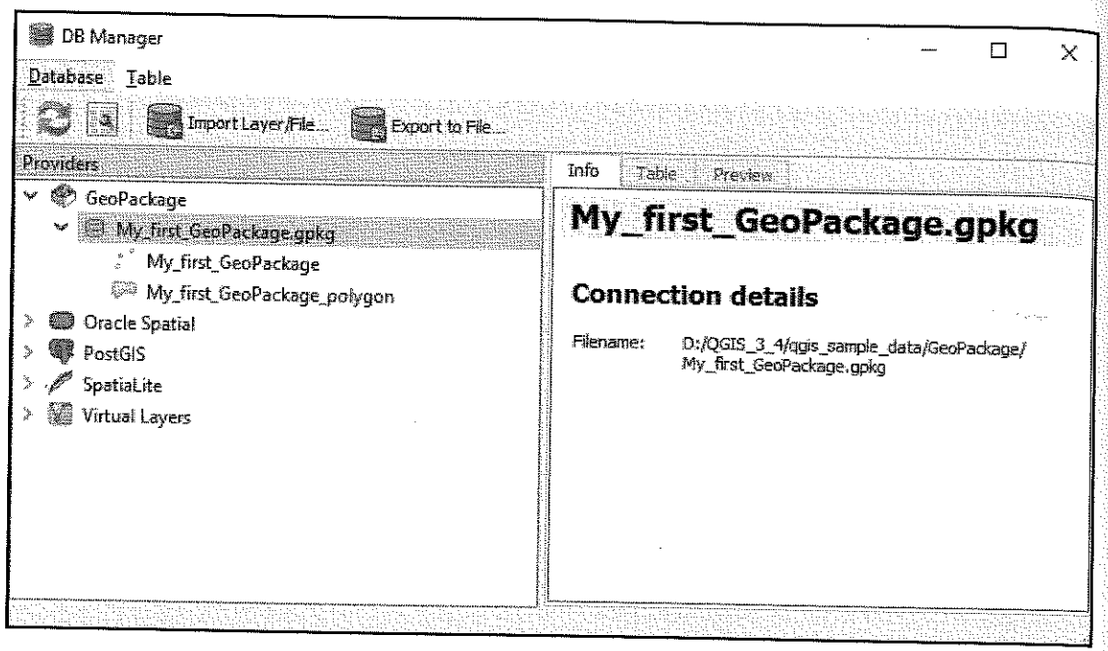
You should see the connection displayed in the following screenshot:



The DB Manager

You can drag and drop these layers into QGIS. You can then upload new data, export existing data, and run SQL on the data. The DB manager performs the same function for all the GIS database types previously listed. If you have access to a database, such as PostGIS, then the DB manager is a very convenient place in QGIS to interact with the data.

Summary

In this chapter, you learned the basics of using data in a GIS. QGIS 3.4 supports all the formats in OGR and GDAL. The default format for QGIS 3.4 is the GeoPackage. We also looked at creating and editing Vector data, as well as attribute tables and geometries. Furthermore, we joined data and used snapping tools to preserve topology. Don't ignore Raster data though; we will use it many times throughout this book. In this chapter, we briefly reviewed its creation and hinted at the powerful GDAL tools built into QGIS. Finally, we looked at spatial databases in QGIS 3.4 and connected to them in DB Manager.

In the next chapter, we will look at styling and visualizing this data.

3
Visualizing Data

In this chapter, we will look at visualizing GIS data. We will build on the knowledge gained in `Chapter 2`, *Data Creation and Editing*, in which we learned how to load, create, and edit GIS data. QGIS automatically styles data when added to the map. This is useful for a quick inspection, but to convey more meaning, we need to style our data so that the information presented becomes more intuitive. That is what this chapter is all about.

The topics covered in this chapter are as follows:

- Styling data
- Interactive styling
- Styling Rasters
    - Styling Terrain data
    - Styling Satellite imagery
    - Raster toolbar
    - Styling landcover maps
- Saving styles
- Styling Vectors
    - Points
    - Simple markers and SVG
    - Lines
    - Polygons

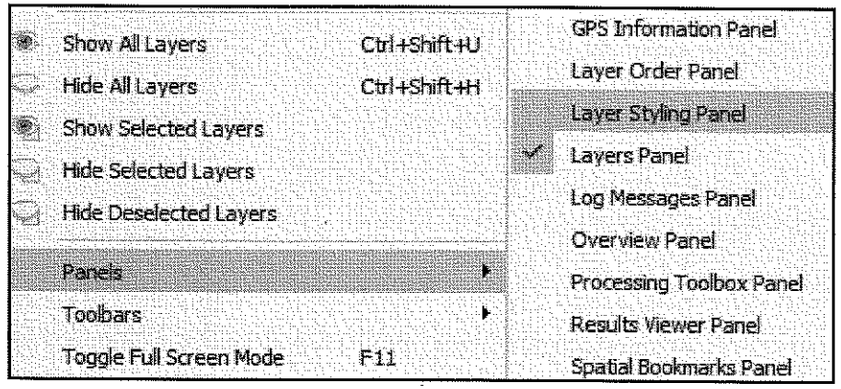
Styling data

We are going to style both Raster and Vector data. QGIS 3 has significantly updated and improved its ability to visualize GIS data. In this chapter, we will show how styling in QGIS can be used to convey more meaning to data.

We will again use the QGIS sample data from `https://qgis.org/downloads/data/` – look for the `qgis_sample_data.zip` file. Download and extract the data to your computer if you have not already done so.

Interactive styling

A major visualization improvement in QGIS 3 is the ability to style GIS data interactively. There are now two main ways to style your data. You can either left-click on a layer and select properties, or you can click on **View** | **Panels** | **Layer Styling Panel**, as shown in the following screenshot:



Selecting the Layer Styling Panel

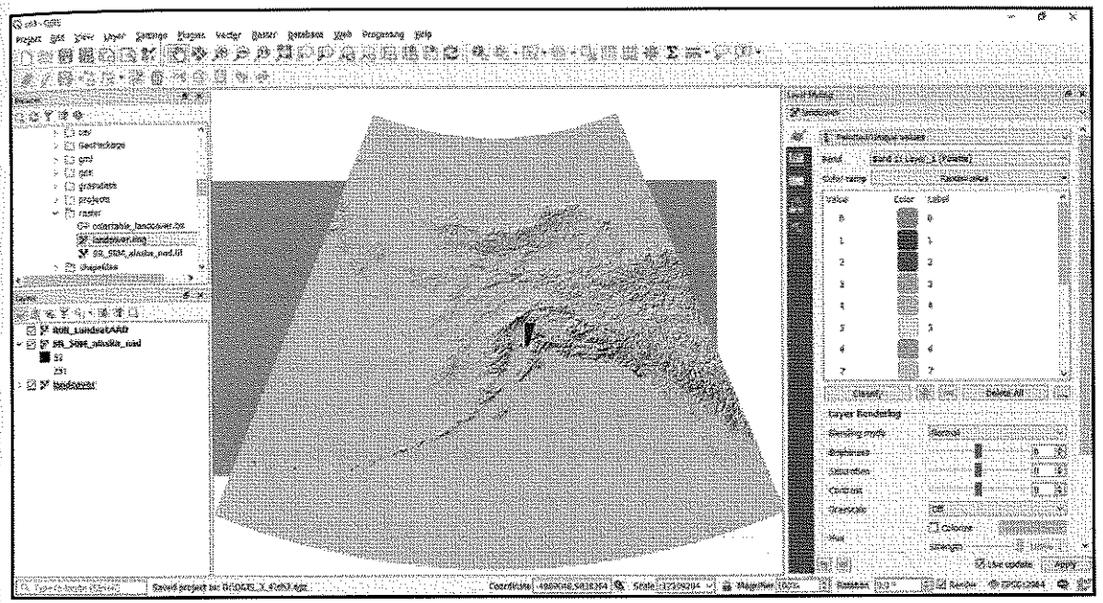
The Layer Styling Panel provides fast feedback, but does take up a lot of screen space. In the **Layer Styling Panel**, check the box next to the **Live Update** option to see changes in real time. In this chapter, we will be predominantly working with the **Layer Styling Panel**, but you will achieve the same results by accessing the layer properties dialog box if you prefer.

Styling raster layers

From the QGIS Sample dataset, load the `SR_50M_alaska_nad.tif` and `landcover.img` files from the `Raster` folder. Turn on the **Layer Styling Panel** if it is not already on, and then load the `RGB_LandsatARD.tif` file from this book's download page.

Download the extra material for this book from `www.packt.com`.

Your screen should look similar to the following. The three raster layers loaded into the QGIS layers panel are shown here:



QGIS with the raster datasets loaded

In the map window, we now have three of the most common types of Raster datasets: a Satellite image (this is Landsat 8 Analysis-Ready Data), a Terrain dataset (Hillshade data that covers the whole of Alaska), and a `landcover` dataset that has been loaded as a paletted image by default.

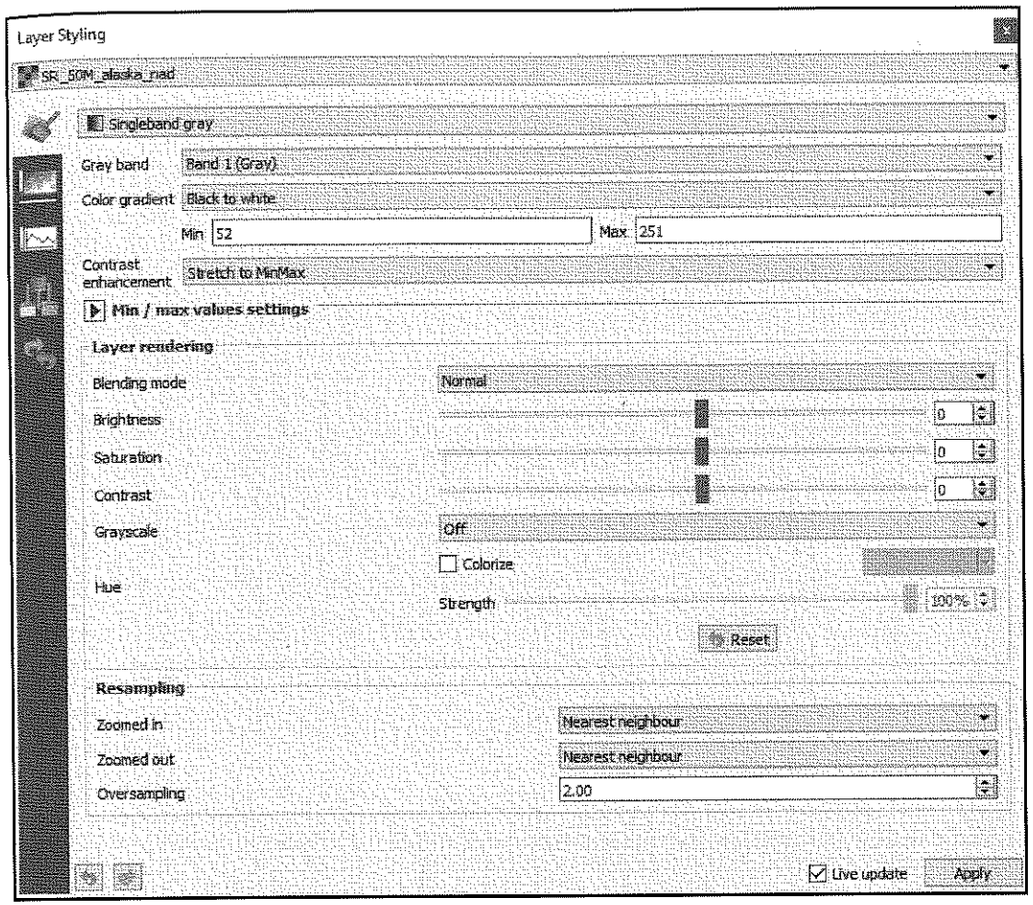
In QGIS 3.4, there are five methods for styling your raster. These methods consist of the following:

- **Multi-band color**: This style is used if the raster has several bands. This is usually the case with satellite images with multiple bands.
- **Paletted**: This style is used if a single-band raster comes with an indexed palette.
- **Single-band gray**: If a raster has neither multiple bands nor an indexed palette (as is the case with elevation models), they will be rendered using this style.
- **Single-band pseudo-color**: Instead of being limited to gray, this style allows us to render a raster band using a color map of our choice.
- **Hillshade**: This is useful for any DEM-derived rasters, such as Hillshade. It gives us the ability to alter the angle at which these datasets are displayed. Think of this option as an on the fly Hillshade for Raster. We will look at how Hillshade Rasters are created in `Chapter 5`, *Spatial Analysis*.

Layer styling – Terrain

The **Layer Properties** dialog box or the **Layers** panel contains similar styling options in the dialog box. We are now going to look at the styling options for terrain data, Satellite RGB data, and landcover/paletted data.

Click on the **Layer Styling** tab button, as shown in the following screenshot:

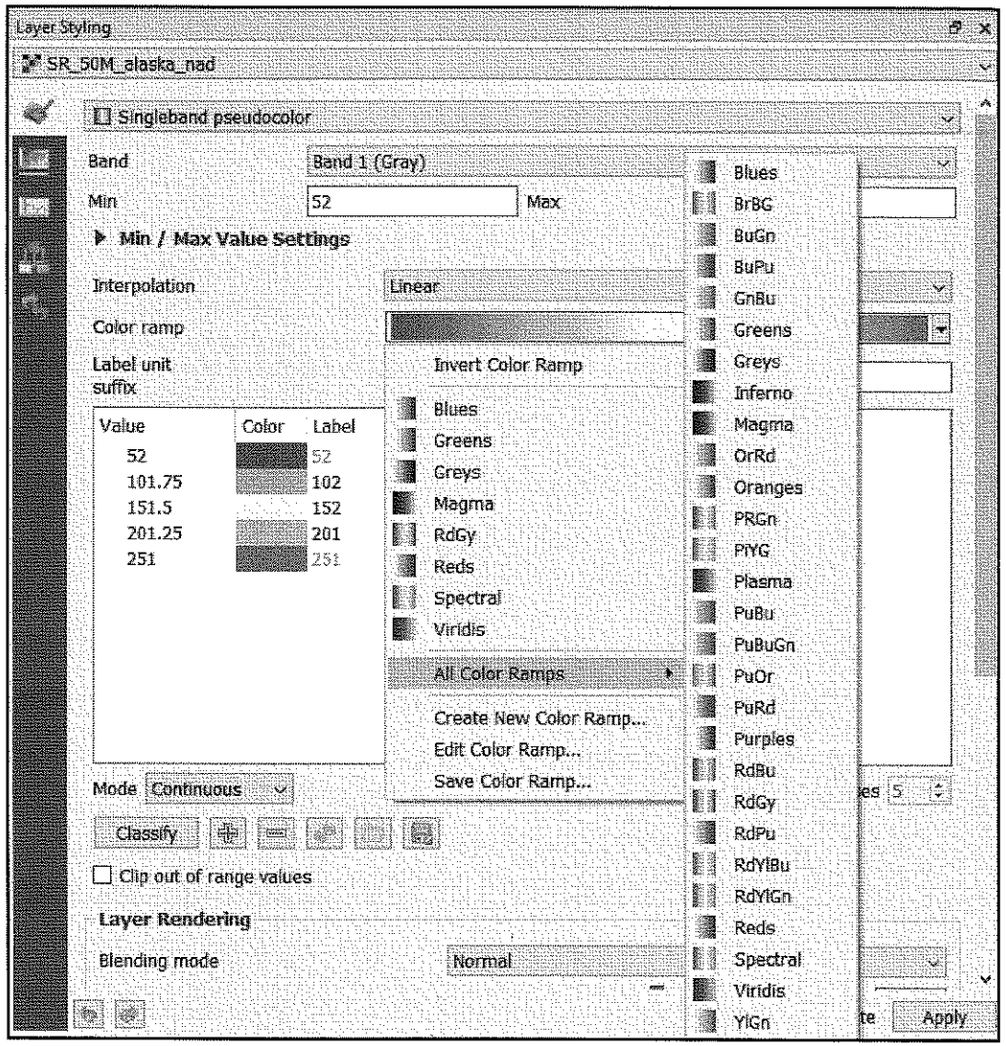


Layer Styling dialog box

There are several useful parameters in here that display the data in the best way. These parameters include:

- **The renderer**: This is set to **Singleband gray** for this image. Change this to **Single-band pseudo-color**. If you are working in the **Layer Styling** panel as I am, you will see the impact of this change immediately.
- **The Min/Max values settings**: This is how we stretch our image. Zoom to the extent of the RGB_LandsatARD layer, change the statistics to the current canvas, and click on the **Mean +/- standard deviation** radio button to alter the way the data is displayed. This is known as **stretching**.

- **The Interpolation drop-down box**: This allows the color ramp to be blended using Linear Interpolation or Discrete in order to use the values as shown in the following color ramp. Leave this setting as Linear.
- **The color ramp option**: Click on the drop-down menu and select **All Color Ramps** | **Viridis**. This color ramp is more suited to terrain display. This setting is shown here:

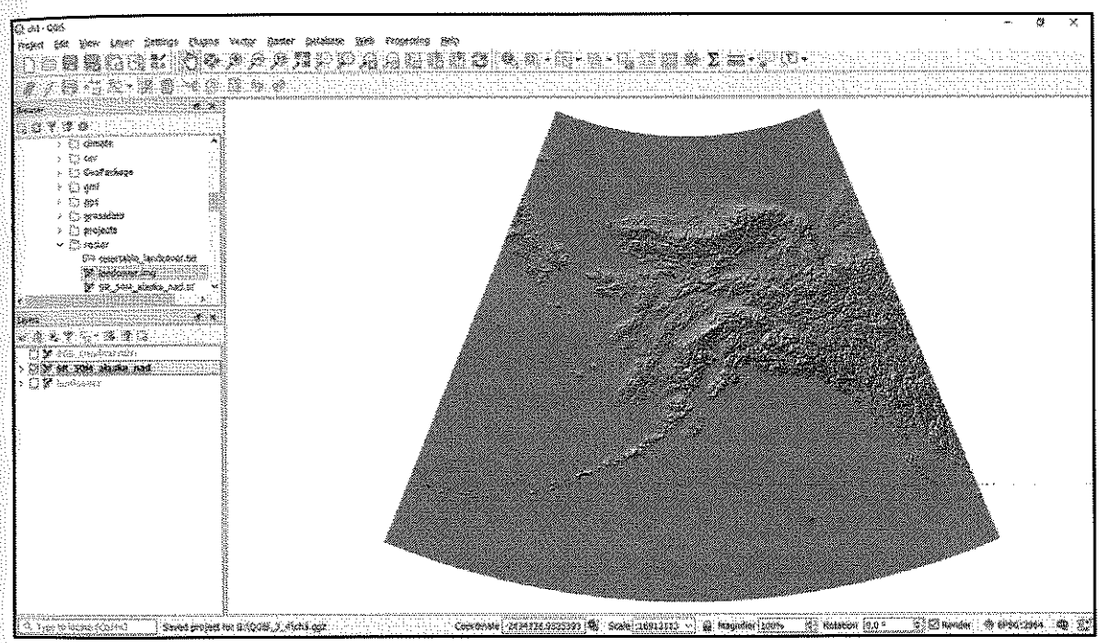


Color ramps in QGIS

- **The mode option**: This enables you to change the way the data is split up into classes. By default the setting is **Continuous**, though you can change to Equal Interval or Quantile. With these settings, you can adjust the number of classes you wish to display.

Under the color settings, we can find a section with more advanced options that control the Raster **Resampling**, **Brightness**, **Contrast**, **Saturation**, and **Hue** options that you probably know from image-processing software. By default, resampling is set to the **Nearest-neighbor** option. To get smoother results, we can change to the Bilinear or Cubic method. For this example, we will set resampling as **Cubic**.

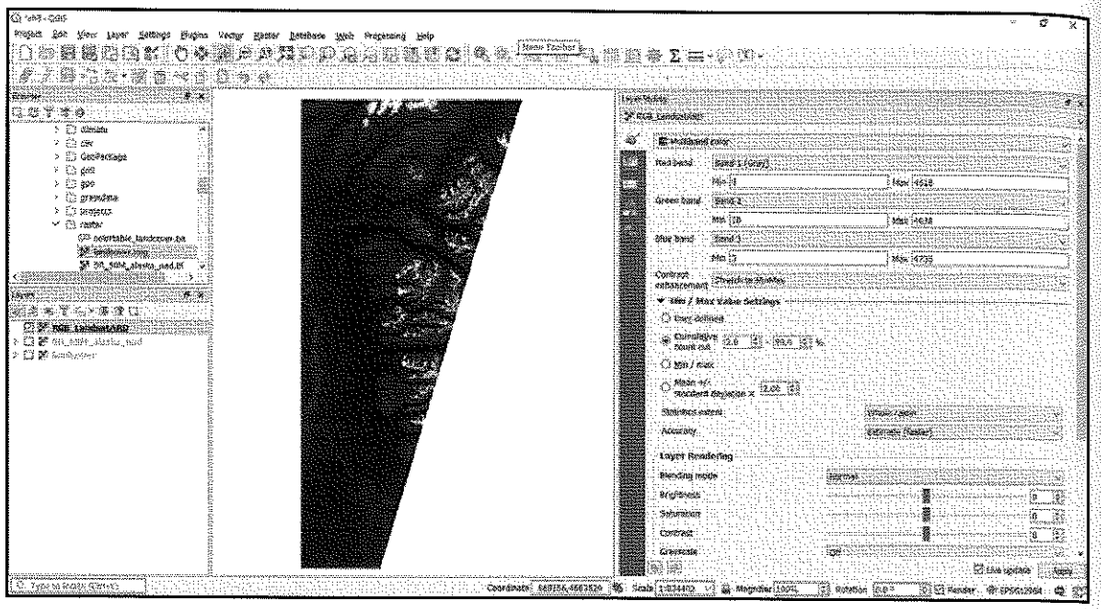
There is one final layer **Rendering** option: **blending**. Leave this setting as normal for this layer. As we build up our map, this setting helps us to integrate this data visually. Turn off the **Layer Styling** panel and zoom to the extent of the **SR_50M_alaska_nad** layer. Your terrain data should look similar to the following screenshot:



Terrain rendered in QGIS

Layer styling – satellite image

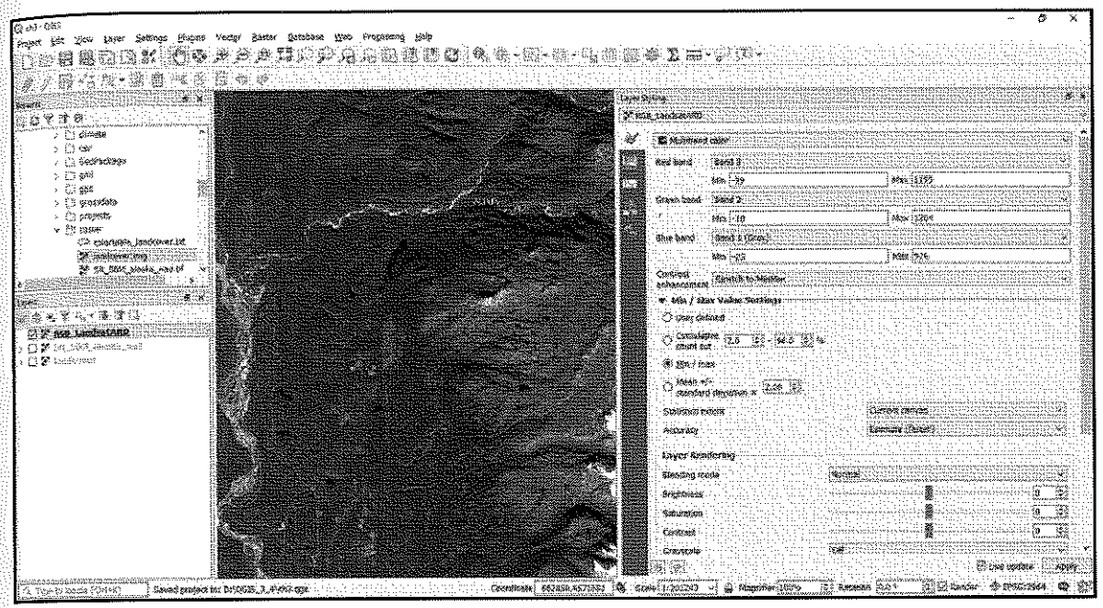
Turn on the **RGB_LandsatARD** layer and zoom in to it. If you haven't stretched or altered the layer, it should appear similar to the following screenshot:



Landsat ARD in QGIS

This data is Landsat **Analysis Ready Data (ARD)**, which was downloaded from the **US Geological Survey (USGS)** in May 2018. All Landsat data is open source and is increasingly becoming part of many GIS workflows. The ARD data means that we do not have to perform any atmospheric correction to the data; it is already converted to surface reflectance and therefore is in a usable format.

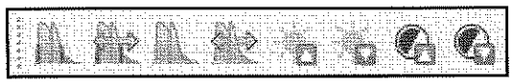
The first thing to do with this layer is to change the order of the bands from RGB 123 to RGB 321. To do this, set the **Red band** to Band 3, the **Green band** to Band 2, and the **Blue band** to Band 1. Set the **Contrast enhancement** to **Stretch** and clip to **MinMax**. Zoom into the data and set the **Statitistic** extent to **Current canvas**. Leave all other parameters as default. The Landsat data should appear similar to the following screenshot:



Stretching satellite data using the Layer Styling panel

Raster Toolbar

The Raster Toolbar (**View** | **Toolbars** | **Raster Toolbar**) is a very useful way of quickly stretching and displaying Raster data. It is especially useful for RGB satellite images. The toolbar looks like this:



Raster toolbar

The first four buttons (displaying the histogram graphs) are useful for stretching the data, while the final four buttons adjust the contrast and brightness. Furthermore, the histogram buttons can alter the data depending on your current view extent.

- The first of these buttons is a local cumulative cut stretch set to the extents of your current map extent
- The second is a local cumulative cut stretch set to the extents of your data
- The third is the local histogram stretch
- The fourth is the histogram stretch to the extents of your data

This toolbar is one of the hidden gems of QGIS. Once you have defined the bands to be displayed, this is often the simplest way of creating a nicely balanced image.

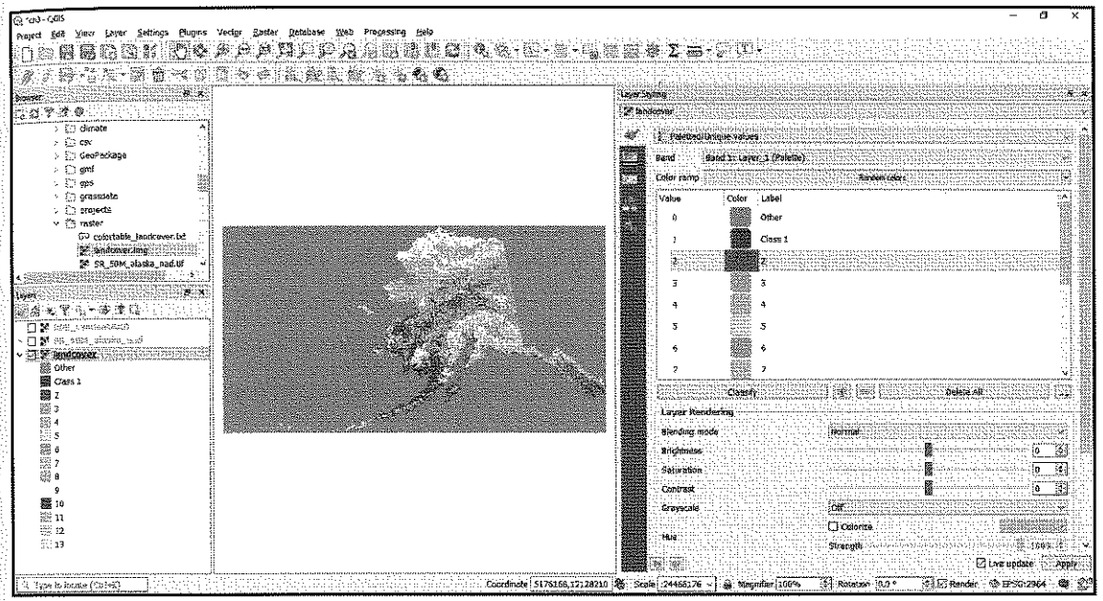
Styling data – landcover map

To conclude this section on styling raster data, let's take a look at the landcover map. By default, when data is added to the layer panel, the landcover map will look similar to the following screenshot:

Displaying landcover data in QGIS

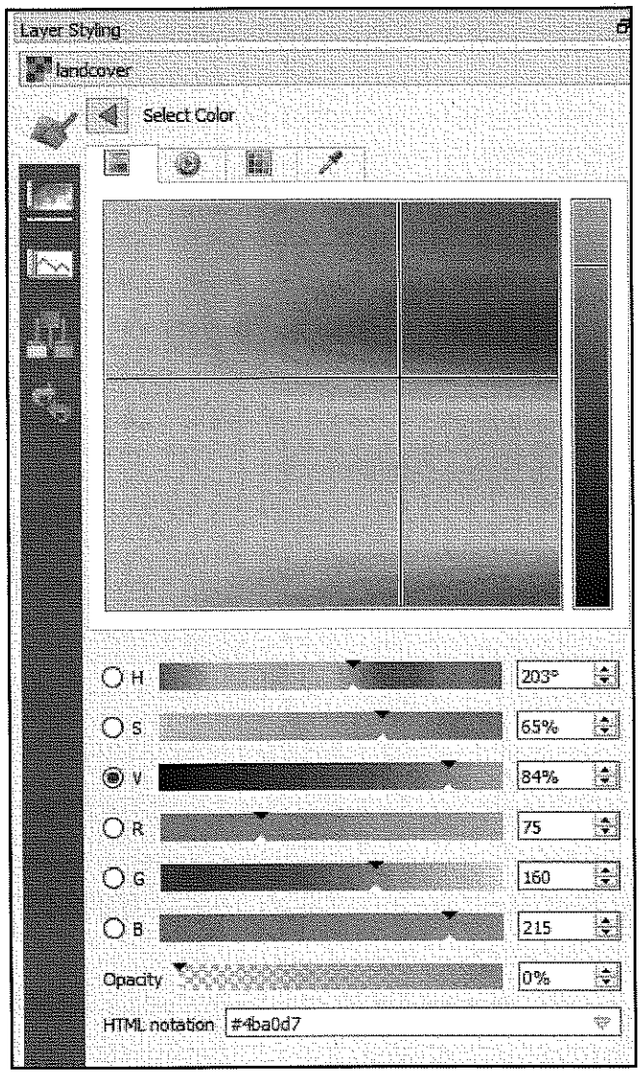
In the same way as for layer styling within the terrain section, we have the ability to make several changes to the `landcover` layer. We are not going to alter the color ramp here. `Landcover` raster datasets are often based on or generated from classifications of Satellite data. If your `landcover` class has an appropriate color, then this will help the end user to understand the data that is being presented to them.

It is also often useful to add a meaningful label to a dataset such as this. If you double-click on the **0** label and set it to **Other** as well as setting the next label to **Class 1**, you will see the **Layers** panel update at the same time:



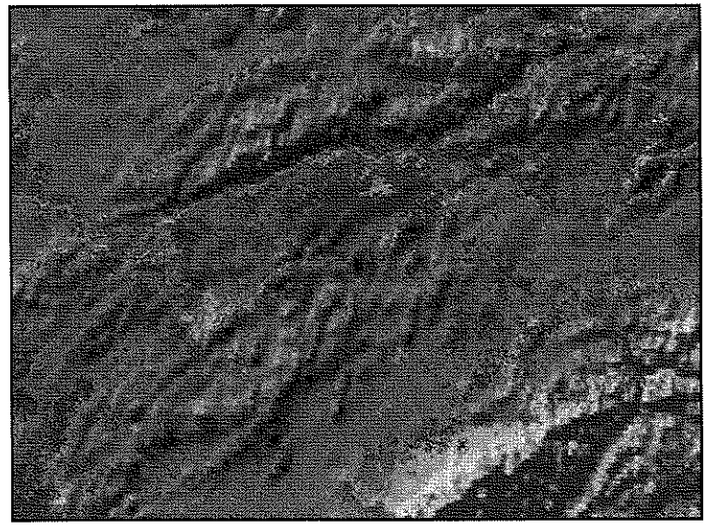
Changing the landcover dataset in QGIS

Continue to label all of the other labels in this way. After you have labelled them, double-click on the blue color which corresponds with Value `0` . Alter the **Opacity %** to `0%`, as shown in the following screenshot:



The color picker

This will make the blue color transparent. Finally, let's look at the blending options in the Layer-rendering section on the layer-styling tab. First, turn on the **SR_50m_alaska** layer. Next, set the **Blending** mode to **Lighten** and see the impact on the display. In this example, I want to combine the **SR_50m_alaska** layer with the landcover layer in an attempt to show more details and highlight the geomorphology of Alaska. To do this, I will set the **Blending** mode to **Multiply** and leave the other settings at their default options. As I zoom into the data, I can see the impact of the Hillshade combined with the landcover classification. It should look similar to the following screenshot:

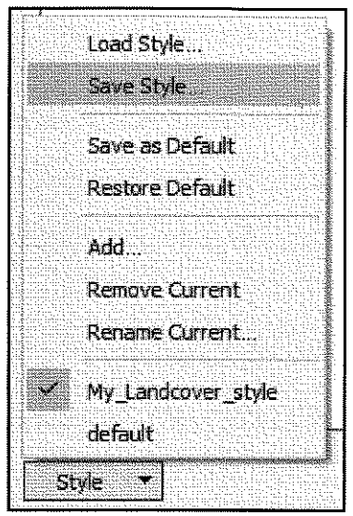


Combining the raster datasets

Saving styles

Before we move on to styling vector layers, it is worth noting that whenever you style your data, you can save the style. This means that you can reuse it again on other layers and in other projects.

To do this, right-click on the **Layer** in the **Layers** panel and select **Properties**, then click on the **Style** button in the bottom left of the **Layer Properties** dialog box and select **Save Style...**, as shown in the following screenshot :



Saving the style

A `.qml` file will be saved to your disk. Follow the same process to generate qml styles for all the layers and then save your map. Alternatively, you can right-click on the **Layer** in the **Layers** panel and select **Export | Save as QGIS Layer Style File**.

Saving to Styled Layer Description (`.sld`) files can be done with the SLD4Raster plugin. This useful plugin will allow you to upload your styling directly to Geoserver as well. An SLD file is an OGC format. For more information, see `http://www.opengeospatial.org/standards/sld`.

Styling vector layers

As we saw when we loaded vector layers, QGIS renders them using a default style and a random color. In the following exercises, we will style point, line, and polygon layers. You will also get accustomed to the most common vector-styling options.

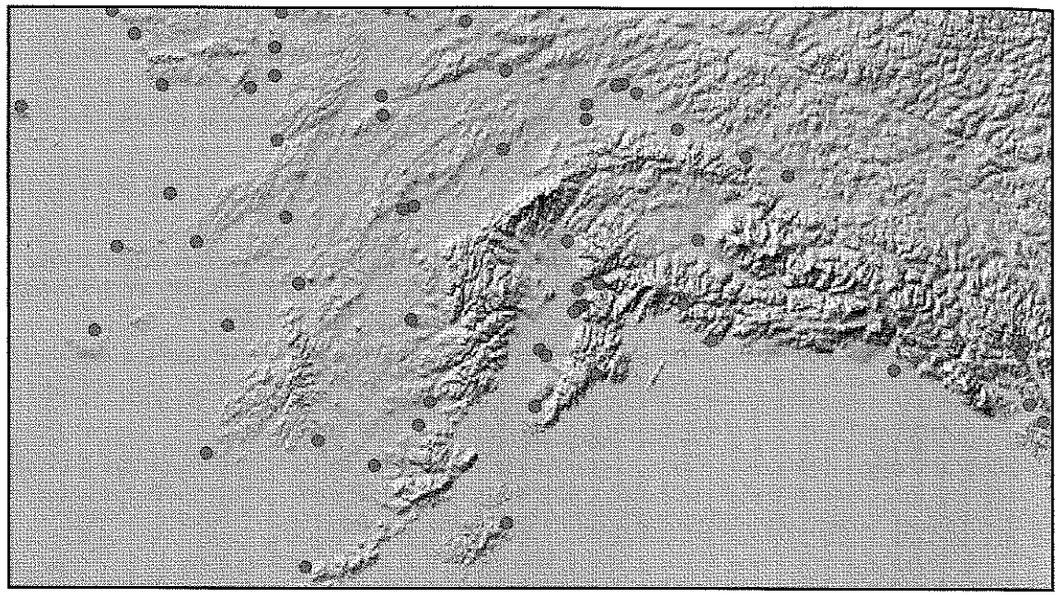
Regardless of the layer's geometry type, we always find a drop-down list with the available style options in the top-left corner of the Style dialog. The following style options are available for vector layers:

- **Single Symbol**: This is the simplest option. When we use a Single Symbol style, all points are displayed with the same symbol.
- **Categorized**: This is the style of choice if a layer contains points of different categories. For example, a layer that contains the locations of different animal sightings.
- **Graduated**: This style is great if we want to visualize numerical values, for example, temperature measurements.
- **Rule-based**: This is the most advanced option. Rule-based styles are very flexible because they allow us to write multiple rules for one layer.
- **Point displacement**: This option is only available for point layers. These styles are useful if you need to visualize point layers with multiple points at the same coordinates. For example, students living at the same address.
- **Point Cluster**: As with Point displacement, this option is only available for point layers. By default, the Point Cluster shows a numerical label if the points overlap with the count of the points.
- **Inverted polygons**: This option is available for *polygon layers only*. By using this option, the defined symbology will be applied to the area outside the polygon borders instead of filling the area inside the polygon.
- **Heatmap**: This option is available for point layers only. It enables us to create a dynamic heatmap style.
- **2.5D**: This option is available for polygon layers only. It enables us to create extruded polygons in 2.5 dimensions.

Creating point styles – an example of an airport style

From the sample data, load `airport.shp`. For context purposes, you can keep the Raster layers we just used if you like, or you can start a new project. I am going to keep them in as layers.

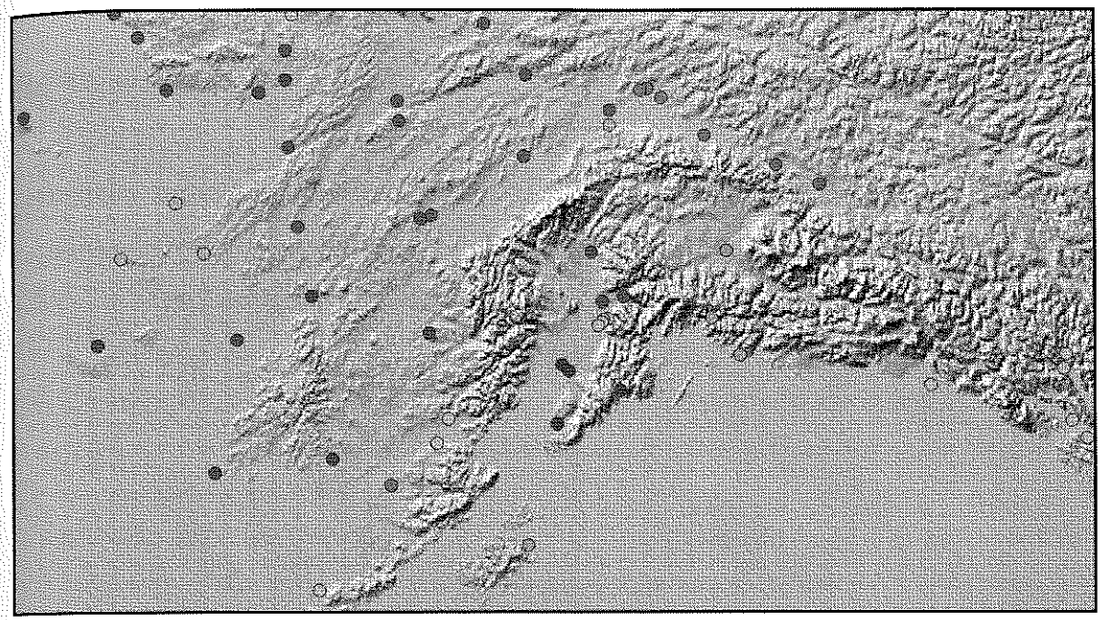
Open the **Layer Styling** panel. As was the case in the *Raster Styling* section, any changes you make will be seen in the map as you make them. In order to see the points on our hillshade map from before, set the symbol size to `4` and the color to red. In styling options for the Hillshade layer (`SR_50M_alaska_nad`), I have set the symbology to **Singleband grey**. If you are following along, the QGIS should look similar to the following screenshot:



Airports plotted as dots on the Hillshade raster

We will return to the single symbol styling in the following subsection. First, let's take a look at all the options for styling a point layer. Change the **renderer** to **Categorized** and select the the `fk_region` column as the category. As with the landcover raster, if you change the labels, the data in the table of contents will also change.

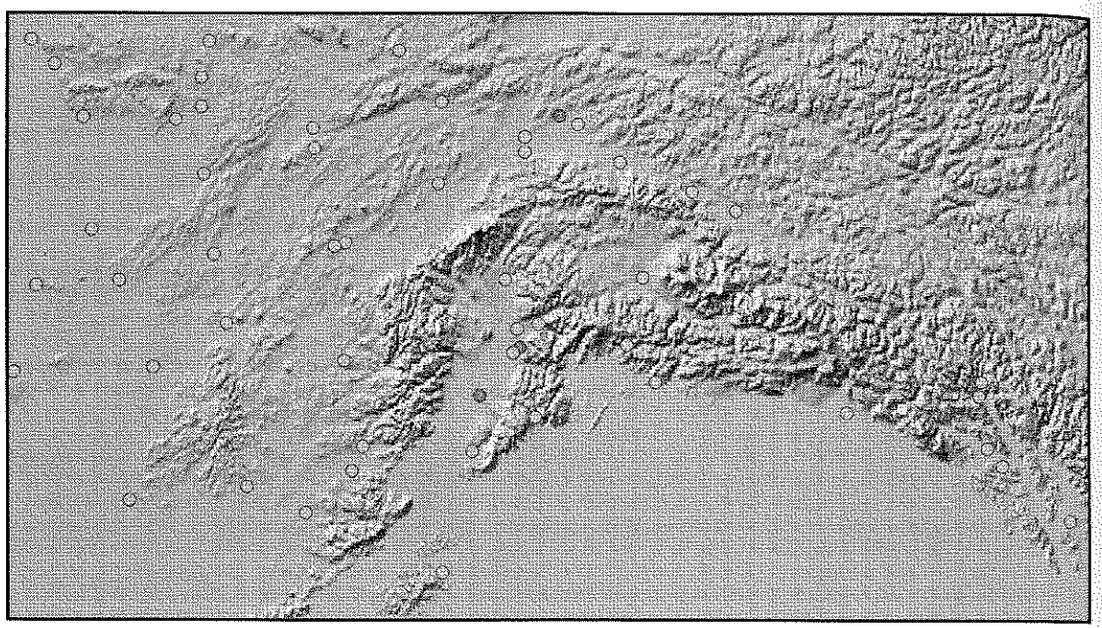
This is an important point to remember when it comes to making maps in `Chapter 4`, *Creating Great Maps*, as the Legend will contain this information. QGIS should look similar to the following screenshot:



Airports plotted as colored dots on the Hillshade raster

This is useful if your data has categories you wish to highlight. This is also a fast way to spatially inspect your data and a good aid for the quality control of a project. This is especially important when digitizing and manually entering data into fields.

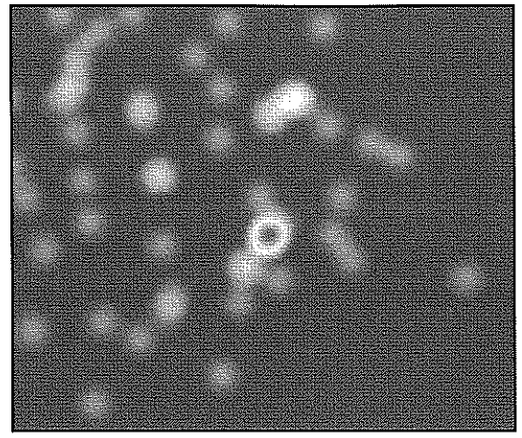
Reset the symbology of the layer by setting the styling back to single symbol. Then click on Point Cluster (Point Density will do a similar thing but will move the clustered points around a point; when making maps, choose the option that best fits your data). Clicking on Point Cluster will, depending on your zoom level, display the number of points at the same geographical location. This should look similar to the following screenshot:



Point clustering

Be attentive to the scale you are working on. This is *airport location* data, and it is very unlikely that airports will share the same x,y coordinates. However, as you zoom out and the scale changes, clustering occurs. Be sure that you do not misinterpret your data.

Set the point styling to heatmap and change the color ramp to **Spectral**. This option will build a heatmap raster on the fly to show areas of clustering (hot areas) in your data. It should look like the following screenshot:



On-the-fly heatmap

We will return to heatmaps in `Chapter 5`, *Spatial Analysis* where **Kernel Density Estimation (KDE)** has been added in the default Processing Toolbox.

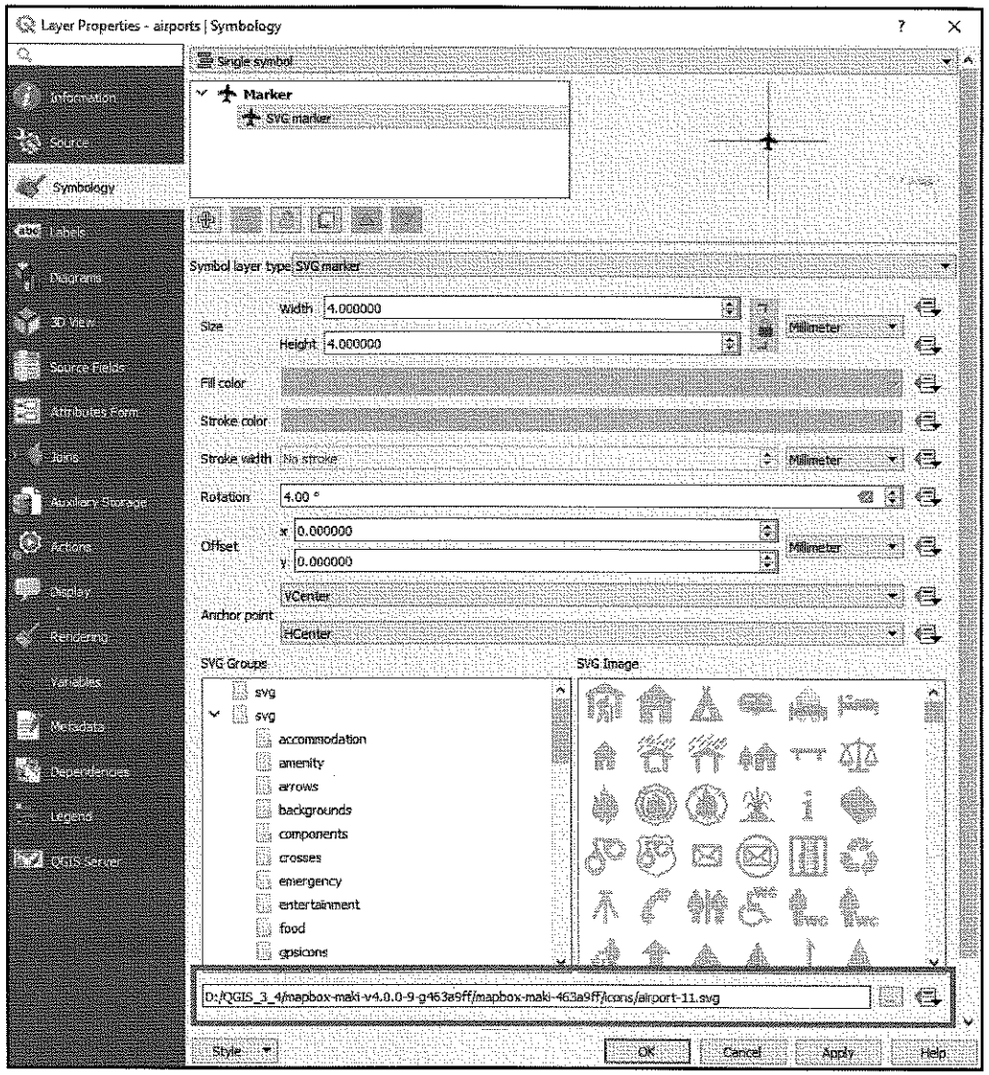
Simple marker

The simple marker tool deserves its own section. In this section, we will use the **Layer Properties** dialog box. Right-click on the layer in the **Layers** panel and select **Properties**. The options available for simple markers include Colors, Size, Rotation, and Form. However, sometimes a symbol that you want is not available. If this is the case, you can either create your own SVG files or import an existing one.

Download the SVG Mapbox symbol set from `https://www.mapbox.com/maki-icons/`.

SVG

In the **Layer Properties** dialog box, select **SVG** . Set the height to `4` and the width to `4`. At the bottom of the dialog box, point to the `airport-11.svg` file downloaded from Mapbox, as shown in the following screenshot:



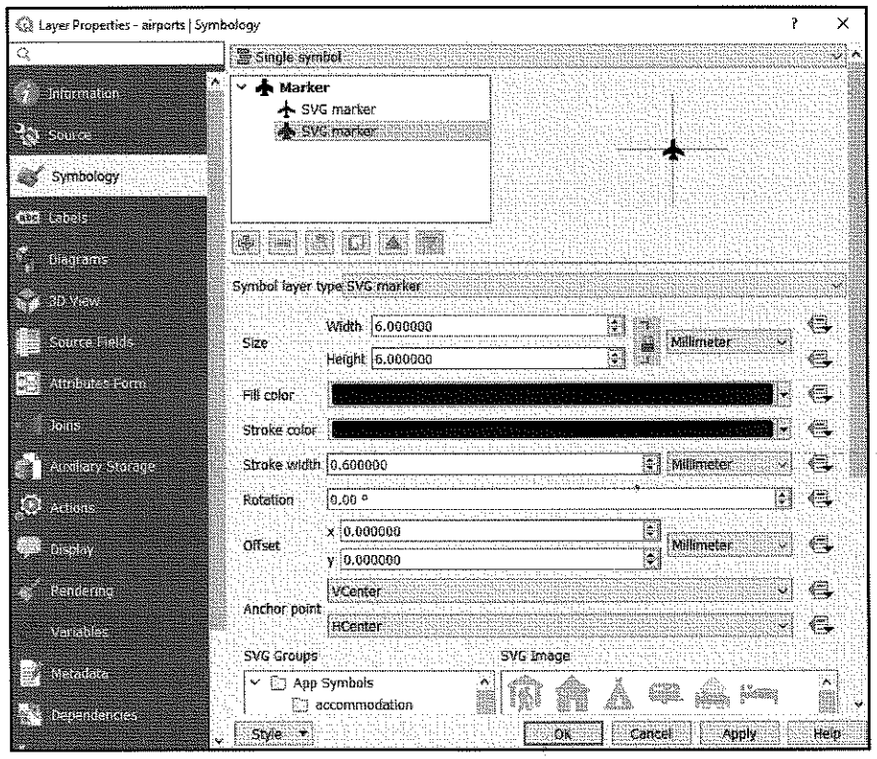
Layer property settings

When you select **OK**, small black airplane symbols should appear and replace the points on your map. There are a variety of SVG files available online if the symbol you need is not available as standard.

SVG marker: Each QGIS installation comes with a collection of default SVG symbols. Add your own folders that contain SVG images by going to **Settings** | **Options** | **System** | **SVG Paths**.

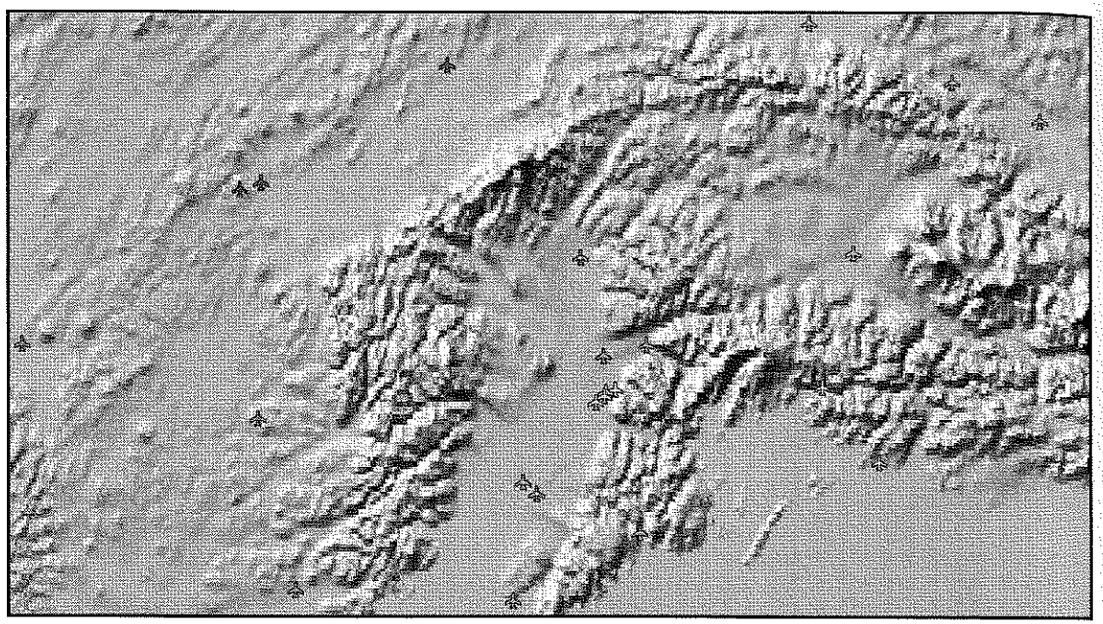
Default symbols

In QGIS 3, there is an airplane symbol in the default library. Look for topo airport in the symbols window in the **Layer Properties** dialog box. Select the bottom SVG marker and set the **Stroke color** to black. When you have done this, your screen should look similar to the following:



Marker symbols

By clicking on the **OK** button, this will apply a black airplane with a white outline symbol to your map, which is slightly clearer than before. Finally, we can take this symbol and, like before, display it according to the `fk_region` category. Now choose **Categorized** from the style drop-down box, select **Random colors** in the color ramp, and click the **Classify** button in the bottom-left of the screen. Click on the **OK** button and your map will consequently look similar to the following screenshot:

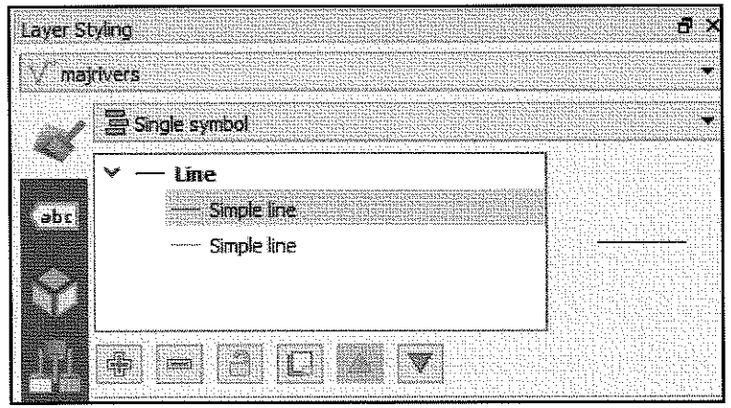


Colored marker symbols on Hillshade raster

We have only scratched the surface with the display of points; there are many combinations. For example, symbols can be rotated, overlaid on each other, and offset from the location and style in many different ways. Think about what you wish to convey and how best to convey it, and QGIS will be able to accommodate many variations of the examples we have shown.

Creating line styles – an example of a river

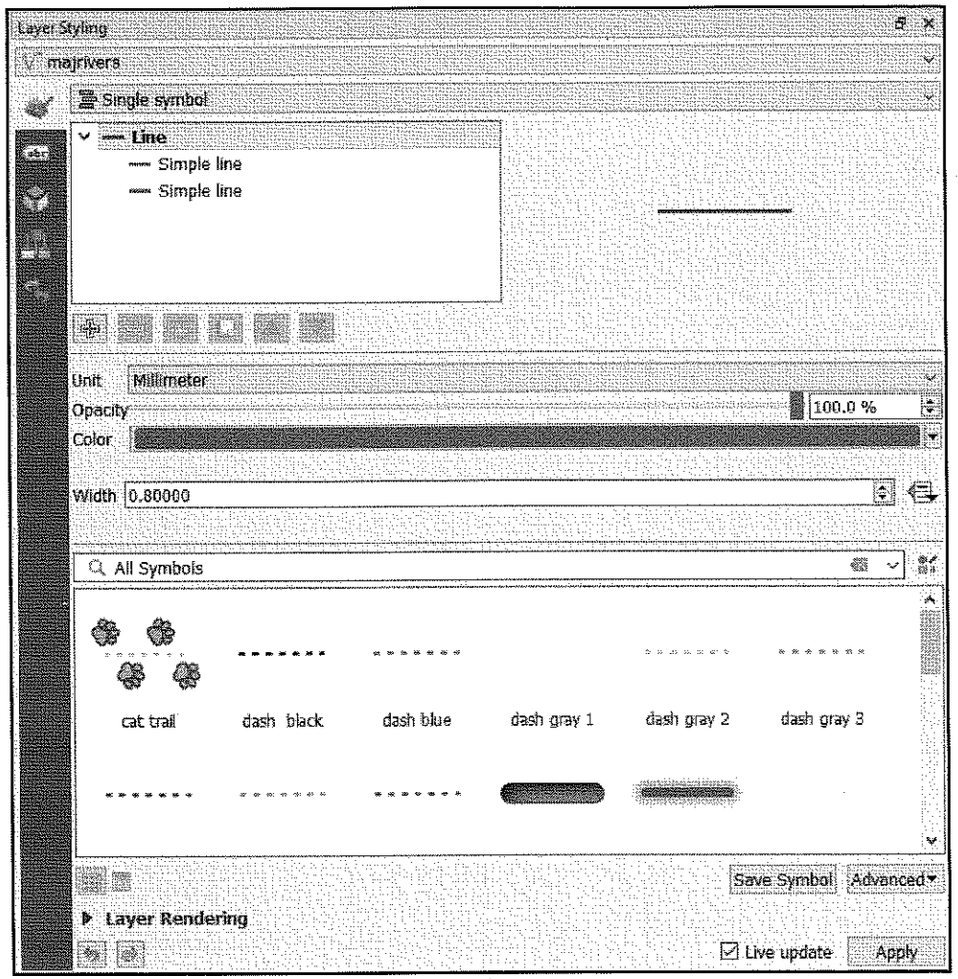
Load `majrivers.shp` into QGIS. We will use this data to create a line style that consists of two colors: a fill color and an outline color. To do this, open the **Layer Styling** panel and select a single symbol. Beneath this symbology, click on the green plus icon to add a new **Simple line**. You should now have two lines showing, which look similar to the following screenshot:



Layer styling on lines

The lower line will be our outline color, and the upper one will be the fill color. Select the upper simple line and change the color to blue and the width to `0.5` millimeters. Next, select the lower simple line and change its color to gray and the width to `0.8` millimeters, which is slightly wider than the other line. Check the preview and select **Apply** to test how the style looks when applied to the river layer.

You will notice that the style doesn't look perfect yet. This is because each line feature is drawn separately, one after the other, and this leads to a rather disconnected appearance. To change this, select the Line entry in the symbol layers list and click on the **Symbol Levels** dialog of the **Advanced** section (the button in the bottom-right corner of the style dialog), as shown in the following screenshot:



Adjusting the layer styling for a line dataset

This will bring up a new window. Now select Enable symbol levels and your river layer should change. Your map should now look similar to the following screenshot:

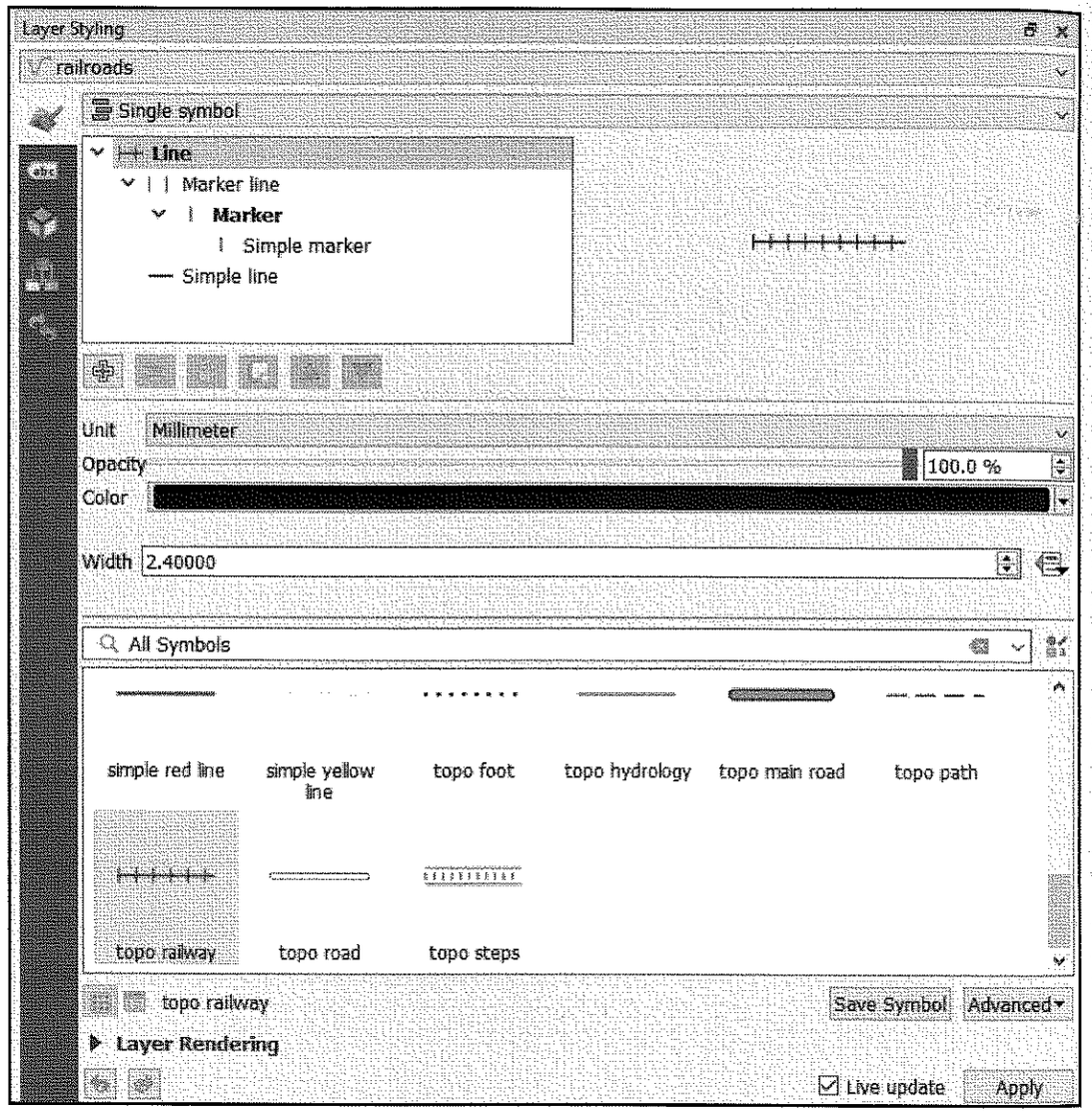
Adjusting the symbol levels

Whenever we create a symbol that we might want to reuse in other maps, we can save it by clicking on the **Save** button under the symbol preview area. We can assign a name to the new symbol, and after we save it, it will be added to the saved symbols preview area on the right-hand side.

Before we move on to styling polygons, let's take a look at the other symbol layer types for lines, which include the following:

- **Simple line**: This is a solid or dashed line.
- **Marker line**: This line is made up of point markers located at line vertices or at regular intervals.
- **Geometry Generator**: This enables us to manipulate geometries and even create completely new geometries using the built-in expression engine.

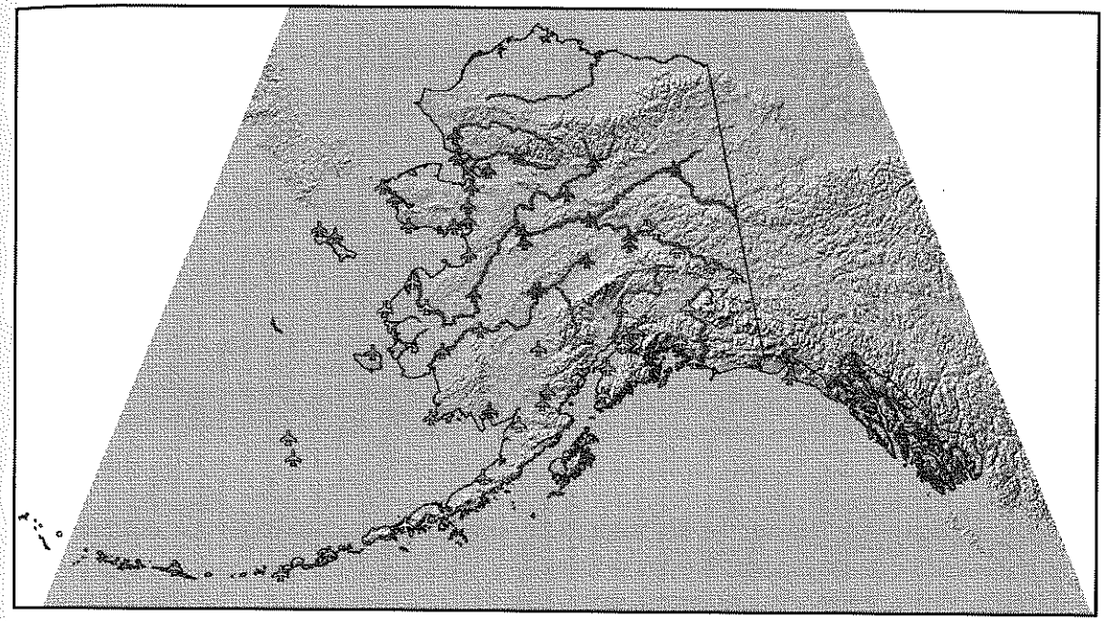
A common use case for Marker-line symbol layers are train-track symbols. These often feature repeating perpendicular lines, which are abstract representations of railway sleepers. The following screenshot shows how we can create a style like this by adding a marker line on top of two simple lines with the **Layer Styling** panel:



Layer styling for topo railway

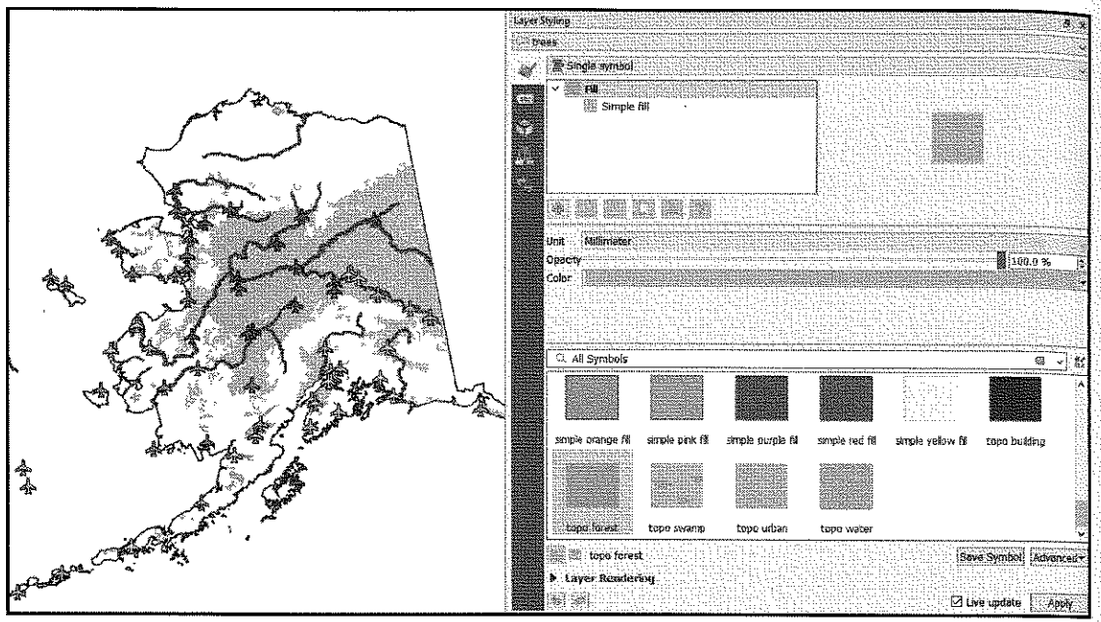
Creating polygon styles – an example of a landmass style

Load `alaska.shp` into QGIS and zoom to the extent of the polygon. Let's use this shapefile to create a boundary for Alaska. Open the **Layer Styling** panel and select Single symbol. Click on simple fill and set the fill color to transparent fill (this is a checkbox selection). Set the stroke width to `0.5` mm and the stroke style to dash line. Your screen should now look similar to the following screenshot:



The view of all the styled data

Turn off the `SR_50M_alaska_nad` layer (Hillshade) and add `lakes.shp`, style them with **topo water**, then add in `trees.shp` and style them as **topo forest**. Now your map should look similar to the following screenshot:



Fine tuning the styling

Now you can see the power of layers and layer control. Keep points at the top and lines next, followed by polygons and Raster datasets.

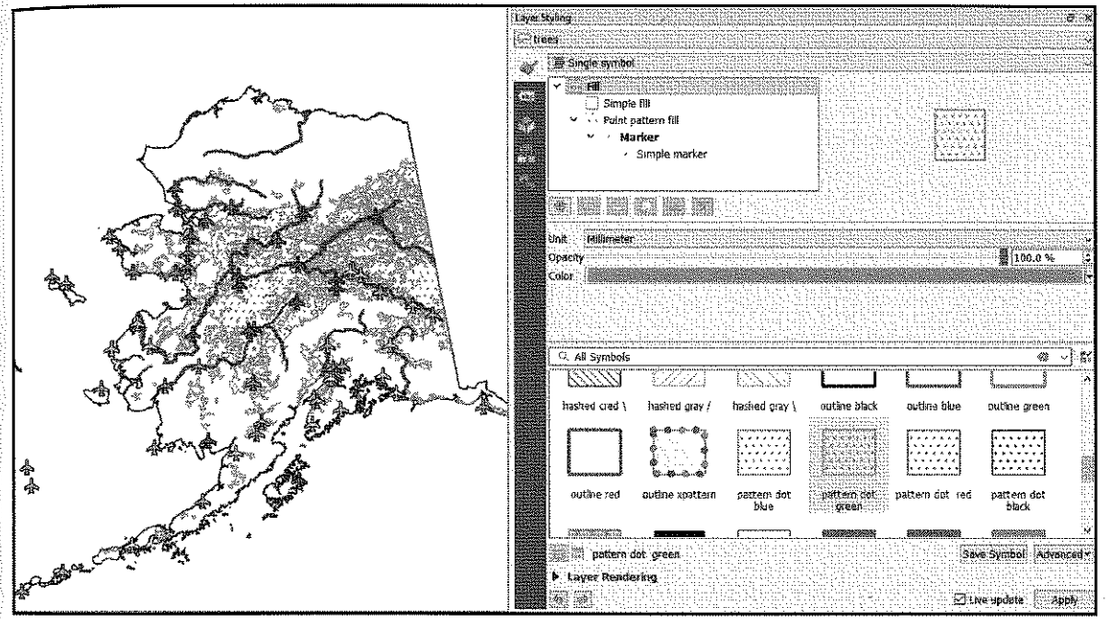
Finally, let's take a look at the other symbol layer types for polygons:

- **Simple fill**: This defines the fill and outline colors as well as the basic fill styles.
- **Centroid fill**: This allows us to put point markers at the centers of polygons.
- **Line/Point pattern fill**: This supports user-defined line and point patterns with flexible spacing.
- **SVG fill**: This fills the polygon using SVGs.
- **Gradient fill**: This allows us to fill polygons with linear, radial, or conical gradients.
- **Shapeburst fill**: This creates a gradient that starts at the polygon border and flows toward the center.

- **Outline – Simple line or Marker line**: This makes it possible to outline areas using line styles.
- **Geometry Generator**: This enables us to manipulate geometries and even to create completely new geometries using the built-in expression engine.

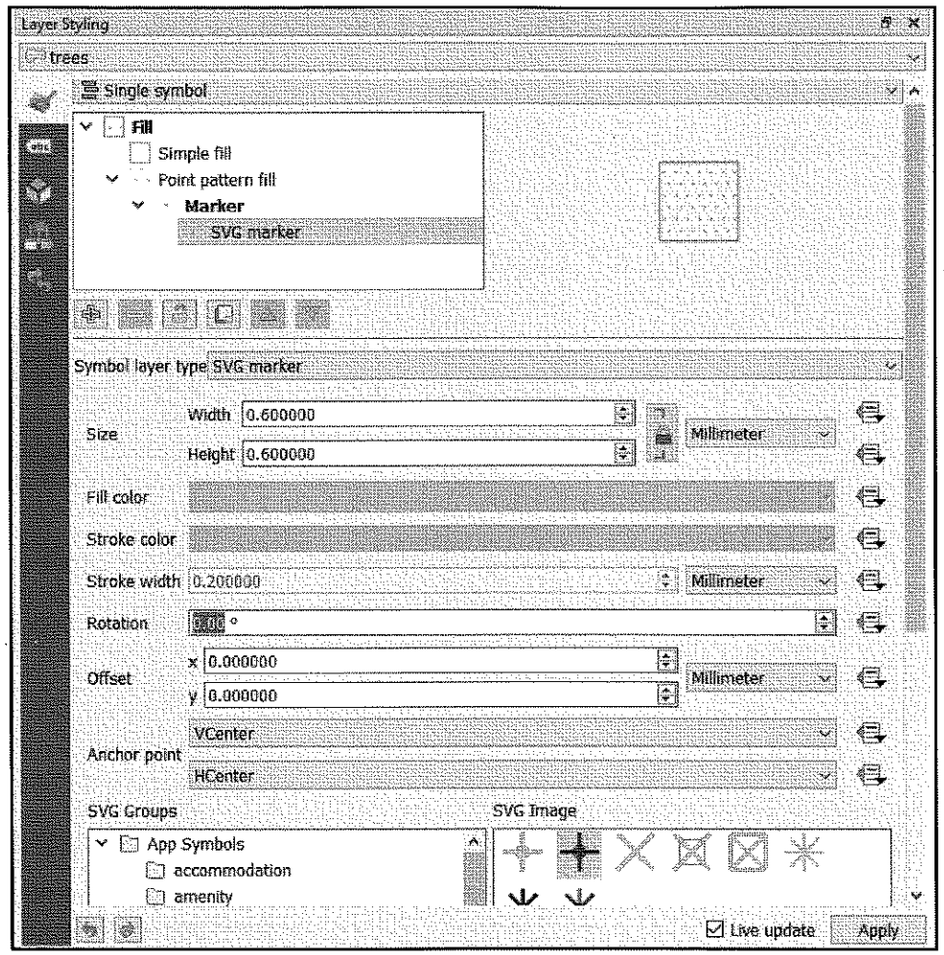
Some examples of these are shown in the following screenshot.

The Point pattern fill is useful for showing different vegetation types. In the following example, the fill is a simple fill with a point pattern overlaid. To shortcut to this symbol type, locate the **pattern dot green** symbol in the symbols, as shown in the following screenshot:



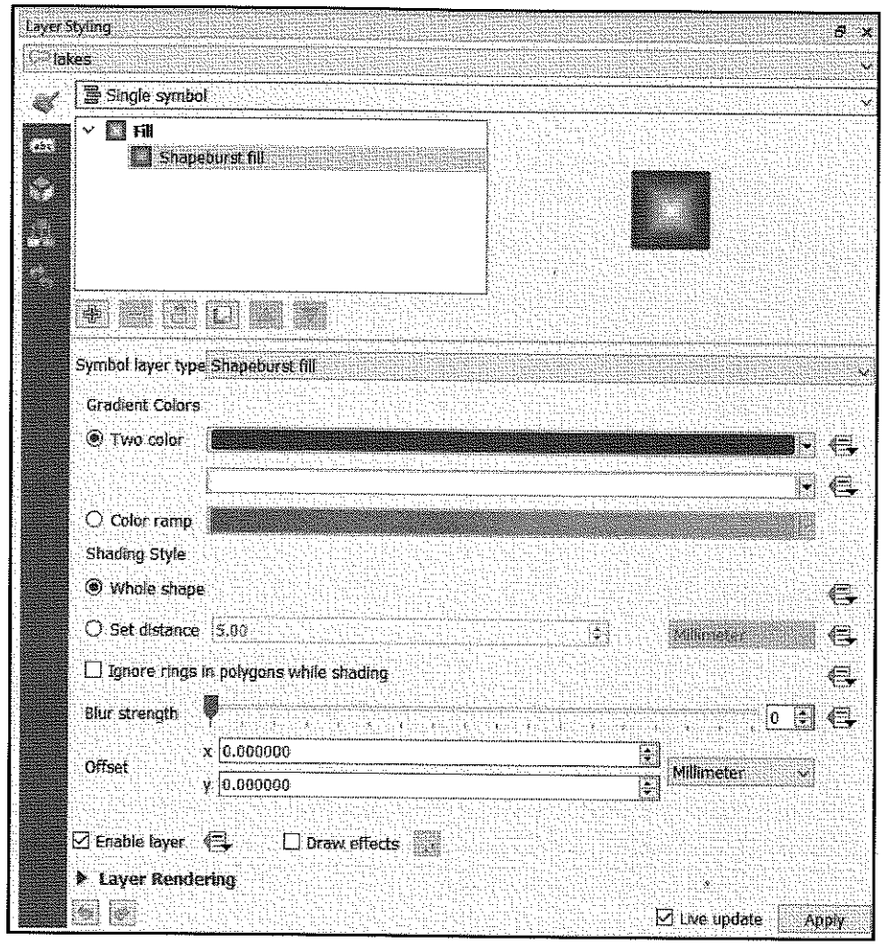
Point pattern styling

A point pattern fill can be customized using any of the marker types. For example, the following screen shows a cross from the icons in the SVG markers used for the pattern fill:



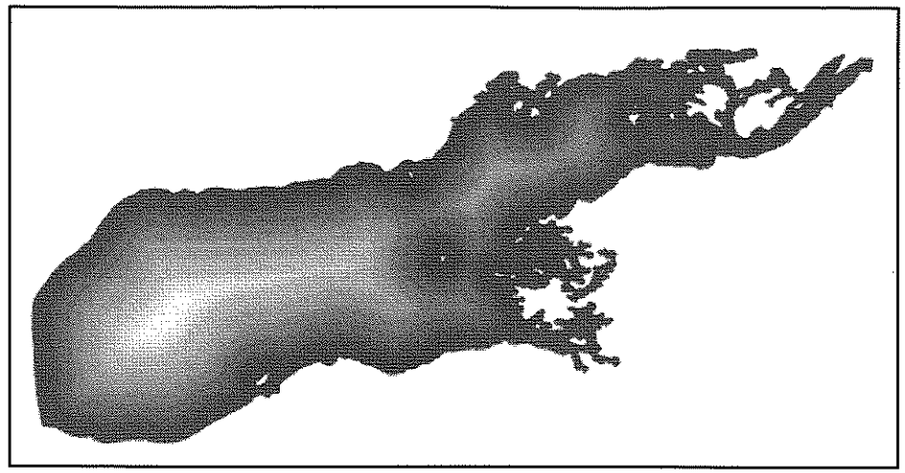
SVG markers for the pattern fill

The Shapeburst fill symbol layer type is good for symbolizing water bodies. It does this by using a gradient fill that flows from the polygon border inward. This option is shown for the lakes layer in the following screenshots:



Shapeburst fill symbol layer styling

As always, choose the best option to visualize the data that you have, and then save the project.The result of the styling would be as follows:



Result of the styling

Summary

This chapter showed you how to symbolize Raster and Vector data. We have progressed from quickly inspecting our data to presenting it in a way that adds meaning. We have also covered a range of examples, including styling GIS data in Alaska. The focus has been on building a series of layers that complement each other.

In the next chapter, we will look at bringing all of this knowledge together by using the Print Layout to create maps from your data.

4
Creating Great Maps

In this chapter, we will cover some of the important features of QGIS that enable us to create great maps. We will also learn how to label features, which can now be done interactively in QGIS 3. QGIS 3 has improved the way maps are created with new print layout tools. We will look at these in detail in the coming sections, before looking at ways of sharing data at the end of the chapter.

Topics covered in this chapter include the following:

- Communicating with data
- Labeling
- Creating maps
- Loading data
- Map outputs

QGIS 3 is used on a worldwide basis to produce stunning maps. To get an idea of the maps that QGIS is capable of producing, visit the following link: `https://www.flickr.com/groups/qgis/pool/`.