Lesson 4: Displaying Geospatial Data

## INTRODUCTION

In this lesson you will learn about displaying geospatial data. You will learn about map design and the elements that are used in the design process. A map critique is provided to help you understand best practices for creating a map and how to make adjustments and modifications as needed.

## LESSON OBJECTIVES

By the end of this lesson, you will be able to:

1. Apply cartographic principles to produce cartographic products.

## LEARNING SEQUENCE

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| Required Reading | Read the following:  Displaying Geospatial Data   * Displaying Geospatial Data * Maps * The Cartographic Process * Map Design * Map Critique |
| Assignments | Complete the following assignments:   * Lab: Displaying Geospatial Data * Quiz: Displaying Geospatial Data |

## INSTRUCTION

**Displaying Geospatial Data**

## GIS Output: Maps

The primary output of a GIS is a map. For a GIS to be widely useful, maps must be created to disseminate the data. That’s not to say that maps are the only output of a GIS, as statistics, reports, and videos, among others, can be outputs from a GIS, however, maps are the primary means in which spatial information is displayed from a GIS.



Let us first define the idea of a map. A map is a way of representing our world based on the knowledge and culture of the mapping society at a particular time in history. The purpose of a map is to transmit knowledge visually. Maps are often considered to be one of the three major modes of communication.

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| **What is a Map?**  Definition  A visual representation of a location or area  Purpose  A vehicle for the transmission of knowledge |

## Who makes Maps?

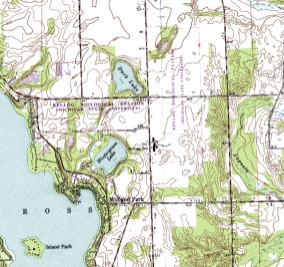
A cartographer is someone who designs and prepares a map for distribution. Cartographers also study the philosophical and theoretical bases of the rules for making maps. Cartographers are trained professionals in the field of cartography which is the art and science of making maps. Cartography is a professional field that has existed for hundreds of years, and it takes cartographers many years of apprenticeship to become skilled at their craft. However, with today’s computer technology allowing us to quickly manipulate, analyze, and visualize spatial information, mapmaking is now being shared by professions outside of cartography. Therefore, it is important that any user of a GIS be trained in cartography so that their maps will be effective tools for communication. This module will provide an introductory look at the skills required to perform proper cartographic design for maps.

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| **Key Facts**  Cartographyis the art and science of making maps.  **A Cartographer is:**   * Someone who designs and prepares a map for distribution. * Someone who studies the philosophical and theoretical bases of the rules for making maps. |

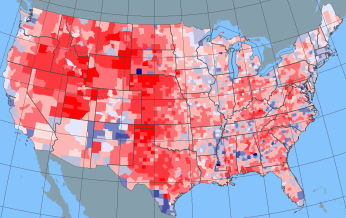
**Maps**

## Types of Maps

Broadly speaking, there are two kinds of maps: reference maps, and thematic maps.

**Reference Maps**

The reference map emphasizes the location of objects in the world. It also shows a variety of the world, and primarily displays physical objects.

**Thematic Maps**

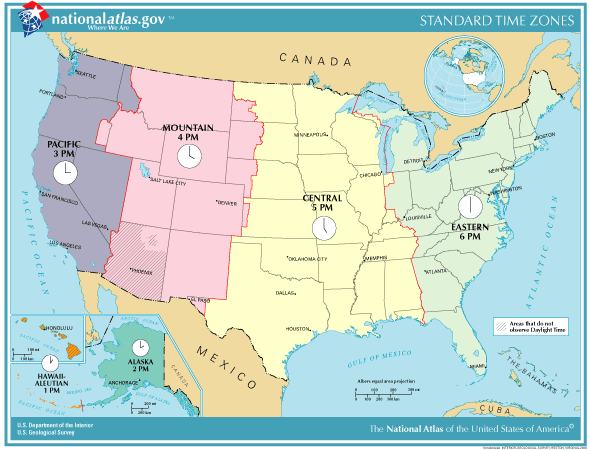
A thematic map, on the other hand, emphasizes attributes. Typically, a thematic map will display information pertaining to a single subject, or theme, and will emphasize the spatial patterns, and variations of an attribute in that theme.

## Two Types of Thematic Maps

If we drill down into the thematic map kind, there are two types of thematic maps: qualitative, and quantitative.

### Qualitative Maps

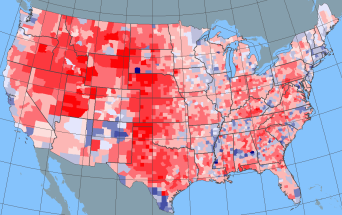
A qualitative map shows nominal data and focuses on the distribution of that nominal information. It is important to note, that since it is a qualitative map, it is not focused on the variation of quantities, rather, it focuses on the location of the distribution.

****This thematic map is a qualitative thematic map showing the standard Time zones of the United States of America taken from the National Atlas. Since a time zone is a nominal type of information, this map focuses on the distribution and location of the time zones, but not any numerical, or quantitative information. In other words, it only shows the different kinds of time zones and where they are located.

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| **Qualitative Maps**   * show nominal data * show distribution * do not include numerical information |

### Quantitative Maps

The quantitative map, on the other hand, shows numerical data, and focuses on the variation of that numerical information from place to place. It is common practice to generalize numbers on a quantitative thematic map, so that the information being visualized can display potentially hidden patterns, and appropriate scales.

Now let’s consider a quantitative thematic map showing a single variable. This quantitative thematic map shows the relative advantage of votes gained by each of the two major party candidates in the 2008 presidential election in the United States of America. The voting information has been collected to County level information, for two reasons: one, so that the data can be clearly seen at this map scale, and two, so that patterns of distribution of the quantitative voting information can be more easily seen.

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| **Quantitative Maps**   * Show numerical data * Show variation from place-to-place * Generalized numbers |

## Mediums for Distribution

In addition to the kinds of maps, there are three mediums on which a map may be produced for distribution: tangible, virtual, and mental. In the field of GIS, tangible and virtual maps are the two most common mediums of maps.

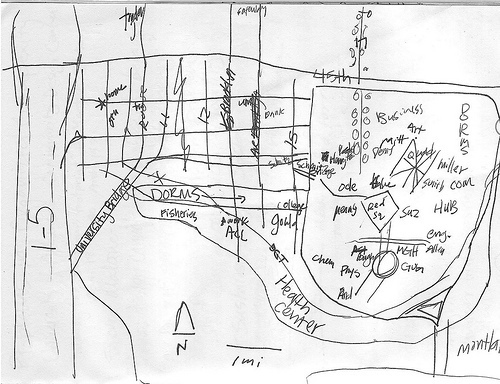
### Tangible Map

A tangible map medium is any concrete object that can be manifested physically, and passed from person to person. For maps, the most common tangible medium is paper. Paper has many advantages as a medium, such as ease of transport, low cost of production, and no requirement of specialized hardware or software to view. A disadvantage of paper maps are that they are not easily updatable, cannot show dynamic content, and are set at a single scale.

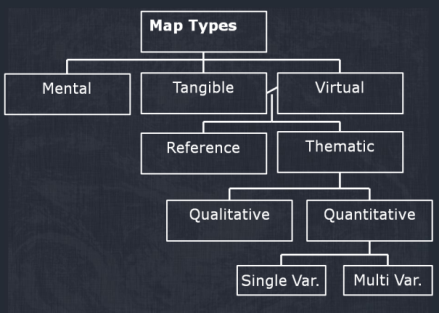
### Virtual Map

The virtual map medium is when the map is stored in a computer’s memory and visualized on output device, such as a monitor, or tablet screen. The virtual medium has the advantage of being easily updatable, supporting animation, able to switch between scales, and being able to quickly transport large distances. Disadvantages are that it requires an investment of hardware and software to view, and may not be as intuitive to use as a tangible map. The third medium is the mental medium of maps.

### Mental Map

A mental map is a map that is stored inside your mind. This mental map is your conceptualization of reality. Mental maps are not concrete, nor are they stored inside of a computer. Therefore, mental maps cannot be transferred between people, without first becoming either tangible, or virtual.

## Selecting a Map Type

In summary, we can create a tree to show how the concepts of map types, map kinds, and map mediums work together. Starting at the top, a map type is stored as either a mental, tangible, or virtual medium. If the map is stored on a tangible or virtual medium, then this will be either a reference, or thematic map. Thematic maps can be further broken down into qualitative or quantitative maps. A quantitative map can display a single or multiple variables at once.

**The Cartographic Process**

## What is the Cartographic Process?

The cartographic process is a series of steps that we follow to go from an unmapped data set to a final mapped form. Cartography is both the art and science of map making; there really is no set process for creating cartographic products. However, there are some best practices and a recommended series of steps if you’re unfamiliar with designing maps. This section will introduce you to, and discuss, one recommended series of steps you should follow to design a map.

This cartographic process has five steps. Is important to note that the steps do not need to happen in exactly this order as cartography is often a dynamic and iterative process. However, some steps you will naturally want to complete first and are listed in the recommended order on the slide.

### Step 1

The first recommended step is to define the purpose and meaning of the map. When we define the purpose and meaning of a map, the goal is to interpret the requirements of the user and to determine what needs to be communicated. Additionally, your job is to determine how to best facilitate communication of your ideas, and create a narrative for the map. It is important to note, that often times, you, and or your customer, may not fully know these requirements at the beginning. Therefore, expect to revisit and redefine the purpose of meeting as you work with the data, and create prototype maps.

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| **Key Facts**  **Step 1: Define Purpose and Meaning**   * Interpret the requirements of the user. * What *needs* to be communicated? * How do you best facilitate the communication of ideas? |

## Step 2

The second step of the cartographic process is to choose the map scale. Defined, the map scale is the ratio of the map distance to the earth distance. The map scale operates along a continuum from a large scale to a small scale.

Broadly speaking, there are three typical map scales. A large scale map covers a small geographic area, and runs from a map scale of 1 to 0 to 1 to 600,000. A medium scale map runs from 1 to 600,001 to 1 to 2,000,000. And a small scale map covers a large geographic area and runs from 1 to 2,000,001 to essentially infinity. The large scale maps, since they show such a small portion of the earth, will allow you to show more details, and more features about the earth surface. As you move to medium and small scale maps, you are showing a larger portion of the earth at once, which does not allow for the same amount of detail. Therefore, medium and small scale maps will not have nearly as much detail as large scale maps will.

Therefore, the amount of detail you can show in a map is directly dependent upon scale, the selection of map scale is possibly the most important decision a cartographer makes. For instance, if you choose too large of a scale, the map may be so large, that you will need to split it up onto multiple maps. On the other hand, if you choose too small of the scale, you may not be able to show the amount of detail that you wish to show as the map will be “zoomed out” too far.

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| **Key Facts**  **Step 2: Choosing a Map Scale**   * Ratio of map distance to earth distance * Operates along a continuum from   large scale to small scale  Map Scales (rule of thumb)  Large Scale Map 🡪 1:0 – 1:600,000  Medium Scale Map 🡪 1:600,001 – 1:2,000,000  Small Scale Map 🡪 1:2,000,001 – 1:∞  Selection of scaleis possibly the most important decision a cartographer makes. |

### Step 3

The third step in the cartographic process is to determine formatting, printing, and economics of reproduction. At this point we should be asking ourselves, what kind of map should we be making? How will the map be displayed, and on which medium will the map be produced? And finally, how much will it cost to create the map on the chosen medium? Depending on your answers to these questions, you may find that while you would like to print the map on paper, the map is so large, that it would be too expensive to economically reproduce.

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| **Key Facts**  **Step 3: Format, Printing, and Economics**   * What *kind* of map? * What *type* of map? * How will the map be displayed? * How much will it cost to create the map? |

## Step 4

The fourth step in the cartographic process is to abstract and generalize the data to prepare it for placement on the map. The abstract and generalize step of the cartographic process is where you may spend the majority of your time when designing a map. The goal of this step is to prepare your geospatial data in a way that only information that is potentially meaningful to the context of the map is included. This means, you will need to select and organize your geospatial data in a way that is necessary to communicate the concept to a map reader without including unnecessary information or details. The end result is the reduction of the amount of detail in a map to create a simple, but effective, visual image.

There are several methods to abstract and generalize your geospatial data: selection, classification, simplification, and symbolization.

Selection

The first method, selection, is where you only use a subset of a geospatial data set on the final map product. The selected data should contain information that is relevant to the message of the map at the chosen scale.

Classification

The second method of abstraction is classification. Classification is the process of combining observations into bins or classes. The goal of classification is to reduce the number of unique symbols on a map, and to aggregate information to a useful enumeration unit, such as a state, or county.

Simplification

The third method of generalization is simplification. Depending on which scale you chose for your map, you may need to simplify the data so that is more visually pleasing on the map. For example, on the figure of the screen, the blue line is the original very detailed path the river. This data set was probably originally intended to be used on a large scale map. However, we wish to use this river path on a medium scale map, but when we place the river path on a medium scale map, it is so detailed that the river looks cramped, and we are unable to print the fine detail on a piece of paper. Therefore, we simplify the line by reducing its complexity, but still maintaining the character of that river path. This is shown as the red line on the figure. Once the river path has been simplified by reducing the number of vertices, the river now looks good at the chosen scale, and is able to be printed with our printing technology.

Symbolization

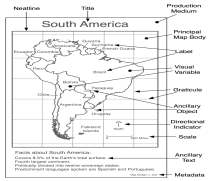
The fourth method of abstraction and generalization is symbolization. Symbolization is the process of assigning such visual variables as color, shape, size, and orientation, among others. The goal of symbolization is to assign a visual marker to represent the spatial phenomenon being mapped.

There are no set rules for how you will symbolize your map, however, there are some strongly recommended conventions that you should consider following. For instance, water should almost always be blue, and land should almost always never be blue. Also, if there is a very common symbol for a feature, for instance a blue circle with a white ‘I’ inside of it stands for information, therefore, you should use that symbol on your map when you want the map reader to know that the feature is where they can get information. One of the great things about cartography is that you can experiment with your design, however, keep in mind, that you need to clearly and succinctly communicate your idea to the maps users.

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| **Key Facts**  **Step 4: Abstract and Generalize**   * Only information that is potentially meaningful to the context should be included. * Cartographers select and organize information necessary to communicate concepts to a map reader. * Cartographers *reduce* the amount of detail on a map to create a simple visual image. |

**Step 5**

The fifth step in the cartographic process is to design the map layout. There’s much more that goes on a map than simply the data, and we must carefully consider the placement and design of each of these elements.

There are 12 elements that compose a map.

Map Body: The map body contains the geographic information that is the focus of the message of the map, and should typically be the largest element on a map layout.

Neatline: The neat line is like a frame for the map; it typically surrounds the entire map, and allows the map to separate itself from the surrounding page or elements. The lines can also surround other map elements to set them apart.

Insets: An inset map is a smaller map body that shows greater detail for an area on the main map body.

Scale Bar: A scale bar communicates the ratio at which the earth’s been reduced to be placed on the map.

Legend: The legend is a map element that lets the user know what each symbol on the map means.

Title: The title, typically placed at the top the map, is usually the largest text of the map and provides a short, descriptive, statement about the purpose of the map, and may include other pertinent information, such as the timeframe for which the map applies.

Directional Indicator: The directional indicator, more commonly known as the North arrow, lets the user orient the map relative to a direction.

Metadata: Metadata is the documentation for the map and the data displayed on the map. Metadata should include items such as the date the map was created, the author of the map, and data sources for the data shown on the map body.

Ancillary Text and Ancillary Objects: Ancillary text and ancillary objects are elements included in the map layout to support the maps message. These may include images of locations or features displayed: locations of the map, charts, graphs, sounds, videos, or simply explanatory text.

Graticule: The graticule references a coordinate, or measurement system, that the map user can use to derive the location, coordinates.

Labels: Labels identify features on the map, typically based on information stored in the features attribute tables.

## Scale, Size, Shape

In addition to considering the twelve map elements it is important to also consider the scale, size and shape of the primary object being mapped, as well as the media onto which the map will be produced.

For instance, if we are mapping Tennessee, we notice that the shape of Tennessee is roughly a wide but not so tall parallelogram. Therefore, we may choose to orient the media in a landscape setting so that Tennessee can use the maximum amount of media as possible.

Additionally, we may be constrained by the size and shape of the media. Therefore, if we have been asked to produce a map showing all manhole covers in a city such as Houston, but we are constrained to a paper size of 8.5 by 11 inches, then we know that we must split our map up into potentially hundreds of pages, each showing a small portion of Houston, as we would be unable to show enough detail to show every single manhole cover on a single 8.5 by 11 inch piece of paper.

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| **Key Facts**  Scale, Size, Shape   * + Size of primary object   + Shape of primary object   + Media size and shape |

**Map Design**

## Title of a Map

The title of a map should be dominant in size and is typically the largest text on the map. A good map title should focus the user’s attention on the purpose of the map. A good map title should also be brief, but descriptive. Typically, a map title will include information such as where the map is focused, what information is being focused upon, and the timeframe for which the map is applicable. Map titles are typically placed at the top center of the production medium, however a map title can truly be placed anywhere so long as it is easily found by the map user. If the map is a figure in a larger document, you should not place the title on the map, but instead, place the title of the map in the caption.

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| **Key Facts**  **Title of a Map**   * + Should be dominant in size   + Focuses attention on map purpose   + Brevity is desired   + Typically includes where, what, and when   + May omit if figure and caption exists |

## Map Body

The map body is the main focus of the map and contains the geographic features that are important to the message of the map. The map body is typically the largest map element on the map, and should dominate the user’s attention. Typically, when designing a layout, the map body is placed first, and other elements are then placed around. However, do not be afraid to move or resize the map body to better accommodate other elements. In the end however the map body, being the map element we want the user to focus on the most, should be easy to find, dominant, and of adequate size to show the geospatial data.

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| **Key Facts**  **Map Body**   * + The main focus on the map   + Contains features important to the message of the map |

## Inset Maps

Inset maps, or small ancillary maps that have a larger scale than the main map body. The role of an inset map is to show more detail in a map body of a smaller geographic area. On this illustration, the United States of America is the main map body, and the smaller map of Arkansas in the lower right-hand corner, is the inset map which is showing a smaller area in more detail. To make it obvious to the map reader where the inset map is referring to on the main map, you should show an outline of the extents of the inset map of the main map body, or provide leader lines from the main map body to the inset map.

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| **Key Facts**  **Inset Maps**   * + Small ancillary map   + Larger scale than map body   + Shows more detail than map body   + Outline of extents shown on main map body |

## Location Map

A location map is a small ancillary map that is at a smaller scale the map body. The location map identifies a location of where the main map body is in a larger geographic context. A location map is to be used when the location of an area on the main map body is unfamiliar or not intuitive to map reader. In this illustration, the map of Arkansas is the main map body, and the smaller map of the lower right-hand corner is the location map. Similar to the inset map, there is a visual marker on the inset map that shows the map reader where the main map body is located.

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| **Key Facts**  **Location Maps**   * + Small ancillary map   + Smaller scale than map body   + Identifies location of main map body   + Used when area is unfamiliar or not intuitive to map reader |

## Map Scale

The map scale is used to measure linear relationships on the map. A map scale is typically included on a reference map, but is not required to be included on thematic maps. A map scale should only be included on a map when you want the user to measure the distance on the map, or the scale of the map is not intuitive to the map reader. There are three types of scales that we can place on a map: a graphic scale, a verbal scale, and a representative fraction scale.

### Graphic Scale

The graphic scale is perhaps the most common type of scale placed on maps. The graphic scale is a visual representation of the ratio at which the earth’s been reduced. The graphic scale typically starts at zero, and measures out to a meaningful, typically round number. One major advantage of a graphic scale is that if the map is enlarged or reduced, say using a photocopier, then the graphic scale will scale with the enlargement or reduction, and will always be correct. This is not the case with the verbal scale or representative fraction scale. The second type of scale is the verbal scale.

**Graphic Scale**



### Verbal Scale

The verbal scale is a statement that describes how a distance measured on the map relates to a distance measured on the ground. Again, it is important to use meaningful, typically around measurement units to make it easier for the map user to measure distances.

**Verbal Scale**

One inch on the map equals twenty feet on the ground

### Representative Fraction Scale

The third type of scale is the representative fraction scale which is sometimes referred to as the unit scale. The representative fraction scale is a map scale that is used to represent units in centimeters, inches or feet in the form of a fraction or a ratio. This fraction or ratio, 1: *x* is used to indicate one unit on the map.The number to the left of the colon indicates that one unit on the map represents *X* units on the Earth’s surface indicated by the number to the right of the colon.

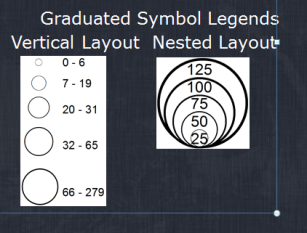
**Representative Fraction Scale**

1:20

## Legend

The legend map element identifies unknown or unique map features succinctly. A legend may optionally have a title, or contain the title of the entire map. The legend needs to have representative symbols that are found on the map followed by a description of what each symbol represents. The symbols on a legend should be the exact same color, shape, and size of the symbols shown the map. If the symbol on the map varies in size, the symbol in the legend should be the size of an average sized symbol on the map. Let’s look at two examples of legends.

For a general reference map legend, it would display all symbols found on the map. The representative symbol should be to the left of the short description, and the legend can be organized vertically in one or more columns.

For thematic map, and in this case, a graduated symbol map, the graduate circle legend is to show how the size of the symbol changes with the value of the attribute that it is representing. Graduated symbol legends can be placed in a vertical layout, horizontal layout, or a nested layout.

## Directional Indicator

The directional indicator is often considered as part of a legend, and may be placed inside the neatline is around the legend, near the legend, or elsewhere on a map. The directional indicator, commonly a North arrow, is necessary when north is not at the top of the map, or the map readers are unfamiliar with the area being displayed on the map. Because map readers are typically familiar with orientation of large landmasses, or their own country or state, north arrows are often not necessary on small scale maps. The directional indicator should be reasonable in size, not dominant at all, but should still be easily found by the map reader.

## Labels

Labels communicate attribute or ancillary information directly on the map body, and related to map features on the map body. The purpose of label is to identify features on the map, and help users to orient themselves to the information being displayed on the map. Labels should be placed at locations that allow the map reader to easily associate each label with the feature it is labeling, and should be reasonable in size.

## Metadata

The metadata, or credits, cite the source of data sets used to create the map, provide the map author’s information, the date the map was created, and other explanatory information about the creation of the map. As the metadata is typically not an important part of the map, it should not be visually dominating. Instead, the metadata is typically placed along a bottom edge of the map and deemphasized. If the map reader wants to read the metadata, they will typically spend a little time searching for it.

## Graticule Map

The graticule map element visually represents a coordinate system or location scheme. You should include the graticule on a map if the map reader will be referencing coordinate locations throughout the map. You should use meaningful divisions on the graticule so that it is easy for the map reader to use it. Typically, graticules are omitted from thematic maps as the purpose of a thematic map is not to measure, but to look at spatial distribution and patterns of the data.

## Neatline

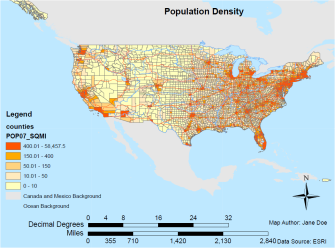
The neatline is considered to be the frame of the map. The neat line should encapsulate the map and if needed map elements. The goal of the neat line is to provide a nice, clean frame for the map to live within, to separate the map from surrounding items on the medium, and direct user’s eyes to the center of the map. Neatlines should not be visually dominant, but should be large enough so that the eye can use it as a frame.

## Ancillary Text and Objects

Ancillary text and ancillary objects are additional, supporting, information that provides a greater understanding of the topic of the map. Examples of ancillary text or objects include: text, pictures, sounds, movies, graphs, and so on. Two common reasons to include ancillary text on a map are to indicate to the map reader the ways in which the data was manipulated that is pertinent to the interpretation of the map, or, to indicate special cases or missing data.

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| **Key Facts**  **Ancillary Text and Objects**   * + Additional information that provides a greater understanding of the topic of the map   + May be text, pictures, sounds, movies, graphs, etc…   + Indicates data manipulation pertinent to the interpretation of the map   + Indicates special cases or missing data |

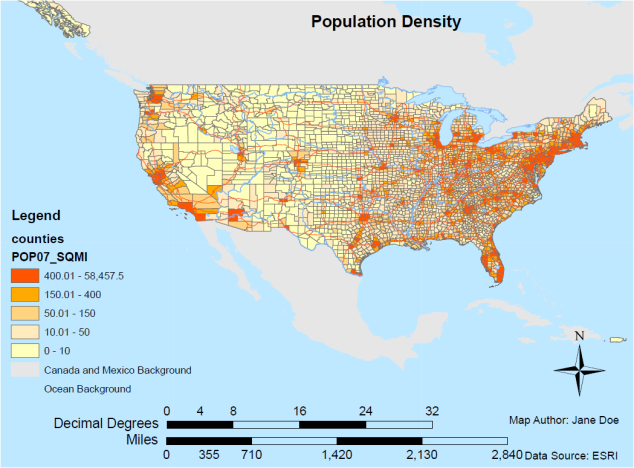
## Map Elements: Best Practices

With the map elements described in more detail, we should take a brief moment to explain best practices when placing these map elements on a map. It is important that you place map elements so that they are positioned and sized in accordance with their importance. The most important items should be roughly within the center of the map. Important items should also be placed at the top of the page. This is typically why the title is at the top of the page, and the map body is in the center of the page. Map elements should use as much space as possible within the neat line so that white space is reduced. Additionally, the map elements should be placed around the map so that the map has a visual balance that is pleasing to the eye.

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| **Key Facts**  **Map Elements Best Practices**  Place map elements so that….   * + they are positioned and sized in accordance with their importance   + they reduce white space   + they balance the map layout |

**Map Critique**

## Map Critique Original: Population Density

This is a map that may be considered typical for someone who is new at making maps. There are some undesirable characteristics of this map. The author chose not to change the default behavior of the mapping software which is the probable cause of some of the issues with the map that probably simply occurred due to the map author not knowing any better. In either case, let’s look at the map and point out where the map design could be improved.

### Title

As the title is often the first thing a map user reads, and provides a concise description of the map, let’s examine that first. The current title of the map is simply entitled “Population Density.” While at its core, the map is about population density, the title is still fairly vague. It does not answer the question of when the population was that dense, and why we are only seeing the lower 48 states of the United States, or why Alaska and Hawaii were left off the map. Additionally, the title is slightly off-center. It would be much better if the title was centered on the top of the page. Next, let’s focus on the north arrow.

### Directional Indicator

The north arrow is way too large for this map. Remember, that items should be sized relative to their importance. The north arrow is not so important for this map that it would need to stand out that much. Additionally, assuming that the audience for this map would be Americans, the North arrow might not even be necessary since Americans are used to seeing United States, and having north be up on a map, making the north arrow redundant. If the north arrow is to be left on this map, it should be made considerably smaller, and placed out-of-the-way.

### Metadata

If we look right below the north arrow, we have the metadata showing the map author and the data source. There are two problems here. One, the text is too large. Map readers will look for the metadata if they want to see it, but it should not jump out this much. The font size should be reduced for the metadata. For the data source, ‘ESRI’ not very descriptive. It doesn’t tell us what year the data set was created, and a majority of map users would not be able to track down the original data source simply by ‘ESRI’.

### Scale Bars

Next let’s consider the scale bars. The scale bars have multiple problems. First, one of the scale bars represents the distance in decimal degrees. A decimal degree is not a useful unit to measure distances on a map. I cannot think of the last time I have measured distance using decimal degrees. Second, the divisions and end points of the scale bars are not in meaningful, easy-to-use numbers. Instead of 0 to 32, why not 0 to 30? Instead of 0 to 2,840, why not 0 to 3,000? Using round numbers on your scale bars, make it easy for the map reader to scale distances. Third, the scale bars are too wide. The scale bars could easily be one third their width and be just as useful, and not so visually dominant on the map. Remember, the scale bars in this map are not that important, and should be deemphasized so as to not attract the eye from the map body. Lastly, the scale bars are too tall which causes them to be emphasized detracting from the map. Next, let’s focus on the legend.

### Legend

As a matter of style, you should not title the legend with the word “legend.” Map readers know that this is the legend, and you could use that space better by replacing it with a descriptive title for the legend. One exception would be for, say, elementary schoolchildren who are not familiar with the components of a map yet and therefore need this instruction about what a legend is and what it looks like. Next, the description of the population density data is not well formed, and provides the column name from the attribute table, which is not useful to the map reader. Instead of the word counties, and POP07\_SQMI, a more appropriate legend title would be ‘Persons per square mile’. Looking at the numbers to the right of each patch in the legend, it is not consistent with the number of decimal places.

For instance, the bottom entry has no decimal places and is simply the entry 0 – 10, while the next three entries above it have two decimal places for the lower number and no decimal places for the higher number, while the top entry has two decimal places for the lower number, and one decimal place for the higher number.

Since we’re talking about persons, we should round to the nearest whole person.

The bottom two entries referring to the background of Canada and Mexico, and the ocean background, are not required for this legend, as the water and surrounding countries features aren’t unfamiliar for the map reader, and therefore, do not need to be placed on the legend. Additionally, the symbol for the ocean background on the legend blends in with the actual ocean background behind it, therefore, making it look like there is no legend entry for the ocean background. Now let’s focus on the map itself. The United States is slightly off-center and could be made quite a bit larger to fill the page. There is quite a bit of white space above and below the main feature of the map, which is considered wasteful. Additionally, only the southern tail of Alaska is shown on the map, which looks sloppy, and makes the map reader wonder why only a portion of Alaska was shown. By enlarging the contiguous United States, the tail of Alaska would not be shown.

### Map Features

If we consider the features included on the map, we have county outlines, roads, and rivers. The question becomes: “Are roads and rivers really necessary to show a map of population density?” Perhaps the roads, and/or rivers should be left off the map so that it is less cluttered and simpler to read. Additionally, the color of the roads is very close to the color of the most densely populated area. This makes it hard to see exactly what is going on in the counties underneath the roads. The, smaller counties may be completely covered by road lines, making it look like a county is densely populated when it is not.

### Map Projection

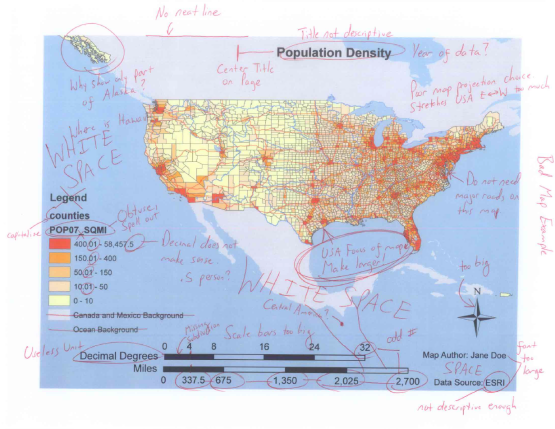
It is clear that this map is not any particular projection based on the flatness of the northern boundary line of the United States. As the data that we are showing is based off of population per square mile, an equal area projection should be applied to this map as relative size is important when determining how dense counties are. Another thing to note about the map is that although Canada and Mexico are included, South America is not. If you’re going to include surrounding countries, you need to include all of the surrounding countries that my show up on the map.

### Neatline

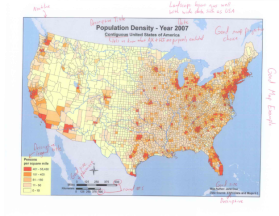
There is no neatline surrounding the map. In order to provide a nice frame for the map, and to have it stand out against its surroundings, a neatline should be included.

## Map Critique Example 2: Population Density

Here’s the same map with all the issues highlighted. As you can see, what may initially look like an ‘OK’ map really has many, many problems.



## Map Critique Example 3: Population Density Redesign

This is a redesign of the map. This redesign took about five minutes of time, and made the map significantly more attractive, and useful.

* The title is much more descriptive. It states that it is the population density for the year 2007, and specifically notes that it is for the contiguous United States of America which lets the map reader know that Alaska and Hawaii are purposely excluded for map.
* The projection is changed to an equal area projection that allows for the map reader to make proper areal comparisons between counties. The roads also have been taken off the map which allows for the counties to be the main focus of the map and not be obscured.
* The scale bars have been greatly reduced in size, are using round numbers, and are in meaningful units.
* The north arrow has been greatly reduced in size and placed in a better location.
* The metadata is more descriptive and is a good size.
* The legend has been reduced in size has been given a descriptive title, and the numbers are now consistent with respect to the number of decimal places.
* A nice frame was placed around the map.

Even with this redesign, one could argue there are still a few issues. For instance, the metadata is placed on top of some background data which makes it a little difficult to read. Additionally, the scale bars are half on and half off of Mexico and rivers are still included on the map, which might be a feature that is not required. However, overall, with just a little extra work, and careful consideration, we’ve gone from a very poorly designed map, that was hard to read, and not pleasing to the eye, to a well-designed map that is much easier to read and is pleasing to the eye.

Remember, map design is an iterative process. Don’t be afraid to radically redesign your map a few times to see how you might improve it. Also, show your map to a friend, family member, or colleague, and get feedback. Even though they may not be trained in cartography, people can often easily identify an ugly map, and might provide an important perspective on your map design.

## SUMMARY

In this lesson you learned that maps are the primary output for GIS. You also learned about cartographers and the types of maps used such as reference, which is the most common, and thematic maps. In this lesson you learned about mediums in which maps are found and how to choose a map. The steps of the cartographic process where covered to show you how to take unmapped data sets and use them to make a map. In this lesson you had the opportunity to explore the design of maps and the elements used to ensure the finished map is easy to use by the reader. Refer to critiqued sample map for best practices for creating a map.

## ASSIGNMENTS

1. Lab: Displaying Geospatial Data

2. Quiz: Displaying Geospatial Data