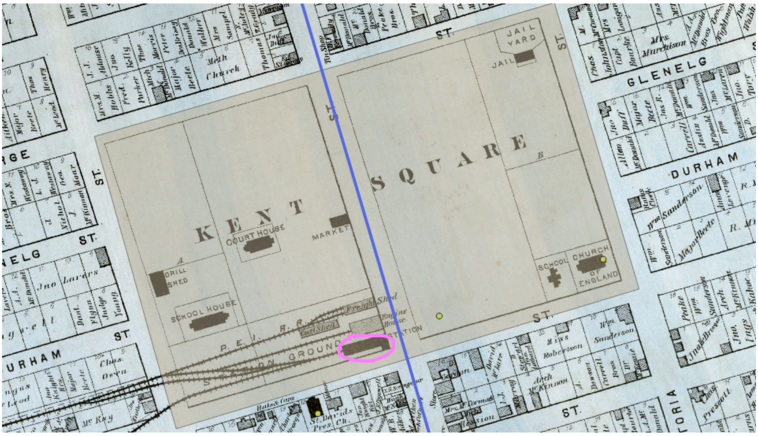


Figure 4.47

> **Note**: if you are finding it difficult to see the railway station among the points, lines, and polygons that we created in Stream A, you can uncheck them in the Layers table of contents.

- Click on the location of the station building on the 1880 map of Georgetown to place our point.
- In the Feature Attributes dialogue box that appears, type in the following details:
  - ID: 01
    - As we add more points to the 1880buildings layer, we will give each new point a unique ID number.
  - Name: Railway Station
- Click OK.

You will now see a point appear where the railway station is located on the Georgetown map. In my case, the point is brown.

The polygon that we created in Stream A is also brown, so I am going to change this point's colour to pink.

- In the Layer Styling panel to the right of your screen, under Color, click the dropdown arrow and select a shade of pink.
- Click Apply.

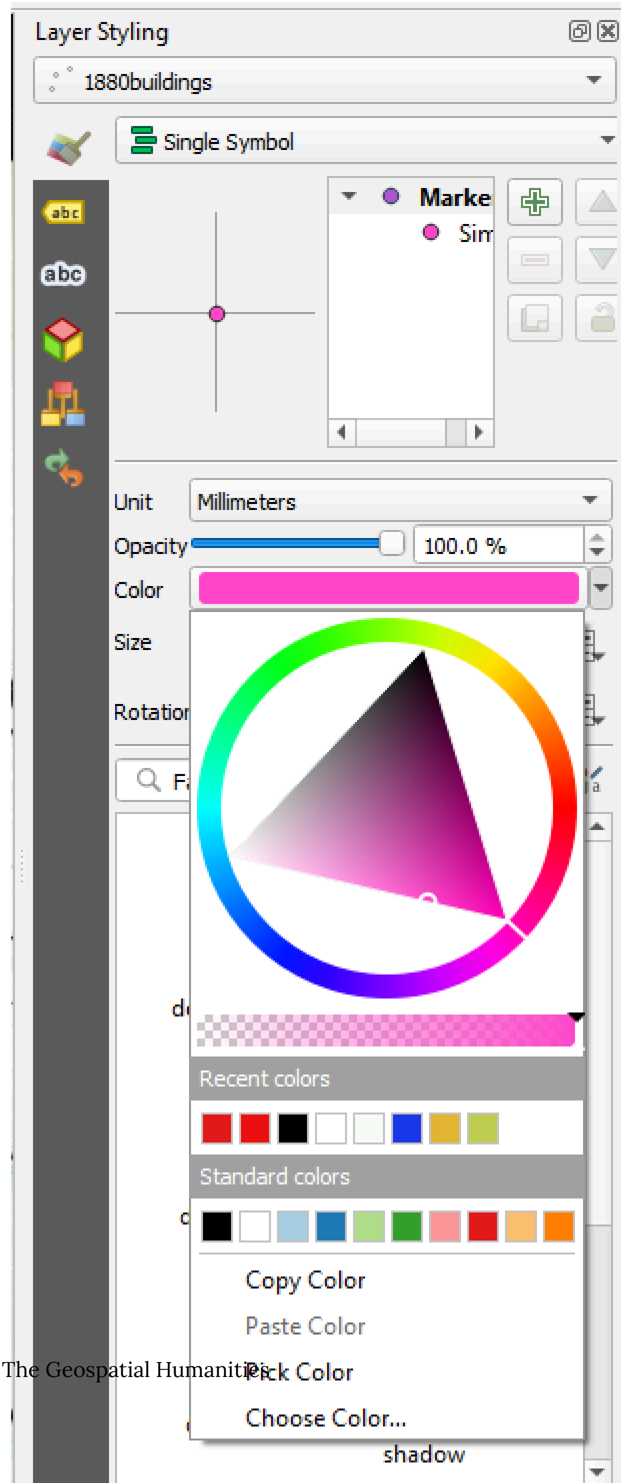

Layer Styling
1880buildings
Single Symbol
Marke
Sim
Unit
Millimeters
Opacity
100.0 %
Color
Size
Rotation
Recent colors
Standard colors
Copy Color
Paste Color
Pick Color
Choose Color...
shadow

Figure 4.48

Adding a Point for Georgetown's Customs House

- As we did when mapping Georgetown's railway station, we will first identify Georgetown's customs house on the map. It is circled in pink in the screenshot below:

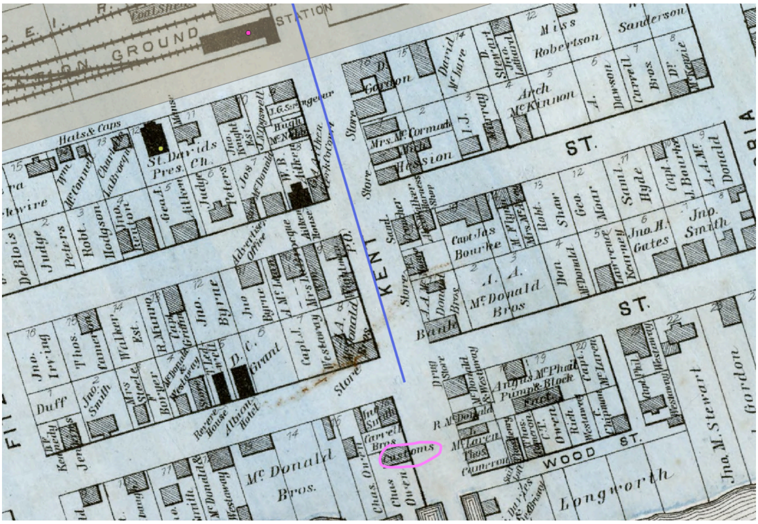


Figure 4.49

- Click on the location of the customs house on the Georgetown map to place our point.
- In the Feature Attributes dialogue box that appears, type in the following details:
    - ID: 02
    - Name: Customs House
- Click OK.

You will now see a point appear where the customs house is on the basemap.

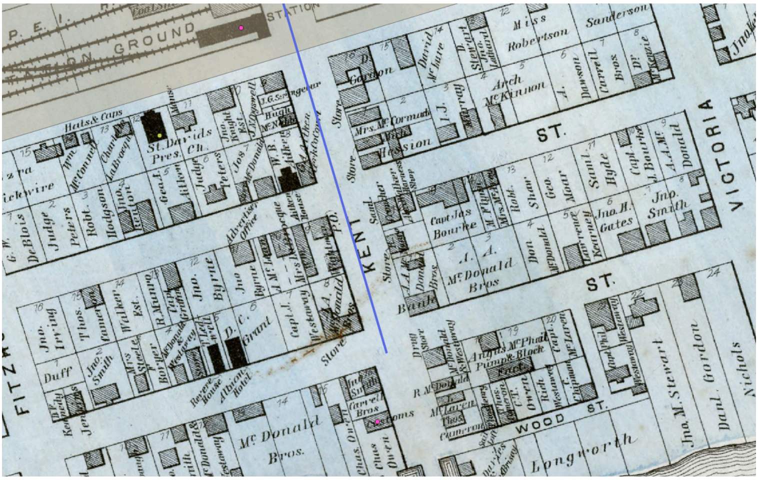


Figure 4.50

Adding a Point for Benjamin Davies' Shipyard

- Let's identify Benjamin Davies' shipyard on the map. It is circled in pink in the screenshot below:

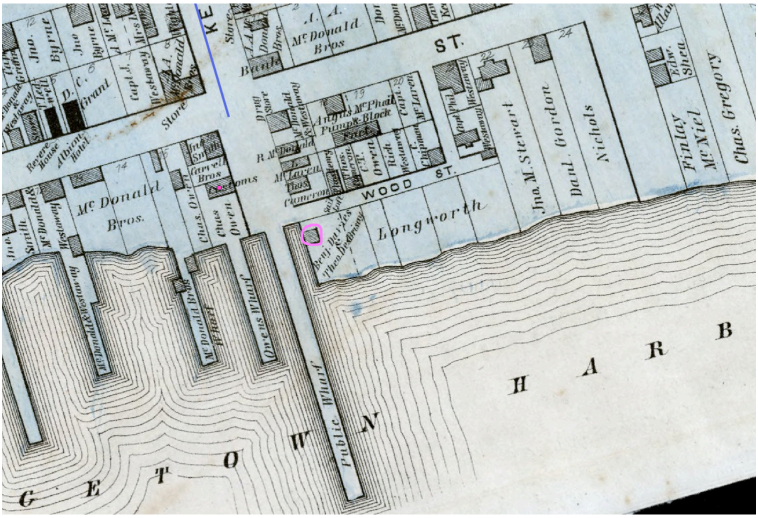


Figure 4.51

- Click on the location of Benjamin Davies' shipyard on the Georgetown map to place our point.
- In the Feature Attributes dialogue box that appears, type in the following details:
    - ID: 03
    - Name: Shipyard
- Click OK.

You will now see a point appear where the shipyard is on the basemap.

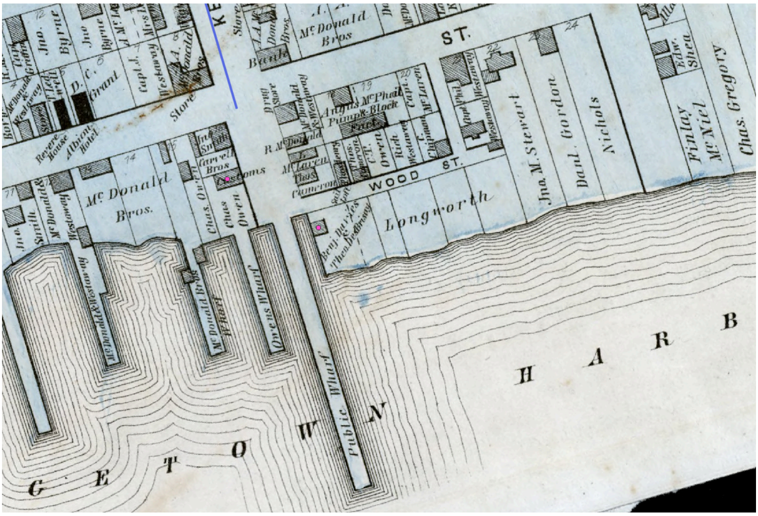


Figure 4.52

Saving the Vector Data

As always, let's save the vector data that we just created.

- Click the "Save Layer Edits" button.

Figure 4.53

Lines

Creating a New Shapefile Layer

Once again, we will first create a new shapefile:

- Click Layer
- Hover over Create Layer
- Click New Shapefile Layer

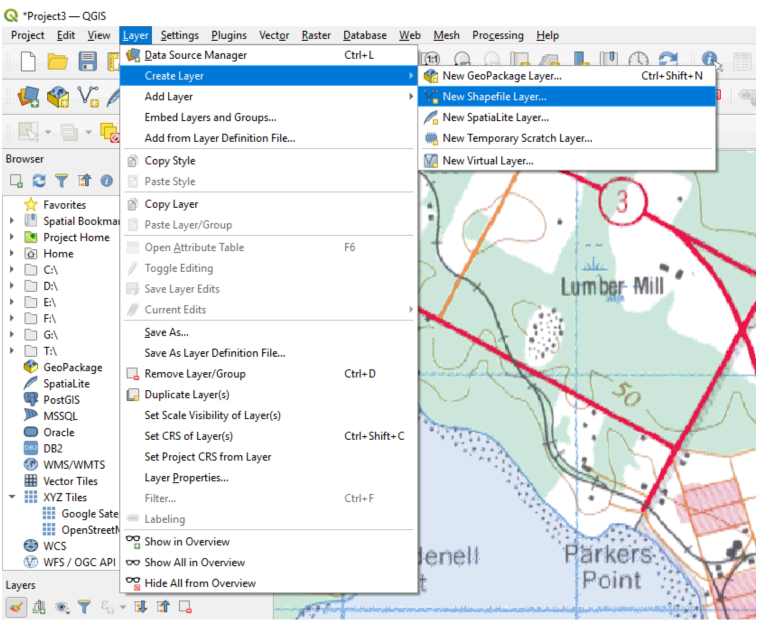


Figure 4.54

Fill out the following information in the dialogue box that appears:

File Name: …QGIS\Chapter4\Vectors\1880ferrywharf.shp

- To save our shapefile in the correct location, click the ellipsis to the right of the File Name field. Navigate to QGIS\Chapter4\Vectors. Enter **1880ferrywharf** as the File Name, and then click Save.

File Encoding: UTF-8

Geometry Type: Line

Additional Dimensions: None

Underneath Additional Dimensions, we can also make sure the CRS is set to "Project CRS: EPSG: 2954."

Under New Field, we can enter the following information:

- Name: Name
- Type: Text Data

We can leave the other settings.

- Click Add to Fields List.

We are creating this new field so that we can keep track of the names of the places for which we are creating lines.

- Click OK

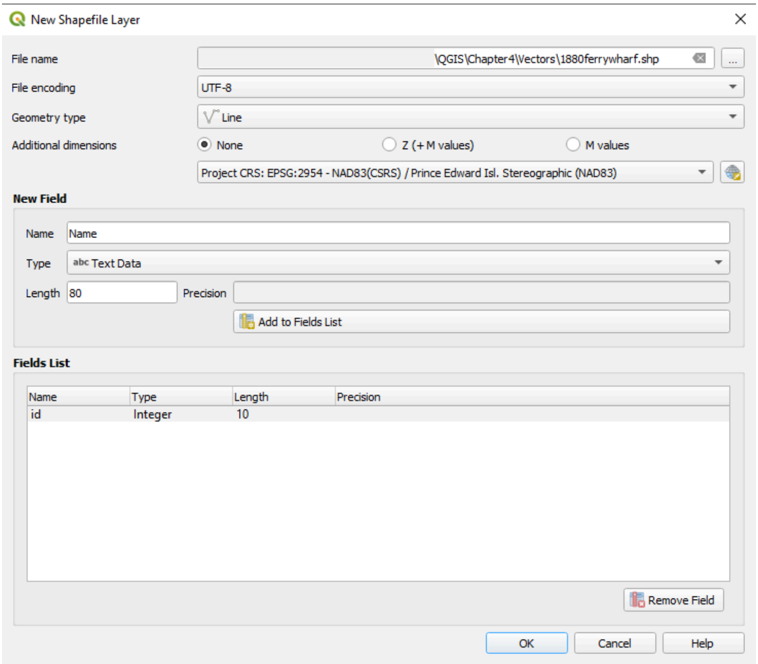

New Shapefile Layer
File name
\QGIS\Chapter4\Vectors\1880ferrywharf.shp
File encoding
UTF-8
Geometry type
Line
Additional dimensions
None
Z (+ M values)
M values
Project CRS: EPSG:2954 - NAD83(CSRS) / Prince Edward Isl. Stereographic (NAD83)
New Field
Name
Name
Type
abc Text Data
Length
80
Precision
Add to Fields List
Fields List
Name
Type
Length
Precision
id
Integer
10
Remove Field
OK
Cancel
Help

Figure 4.55

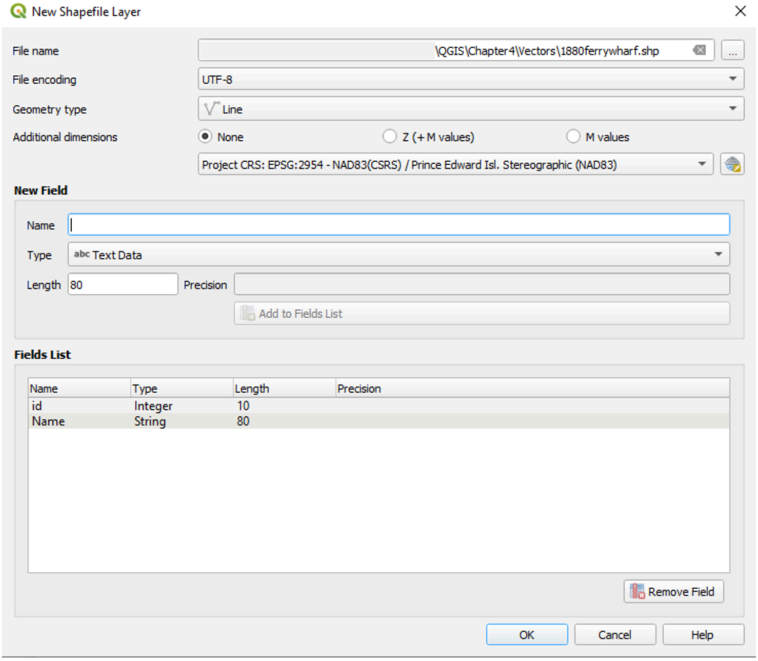


Figure 4.56

Adding the Line

- Click Toggle Editing

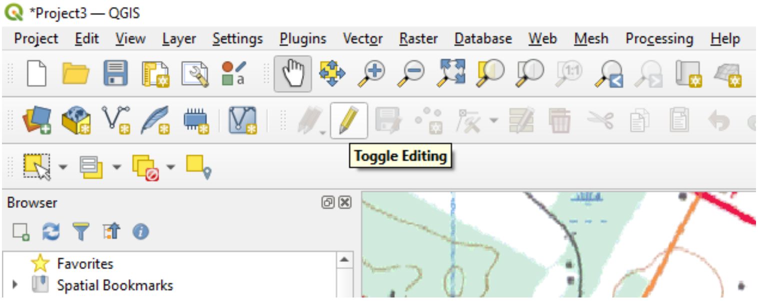


Figure 4.57

- Click Add Line Feature

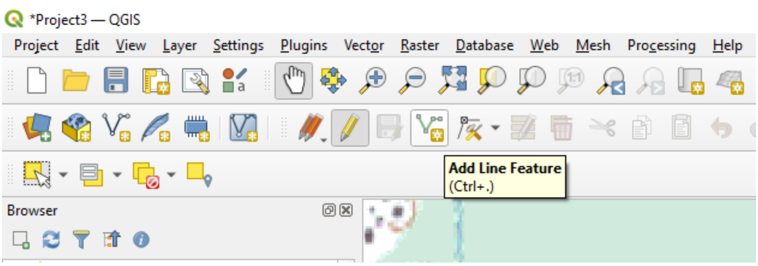


Figure 4.58

Adding a Line for the Ferry Wharf

- Find the ferry wharf on the left side of the map. It is identified in pink in the following screenshot:

Figure 4.59

In Stream A, we created a line with only one segment. In this step, we are going to create a multi-segmented line.

- Left-click once at the base of the Y-shaped wharf.

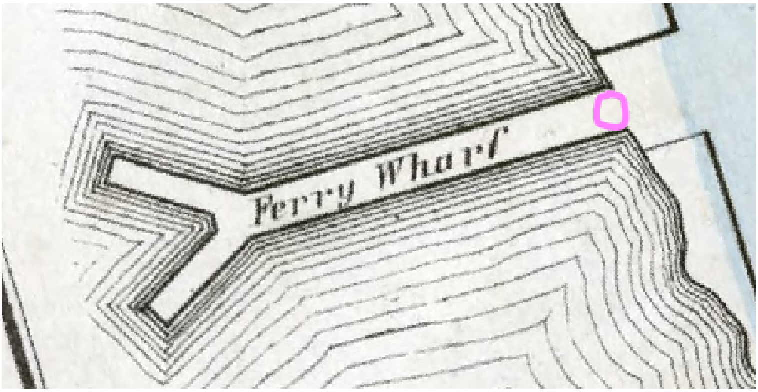


Figure 4.60

- Move your mouse to the point of the Y where the forks begin and left-click again.

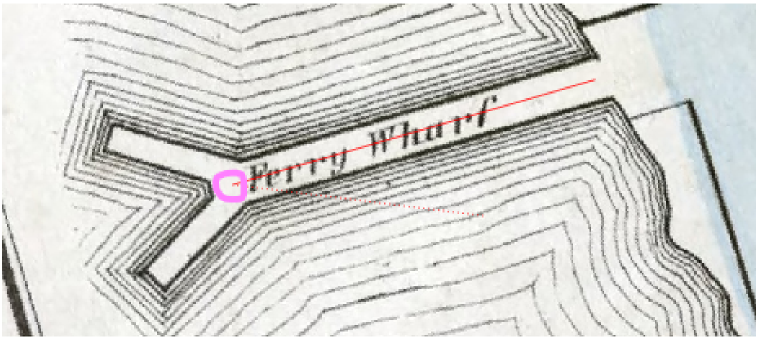


Figure 4.61

- Move your mouse to the end of the upper fork and left-click again.

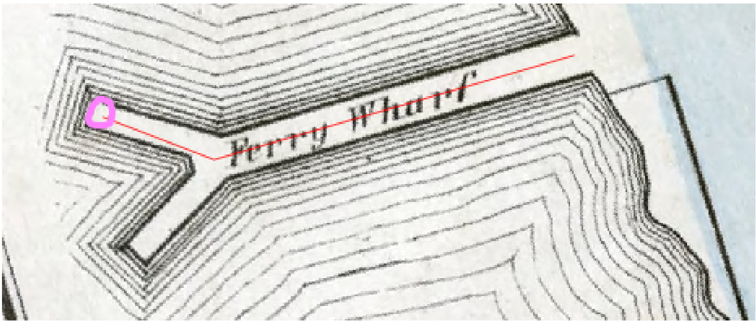


Figure 4.62

- Move your mouse across the to the end of the other fork and left-click again.

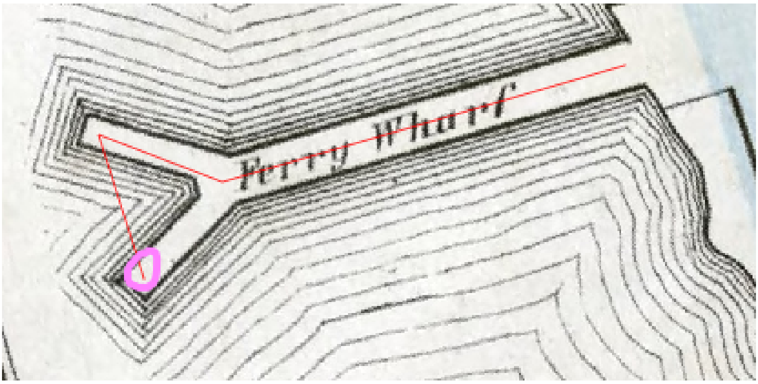


Figure 4.63

- Move your mouse to back to the point of the Y where the forks begin and left-click again.

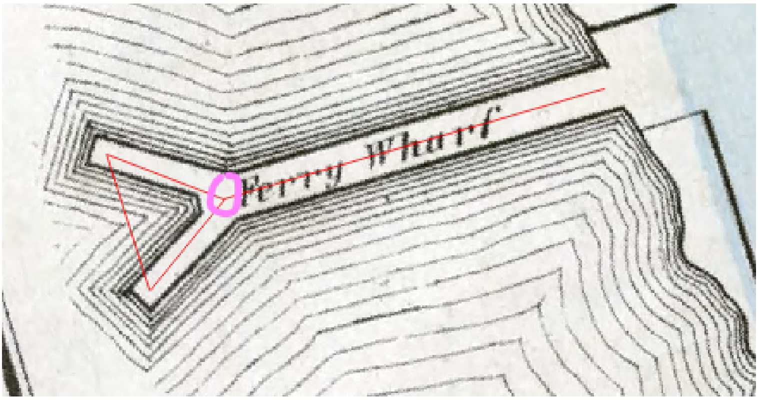


Figure 4.64

- Right-click to complete the line.
- In the Feature Attributes dialogue box that appears, type in the following details:
  - ID: 01
  - Name: Ferry Wharf
- Click OK.

The line is thin, which makes it difficult to see.

- In the Layer Styling Panel, change the line's width to 1.00 and click Apply.

The line is now much easier to see.

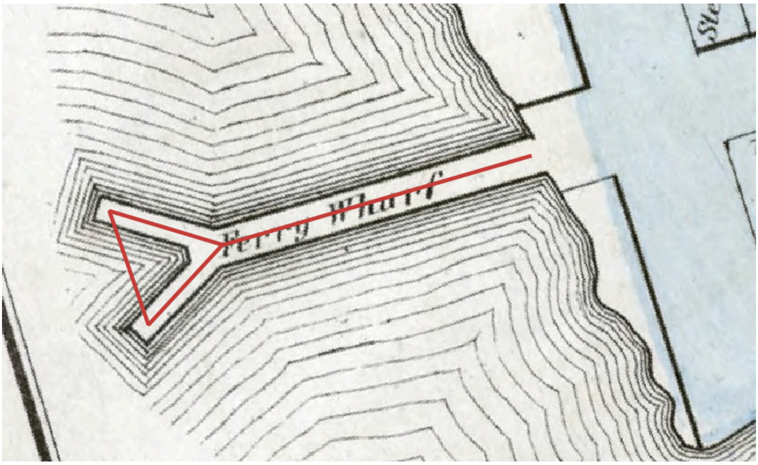


Figure 4.65

Saving the Vector Data

As always, let's save the vector data that we just created.

- Click the "Save Layer Edits" button.


Figure 4.66

Polygons

Creating a New Shapefile

Once again, we will first create a new shapefile:

- Click Layer
- Hover over Create Layer
- Click New Shapefile Layer

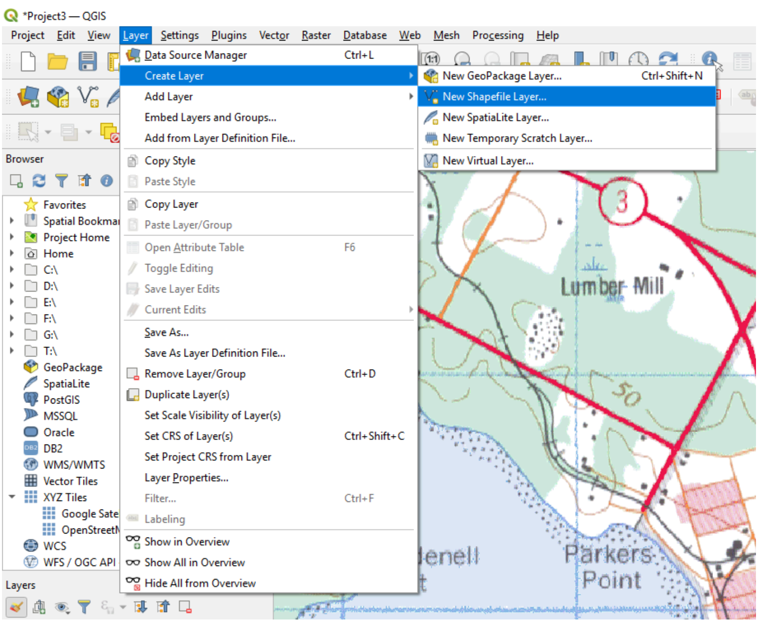


Figure 4.67

Fill out the following information in the dialogue box that appears:
File Name: ...QGIS\Chapter4\Vectors\1880railwaywharf.shp

- To save our shapefile in the correct location, click the ellipsis to the right of the File Name field. Navigate to QGIS\Chapter4\Vectors. Enter **1880railwaywharf** as the File Name, and then click Save.

File Encoding: UTF-8

Geometry Type: Polygon

Additional Dimensions: None

Underneath Additional Dimensions, we can also make sure the CRS is set to "Project CRS: EPSG: 2954."

Under New Field, we can enter the following information:

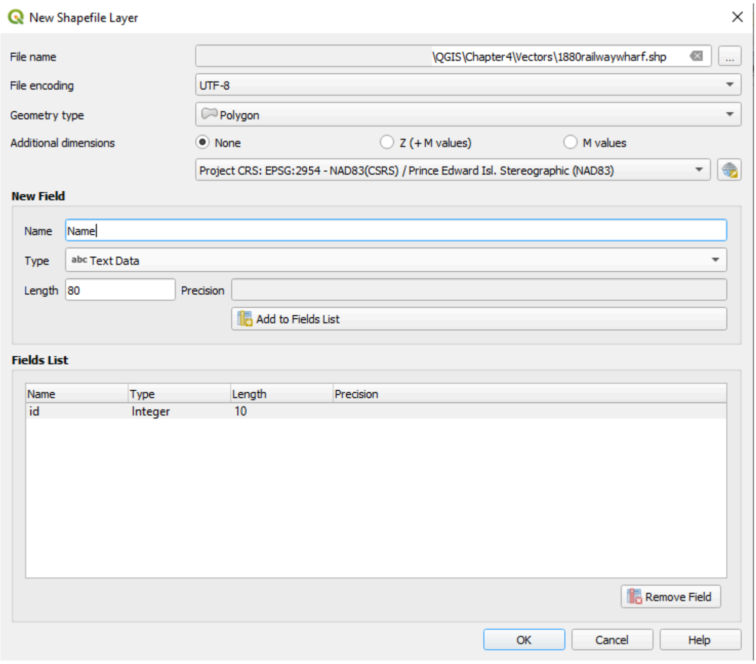
- Name: Name
- Type: Text Data

We can leave the other settings.

- Click Add to Fields List.

We are creating this new field so that we can keep track of the names of the places for which we are creating polygons.

- Click OK



New Shapefile Layer
File name
\QGIS\Chapter4\Vectors\1880railwaywharf.shp
File encoding
UTF-8
Geometry type
Polygon
Additional dimensions
None
Z (+ M values)
M values
Project CRS: EPSG:2954 - NAD83(CSRS) / Prince Edward Isl. Stereographic (NAD83)
New Field
Name
Name
Type
abc Text Data
Length
80
Precision
Add to Fields List
Fields List
Name
Type
Length
Precision
id
Integer
10
Remove Field
OK
Cancel
Help

Figure 4.68

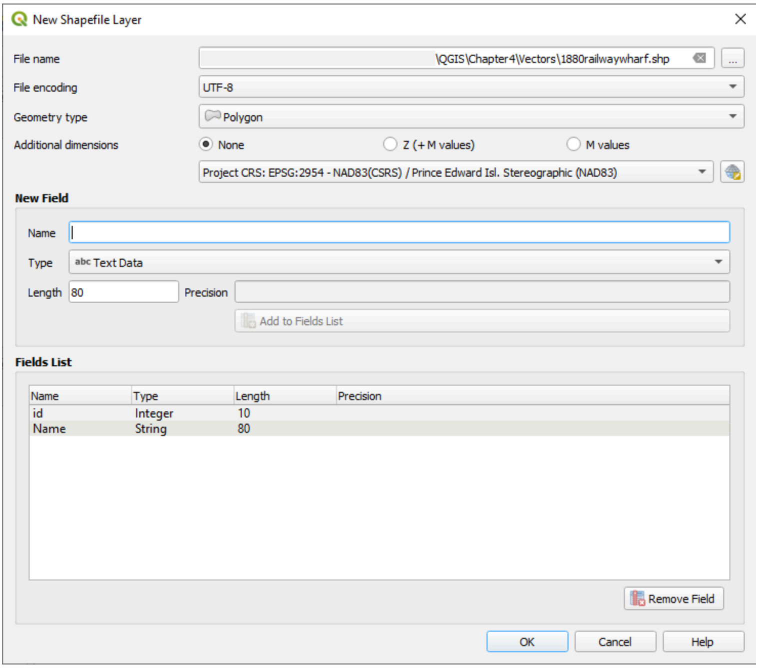


Figure 4.69

Adding the Polygon

- Click Toggle Editing

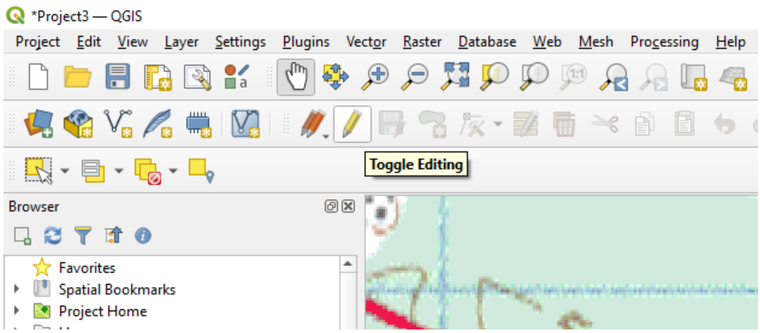


Figure 4.70

- Click Add Polygon Feature

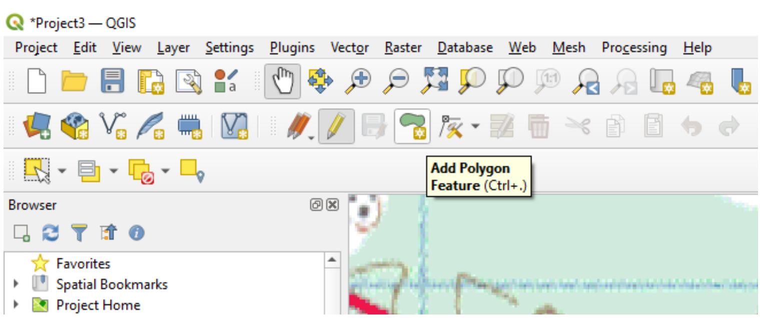


Figure 4.71

Adding a Polygon for the Railway Wharf

- Locate the railway wharf on the map. It is circled in pink in the following screenshot:

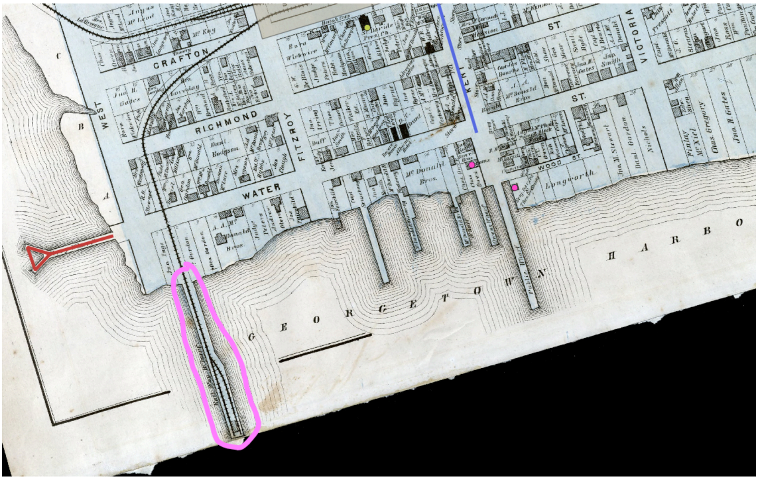


Figure 4.72

In Stream A, we created a rather straightforward, rectangular polygon. In this step, we will create a polygon for a shape that is slightly more complex.

- Left-click once at the top-left of the wharf.

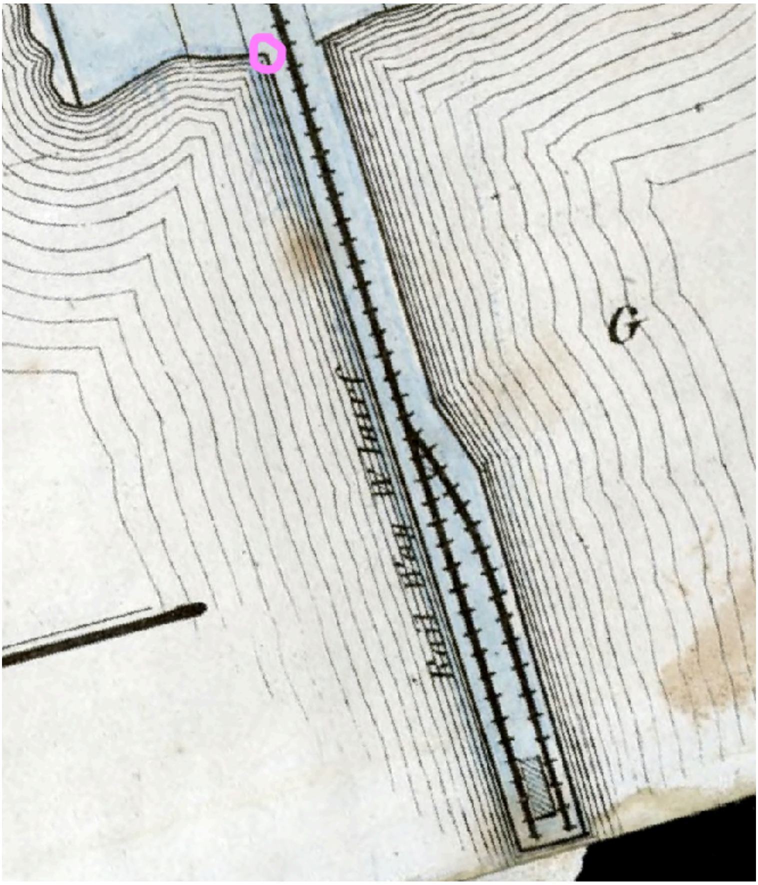


Figure 4.73

- Move your mouse to the bottom-left of the wharf and left-click again.

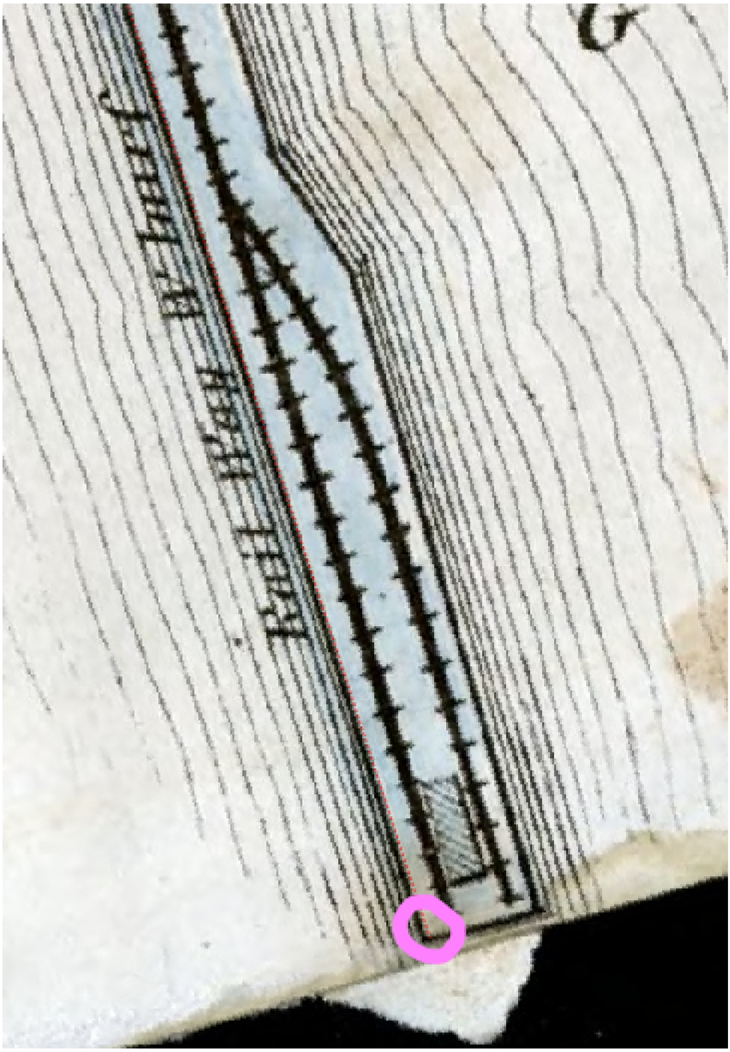


Figure 4.74

- Move your mouse to the bottom-right of the wharf and left-click again.

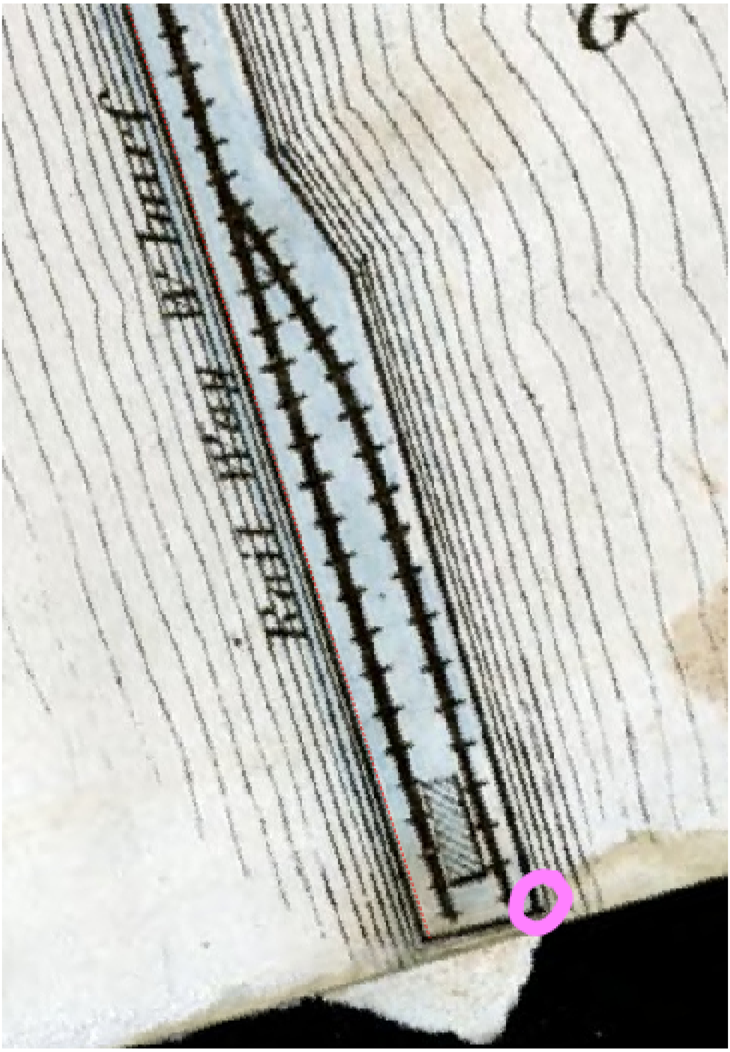


Figure 4.75

- Move your mouse to the next vertex that is above and left-click again.

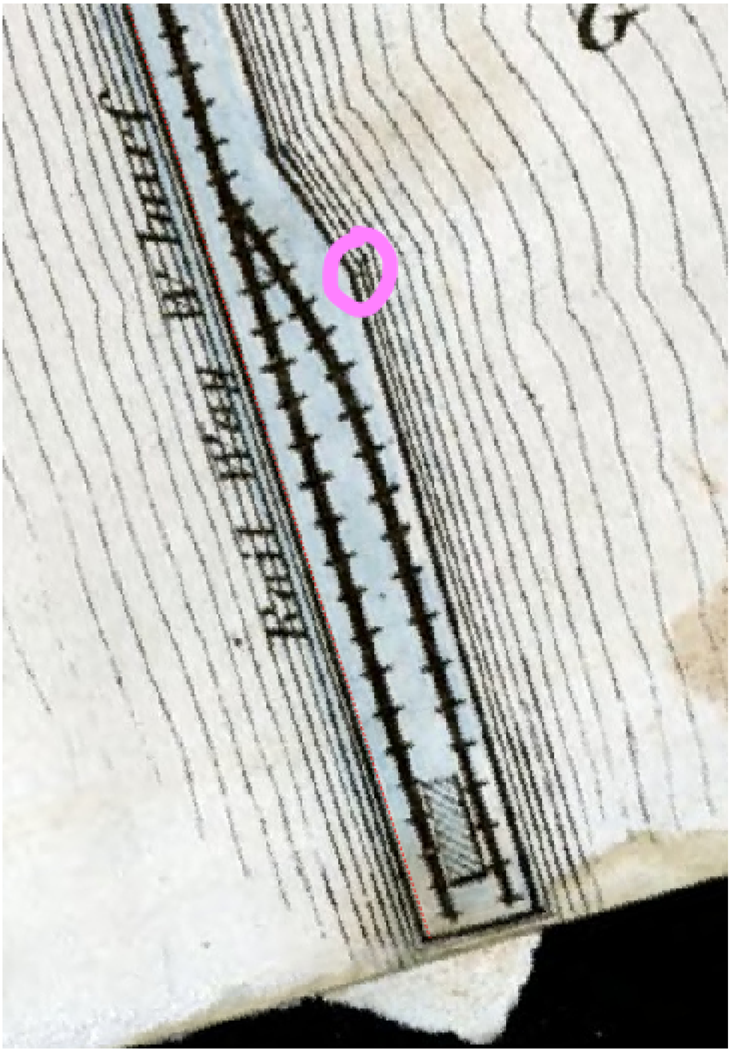


Figure 4.76

- Move your mouse to the next vertex that is above and left-click again.

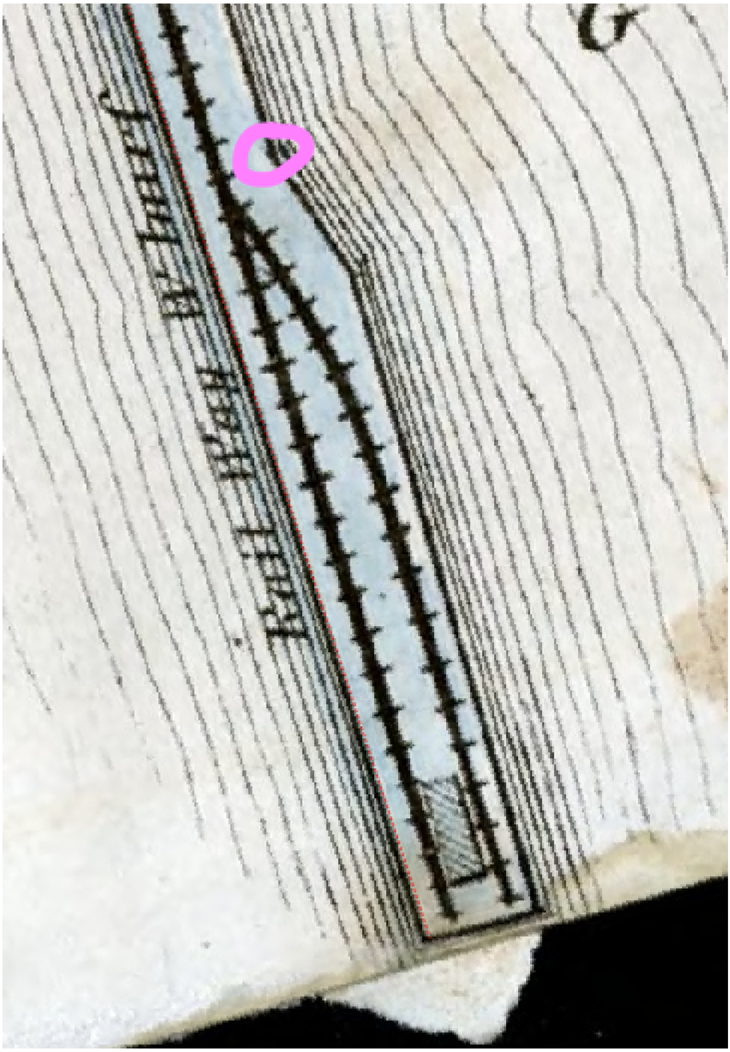


Figure 4.77

- Move your mouse to the next vertex that is above and left-click again.

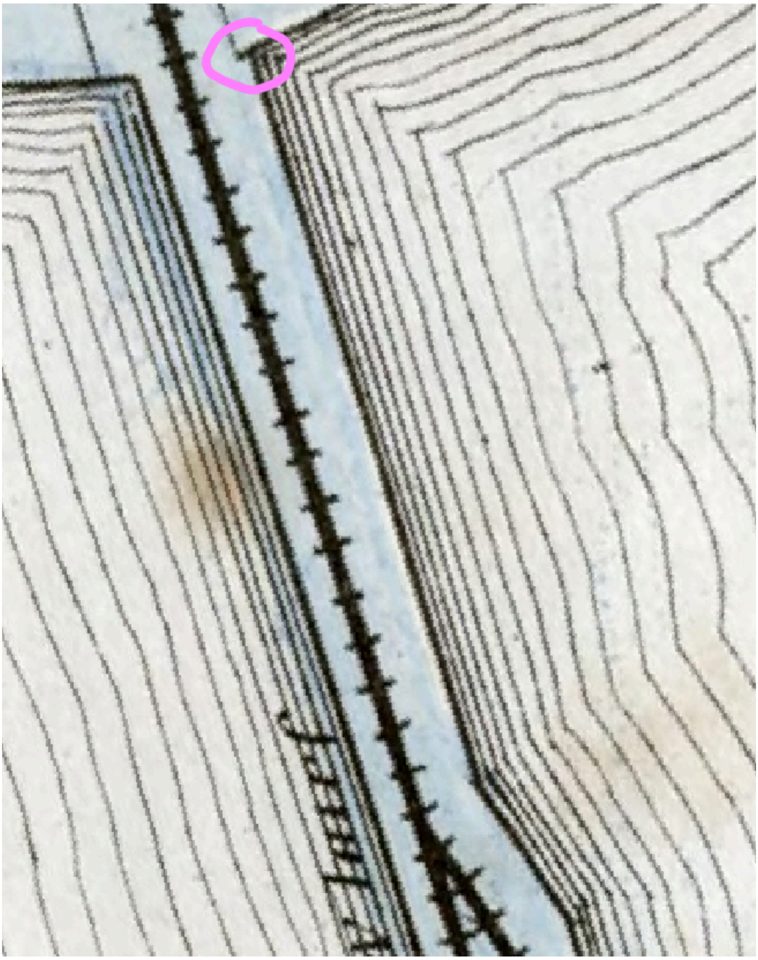


Figure 4.78

- Right-click to save the polygon.
- In the Feature Attributes dialogue box that appears, type in the following details:
    - ID: 01
    - Name: Railway Wharf

- Click OK.

Here is our preliminary result:

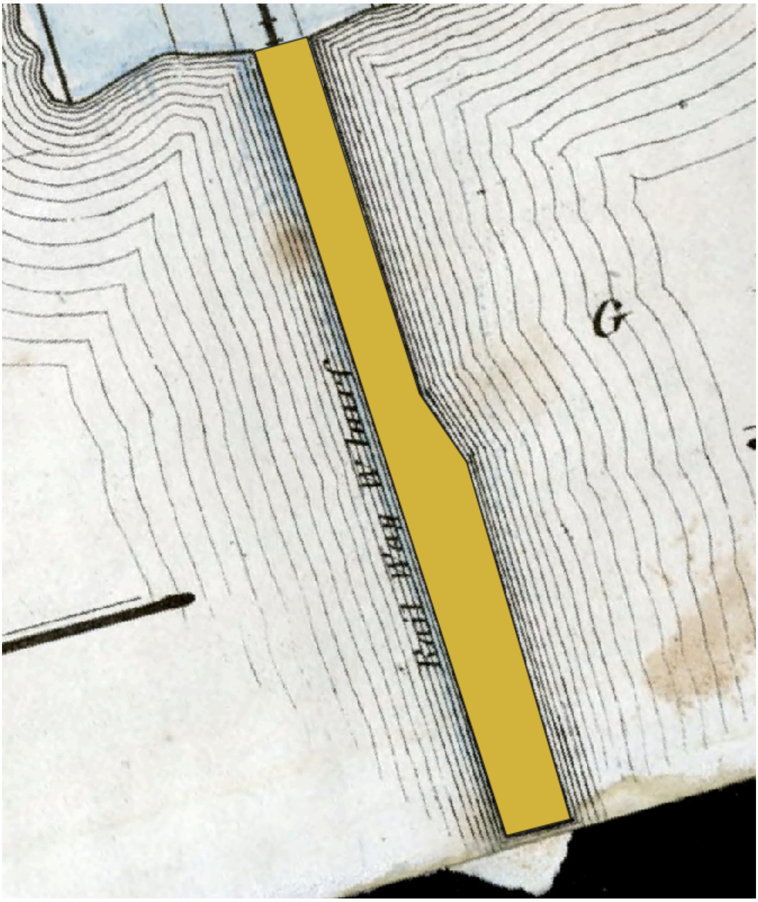


Figure 4.79.

We liked how our polygon in Stream A had some transparency. Using the Layer Styling panel, we will change this polygon's transparency to 50.0%. So that I can see it better, we will also change its colour to purple.

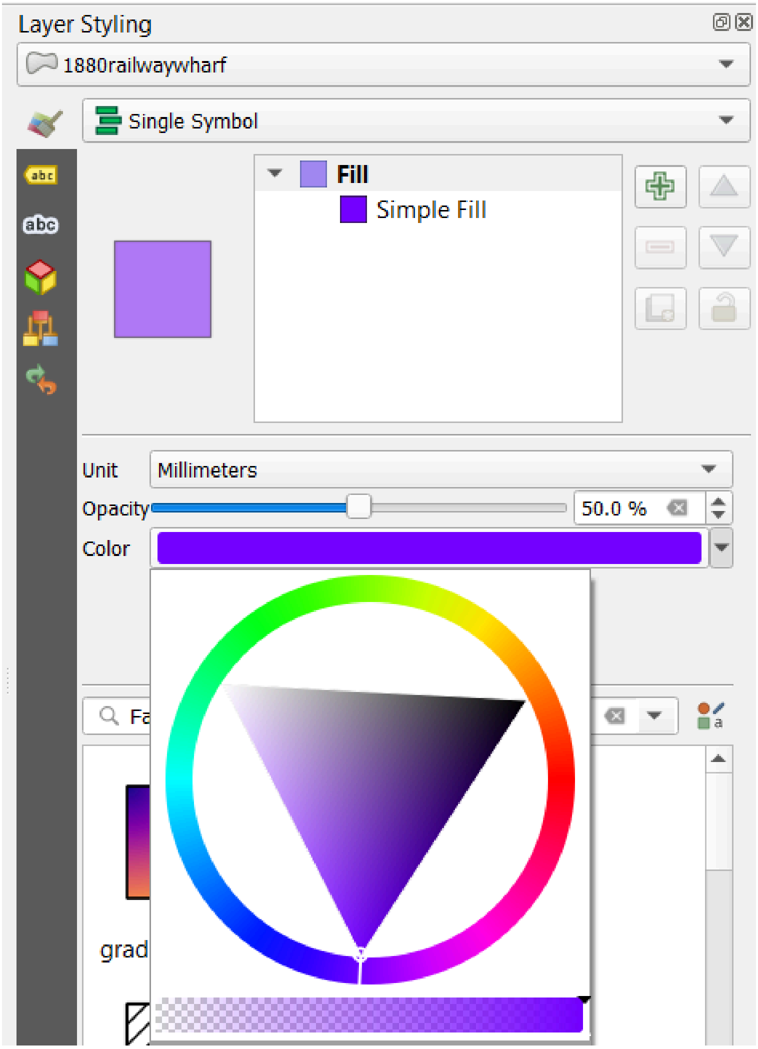


Figure 4.80

Here is the result:

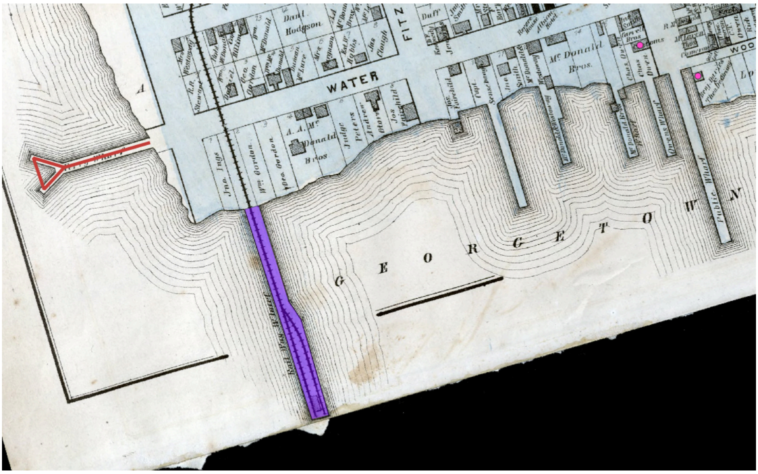


Figure 4.81

Saving the Vector Data

As always, let's save the vector data that we just created.

- Click the "Save Layer Edits" button.

Figure 4.82

Conclusion to Chapter 4

After having georeferenced and digitized the 1991 and 1880 maps of Georgetown, we can now point to a few pieces of spatial evidence of Georgetown's decline in the twentieth century. If we wanted to pursue this line of study further, we could pair our GIS work with additional research done in other sources, thus effectively combining spatial and non-spatial perspectives of the topic.

Optional for Streams A and B: Editing Features

You may notice that some areas of the features we created in this lesson do not line up exactly how you had intended. Or you may realize that you forgot to include some attribute data for a feature. QGIS offers various tools to edit features after we have created and saved them.

[[Follow this link to see the section on optional editing features.]]

SECTION V

CHAPTER 5: CREATING AN EXPORTABLE MAP IN QGIS

Getting Started

Overview and Example Exercise

Now that we have created some maps within QGIS, we may wish to export these as static images that we could include in a presentation, article, or book. QGIS offers a couple of options for doing so, depending on much detail you would like to include alongside the map.

We can quickly export our map without adding any metadata by using the Import/Export feature in the Project menu.

On the other hand, if we wish to add metadata, including a title, legend, and scale bar, we can create a Print Layout.

It is up to you to choose which map you would like to export in this chapter. Choose from among the ones we have completed thus far. As an example, we will create a layout of the 1935 inventory region filtered and graduated layer that we created in Chapter 2: Copying a Project and Layer Styling. The main focus of the map will be Eastern Prince County, with a specific concentration on the town of Kensington—a community that only began in the late-nineteenth century once the interior of the Island had been sufficiently cleared of trees (and once the PEI Railway was built—but that is another story).

The Import/Export Menu

If we wish to export a static image of our map without adding any metadata alongside it, we can use the Import/Export menu in QGIS. This option is well-suited to occasions when all you need is a quick screenshot of your map. There is an option to copy your map to your clipboard. There are also options to save your map as an image file or as a PDF.

Copying a Screenshot of a Map

To copy a screenshot of your map,

- While viewing a map that you would like to export, click the Project menu.
- Click Import/Export
- Click Export Map to Image

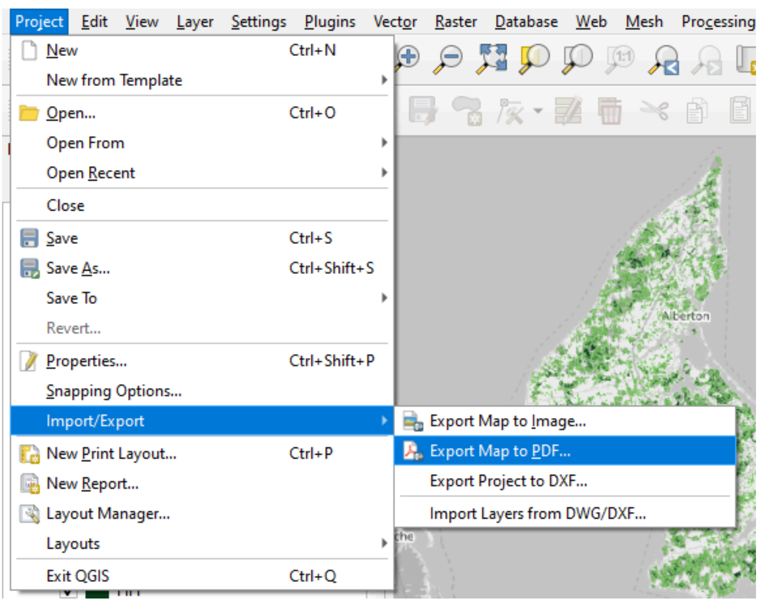


Figure 5.1

- In the window that pops up, the settings will be set according to the current place to which you have panned and zoomed.
- Click Copy to Clipboard

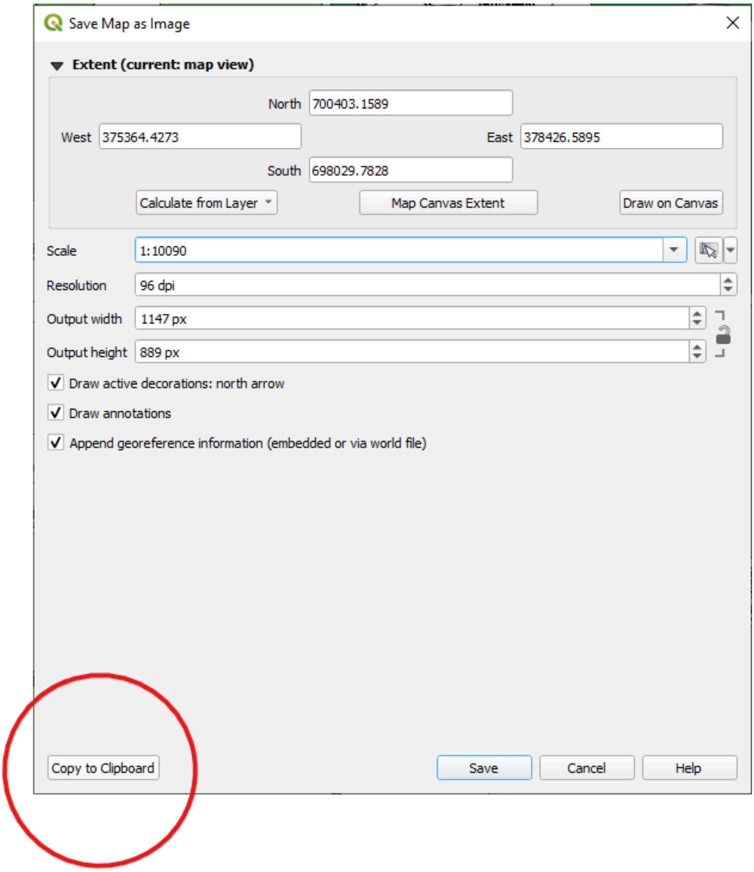


Figure 5.2

You can now paste your image wherever you would like, such as in a word-processing document or in an email.

Saving a Map as an Image File

If you wish to do essentially what we just did but, instead, save your image as a file,

- While viewing a map that you would like to export, click the Project menu.
- Click Import/Export
- Click Export Map to Image
- In the window that pops up, the settings will be set according to the current place to which you have panned and zoomed. You can leave the settings as they are.
- Click Save

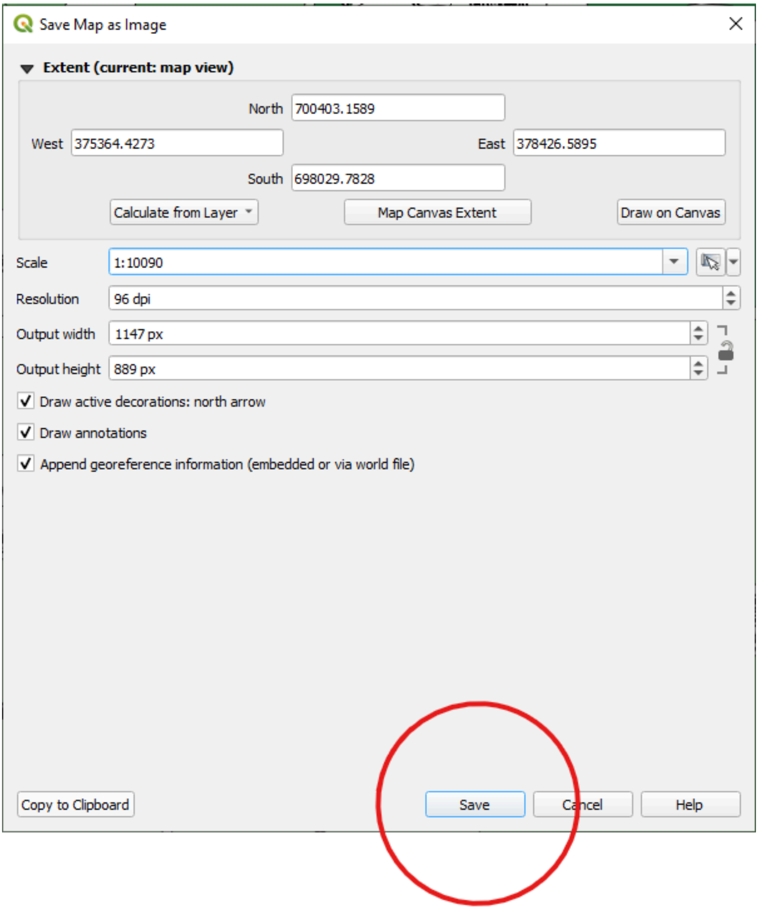


Figure 5.3

A window will pop up asking us where we want to save our image file.

- Navigate to where you would like to save the file and provide a file name.

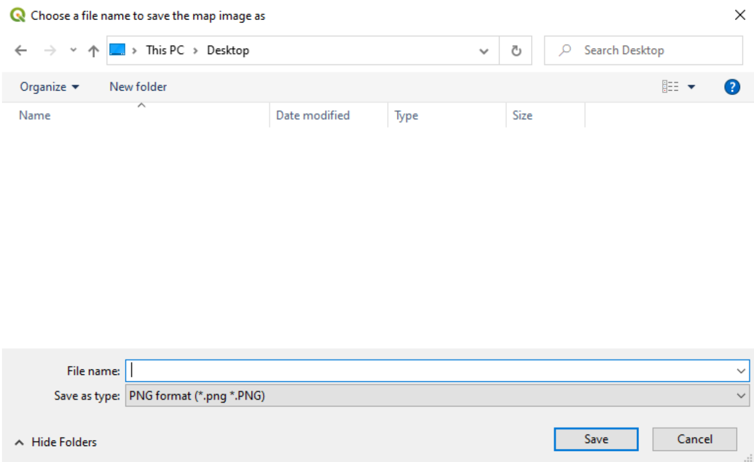


Figure 5.4

Saving a Map as a PDF

To save an image of your map as a PDF,

- While viewing a map that you would like to export, click the Project menu.
- Click Import/Export
- Click Export Map to PDF

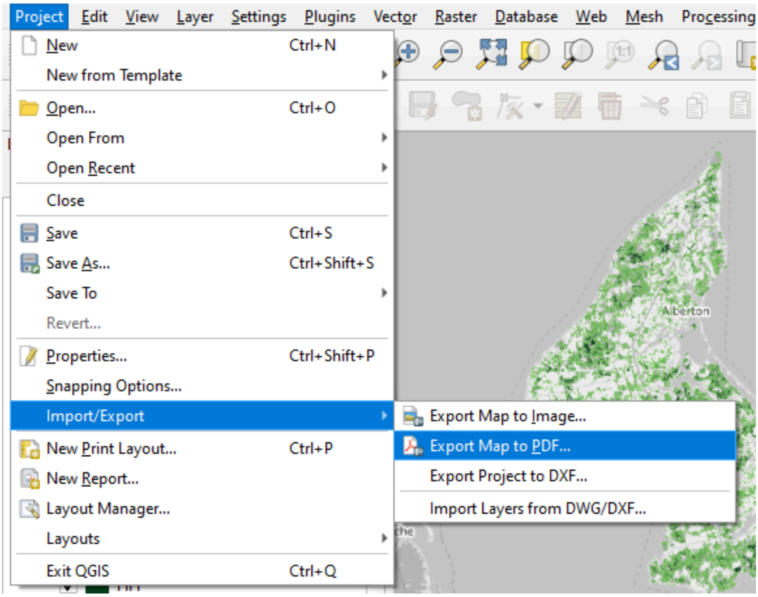


Figure 5.5

- In the window that pops up, the settings will be set according to the current place to which you have panned and zoomed. You can leave the settings as they are.

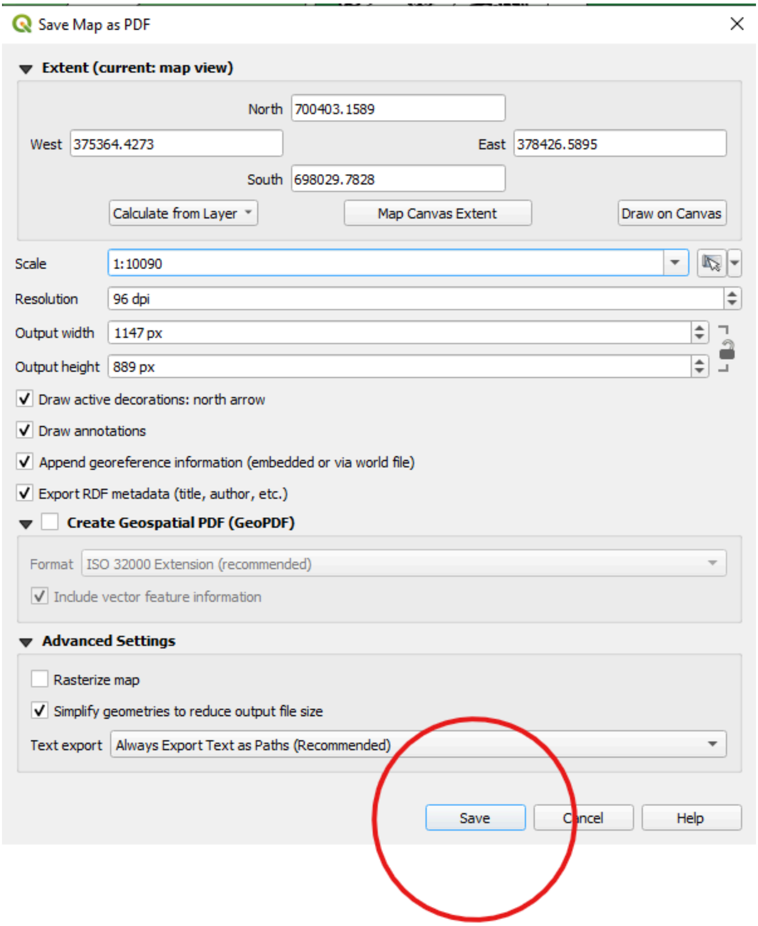


Figure 5.6

- Click Save

A window will pop up asking us where we want to save our image file.

- Navigate to where you would like to save the file and provide a file name.

Becoming a Cartographer: Creating a Layout

If we wish to create a more sophisticated output of our map, one that includes items such as a legend and north arrow, we can create a layout.

We create layouts in the Print Layout window. This interface is different than the one that we have used thus far for mapping, which is called the Main Canvas. In the Print Layout window, we have all the options we need to design our map output. As we do so, we are engaging in the practice of cartography, which introduces artistic expression into the scientific practice of mapmaking. In the past, cartographers spent a great deal of time and effort to create their maps by hand. Let's remember the map of Prince Edward Island that we saw in Chapter 1, a beautiful work of art created by Captain Holland and revised by successive generations of mapmakers. The 1798 version that we used was produced—painstakingly, no doubt—by the mapmaker H. Ashby in London, United Kingdom.

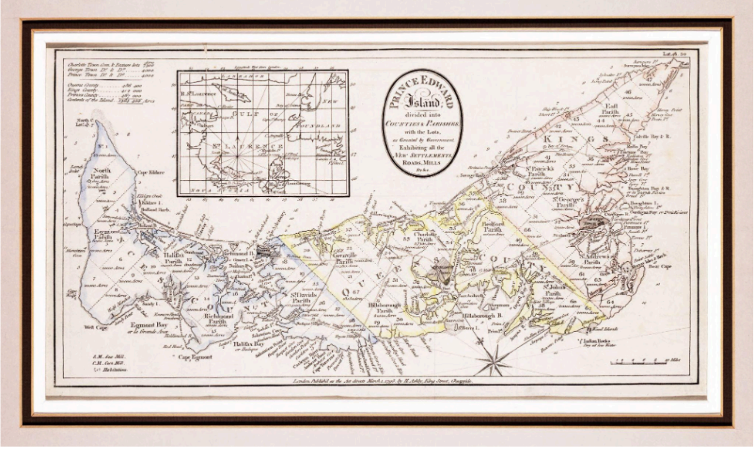


Figure 5.7.

In this part of the chapter, we will use modern-day methods continue in this age-old tradition of designing an accurate and appealing map.

As cartographers, we are telling a story with our map. We have a choice in how we wish to present spatial data in order to tell this story. Our decisions shape how an audience interprets our map. As when writing a story, it is advisable to consider your purpose and audience when telling a story through spatial means.

Opening the Print Layout Window

To open the Print Layout window:

- While in the Main Canvas, click the New Print Layout button located at the top-left of the main QGIS window.

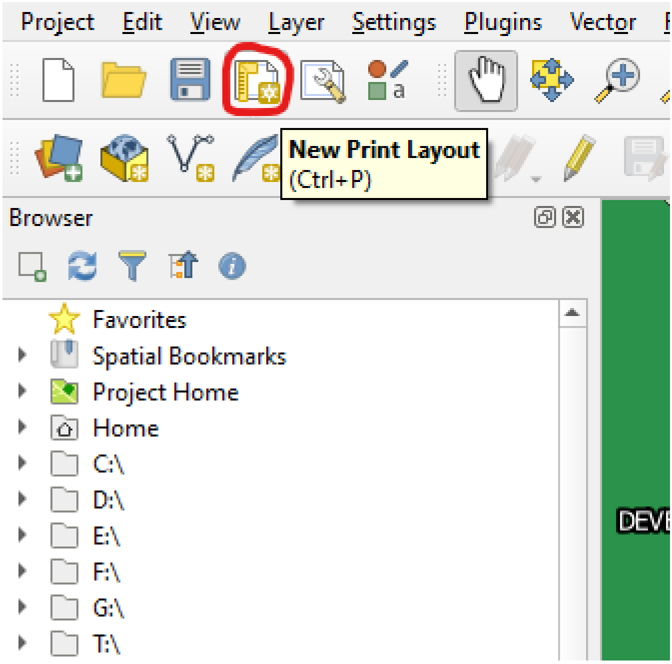


Figure 5.8

Note: if we had already created some Print Layouts, we could click Show Layout Manager, which lists all of the Print Layouts that we have been previously created.

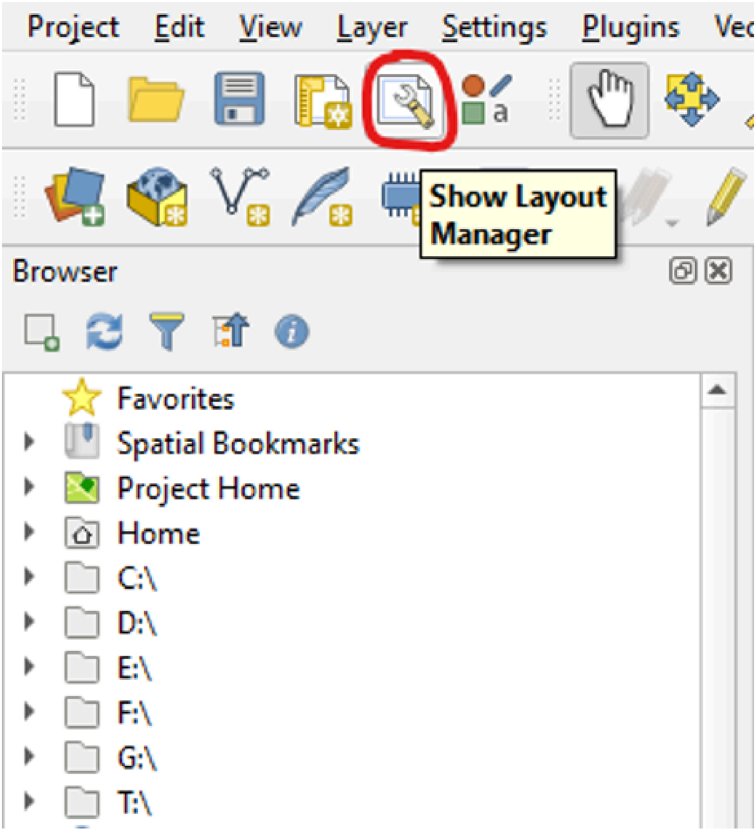


Figure 5.9

After clicking New Print Layout, the following window will pop up:

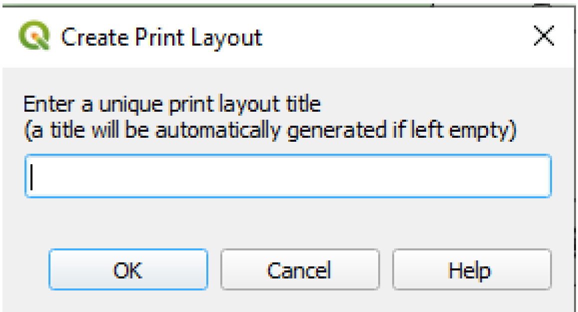


Figure 5.10

- Type in “Chapter 5 Layout”
- Click OK.

A new window will pop up containing the Print Layout interface.

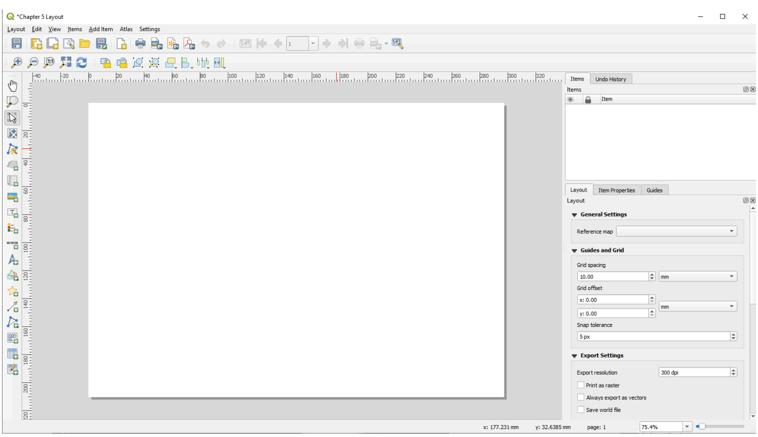


Figure 5.11

You will now have two QGIS windows open: one for the Main Canvas and one for the Print Layout.

The layout will initially be a blank white page. In the following steps, we will add our spatial data and some metadata.

Setting the Page Size

When we create layouts, the goal is often eventually to print them. We may want to specify which size of paper onto which we will eventually print our layout. To set the page size:

- Right-click anywhere in the blank white space of the layout page.
- Click Page Properties

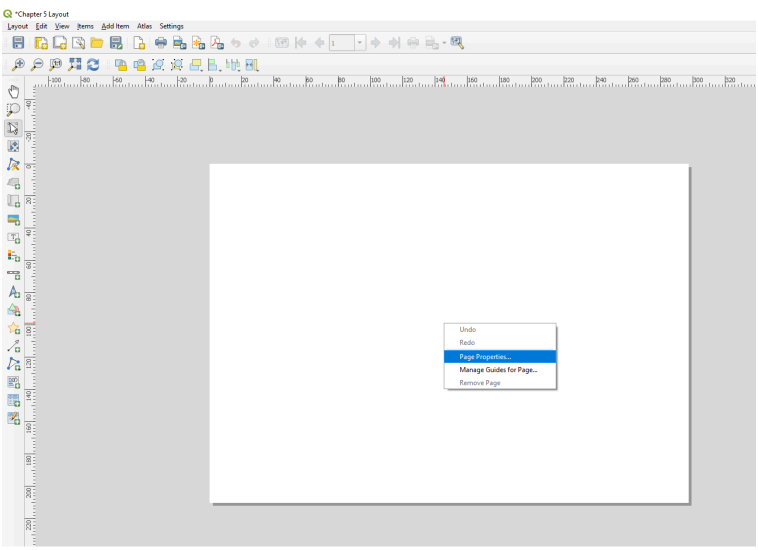


Figure 5.12

- In the Item Properties tab to the right, change the size to one you prefer. We have chosen Letter.

- You can also change the orientation to portrait if you would like, but the rest of this chapter will be done in a landscape orientation.

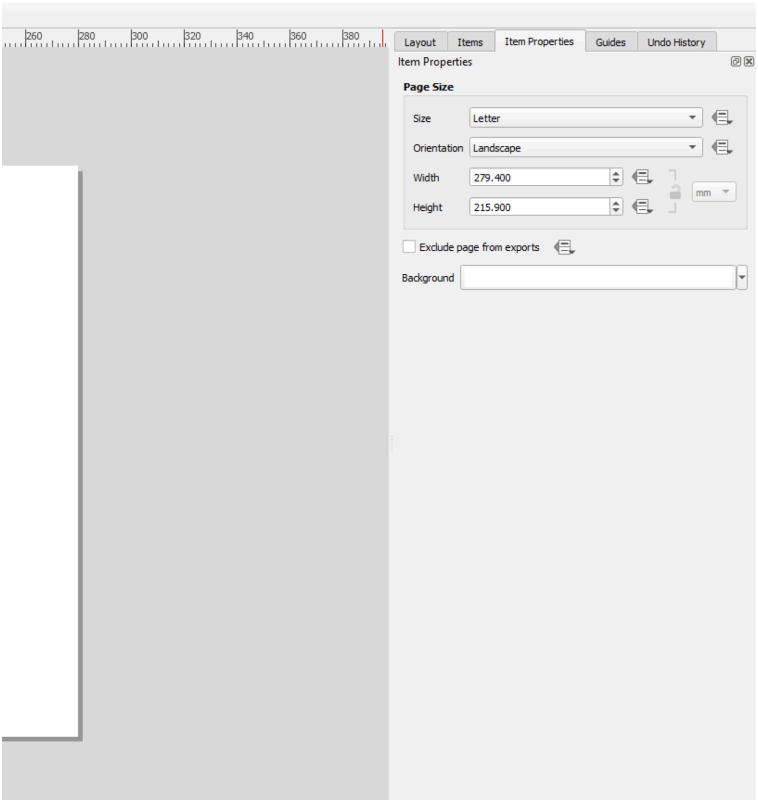


Figure 5.13

Adding Guidelines

We will create some guidelines to help us place our map, legend, and other items precisely on the map layout page. These guidelines will not appear in the file that we output at the end.

We will first add some guidelines to demarcate the outer limits of our page.

- Right-click anywhere in the blank white space of the Print Layout page.
- Click Manage Guides for Page

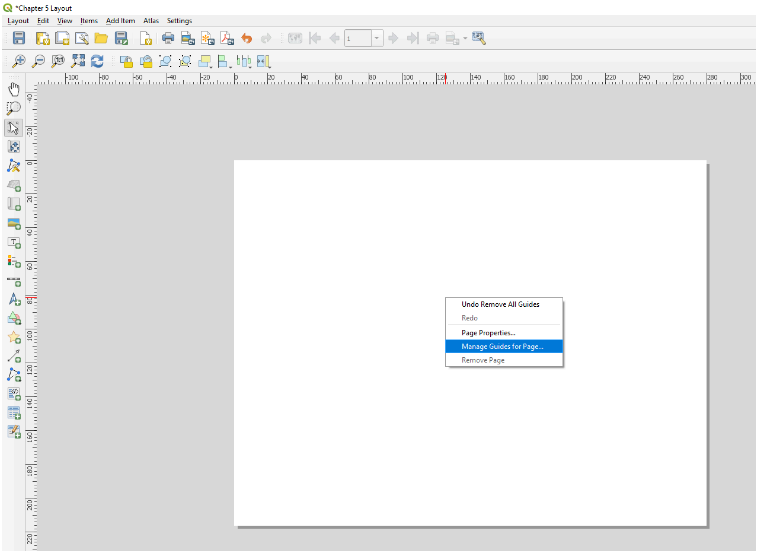


Figure 5.14

- In the Guides tab to the right, click the green plus button to add a horizontal guide at 0.25 inches.
- Add another horizontal guide at 8.25 inches.
- Enter two vertical guides: one at 0.25 inches and one at 10.75 inches.

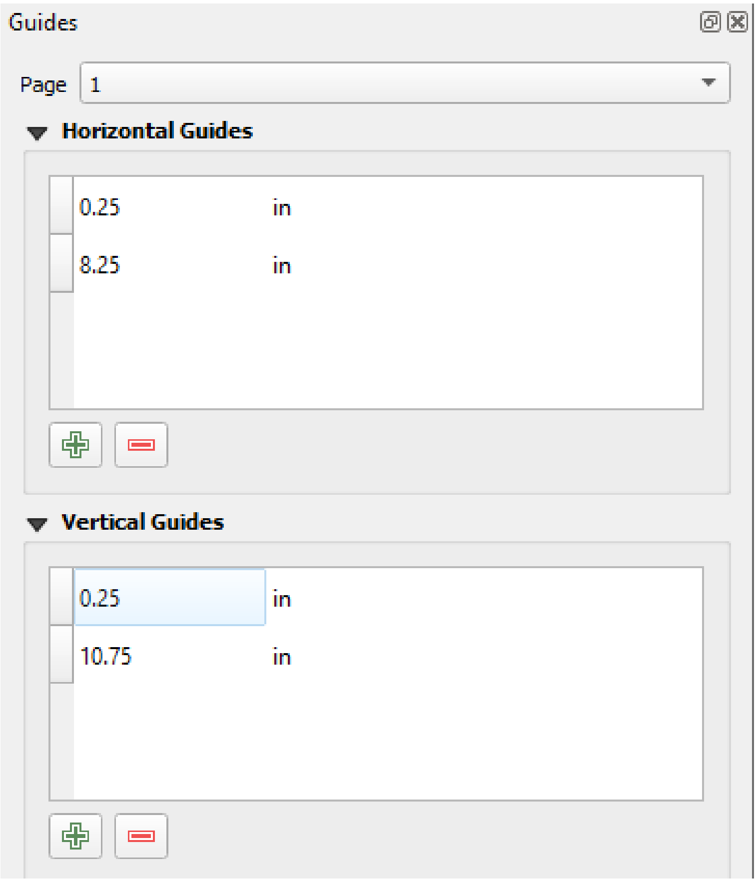


Figure 5.15

Note: make sure to click the dropdown menu to change the guide units from millimetres to inches.

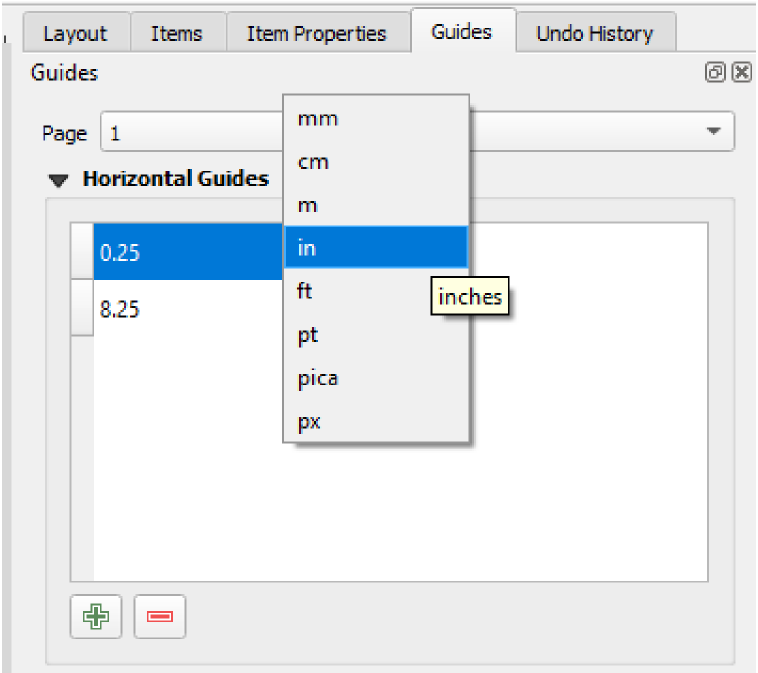

Layout
Items
Item Properties
Guides
Undo History
Guides
Page
1
Horizontal Guides
0.25
8.25
mm
cm
m
in
ft
pt
pica
px
inches

Figure 5.16

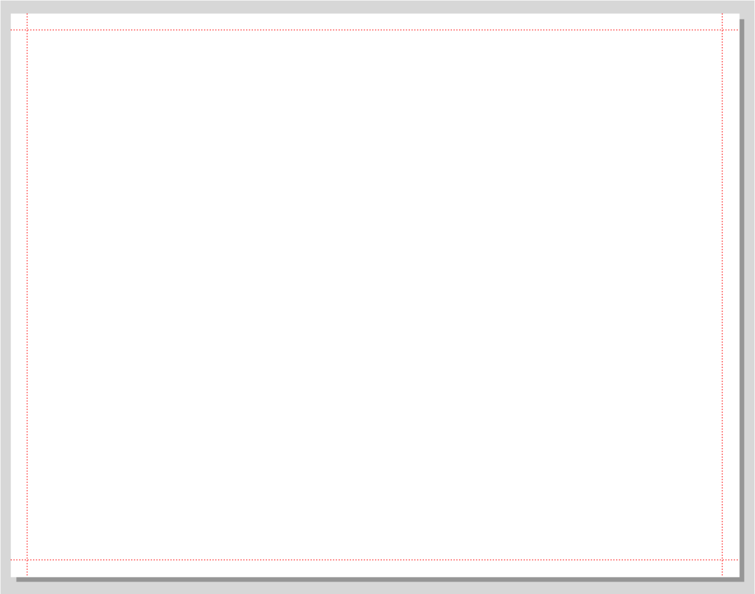


Figure 5.17

We will now add guides to divide our page into sections. We will add our spatial data and metadata into these sections.

Let's create an area into which we can type the title of our map.

- Add a horizontal guide at 1 inch from the top of the page.

INSERT PICTURE HERE************************************

We can also create areas on the right-hand side and bottom of the map where we can place the rest of our metadata.

- Add two vertical guides: one set at 8 inches and one set at 8.25 inches.

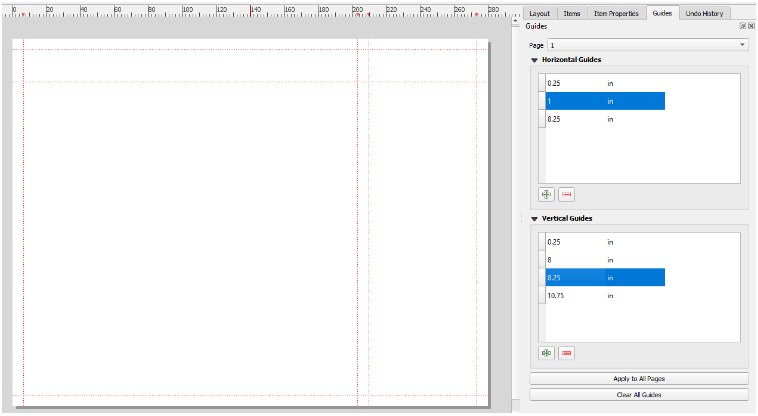


Figure 5.19.

Finally, we will add a few more guidelines that will demarcate the position of the inset map that we will add in subsequent steps.

- Add one horizontal guide at 1.25 inches and one at 3.75 inches.
- Add one vertical guide at 0.5 inches and one at 7.75 inches.

Your layout page will now look like this:

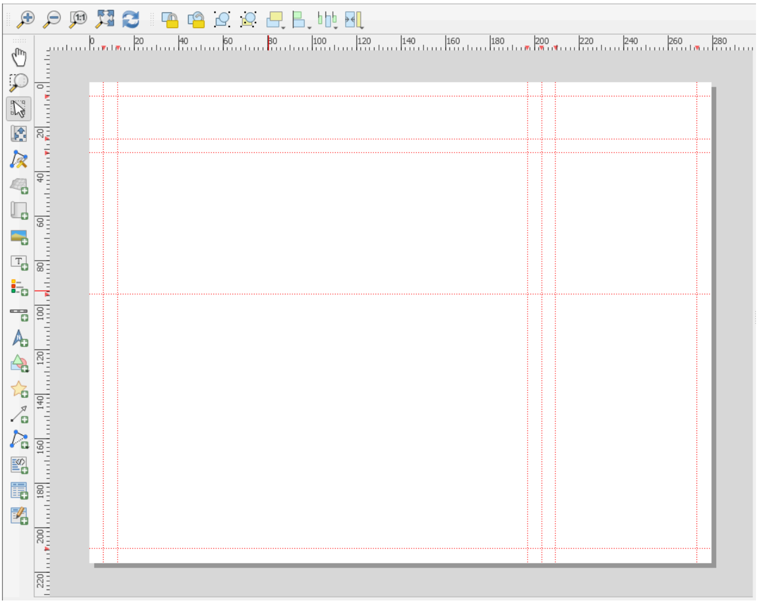


Figure 5.20

Adding Maps to the Layout

We can use the guidelines we just created as we add our map and metadata to our print layout page.

Adding the Main Map Frame

When we add an image of our map to the print layout page, it is called a map frame. To add the main map frame to our layout,

- In the toolbar on the left of the screen, click Add Map. (This tool allows us to add map frames.)

- The layers that we will add when we click this button is the ones that we currently see in the Main Canvas of QGIS. Make sure you go to the Main Canvas and turn on the layers that you would like to add to the layout before you click the Add Map button. In this case, we turned on the 1935 inventory region filtered and graduated layer and the OSM Grayscale layer.

INSERT PICTURE HERE************************************

- With your cursor as a crosshairs, left-click and hold on the top-left corner of the central box we created with our guidelines.

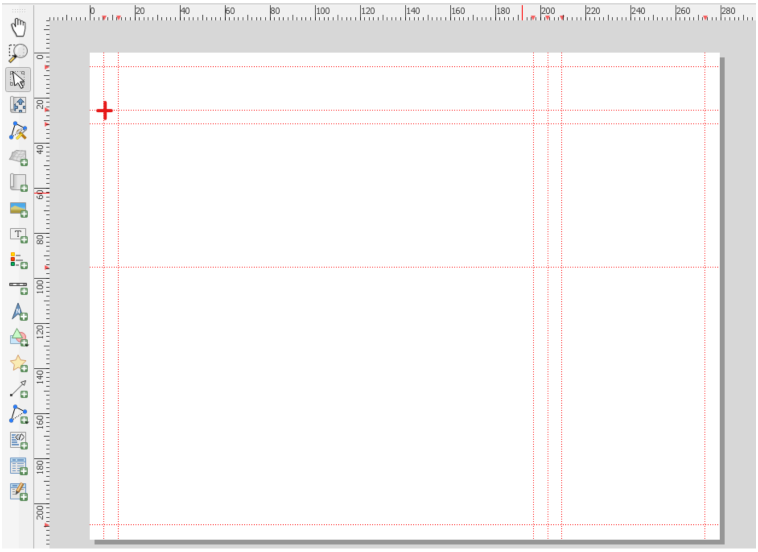


Figure 5.22

- Drag to the bottom-right corner of the central box and let go of the click there.

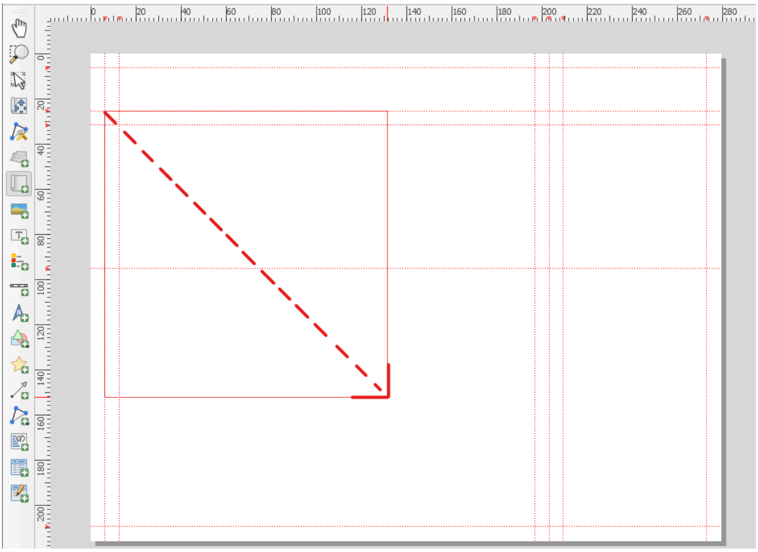


Figure 5.23

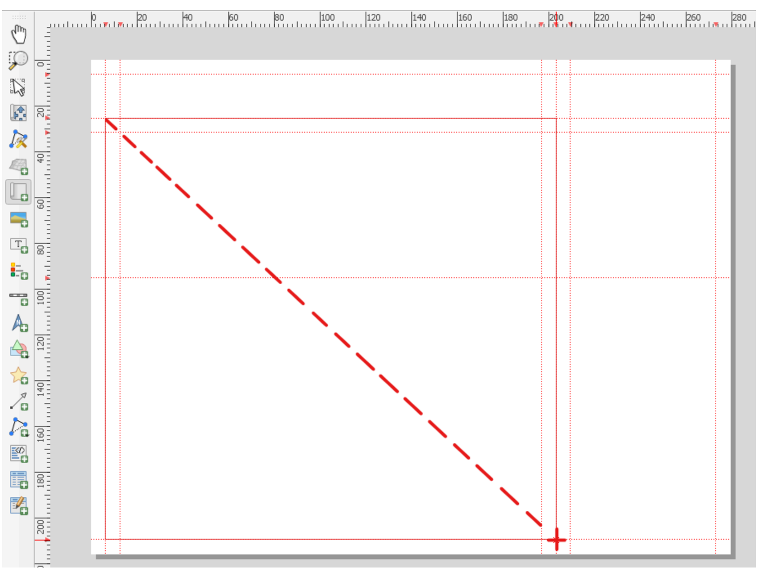


Figure 5.24

The map that you can see in the main mapping view will render.

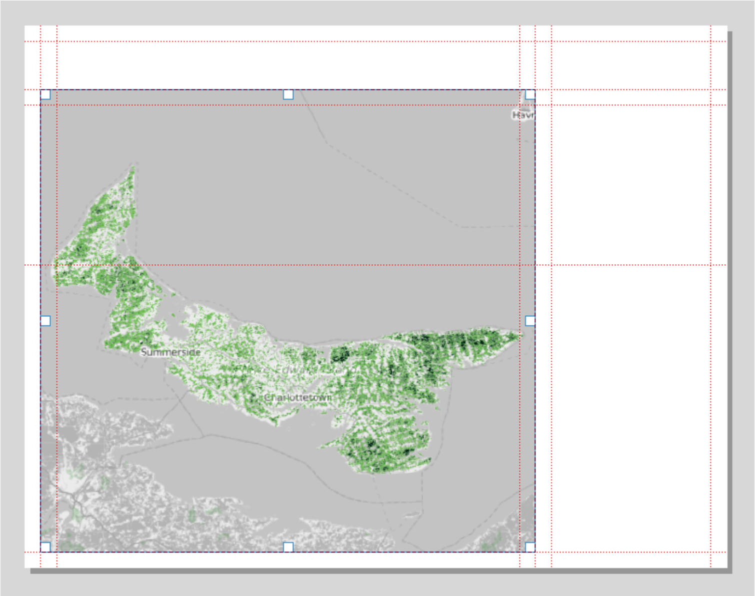


Figure 5.25

Note: if you forgot to turn on a layer in the Main Canvas before drawing the main map, you can leave the map frame drawn in the Print Layout, return to the Main Canvas, turn on the needed layer, and then come back to the Print Layout window. Click the Refresh View button to see the changes you made in the Main Canvas be reflected in the Print Layout.

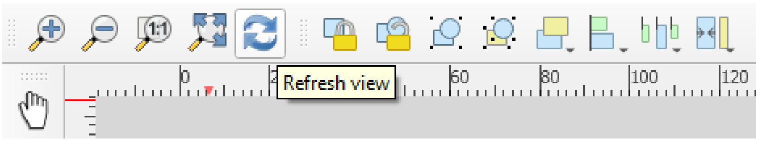


Figure 5.26.

Pan to Kensington

- In the toolbar on the left-hand side of the layout window, click the button called Select/Move an Item

INSERT PICTURE HERE***********************************

- Click to select the main map frame.
- In the Item Properties menu to the right, under Main Properties, change the scale to 30000.
- Change the map rotation to -25.00 degrees.

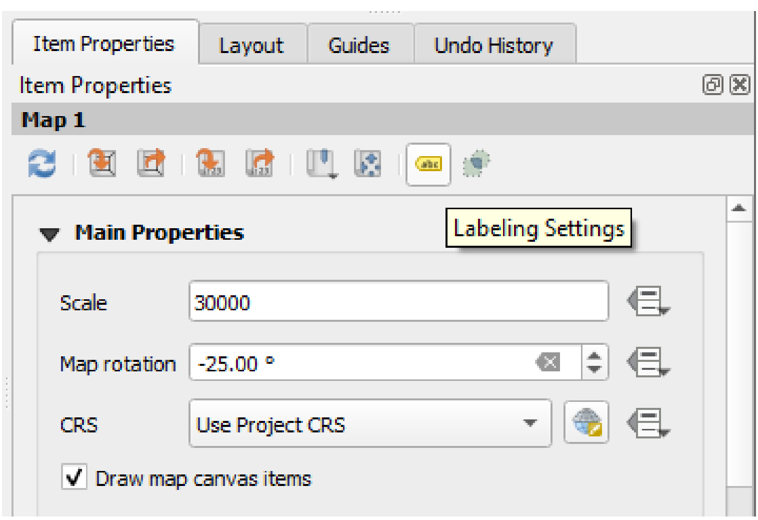


Figure 5.28

- Still in Item Properties, under Extents, change the extent values to the following:
  - X min: 348336.227
  - Y min: 707573.371
  - X max: 354241.728
  - Y max: 713097.871

Note: the scale of your map might change after you enter the above extents. This is OK.

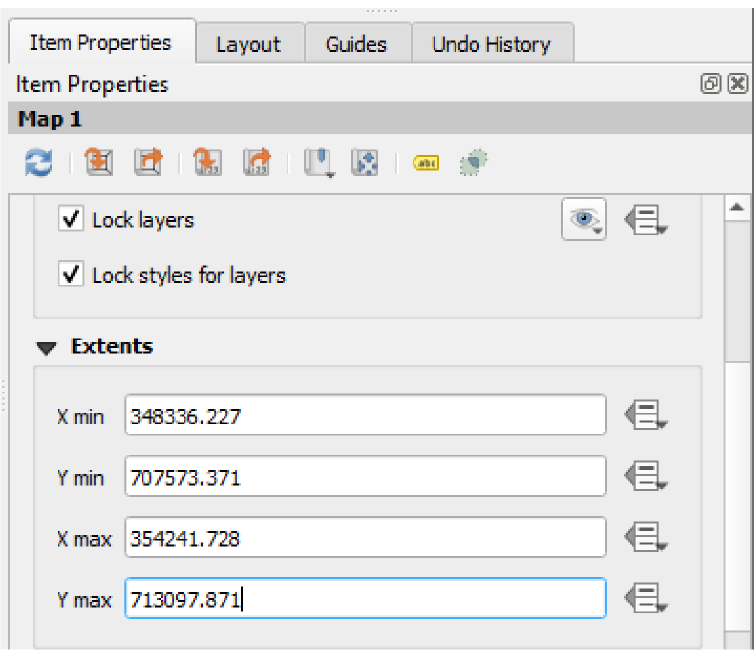


Figure 5.29

After entering the above extents, this is what we see:

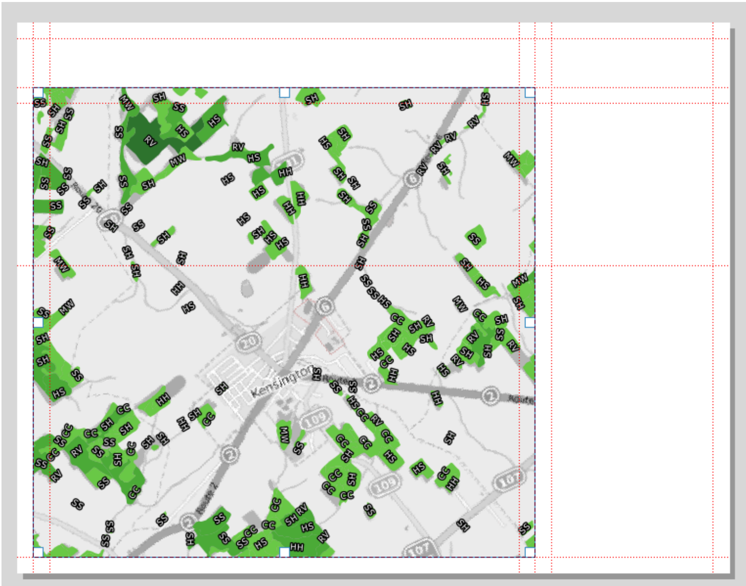


Figure 5.30

> Note: you can also pan around the map by first selecting a map frame with the Select/Move Item tool and then clicking the Move Item Content tool.

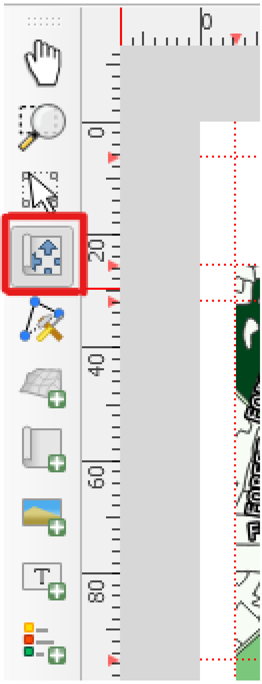


Figure 5.31

Locking the Appearance of the Main Map Frame

Below, we will add an inset map and make other changes to our layout. As it stands right now, the main map frame in our layout is dynamically linked to the map in the Main Canvas. So, when we make changes to the latter, the map frame in our layout will refresh to match. (This refreshing will happen automatically or if we click the Refresh View button.) We want to prevent the main map frame from refreshing as we add our inset map. To do so, we will use a setting called Lock Layers.

- Click on Map 1 (i.e., the main map frame) to select it in the

Items list.

- Under Layers, click Lock layers and Lock styles for layers.

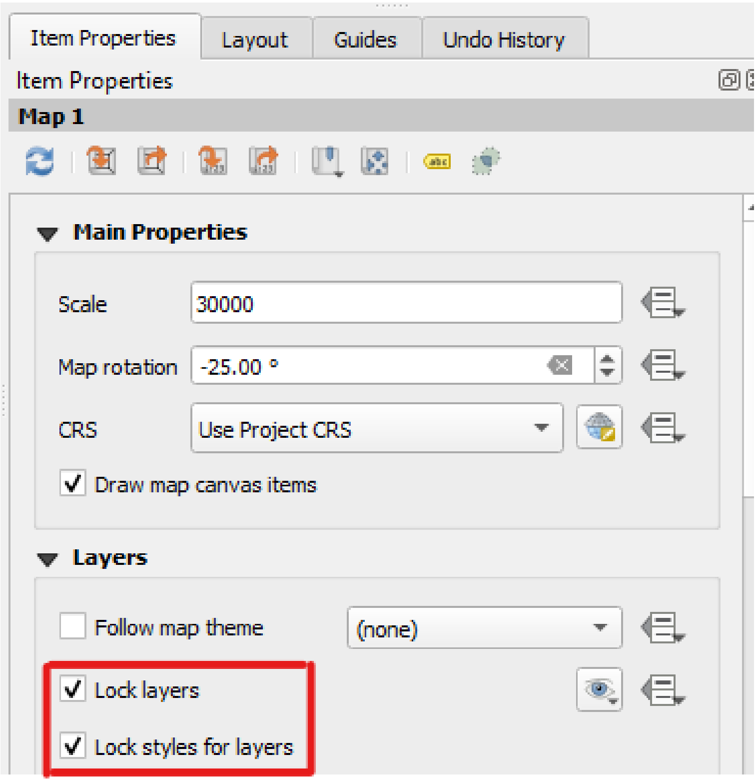


Figure 5.32

Adding an Inset Map

We will now add an inset map in order to give the audience some context as to where Kensington is in relation to the surrounding parts of PEI.

- In the Main Canvas, turn off the PEI placenames layer so that the only layers visible are the 1935 inventory region filtered and graduated layer and the OSM Grayscale layer.

- In the Print Layout window, click Add Map and click and drag to insert it into the 2.5-inch by 7.25-inch area that we created with our guides.

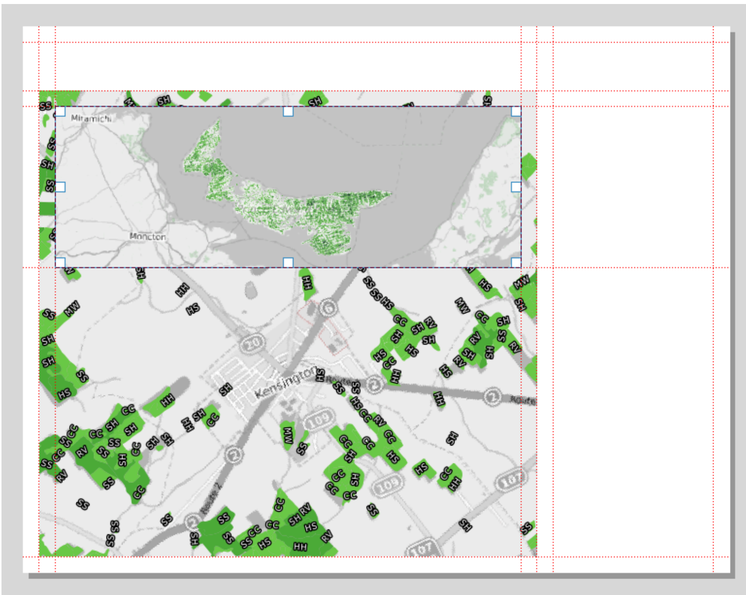


Figure 5.33.

Panning the Inset Map

In the Items pane, click to select Map 2 (i.e., the inset map).
In the Item Properties pane, under Main Properties, set the Scale to 1414456 and the Map rotation to -25.00 degrees.

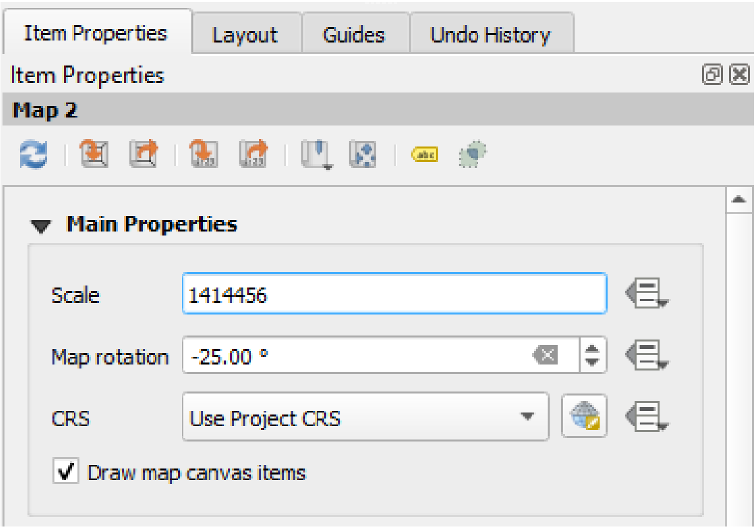


Figure 5.34

- Under Extents, enter the following:
    - X min: 253738.252
    - Y min: 670496.939
    - X max: 509244.468
    - Y max: 758602.530

> Note: after entering the above extents, the scale of your inset map might change slightly. This is OK.

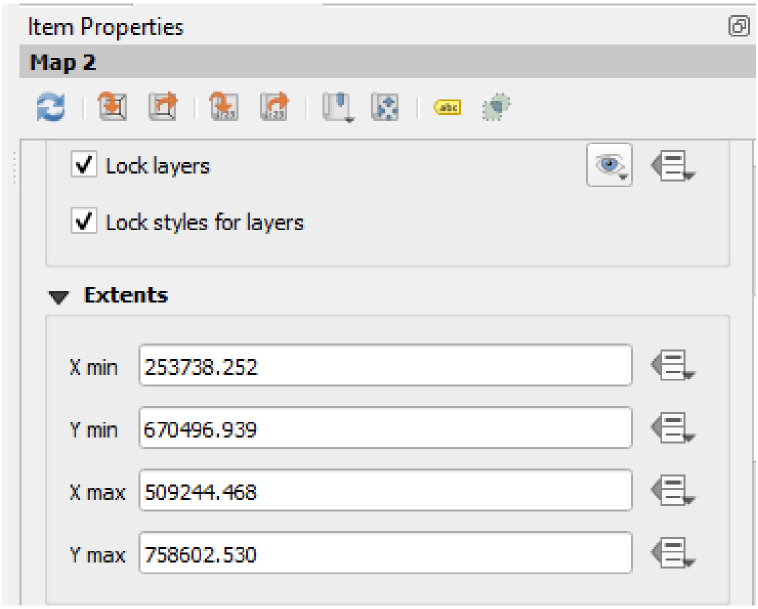


Figure 5.35

- With Map 2 selected in the Items pane, click Lock layers and Lock styles for layers.

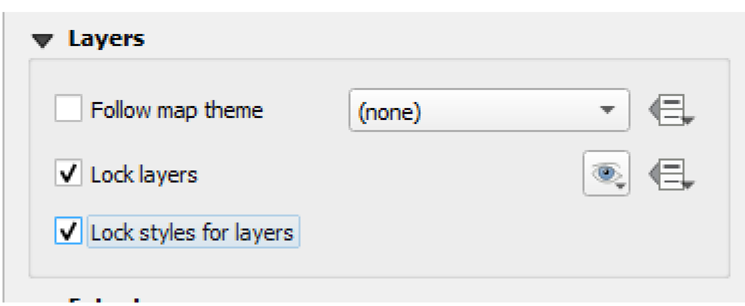


Figure 5.36

This is what our layout looks like so far:

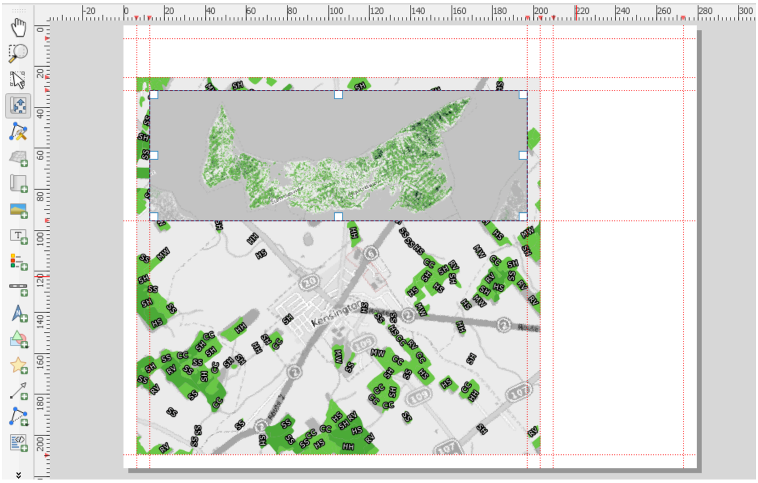


Figure 5.37

Adding an Extent Indicator

The inset map's purpose is to show the audience the geographic context of Kensington, the place shown in our main map frame. However, it may remain unclear as to where Kensington lies within this inset map. For this, we can add an extent indicator using the Overview function in QGIS.

- With Map 2 selected in the Items list, in the Item Properties tab, under Overviews, click the green plus button to add an overview.

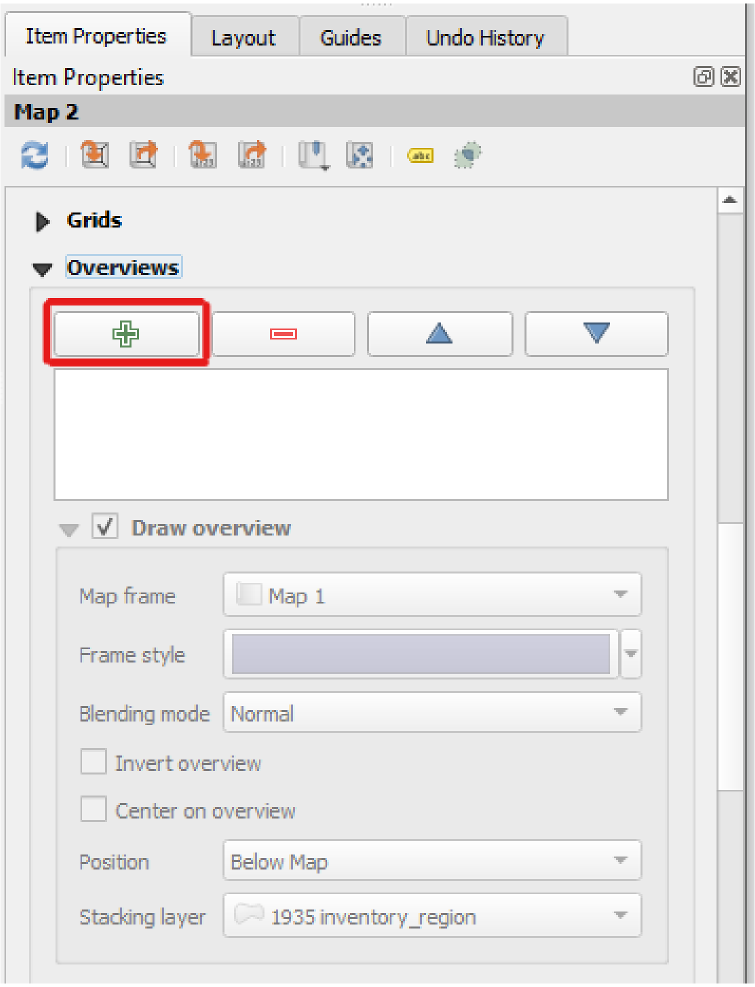


Figure 5.38

An overview called Overview 1 will appear in beneath the green plus button.

- In the dropdown menu next to Map Frame, select Map 1.
    - This is the map frame over the top of which QGIS will

place our extent indicator.

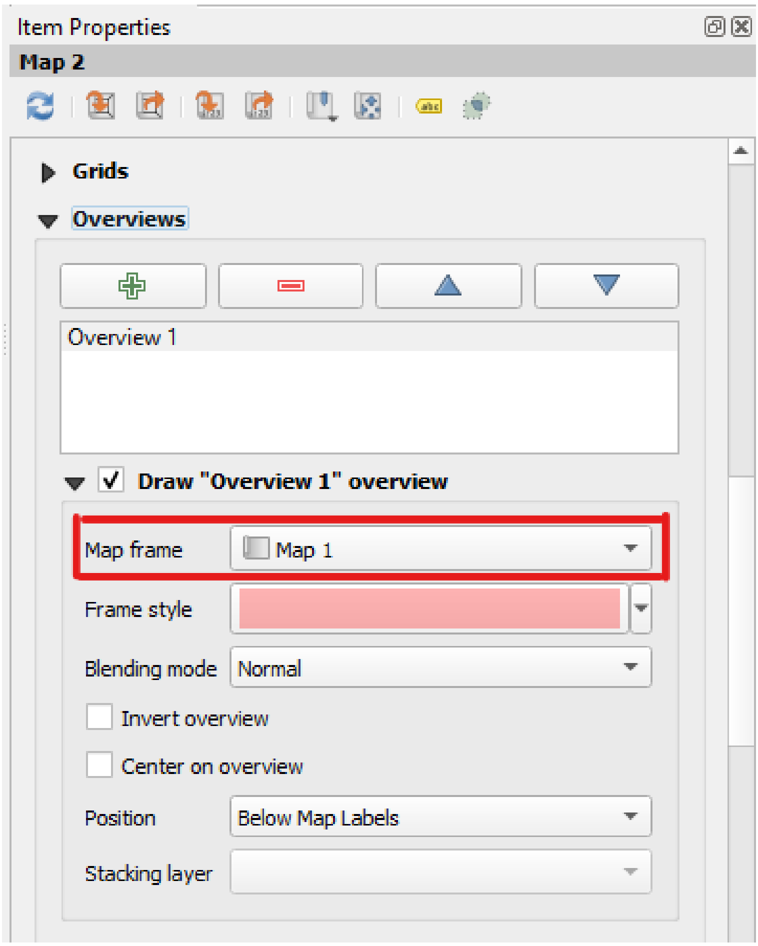


Figure 5.39

A semi-transparent red extent indicator will appear over the top of the inset map. It covers the area that we see in the main map frame. We will change this appearance to a solid red outline so that it is more visible.

- Click the dropdown arrow next to Frame style.
- Click Configure Symbol.
- Click Simple Fill to select it.
- Click the dropdown arrow next to Fill colour
- Under Standard Colours, click red.

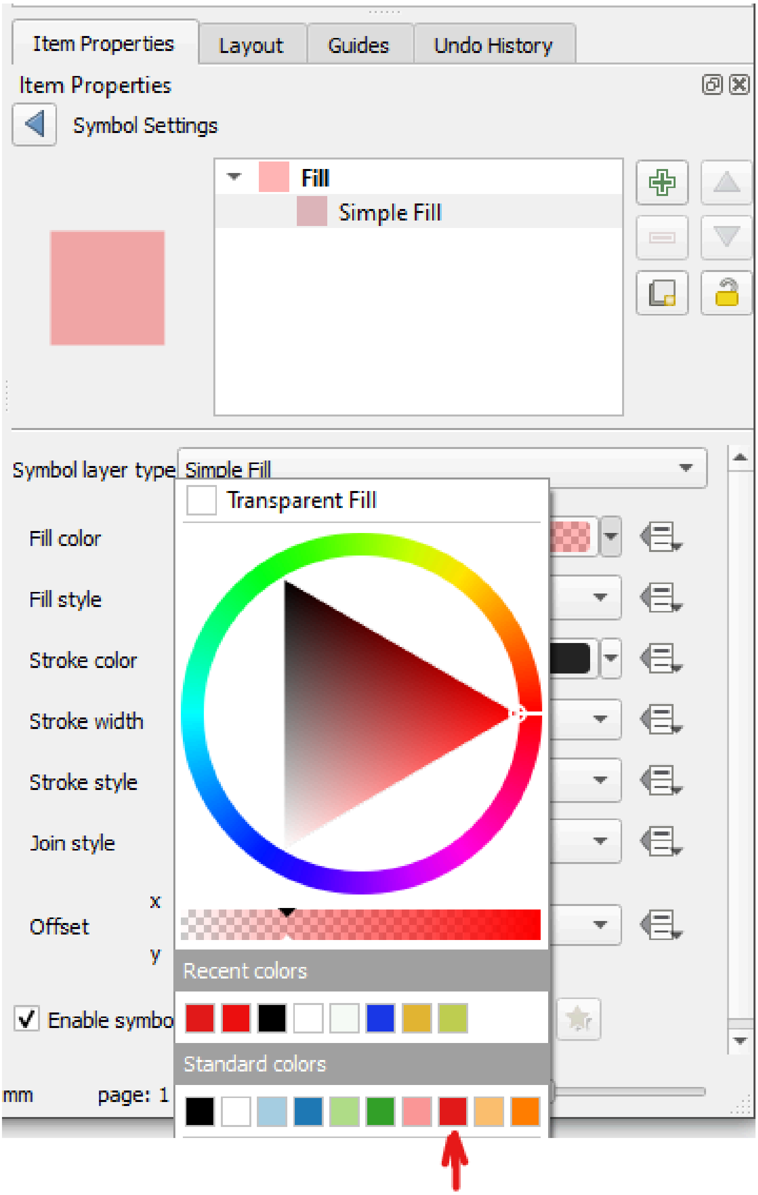

Item Properties
Layout
Guides
Undo History
Item Properties
Symbol Settings
Fill
Simple Fill
Symbol layer type
Simple Fill
Transparent Fill
Fill color
Fill style
Stroke color
Stroke width
Stroke style
Join style
Offset
x
y
Enable symbo
mm
page: 1
Recent colors
Standard colors

Figure 5.40

- Click the dropdown arrow next to Fill Style
- Choose No Brush
- Click the dropdown arrow next to Stroke colour
- Under Standard Colours, click red.
- Change the Stroke Width to 1.00 millimetre.
- Change the Stroke style to Solid Line.

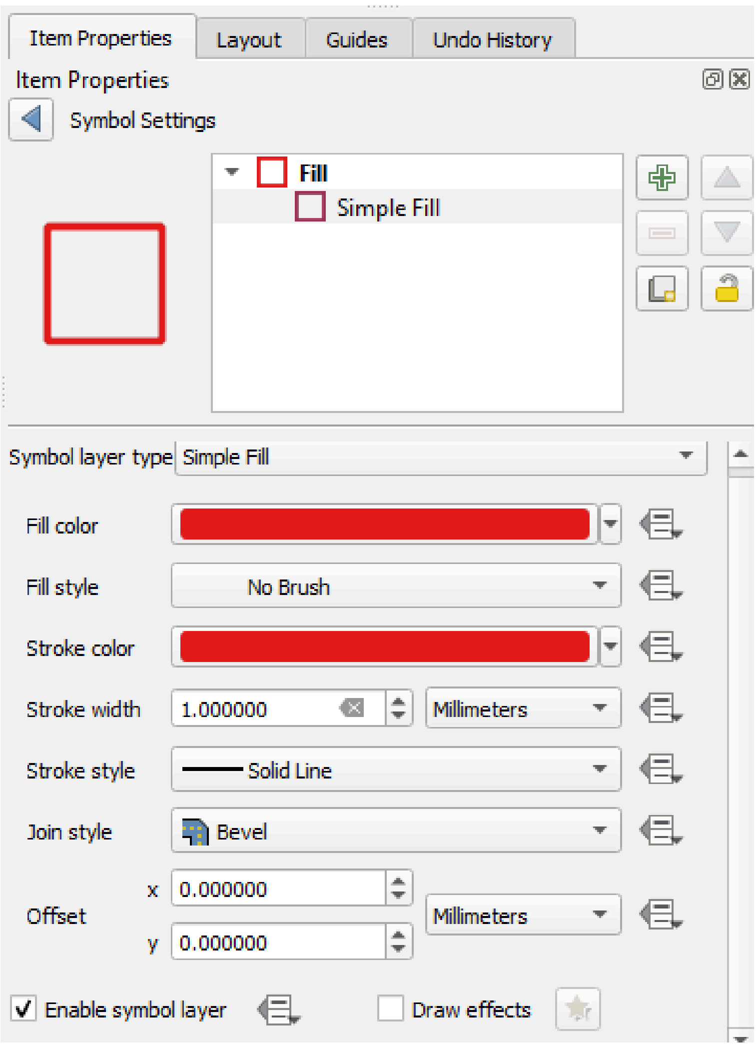


Figure 5.41

Here is the result:

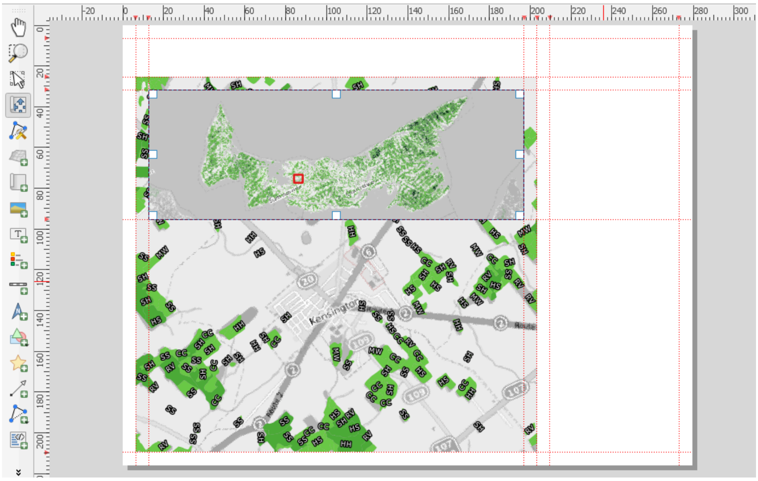


Figure 5.42

Adding a Border around the Inset Map

A border around our inset map may help an audience to see that it is distinct from our main map.

- Use the Select/Move Item tool to select the inset map.
- In the Item Properties tab, check the box next to the word Frame.
- Under Frame, leave the colour as black, set the thickness to 0.50 mm, and set the Join Style to Round.

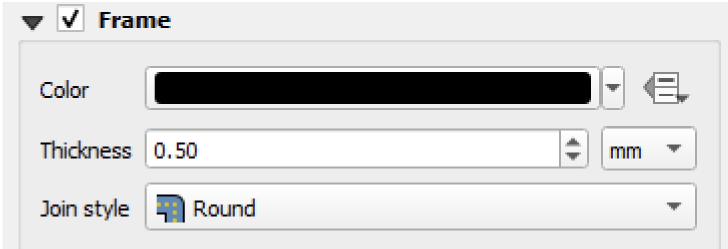


Figure 5.43

The result may be hard to see with our guidelines on, but it is there, and it will become more visible once we export the layout as an image or PDF later in the chapter.

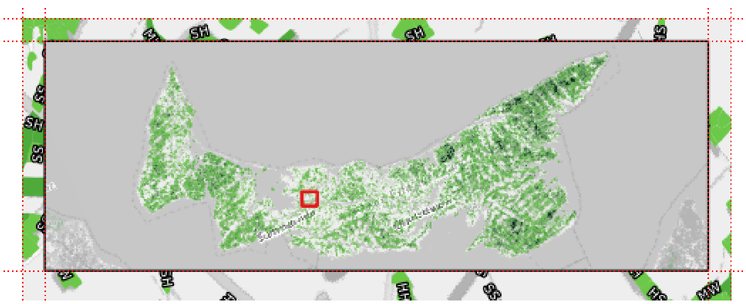


Figure 5.44

Locking the Positioning of the Layers

We have already locked the appearances of the main map frame and the inset map. Now, we will lock the locations of these map frames on the page. This ensures that we cannot accidentally alter the size or location of the map frames.

- In the Items pane, under the symbol of the padlock, check the box for Map 1 and Map 2.

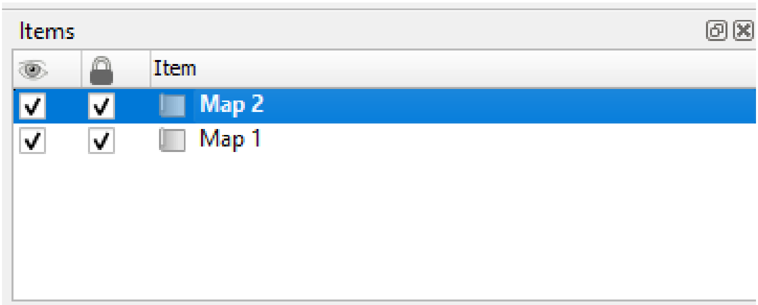


Figure 5.45

Now, if we try to use the Select/Move Item tool to select either the main map frame or the inset map frame, we cannot.

Label Settings

Before we move on, let's adjust the label settings so that labels are not drawn too close to the edge of the map frame. We can also change the settings so that the labels on the 1935 forestry inventory map located underneath the inset map are not drawn.

- Click Map 1 in the Items list.
- In the Item Properties tab, click the Labelling Settings button.

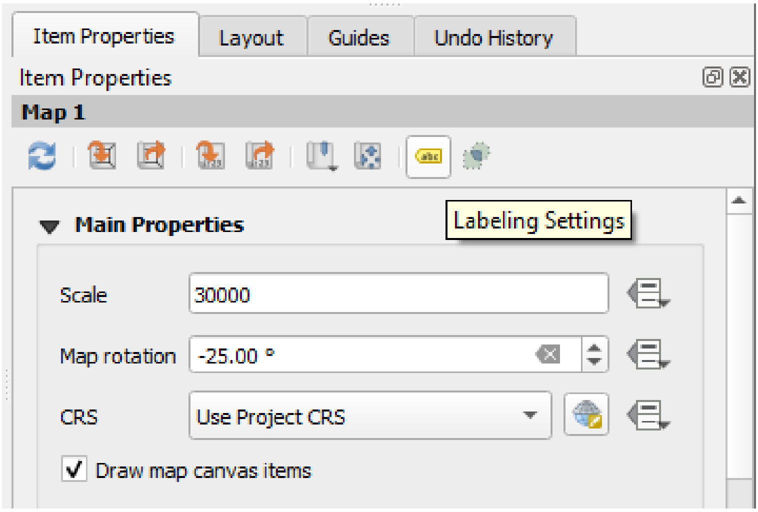


Figure 5.46

- Under Placement, change the Margin from Map Edges value to 2.00 millimetres.
- Under Label Blocking Items, select Map 2.

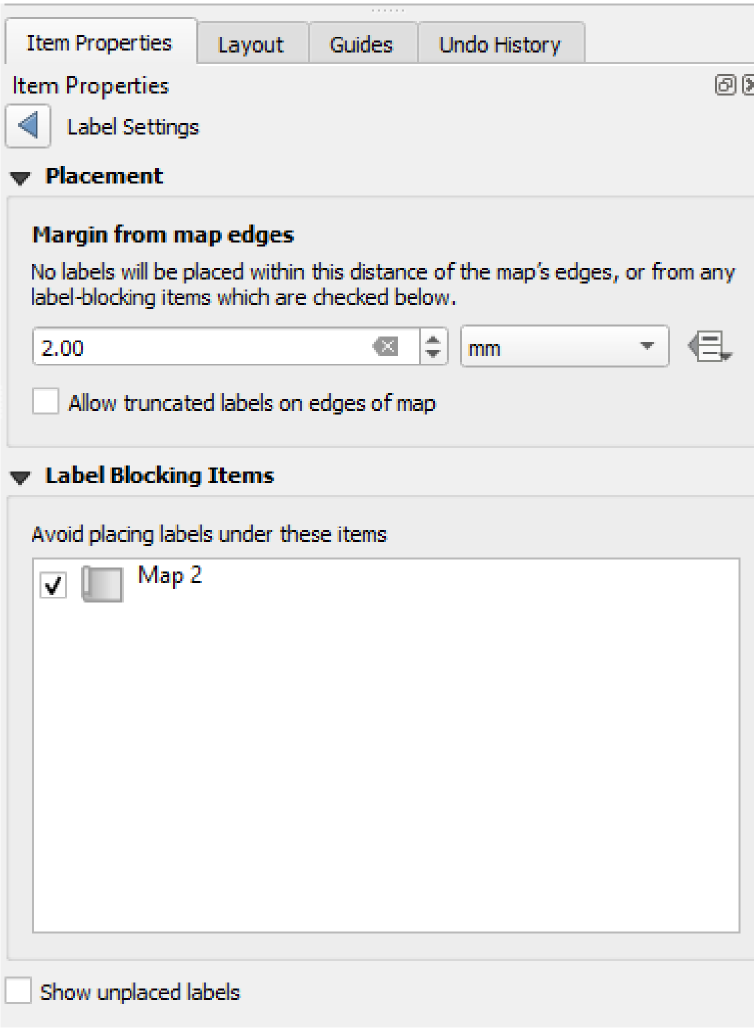


Figure 5.47.

We can now see how QGIS does not draw labels on the main map that would be too close to the inset map:

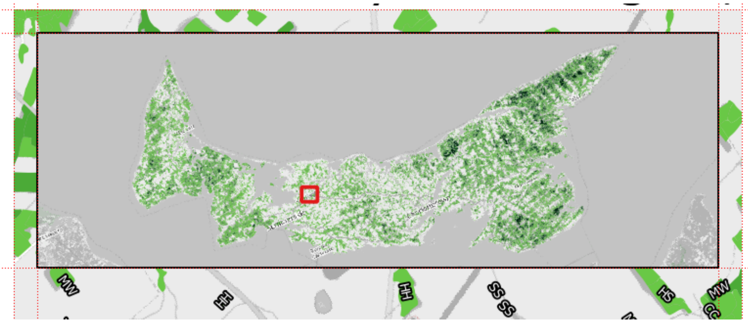


Figure 5.48

Adding Metadata to Our Map

We will now add some metadata around our map frames to help an audience understand our maps.

Adding a Legend

We can add a legend to help users understand the colours of our choropleth map.

- Click Add Legend

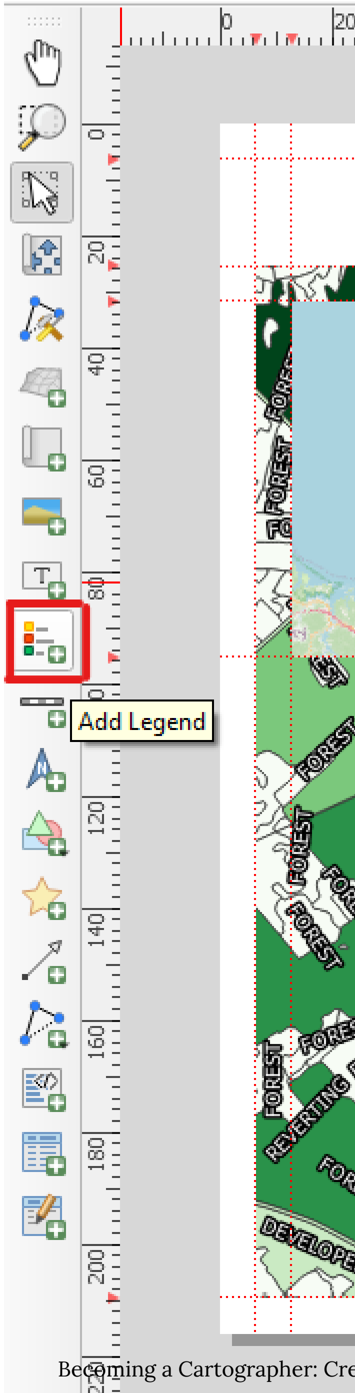

Add Legend

Figure 5.49.

- Place the legend in the space created by the guidelines to the right, using the same click and drag method that we used to add the map frames. When you drag to point that is halfway down the page, a temporary, blue guide will appear. Let go of your click at this point.

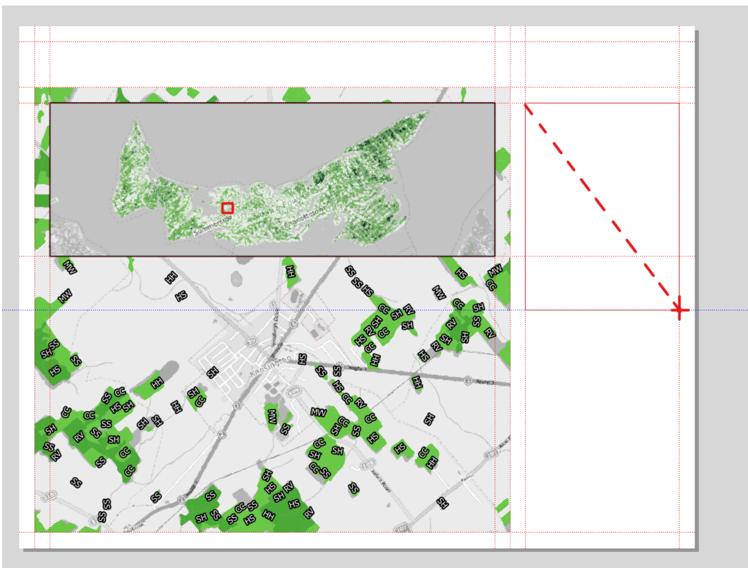


Figure 5.50

We will now start to edit our legend's information.

- Under Main Properties, leave the Title field empty.
- Make sure Map 1 is selected in the Map field.
- In the field called "Wrap text on," enter an asterisk (i.e, *).
- This prepares us to be able to wrap text in our legend in

subsequent steps.

- Leave the Arrangement at Symbols on Left
- Uncheck Resize to Fit Contents.

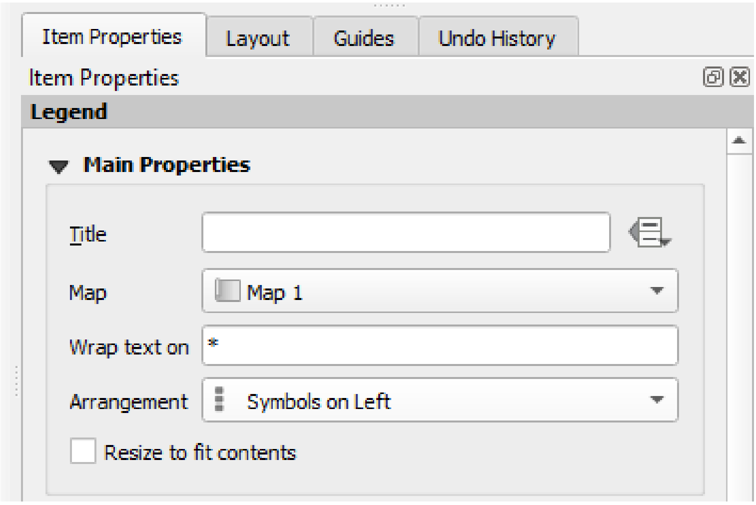


Figure 5.51

Note: sometimes, a legend will not render into the location into which you dragged and dropped it. In this case, after unchecking Resize to fit contents, you may now be able to resize the legend to the desired size by clicking and dragging from its corners.

- Under Legend Items, uncheck Auto Update.
    - This will allow us to change the legend items manually.

- Select any layers other than the 1935 inventory region filtered and graduated layer and the OSM Grayscale layer.
- With these unwanted legend items selected, click the red minus button to delete them.

Note: with Auto Update turned off, deleting a legend item in the Print Layout window does not delete it in the Main Canvas.

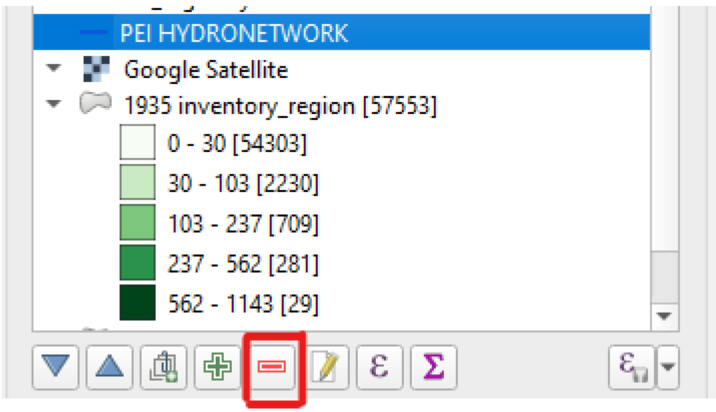


Figure 5.52

With all of the unwanted layers deleted from the legend, we can now rename the layers that we want to keep.

- Click to select the 1935 inventory_region filtered and graduated layer.
- Click the button called Edit selected item properties.

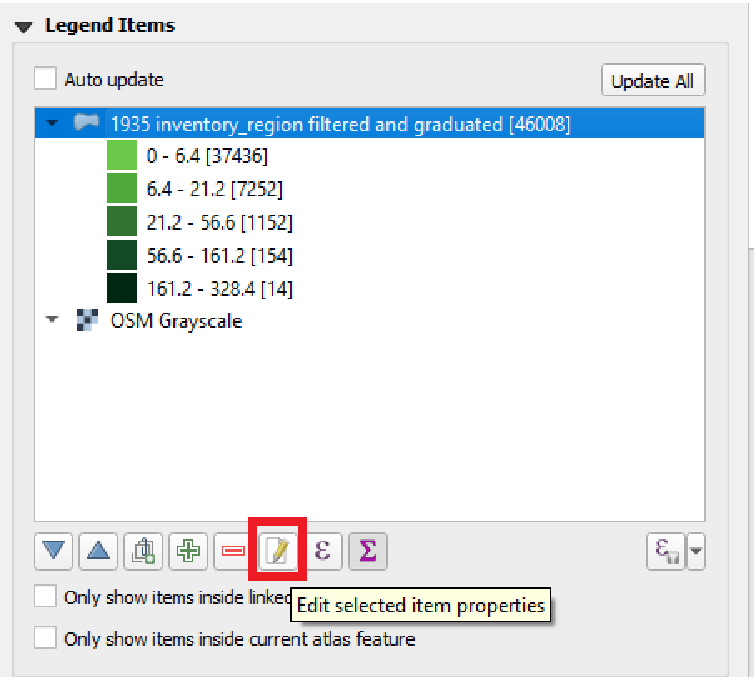


Figure 5.53.

- Type in “Area of Plots, 1935 (ha)*[Feature Count]”

Note that we are including and asterisk so that this text will wrap in our legend.

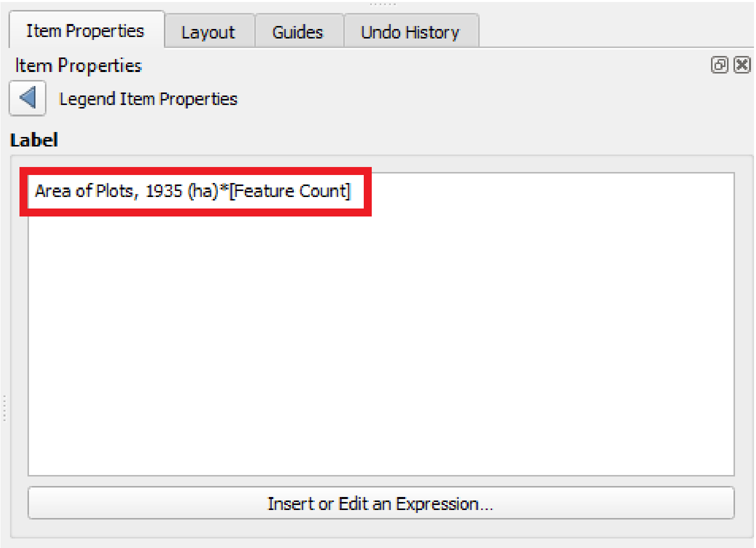


Figure 5.54

Click the back button to return to the rest of the settings.

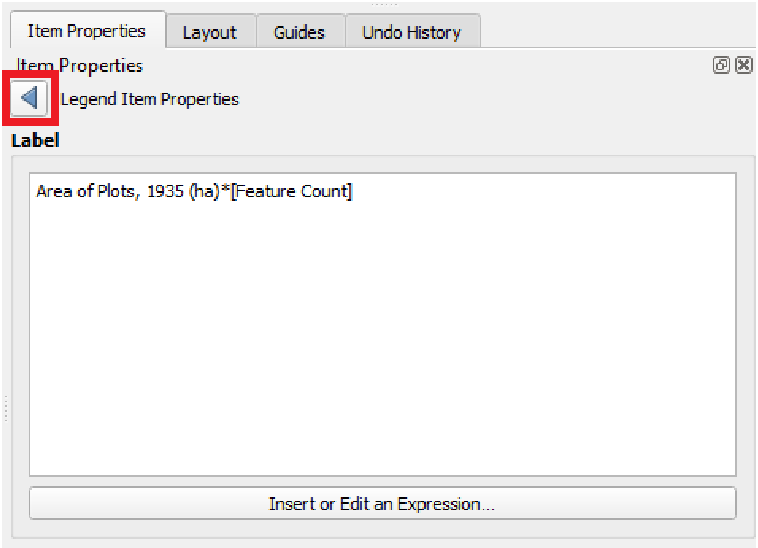


Figure 5.55.

Next, we are going to group and order our legend items.

- Click the Add Group button.

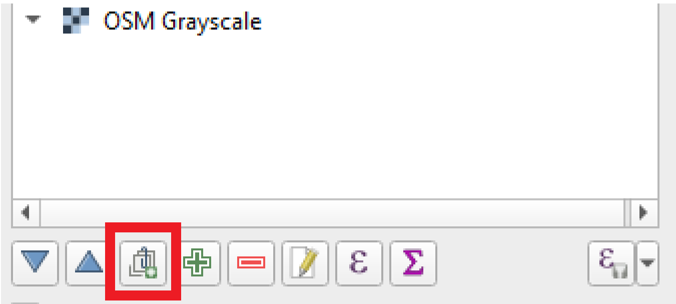


Figure 5.56

- Rename this group to "Base Map."
- Click and hold on the OSM Grayscale layer, drag it over the top of the Base Map group, and release.

> Note: before you release, the Base Map group will have a black rectangular outline.

Figure 5.57

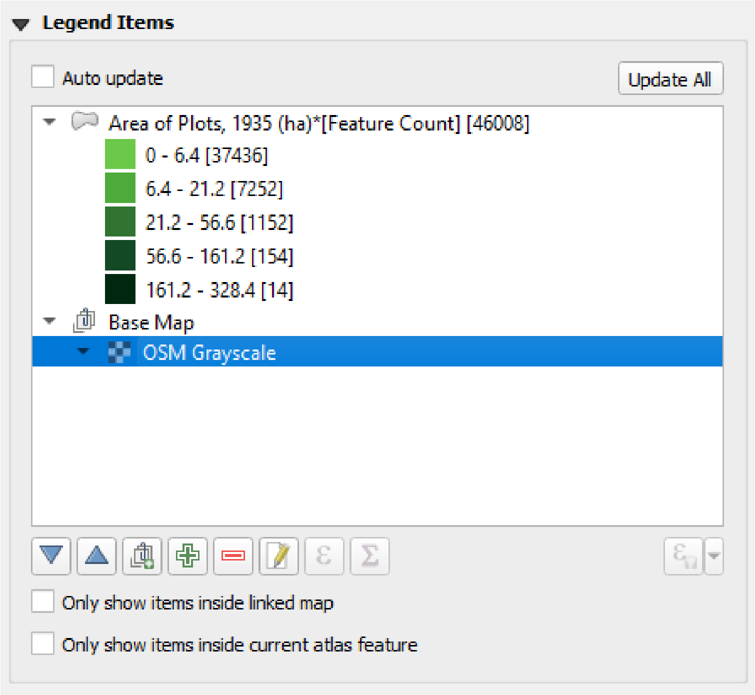


Figure 5.58

We will now change the appearance of the items in the legend in the Print Layout page.

- Right-click the legend item called "Area of Plots (ha), 1935*[Feature Count]"
- Click Group

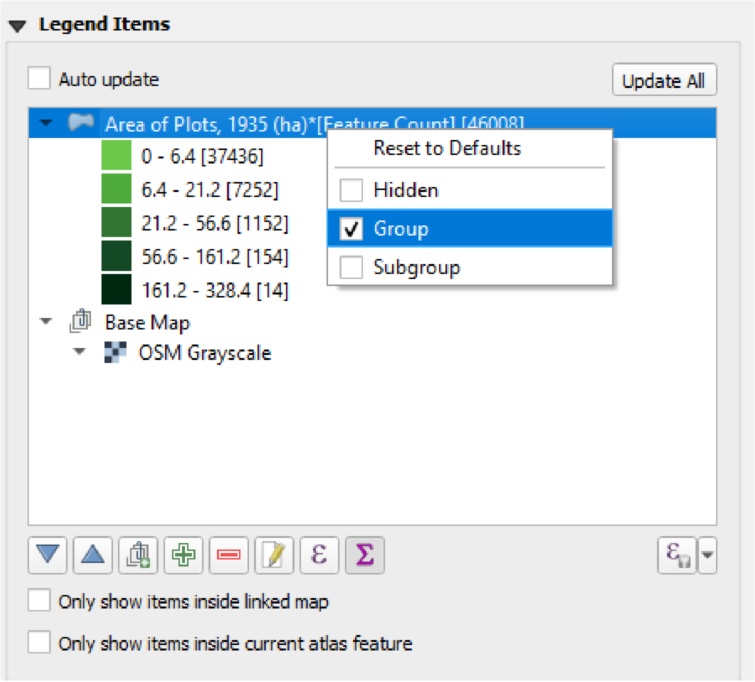


Figure 5.59

- Right-click the Base Map group and make sure it is a Group.
- Right-click the OSM Grayscale layer and make sure it is a Subgroup.
- Arrange the layers so that the "Area of Plots (ha), 1935*[Feature Count]" layer is at the top and the Base Map group is at the bottom.

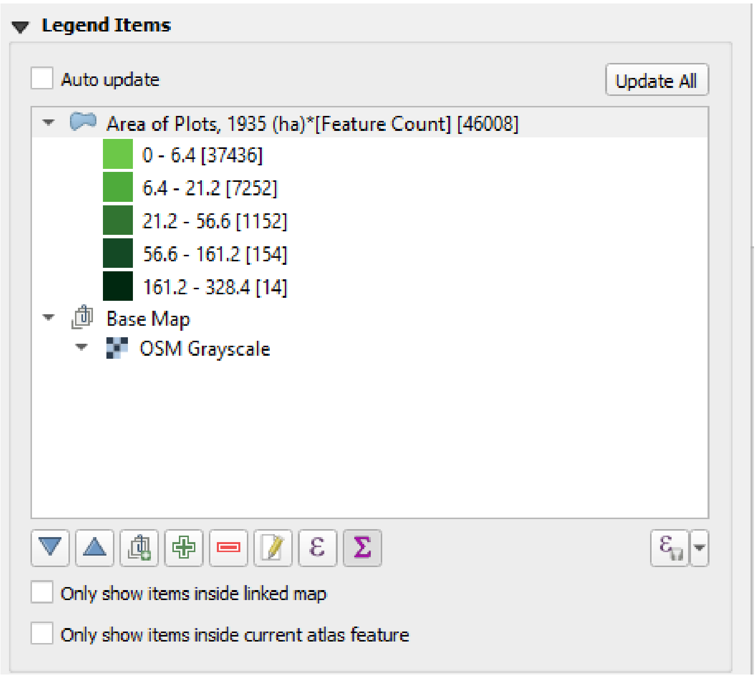


Figure 5.60.

Here is the result on the Print Layout page itself:

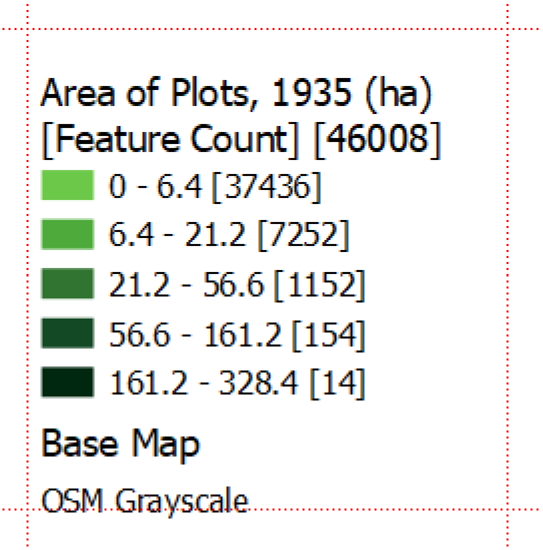


Figure 5.61

Note: that the "Area of Plots (ha), 1935*[Feature Count]" layer wrapped its text according to where we placed the asterisk.

- Before moving on, lock the legend in the Items list.

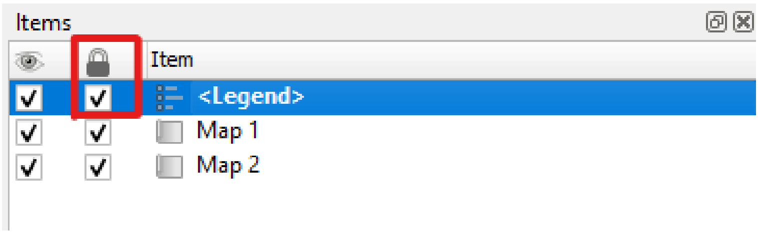


Figure 5.62

Adding a Title

We can now move on and add a title to our map.

Click Add Label.

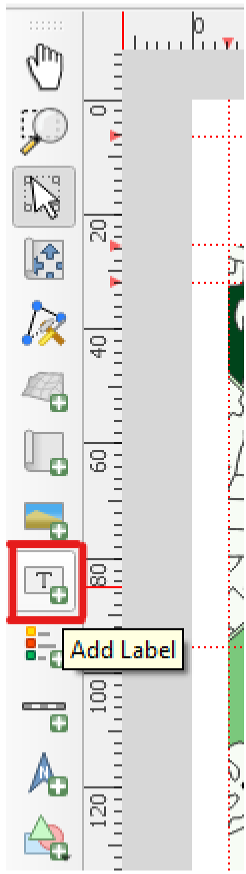


Figure 5.63

Note: although this tool is called "Add Label," it operates essentially like a textbox.

- Click and drag to insert the textbox across the top of our main map frame, nestling it within our guidelines.

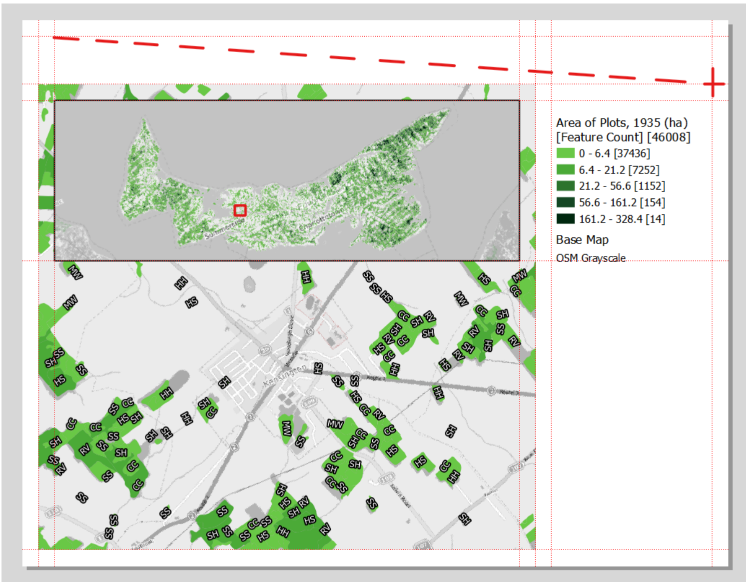


Figure 5.64

- Under Main Properties, type in “Forest Inventory in Kensington, PEI, 1935”

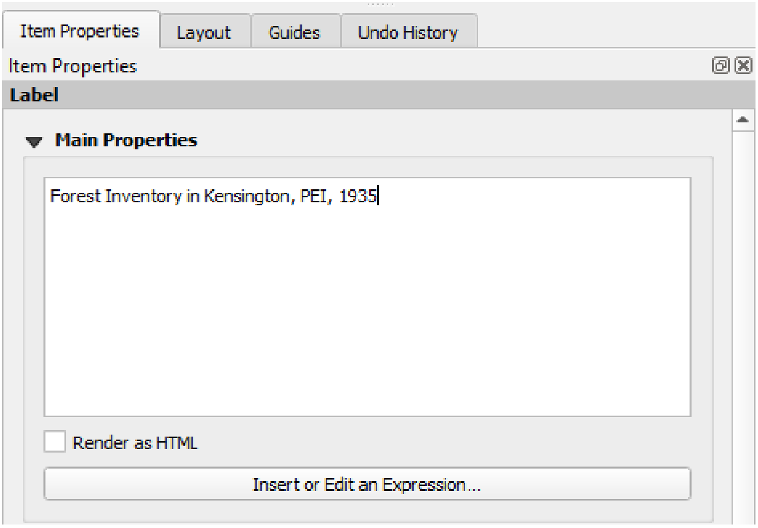


Figure 5.65

- Under Appearance, click the dropdown arrow next to Font and change the font size to 40.

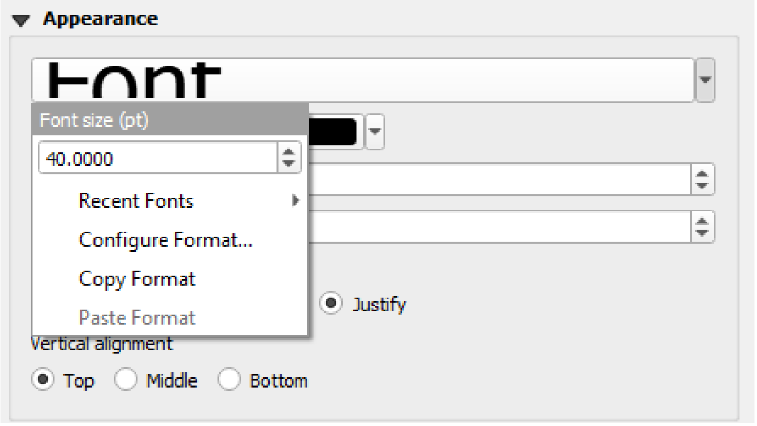


Figure 5.66

- Change the Horizontal Alignment to Left.
- Change the Vertical Alignment to Middle.

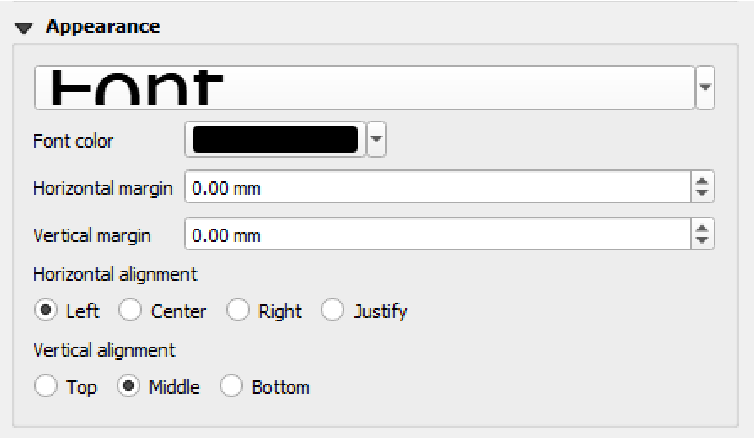


Figure 5.67.

Here is the result:

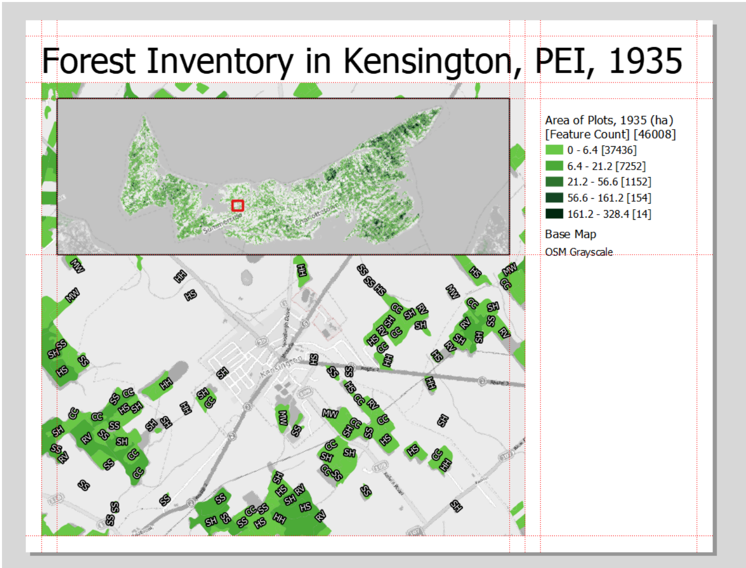


Figure 5.68

Before moving on, lock the title in the Items list.

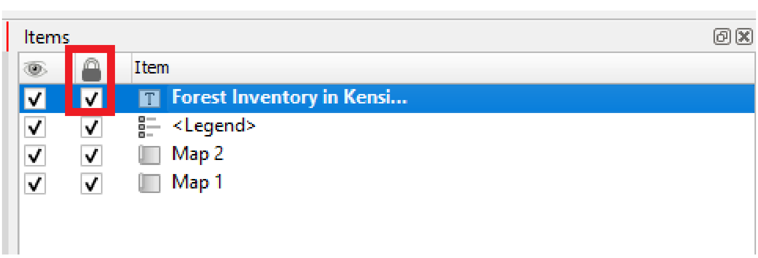


Figure 5.69.

Adding a Scale Bar

Adding a scale bar will help our audience to understand the distances on our map in relation to the real world.

- In the Guides tab, add a horizontal guide at the 7-inch mark.
- Click the Add Scale Bar button.

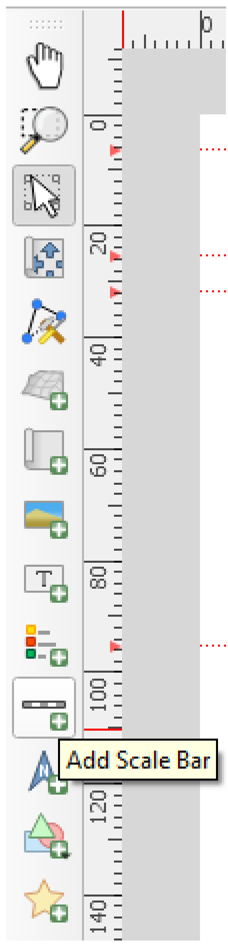


Figure 5.70

- Draw a scale bar between the 8.25-inch mark and the 7-inch mark.

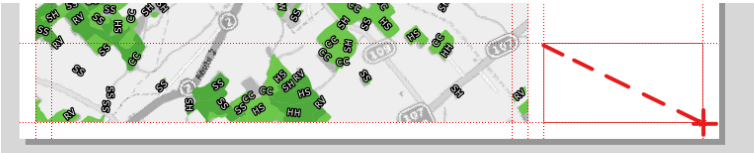


Figure 5.71

- Use the Select/Move Item tool to select the scale bar.
- In the Item Properties tab, under Units, change the Scalebar units to Kilometres.

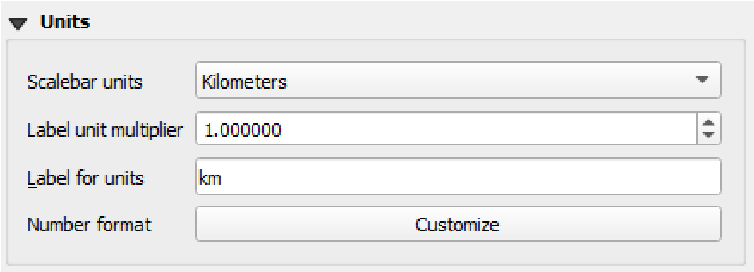


Figure 5.72

- Under Display, change the Box margin to 10.00 mm.
  - This will have the effect of centring our scale bar.

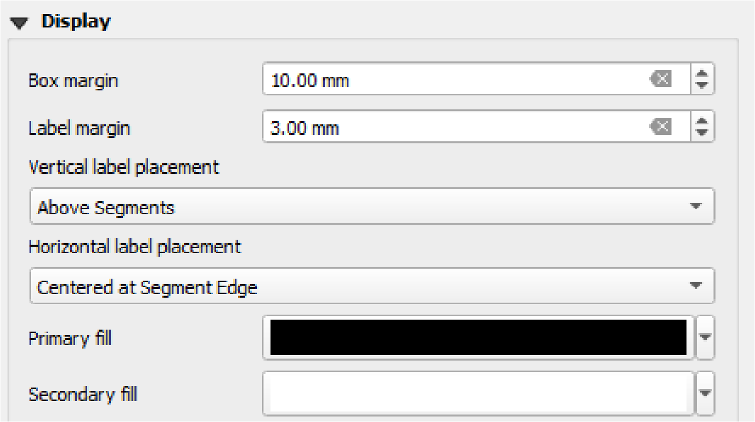


Figure 5.73

Here is the result:

Figure 5.74

Adding a North Arrow

A north arrow can help someone looking at our map to understand the orientation of our map frame.

To add a north arrow,

- Add a horizontal guide at the 4.45-inch mark.
- Click the Add North Arrow button.

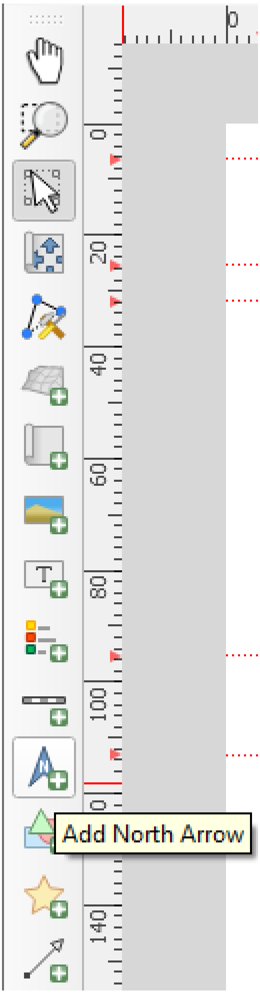


Figure 5.75.

Draw a north arrow between the 4.45-inch mark and the 7-inch mark.

Figure 5.76

We can now change the appearance of our north arrow if we wish.

- Use the Select/Move Item button to select the North Arrow.
- In the Item Properties tab, make sure the SVG Image radio button is selected.
- In the list of SVG Groups, under “App Symbols,” click “arrows.”
- Choose the four-headed compass rose that features the letters N, E, S, and W.

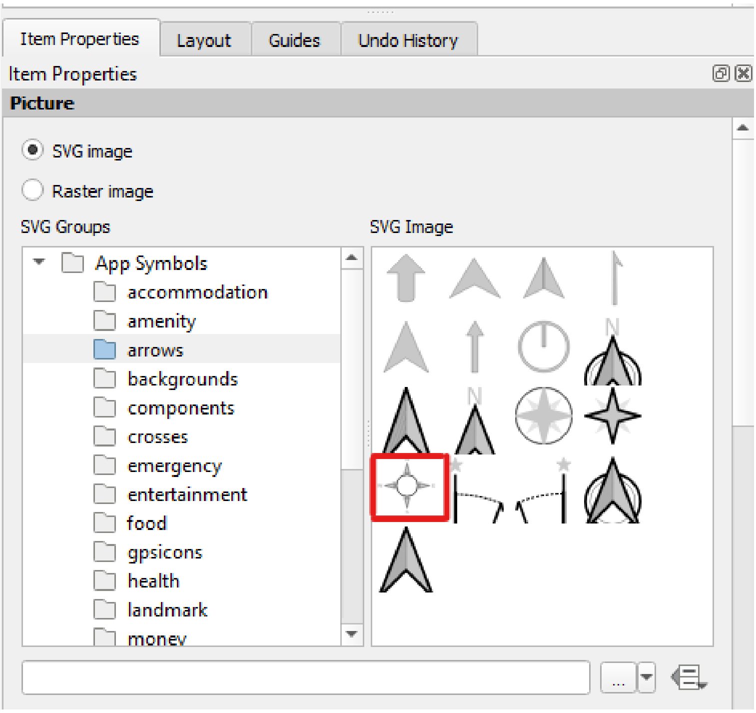


Figure 5.77

Under SVG Parameters, change the Fill colour to black.

Figure 5.78

We can now see the compass rose on our layout page:

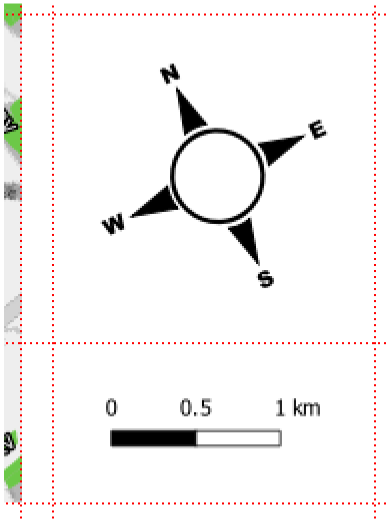


Figure 5.79

Here is the final result of our layout in the Print Layout window:

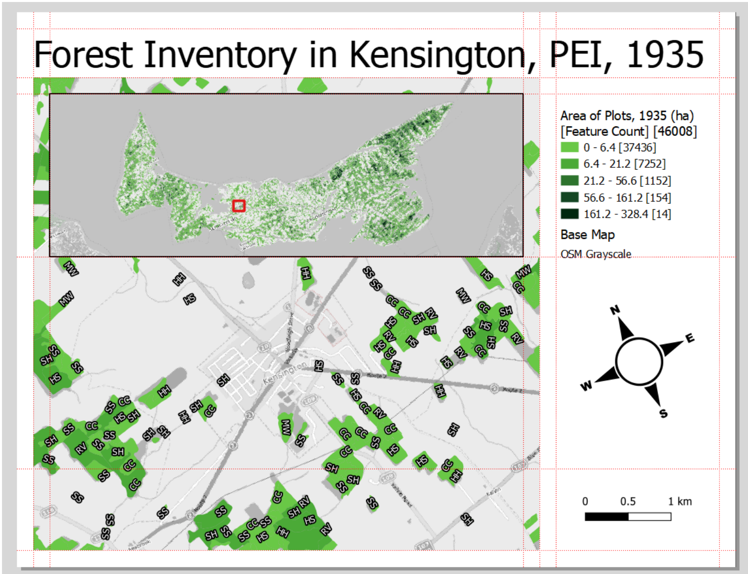


Figure 5.80

Our layout is now complete and ready to be exported.

Exporting Our Layout

We have a few options for exporting our layout.

Print

We can print our layout directly from the Print Layout window.
If you wish to print your layout, click the Print Layout button.

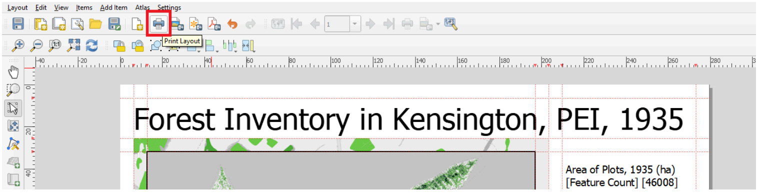


Figure 5.81

Saving as an Image

We also have an option to save our layout as an image file. We could print this file later.

If you wish to save your layout as an image file, click the Export as Image button.

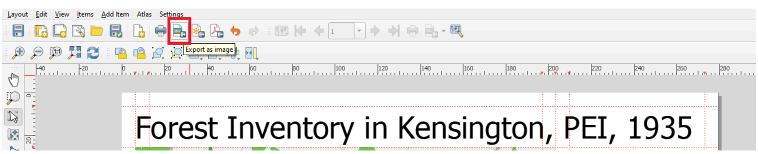


Figure 5.82.

A window will then pop up and ask you where you would like to save your file.

Navigate to an appropriate location, provide a file name, and click save.

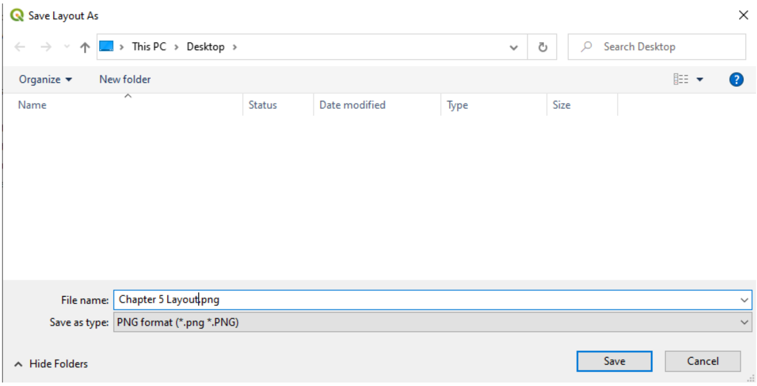


Figure 5.83

Another window will pop up called Image Export Options.

- You can leave the settings at their defaults and click Save.

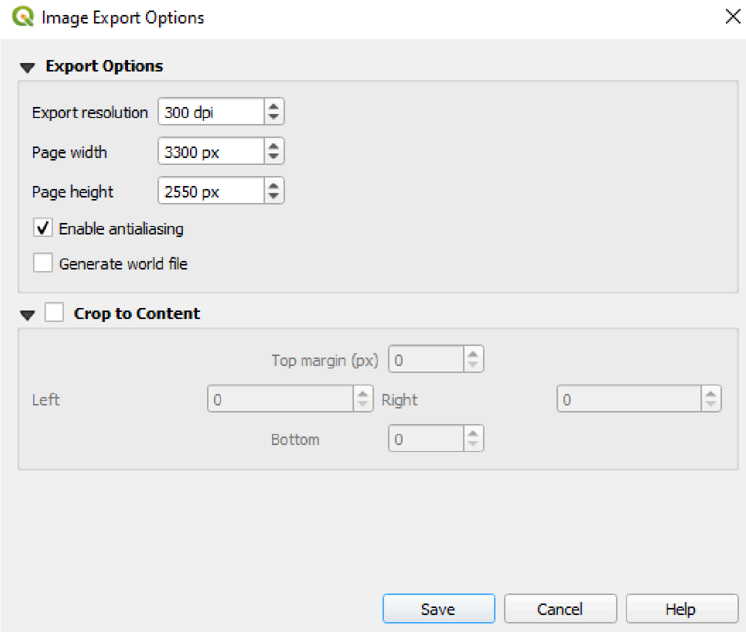


Figure 5.84

Saving as a PDF

We can also export our layout as a PDF.

If you wish to export your layout as a PDF, click the Export as PDF button.

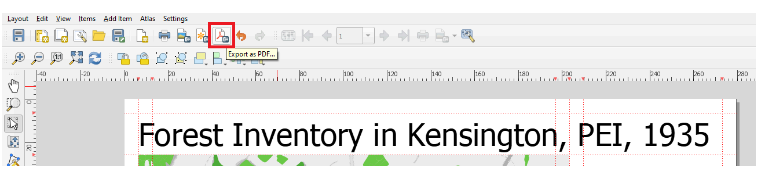


Figure 5.85

A window will then pop up and ask you where you would like to save your file.

- Navigate to an appropriate location, provide a file name, and click save.

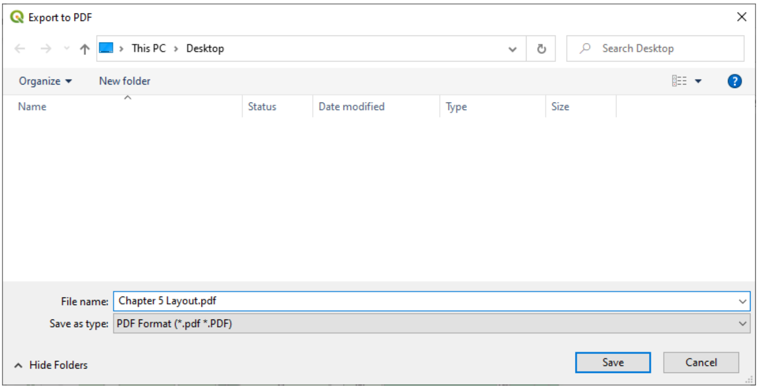


Figure 5.86

A window will pop up asking you to specify the settings for your PDF.

- You can leave the settings at their defaults and click Save.

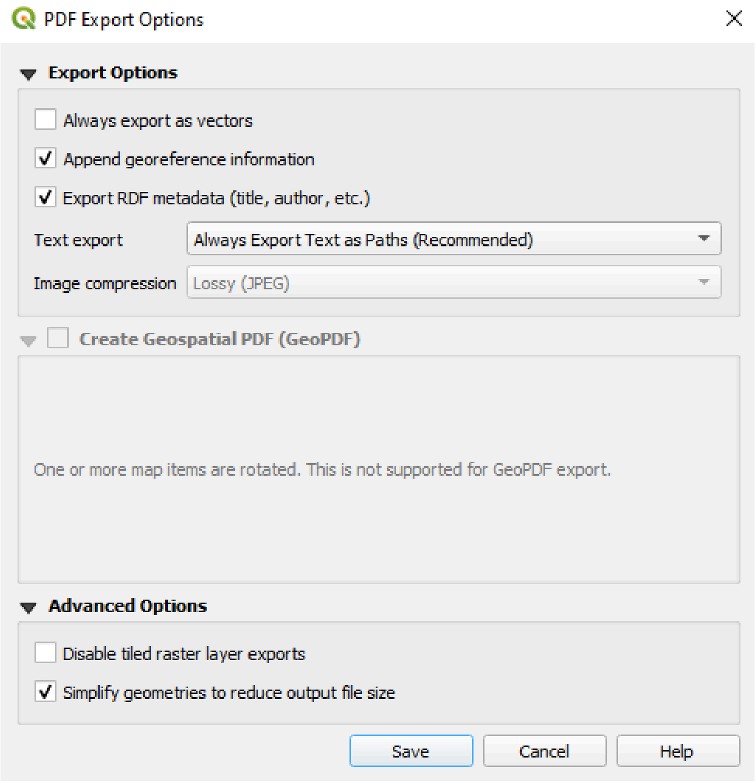


Figure 5.87

The Final Result

Here is the final result of our print layout exported as an image file.

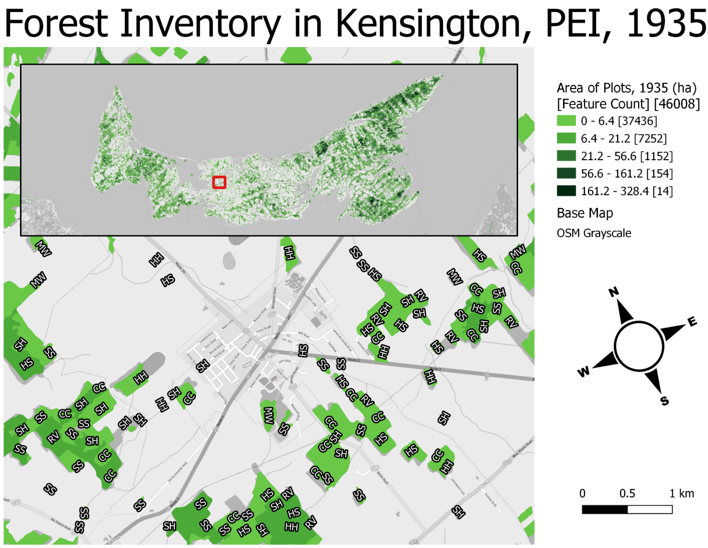

Forest Inventory in Kensington, PEI, 1935
Area of Plots, 1935 (ha)
[Feature Count] [46008]
0 - 6.4 [37436]
6.4 - 21.2 [7252]
21.2 - 56.6 [1152]
56.6 - 161.2 [154]
161.2 - 328.4 [14]
Base Map
OSM Grayscale
N
E
W
S
0
0.5
1 km

Figure 5.88

Conclusion to Chapter 5

This brings us to the end of this chapter, and it also brings us to the end of Volume I of this textbook. We have learned the fundamentals of creating maps in QGIS and, in this chapter, how to export them in an accurate and appealing way. With this knowledge of the fundamentals of using QGIS, you will be able to apply GIS solutions to your projects, whether they be academic or professional.

You can now proceed to Volume II of the textbook, where we will deepen our knowledge of GIS.

Further Resources

Check out these two videos published on YouTube by Statistics Canada. They guide you through the process of making print layouts in QGIS.

Demo 14 – Making Maps in QGIS with the Print Layout (Pt. I)
Demo 15 – Making Maps in QGIS with the Print Layout (Pt. II)