Image from NASA:
https://commons.wikimedia.org/wiki/File:Earth_Western_Hemisphere_transparent_background.png#filelinks

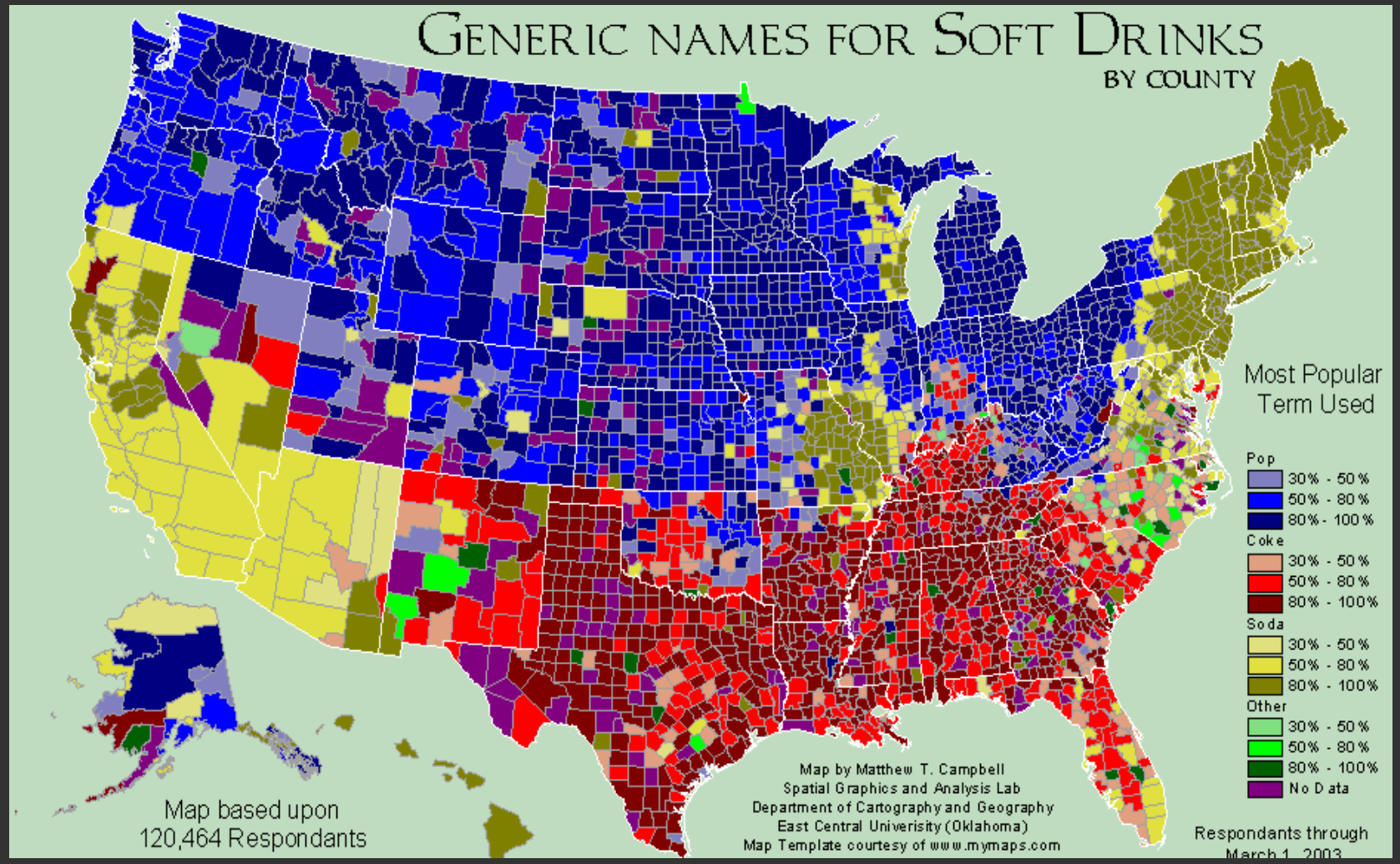
GIScience

Digital Cartography

WV VIEW

AmericaView℠
Empowering Earth Observation Education
AmericaView.org - Est. 2003

Example Map



http://www.popvssoda.com/countystats/total-county.html

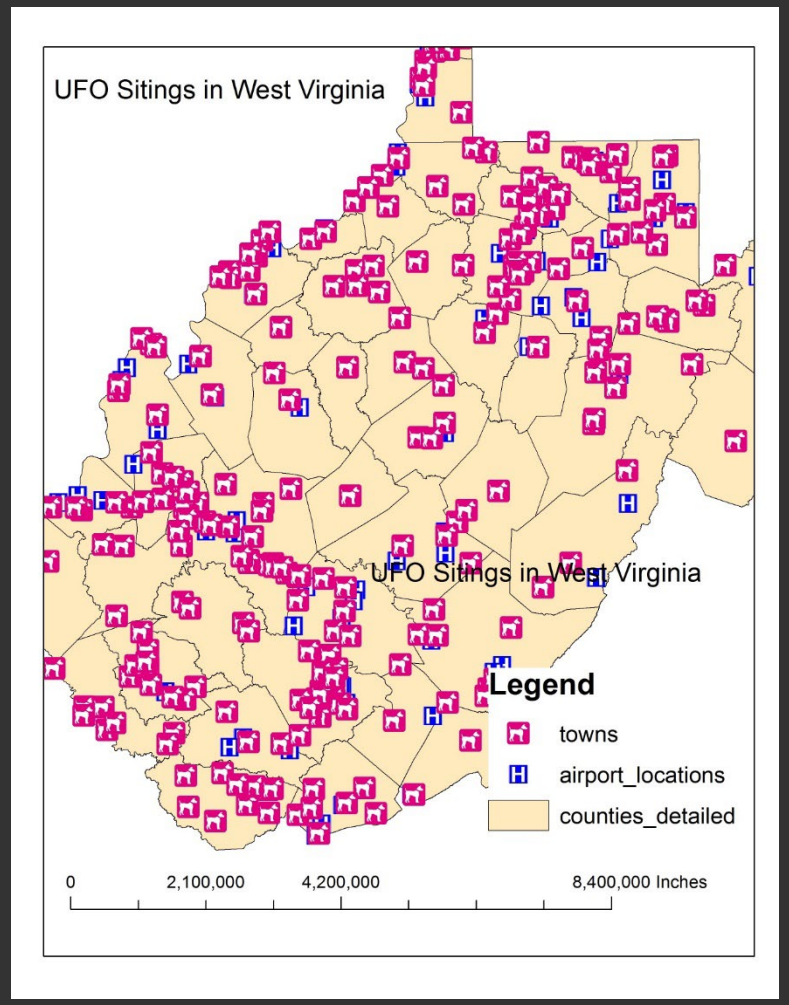
Cartography

- The art and science of making maps

https://commons.wikimedia.org/wiki/File:Austria_hungary_1911_and_post_war_borders.jpg

Maps as Communication

With GIS, it is becoming easier to make maps



- However, its easy to design a poor map

What are you trying to accomplish with your map?

- Show where something is
- Show how things have changed
- Categorize spatial features
- Show quantities
- Etc.

Who’s your audience?

- Other professionals in your field
- Your client
- Your boss
- The general public
- Children

Visual Hierarchy

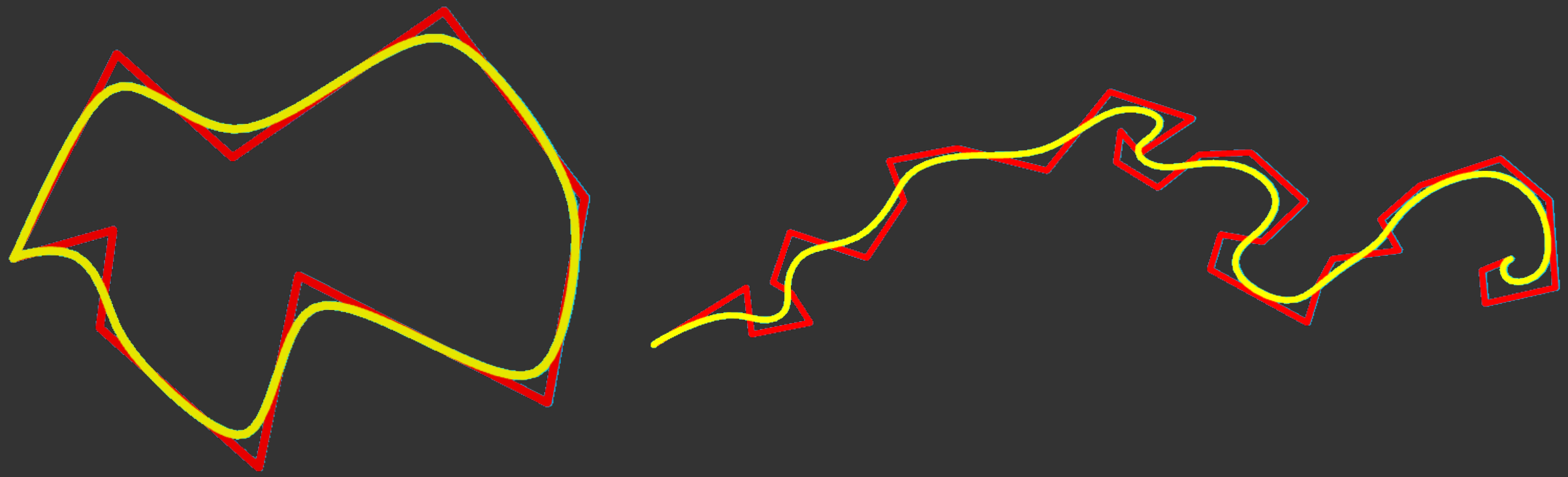
- A map's purpose determines which of its elements are the most important and should be displayed most prominently in the visual hierarchy
- Map design is largely a process of deciding how prominent to make each element of your map layout
- Hierarchy is established by an element's:
  - Position in the map layout
  - Size
  - Amount of open space around it
  - Contrasting colors, line weights, and line details

Quality Maps

1. Communicate effectively
2. Are designed for a specific audience
3. Have visual hierarchy
4. Use colors effectively
5. Use space well
6. Follow cartographic principles

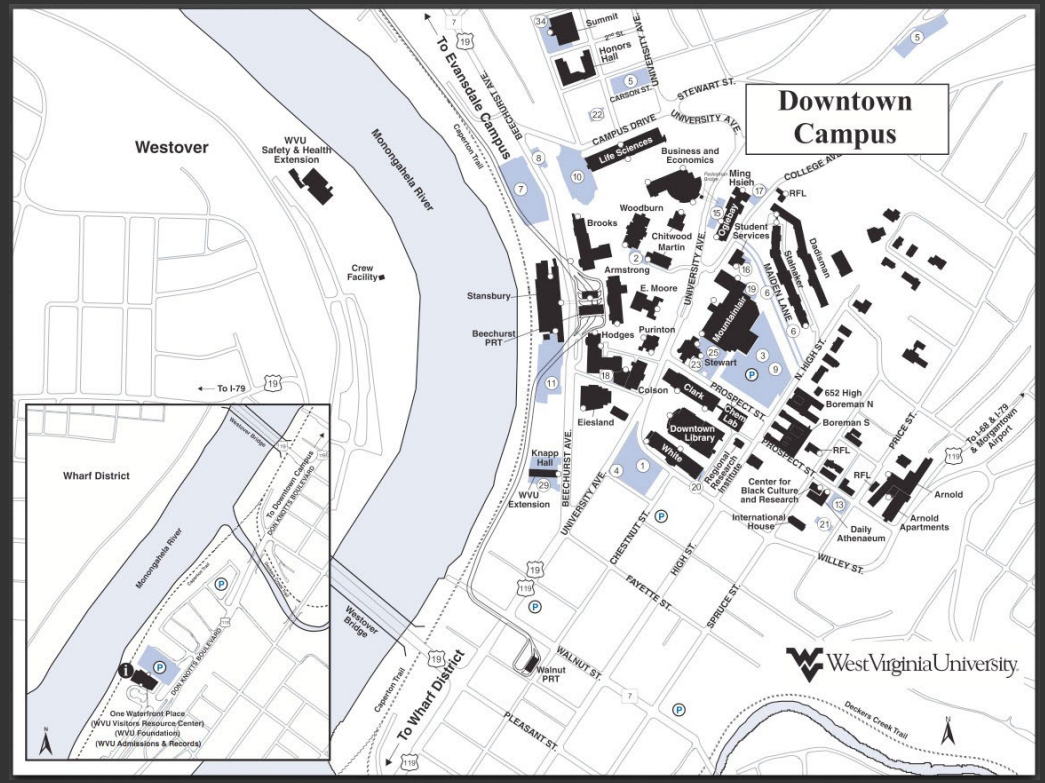
All maps require generalization

- Real world features must be simplified



Map Scale

Small Scale = Zoomed Out, Less detail



Large Scale = Zoomed In, More detail

Assumes maps are printed at same size

In what format will it be presented?

Artwork

Electronic artwork

General points

- Make sure you use uniform lettering and sizing of your original artwork.
- Preferred fonts: Arial (or Helvetica), Times New Roman (or Times), Symbol, Courier.
- Number the illustrations according to their sequence in the text.
- Use a logical naming convention for your artwork files.
- Indicate per figure if it is a single, 1.5 or 2-column fitting image.
- For Word submissions only, you may still provide figures and their captions, and tables within a single file at the revision stage.
- Please note that individual figure files larger than 10 MB must be provided in separate source files.

A detailed guide on electronic artwork is available.

You are urged to visit this site; some excerpts from the detailed information are given here.

Formats

Regardless of the application used, when your electronic artwork is finalized, please 'save as' or convert the images to one of the following formats (note the resolution requirements for line drawings, halftones, and line/halftone combinations given below):

EPS (or PDF): Vector drawings. Embed the font or save the text as 'graphics'.

TIFF (or JPG): Color or grayscale photographs (halftones): always use a minimum of 300 dpi.

TIFF (or JPG): Bitmapped line drawings: use a minimum of 1000 dpi.

TIFF (or JPG): Combinations bitmapped line/half-tone (color or grayscale): a minimum of 500 dpi is required.

Please do not:

- Supply files that are optimized for screen use (e.g., GIF, BMP, PICT, WPG); the resolution is too low.
- Supply files that are too low in resolution.
- Submit graphics that are disproportionately large for the content.

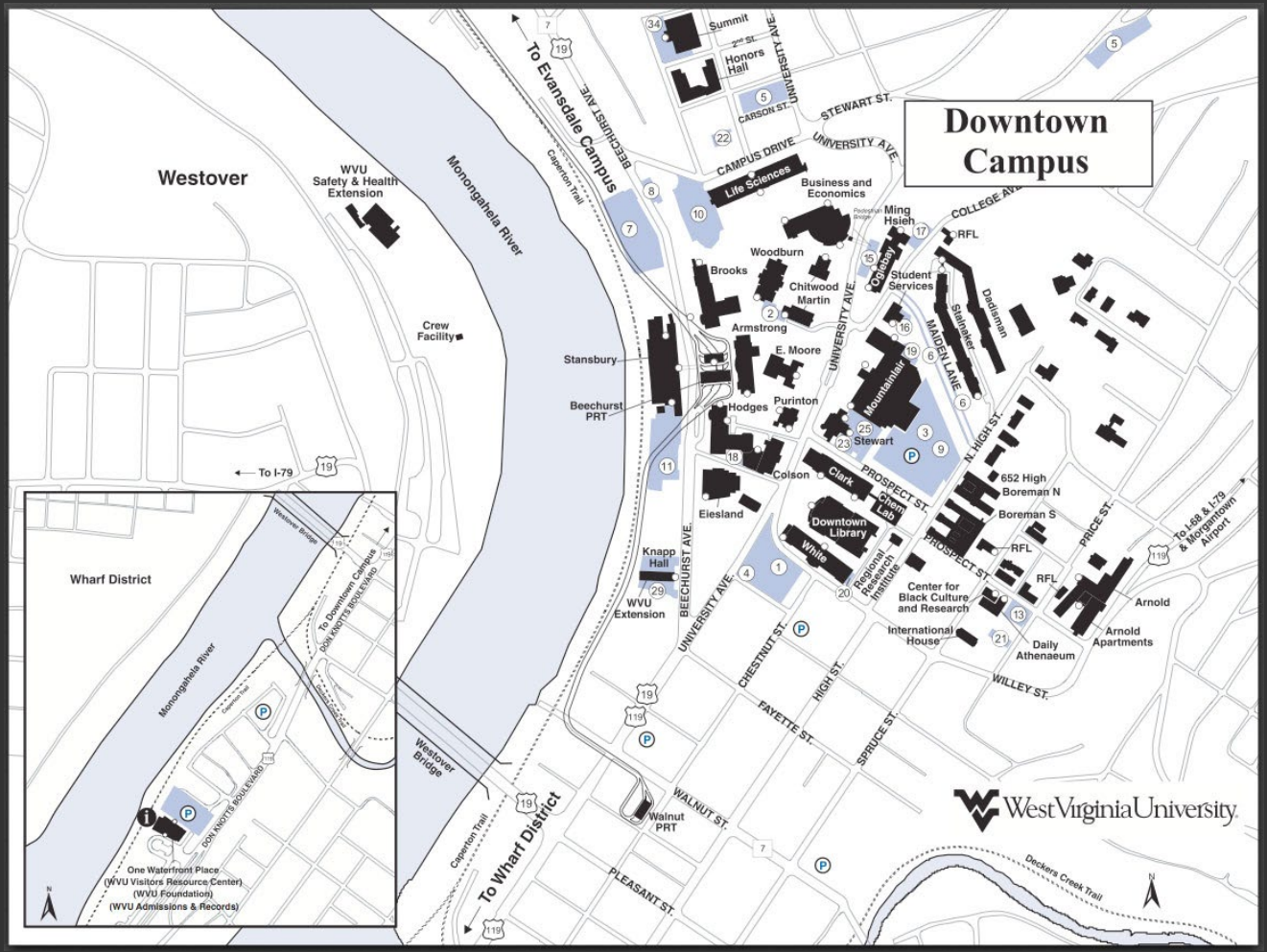
- Color print
- Black-and-white print
- Academic journal
- Newspaper
- Trade journal
- White paper
- Large format
- Computer screens
- Projectors
- Presentations

Guide to Authors: Applied Geography (https://www.elsevier.com/journals/applied-geography/0143-6228/guide-for-authors)

Types of Maps

Reference Maps

- Shows the location of features

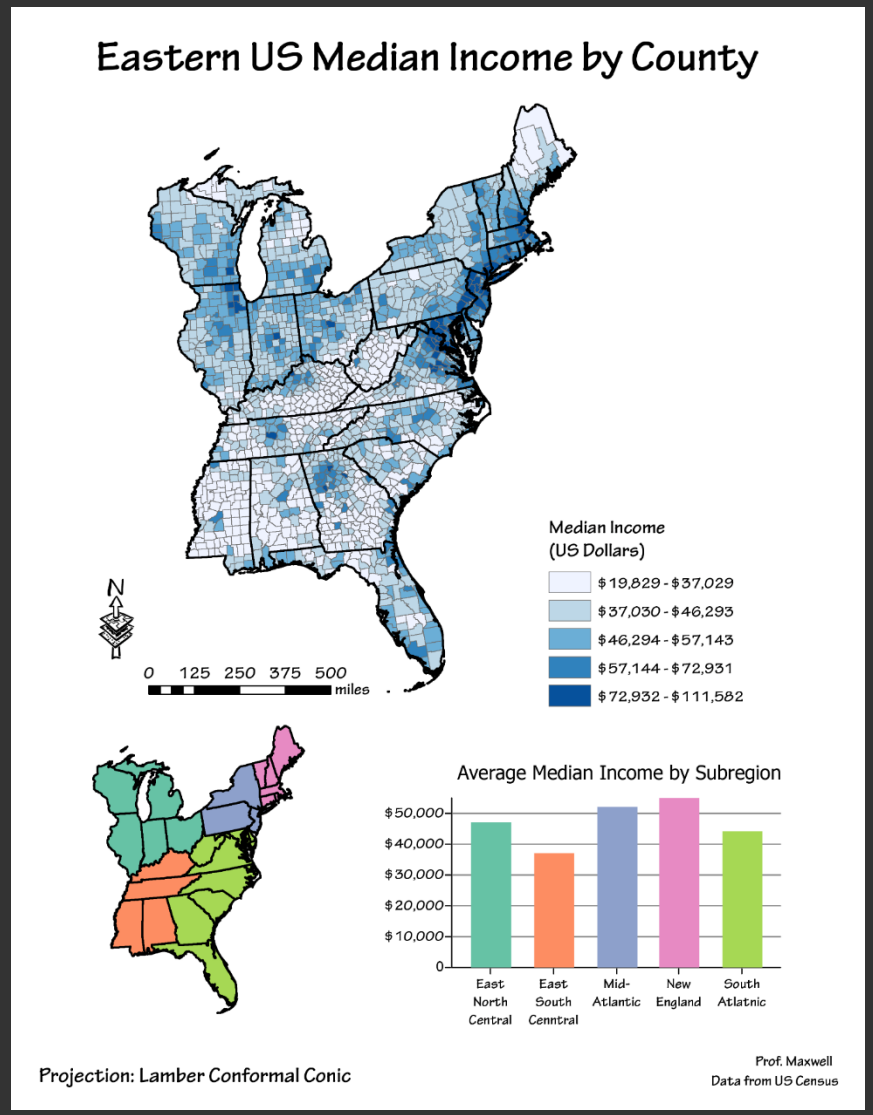


Thematic Maps

Displays a specific theme or feature using a graphical property

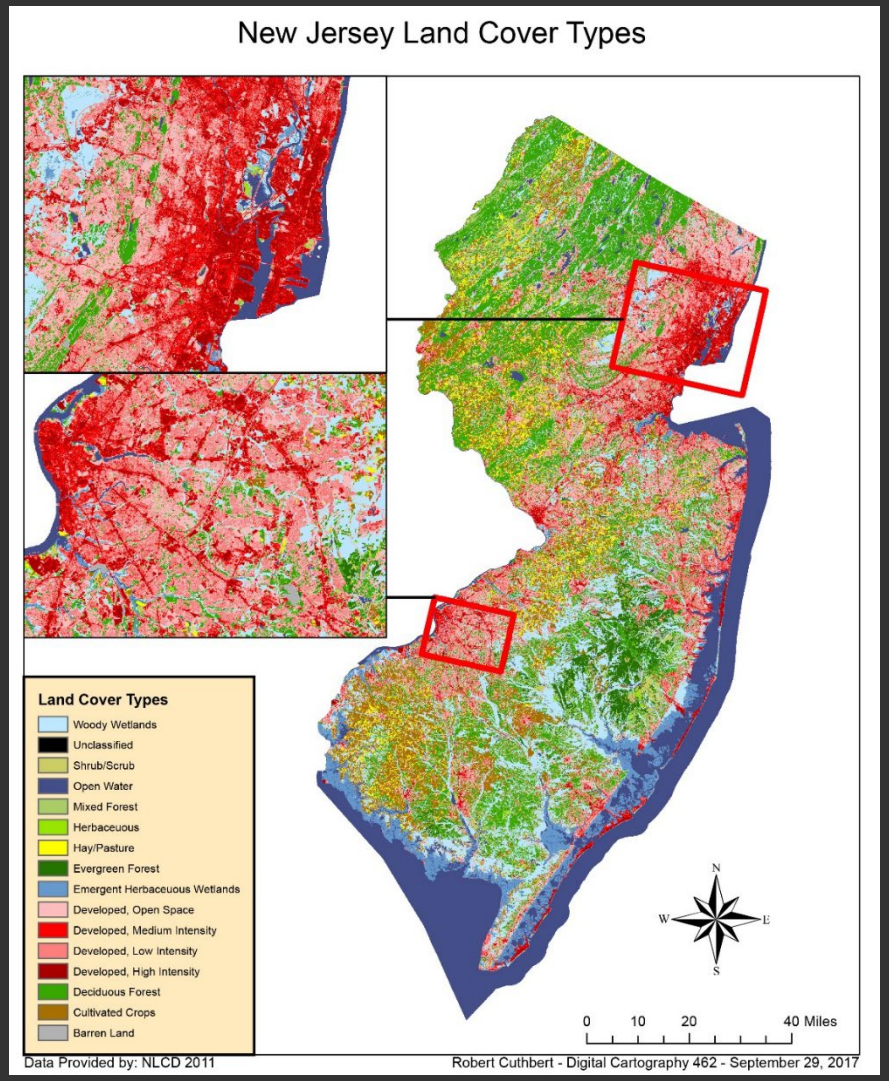
- Color
- Size
- Shape
- Density
- Etc.

Choropleth



- Use color to show a quantity or category

Choropleth



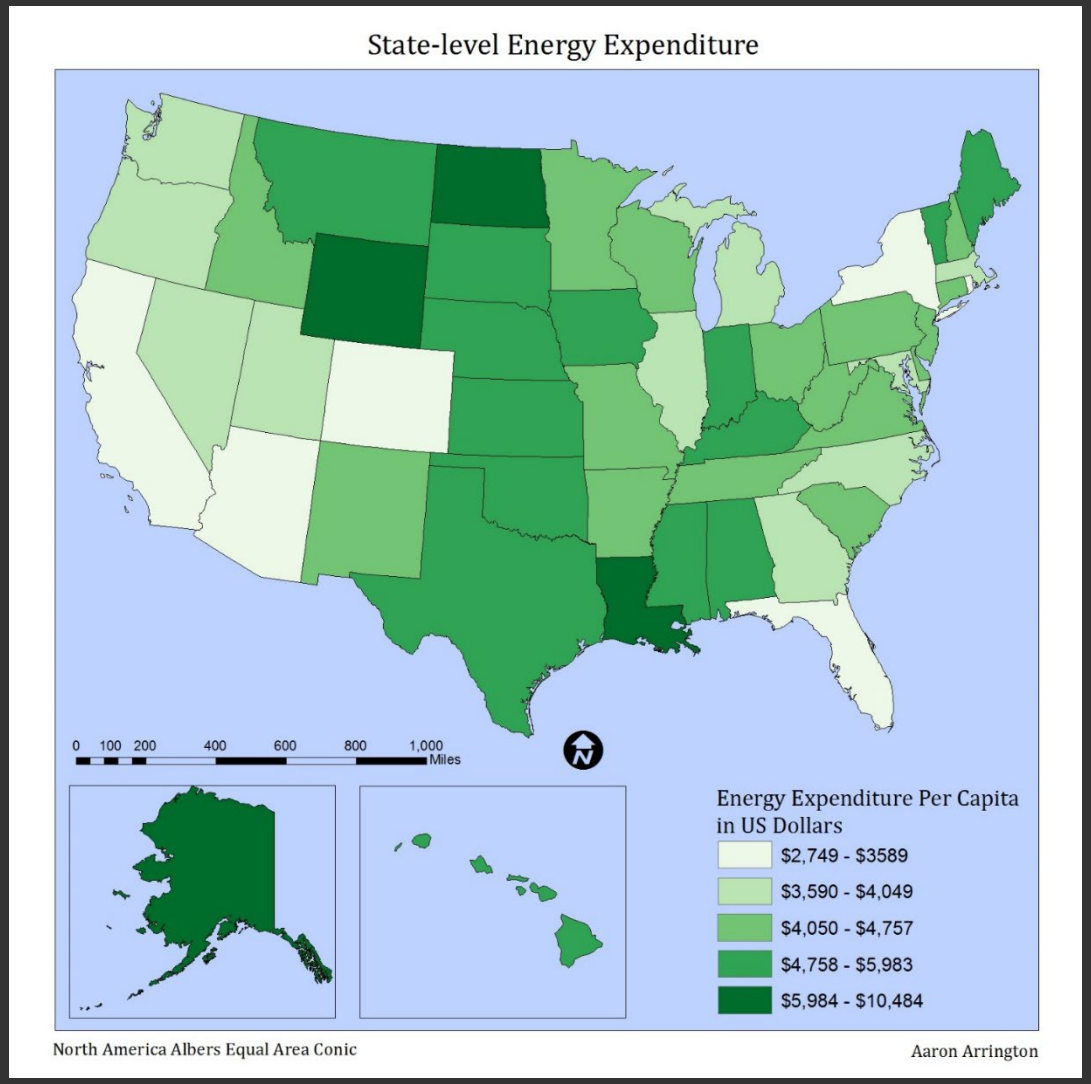
- Use color to show a quantity or category

Map by Robert Cuthbert

Thematic Maps

- Use color to show a quantity or category

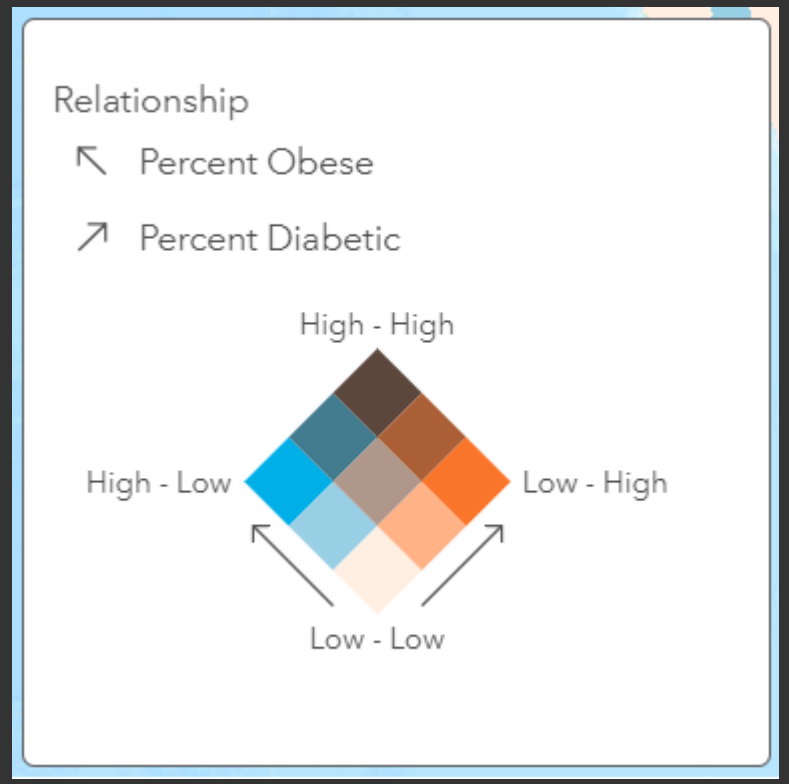
Thematic Maps

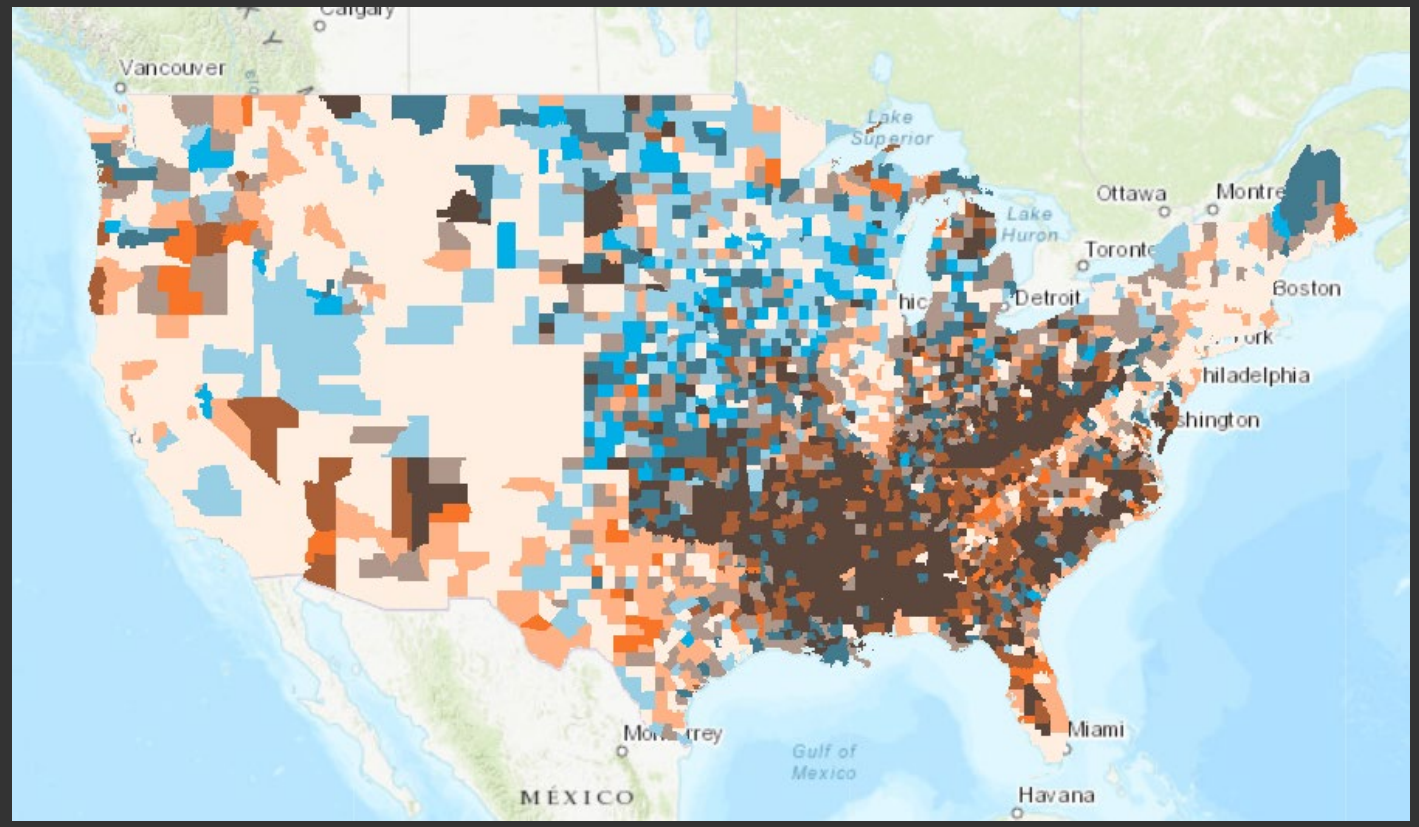


- Use color to show a quantity or category

Map by Aaron Arrington

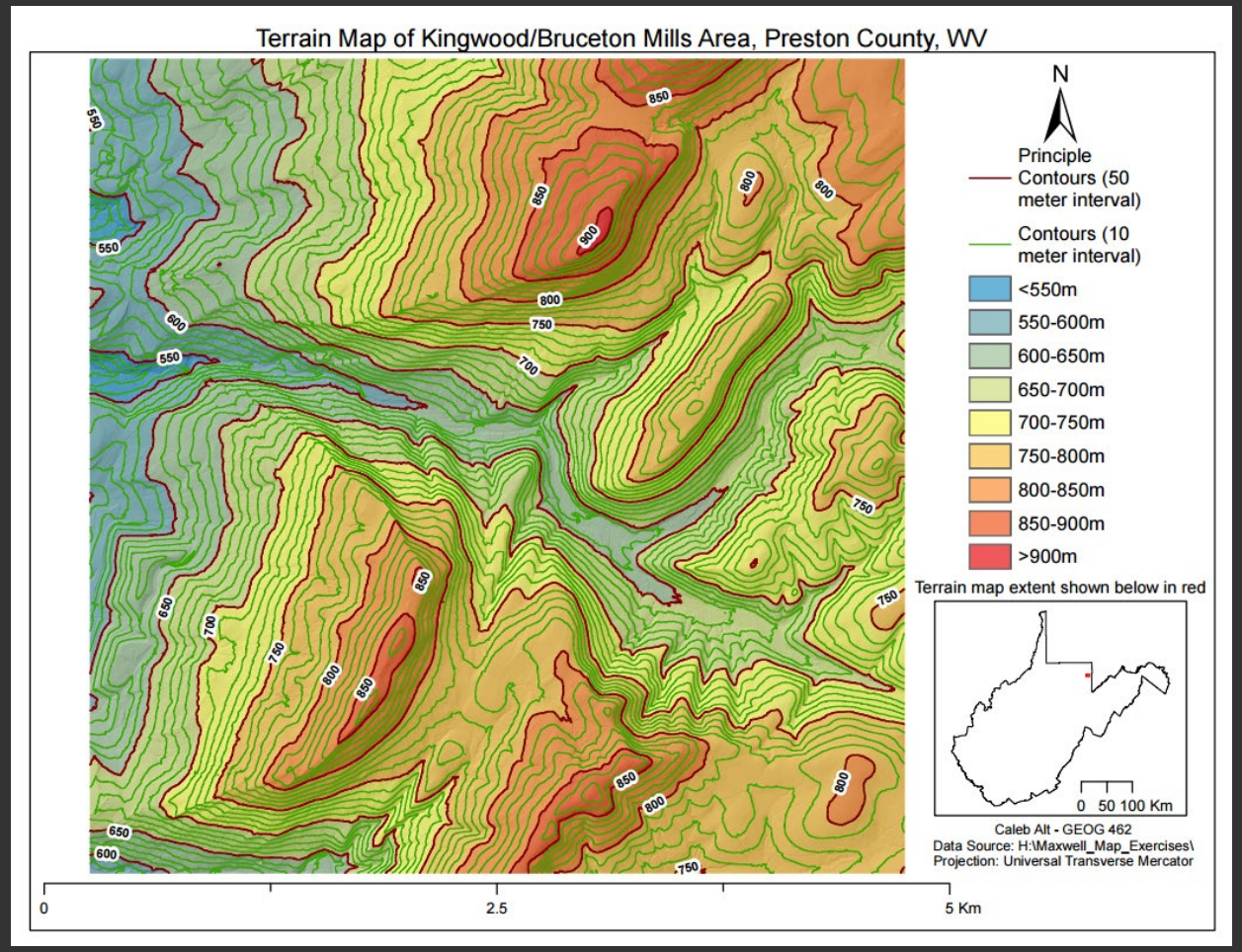
Bivariate Choropleth Map





Example from ArcGIS Online using County Health Rankings 2018

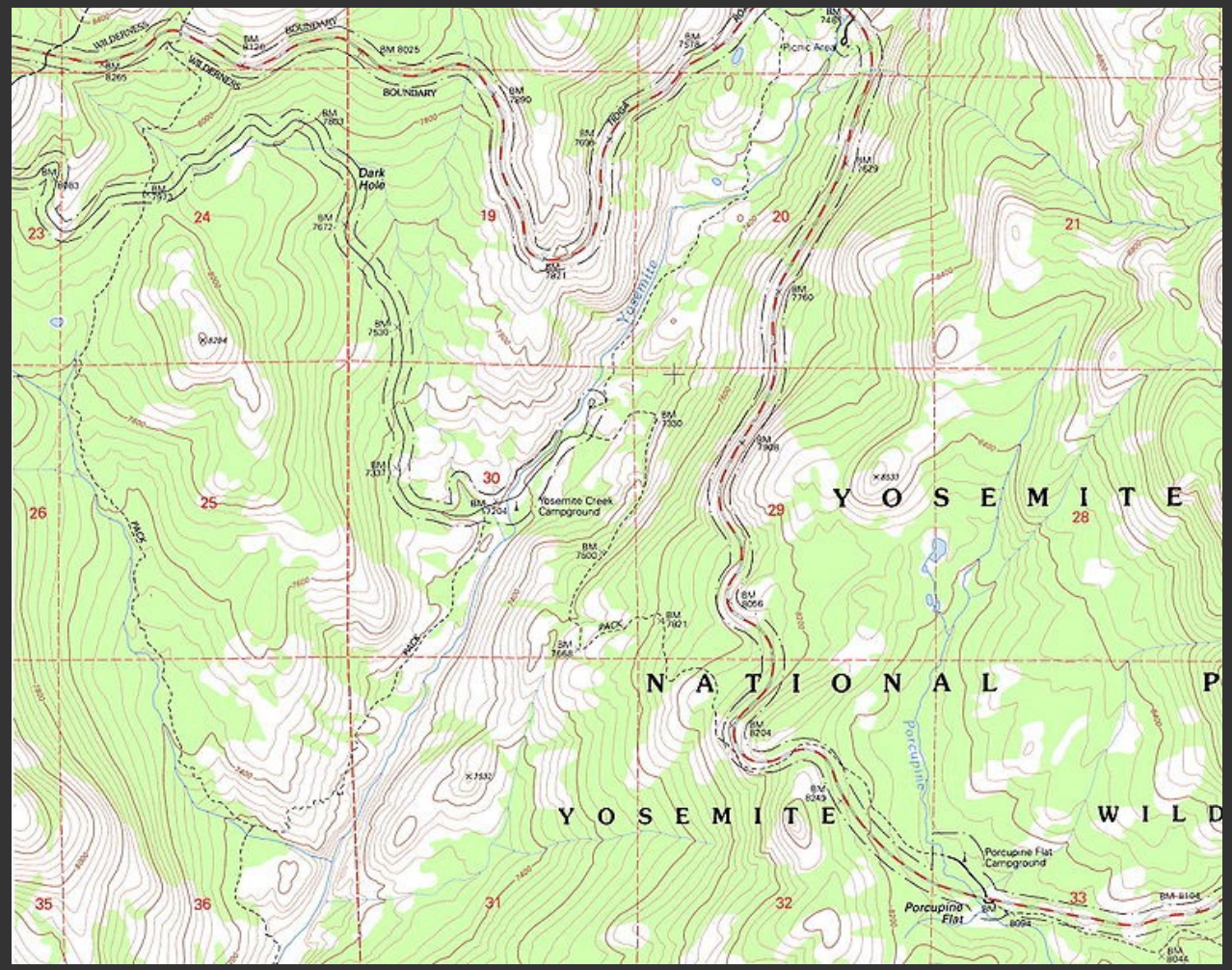
Isarithmic Map



- Use lines of equal value to show a quantity

Map by Caleb Alt

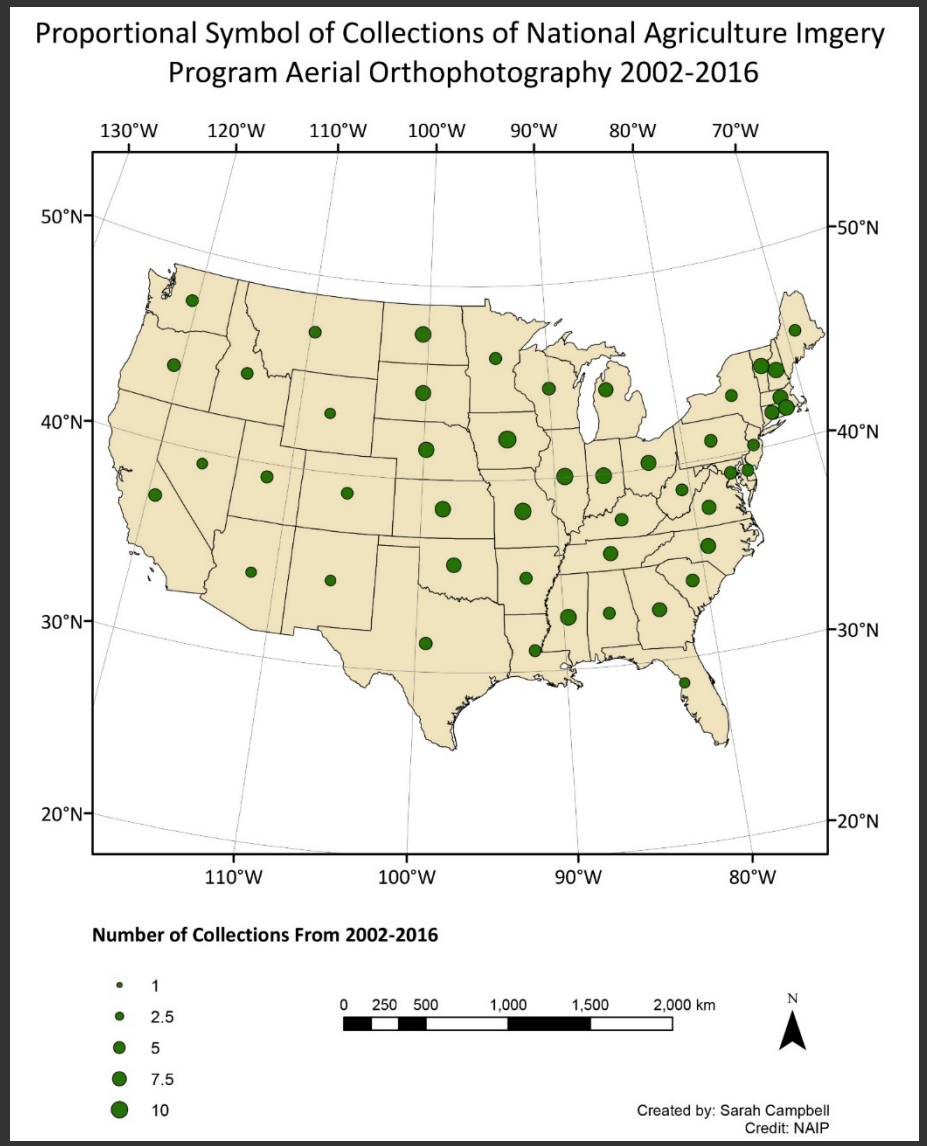
Isarithmic Map



- Use lines of equal value to show a quantity
- Topographic Maps

https://commons.wikimedia.org/wiki/File:Yosemite-creek-campground-topo.jpg

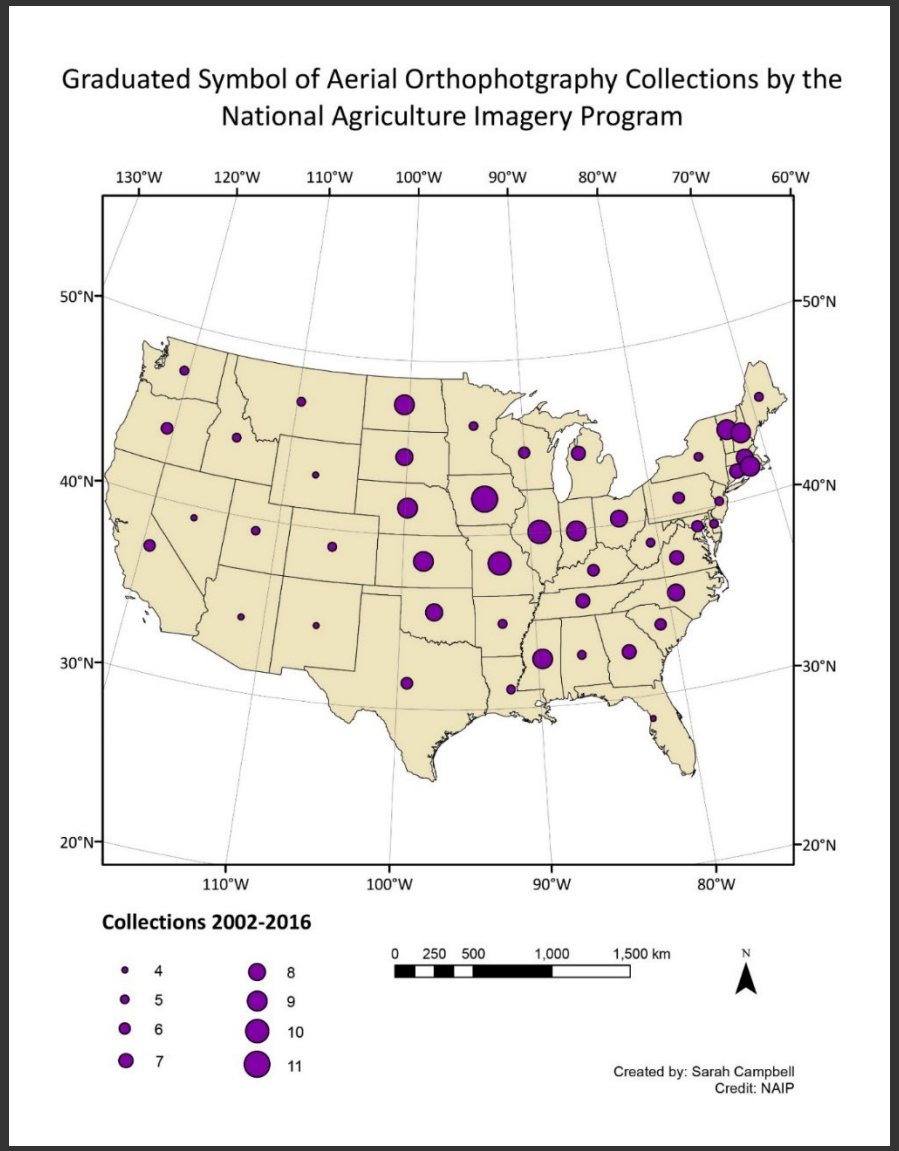
Proportional Symbol Map



- Use size to represent a quantity (scaled continuously)

Map by Sarah Campbell

Graduated Symbol

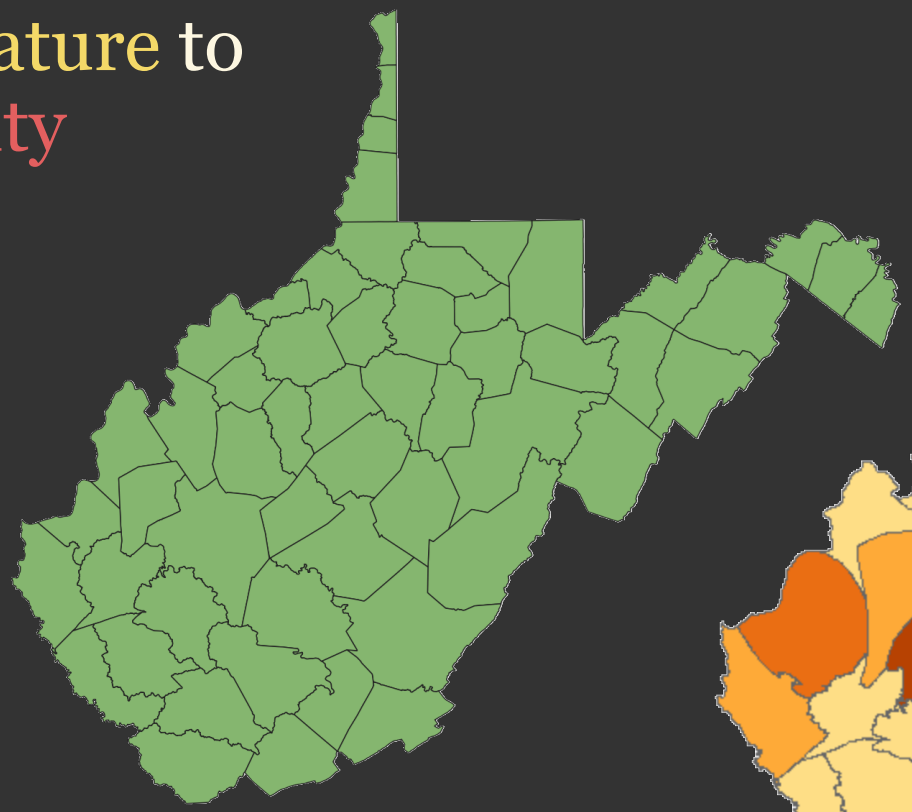


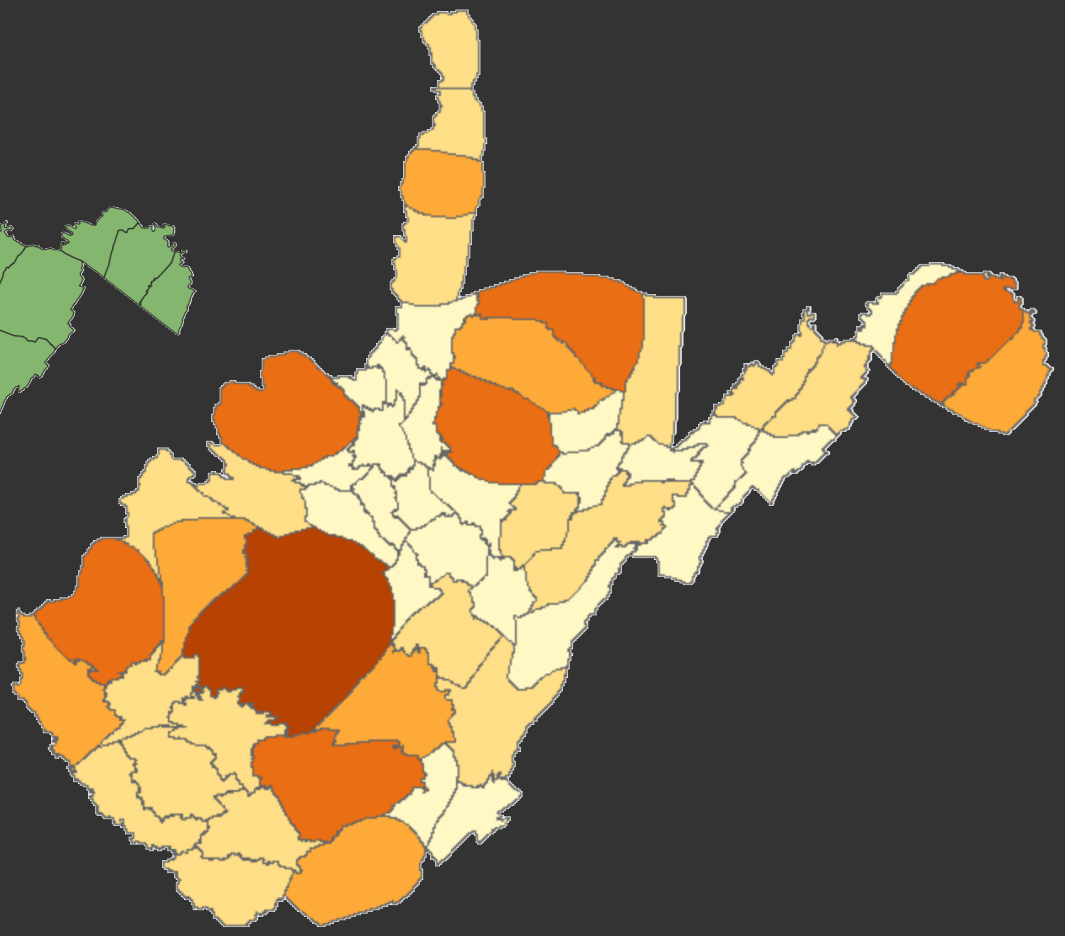
- Use size as bins or ranges to represent a quantity

Map by Sarah Campbell

Thematic Maps

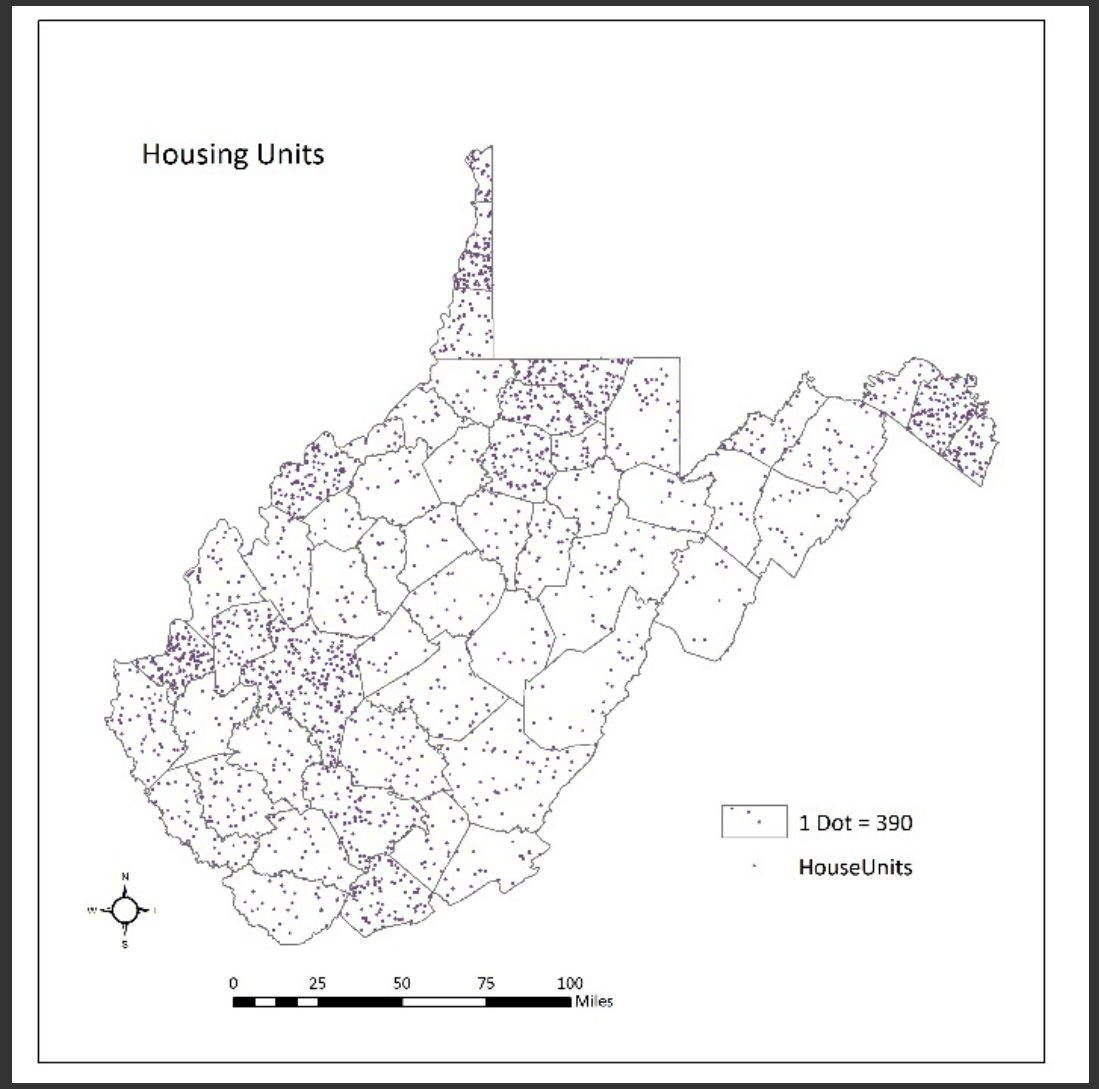
- Resize the map feature to represent a quantity





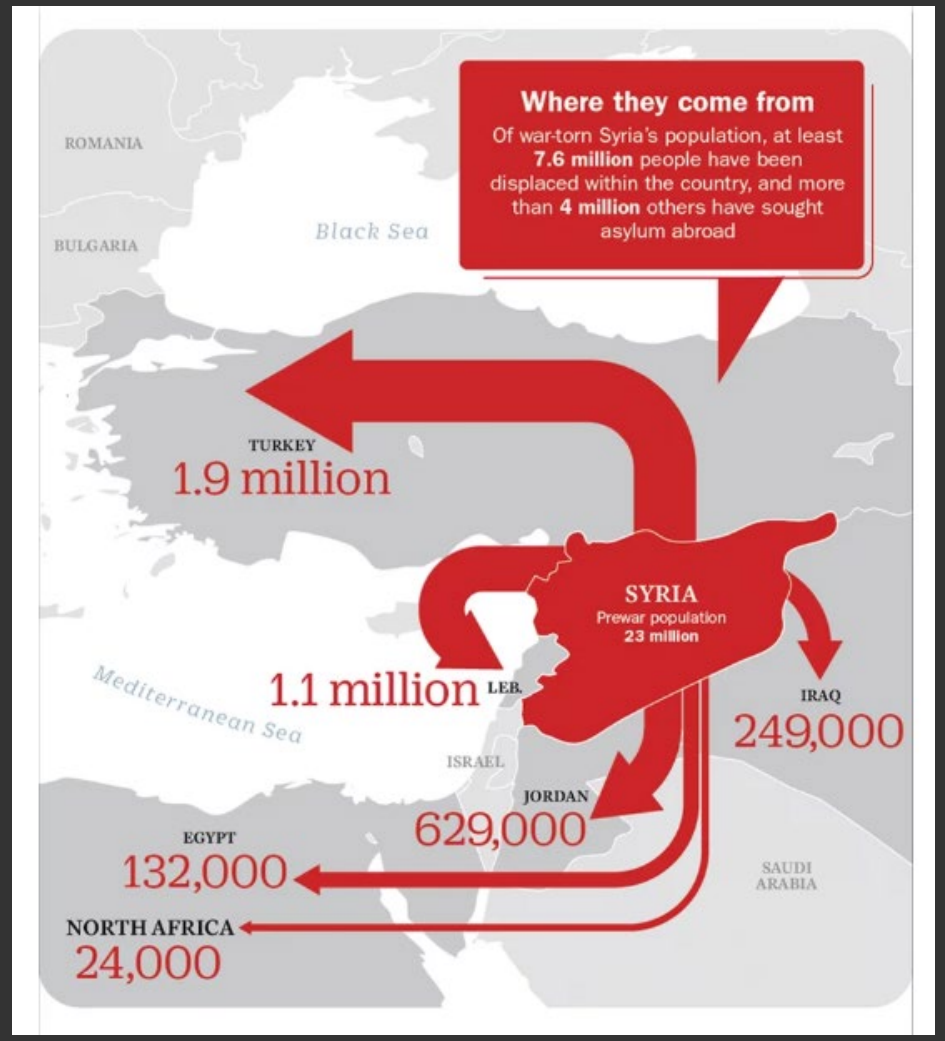
Population by County

Thematic Maps



- Use density of dots to represent a quantity

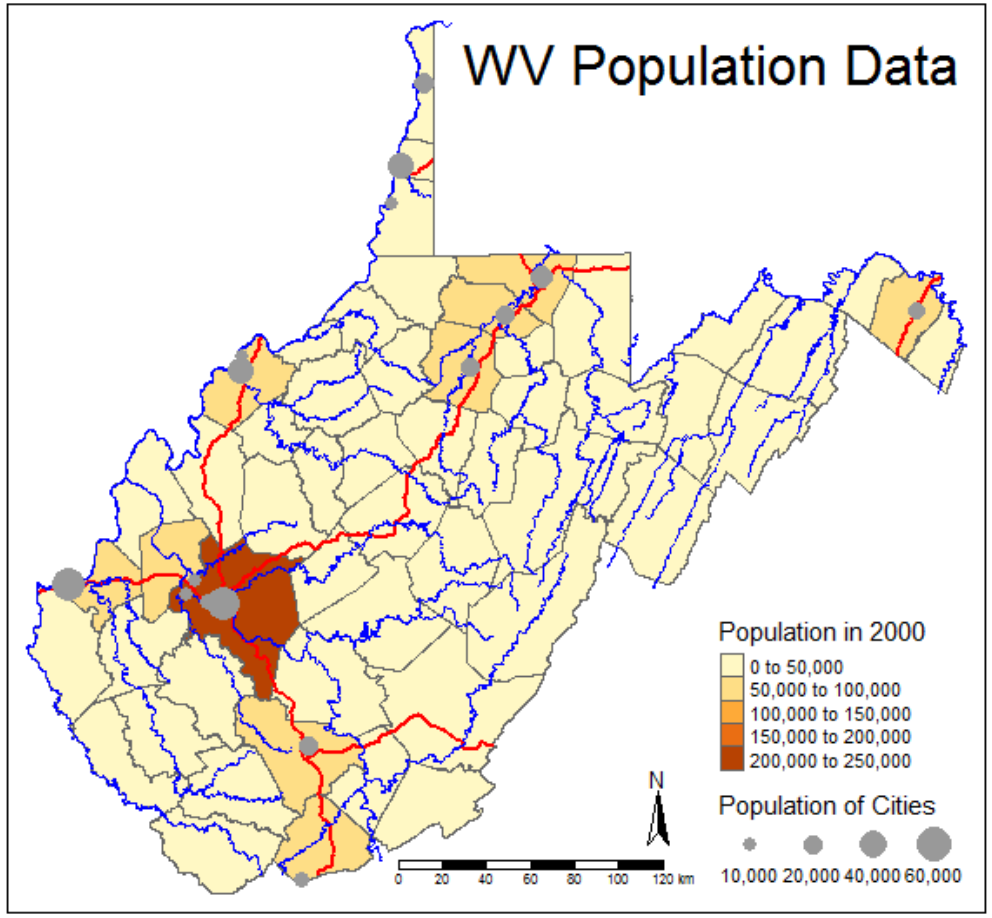
Thematic Maps



http://time.com/4028055/syria-europe-refugees-graphic/

- Show movement or migration using arrows
- Can also show magnitude with arrow size or color

Thematic Maps

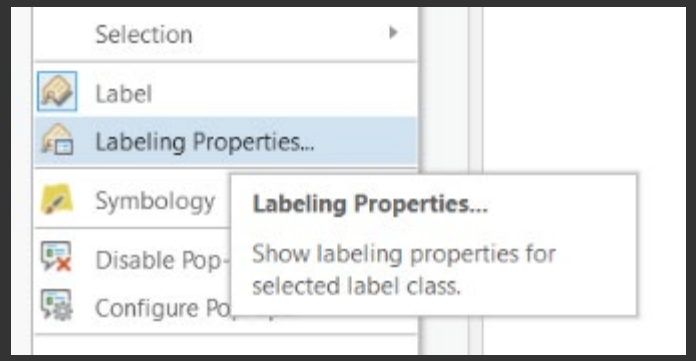


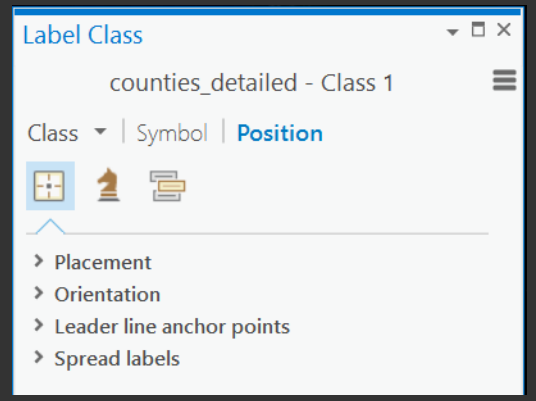
- Maps that show multiple quantities and/or categories using different graphical parameters

Type and Fonts

Map Text

- You should think about text font, size, and positioning
- Generally, the titles have the largest font size





Type

- Type Family = group of type designs that reflect common design characteristics and share a common base name (Calibri, Arial, Comic Sans, Cambria, Courier New, Times New Roman, Verdana)
- Type Style = Roman (normal), bold, *italic* (Less common: condensed, expanded, light, and extra bold)
- Type Face = Family + Style (Gill Sans Ultra Bold)
- Type Size = height (11 pt, 14 pt, 18 pt)
- Font = a set of all alphanumeric and special characters of a particular family, style, and size (Times New Roman 12 pt)

Case

- Title Case = lowercase letters with the first letter of each word set to upper case (except linking words like in, on, or, of, per, by, for, with, the, and, over, etc.)
- Sentence case = only first letter of first word in the sentence is capitalized
- UPPERCASE = all caps

Serif vs. Sans Serif

- Serif = has short extensions at the end of major letter strokes (This is a serif font).
- Sans serif = does not have serifs (This is a sans serif font).

Spacing

- Letter Spacing = space between letters in a word
  - Here I have changed the letter spacing.

- Word Spacing = spacing between words
- Kerning = variation of spacing between adjacent letters
- Leading = vertical spacing between lines
  - Here I have changed the leading.
  - Here I have changed the leading.
  - Here I have changed the leading.
  - Here I have changed the leading.

Color

You can also change the color of your text.

General Typographic Guidelines

1. Avoid the use of decorative fonts.
2. Do not overuse *italics* and **bold**.
3. *Hydrographic features are often in italics*.
4. *Data sources are often in italics*.
5. The wide variety of features on general reference maps might require that you use bold and italics styles outside of these guidelines.
6. Avoid using more than two font families on a map.
7. If you use two font families, they should be distinctively different.
8. Serif fonts tend to be used for natural features.
9. Sans serif fonts tend to be used for cultural features.
10. All type should be readable at the intended reading distance and at the printed size. You may want to show sample maps to the intended audience.
11. Type size should correspond with the size or importance of map features.
12. Avoid font size differences less than 2 points as these can be hard to discern.
13. Critically evaluate and apply type specifications such as font family, font style, type size, letter spacing, word spacing, kerning, and leading.
14. Spell check your work.

General Guidelines for Labeling Features

1. Generally, orient type horizontally (with some exceptions).
2. If graticules are used with curved parallels, orient text with parallels.
3. If labeling diagonal or curved linear or areal features, orient type with orientation of the feature.
4. Avoid overprinting or placing a block of type over a map feature such that the feature is obscured and the text is difficult to read.
5. If overprinting is an issue, consider using a mask or a halo. Make sure that masks or halos do not draw too much attention.
6. If overprinting is an issue, consider using callouts. Make sure that the callout does not draw too much attention.
7. Ensure that all type labels are placed so that they are clearly associated with the features they represent.

Labeling Point Features

1. Avoid overprinting.
2. Preferred positions are shown on the next slide.
3. Do not allow other map features to come between a point symbol and its label.
4. Emphasize the association between the label and symbol, even if it means choosing a less preferred location.
5. If the sequence of preferred locations does not provide a suitable option, consider using a mask, halo, callout, or leader line.
6. Multi-line labels should be placed according to the sequence of preferred locations and horizontally aligned to emphasize the association between the label and point symbol.
7. Point symbols on land that are close to coastlines should be labeled entirely on land if possible.
8. Point symbols that touch coastlines should be labeled either entirely on land or entirely on water.
9. Avoid overprinting coastline with type.
10. Do not exaggerate letter or word spacing.

Label Positioning

Labeling Line Features

1. Place type above line features. Type should be close to the line but not touching it.
2. If labeling features on both sides of a boundary, type can be above and below the line.
3. If feature has complex curves, follow the general trend of the feature and avoid labels that are too curvy and difficult to read.
4. Very long linear features can be labeled more than once. The use of multiple labels is preferred to the exaggeration of letter and word spacing to emphasize linear extent.
5. Text should be upright, not upside down. Text should read left to right.

Labeling Polygon Features

1. Visually center the label within the feature.
2. Allow some space between the label and the feature boundary to avoid crowding.
3. Generally, label along the longest axis of the feature.
4. Consider using all-uppercase type, especially for larger features.
5. Letter and word spacing can be exaggerated to emphasize aerial extent, especially if applied to all upper-case type.
6. Exaggerated leading can also be used to emphasize areal extent.
7. Areal features that are too small to contain a label should be labeled like point symbols.
8. Leader lines can be used to label small areal features.

ArcGIS Maplex

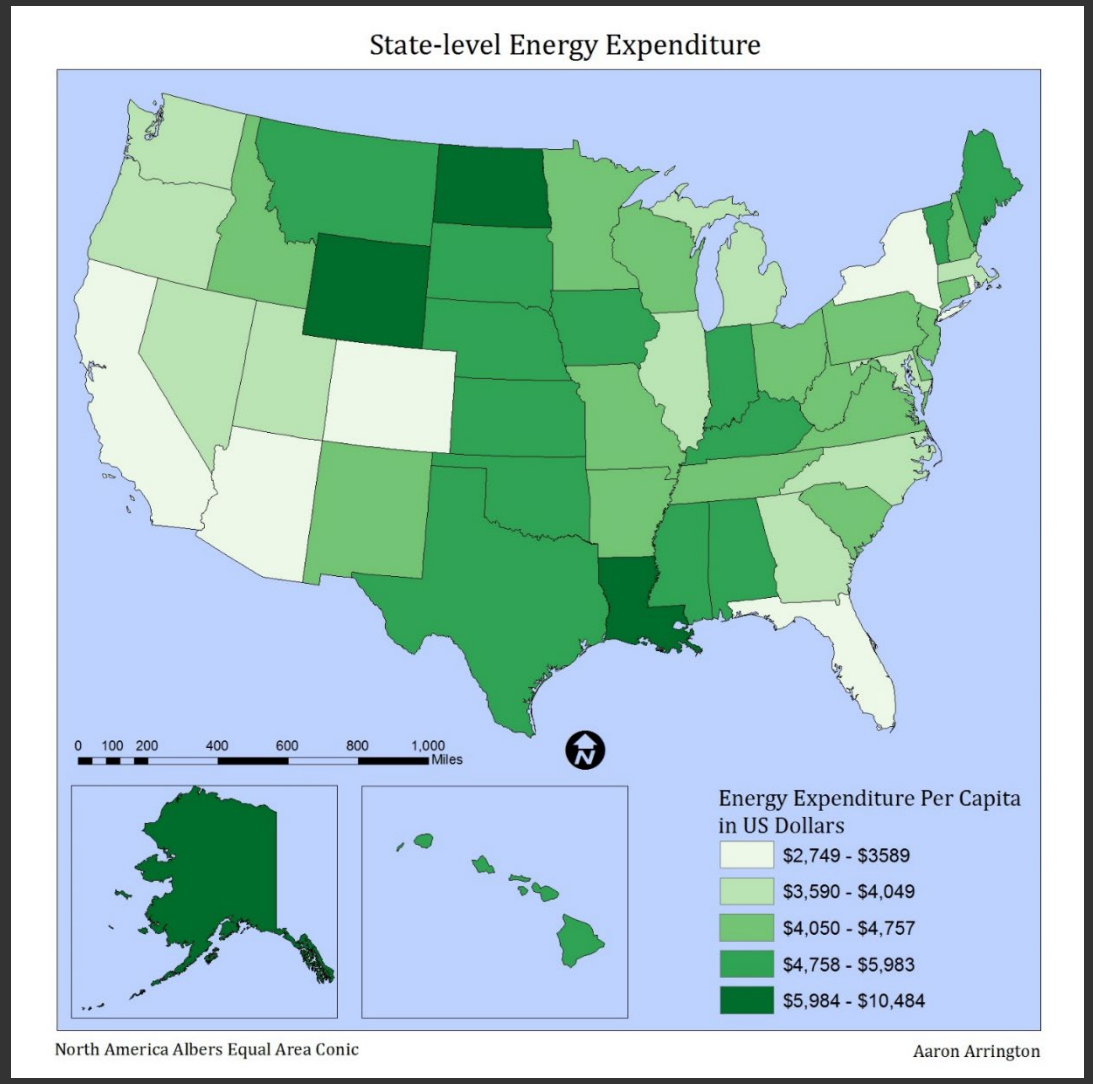
- Well-placed labels can make a map more understandable and useful.
  - Maplex provides a special set of tools that allows you to improve the quality of the labels on your map.
  - Define parameters to control the positioning and size of your labels; Maplex uses these parameters to calculate the best placement for all the labels on your map. You can assign different levels of importance to features to ensure that more important features are labeled before less important ones.
- Maplex controls:
  - how labels should be placed relative to features
  - how labels can be modified or reduced to allow more label placement when the available space is constrained
  - how conflicts between labels are resolved

ArcGIS Maplex

- Advanced placement styles for polygons including styles that represent land parcels, rivers, and boundaries
- Special placement for lines that represent street, river, and contour features
- Ability to offset labels from features
- Repetition of labels at a specified distance along a line or within a polygon
- Control of word and character spacing
- Alignment of labels to projection graticules
- Control of label placement zones
- Flexible placement to allow more labels to fit in an area
- Fine control of label stacking
- Label abbreviation and truncation
- Font reduction parameters for congested areas
- Control of whether a label may extend beyond a feature
- Enhanced weighting of features to determine label placement
- Control over the minimum feature size that will be labeled
- Placement of labels as background text
- Search tolerance to remove duplicate labels
- Ability to control the order in which the label fitting strategies are applied

Map Elements

Map Elements

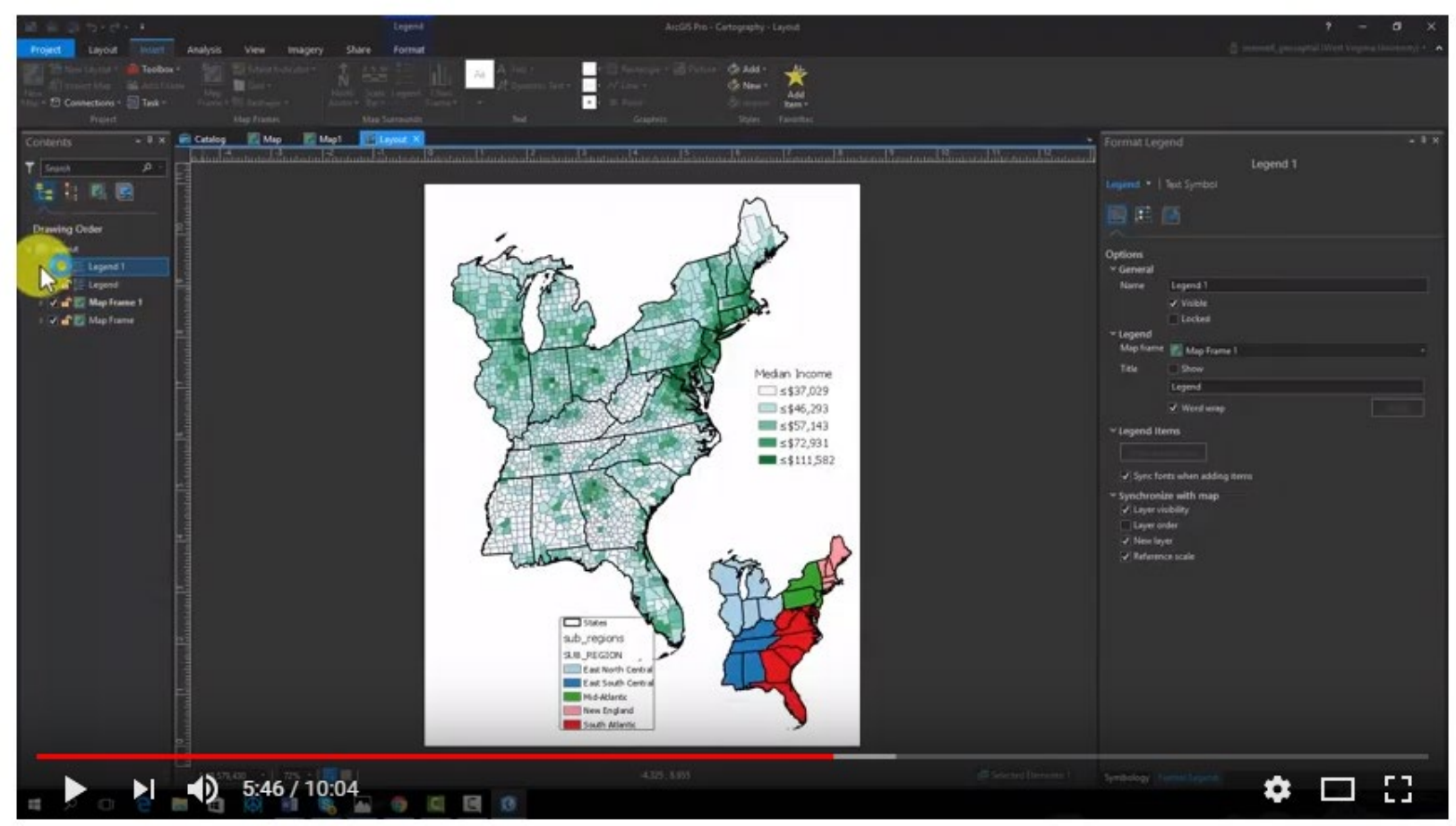


1. Map area
2. Title
3. Map text
4. Inset maps (multiple map frames)
5. Scale
6. Orientation
7. Graticules
8. Coordinate Grids
9. Legend
10. Credits
11. Frames and neat lines
12. Graphics

Map by Aaron Arrington

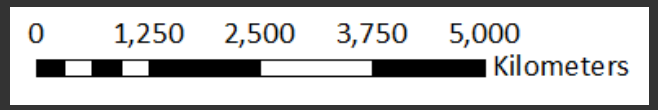
Map Elements in ArcGIS

1. Work in Map Layout
2. Insert options
3. Change symbology in original map
4. Can work with multiple maps
5. Can change map projection for map

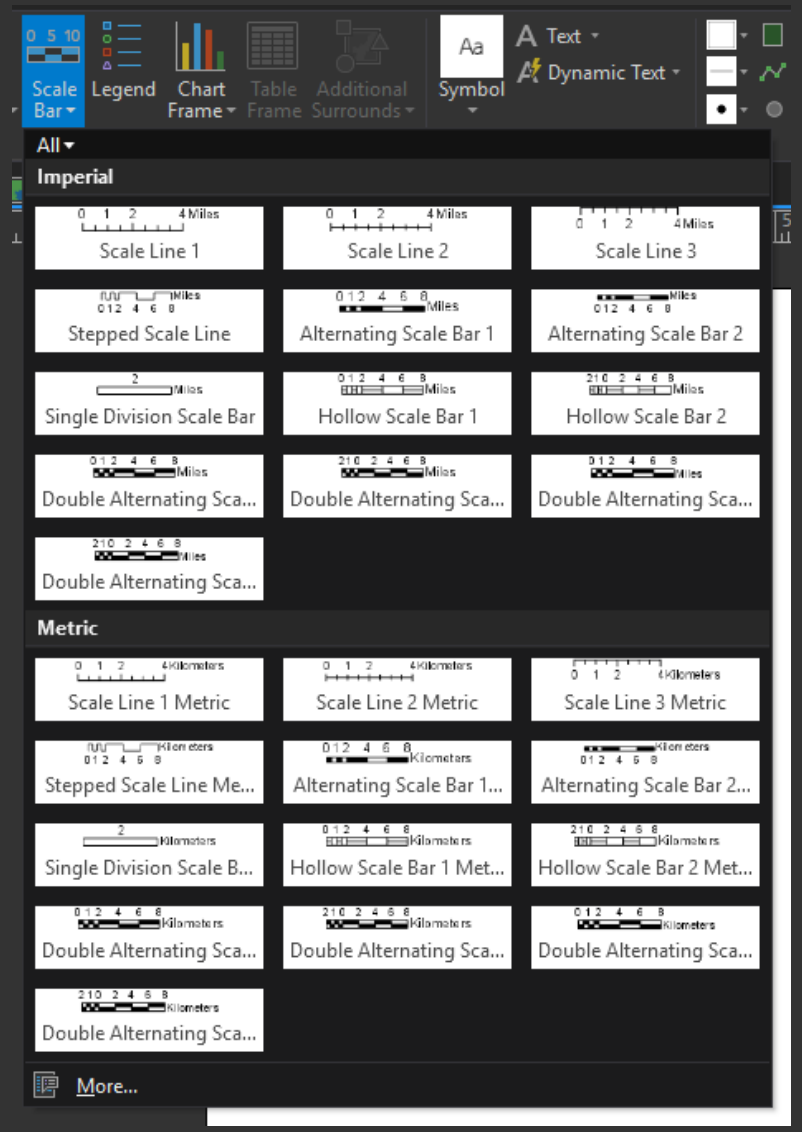


Scale

- Scale Bars
  - Most useful



- Representative Fraction
  - 1:10,000
  - 1:1,000,000
- Verbal
  - One inch to one mile
- Neither Representative Fraction nor Verbal used if map is to be enlarged or reduced in size



Scale Calculations

Problem

Two features are 2.5 inches apart on a 1:24,000 scale map. How far apart are they in miles in the real world?

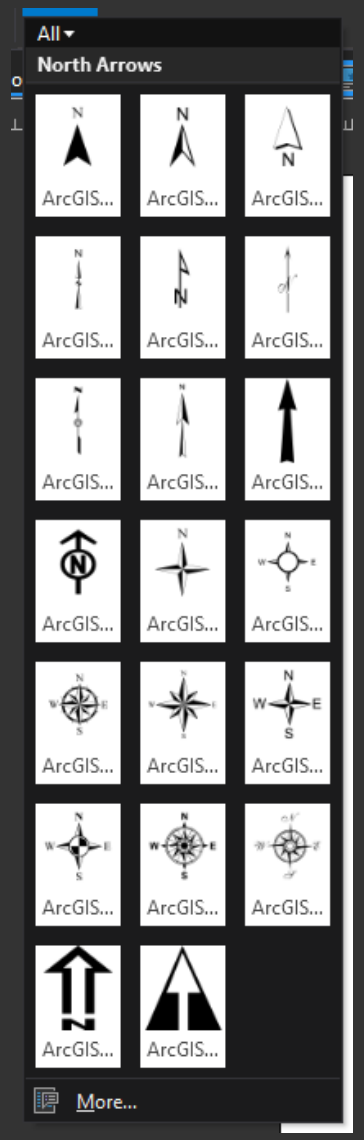
Scale Bar Tips

1. Make sure your units make sense
2. Reference maps often require more detailed scale bars than thematic maps
3. Is a scale bar always required?
4. Breaks should be clean numbers (such as multiples of five or ten)
5. You can control the number of divisions and subdivisions
6. You can include a representative fraction or verbal scale
7. It might be worth stating the projection on the map, as this makes your scale bar more meaningful
8. It should have the same font as the rest of the map
9. It should fit within the visual hierarchy of your map
10. The size and position should be consciously determined
11. You can change the label and position of the label
12. You can change the position of numbering
13. You can change the frequency and position of marks

Orientation

- North Arrow
- Graticules = latitude and longitude
- Coordinate Grids = grid of map coordinates (UTM grid)
- References Grids = grid of reference cells

North Arrow Tips

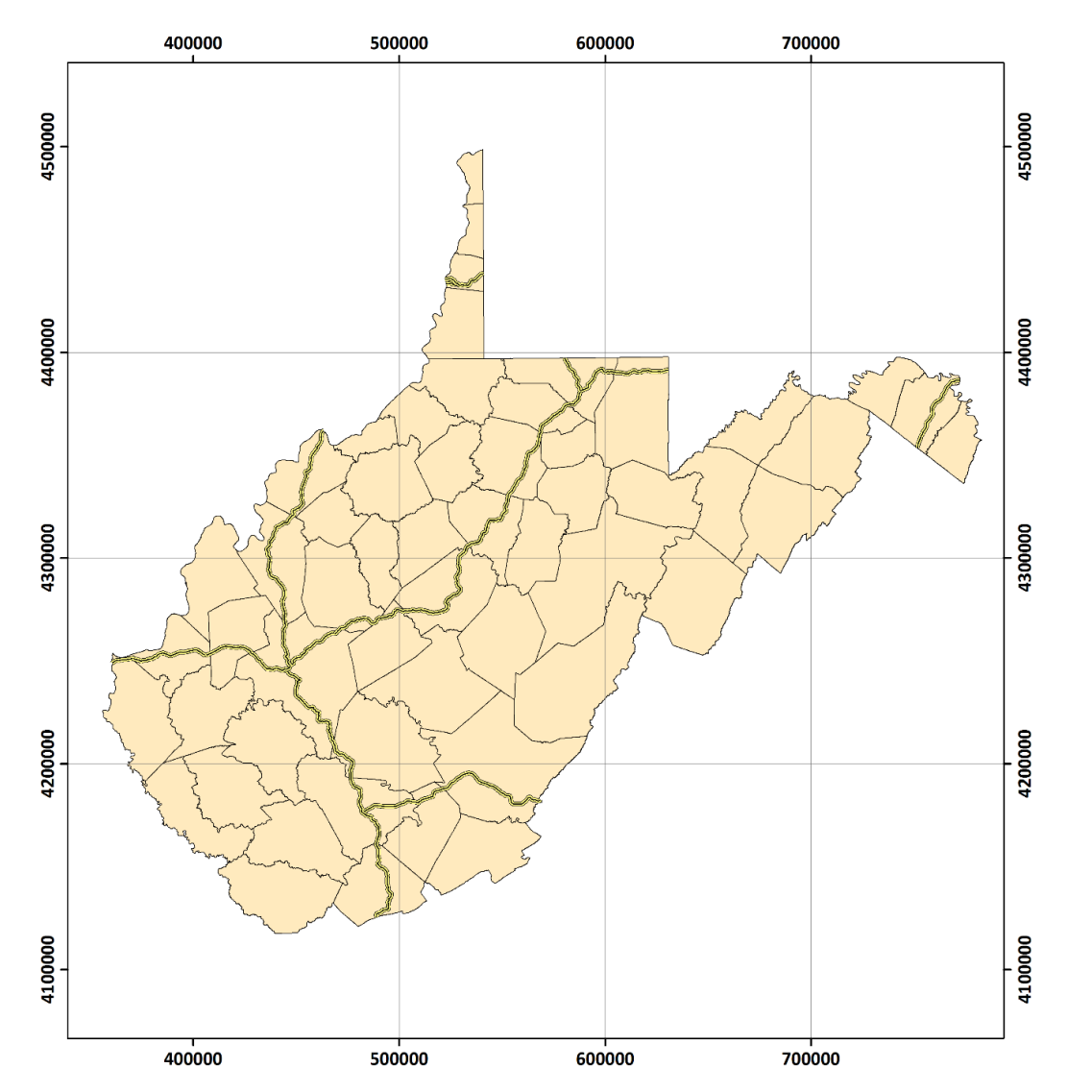


1. Make sure it fits within the visual hierarchy of your map
2. It should not be too big
3. The size and position should be consciously determined
4. You can use ArcGIS north arrows or create your own
5. North may not always be up
6. Is a north arrow always required?

Graticules

130°W
120°W
110°W
100°W
90°W
80°W
70°W
50°N
40°N
30°N
20°N
UNITED STATES
Gulf of Mexico
Content may not reflect National Geographic's current map policy. Sources: National Geographic, Esri, DeLorme, HERE, UNEP-WCMC, USGS, NASA, ESA, METI, NRCAN, GEBCO, NOAA, increment P Corp.

Coordinate Grid

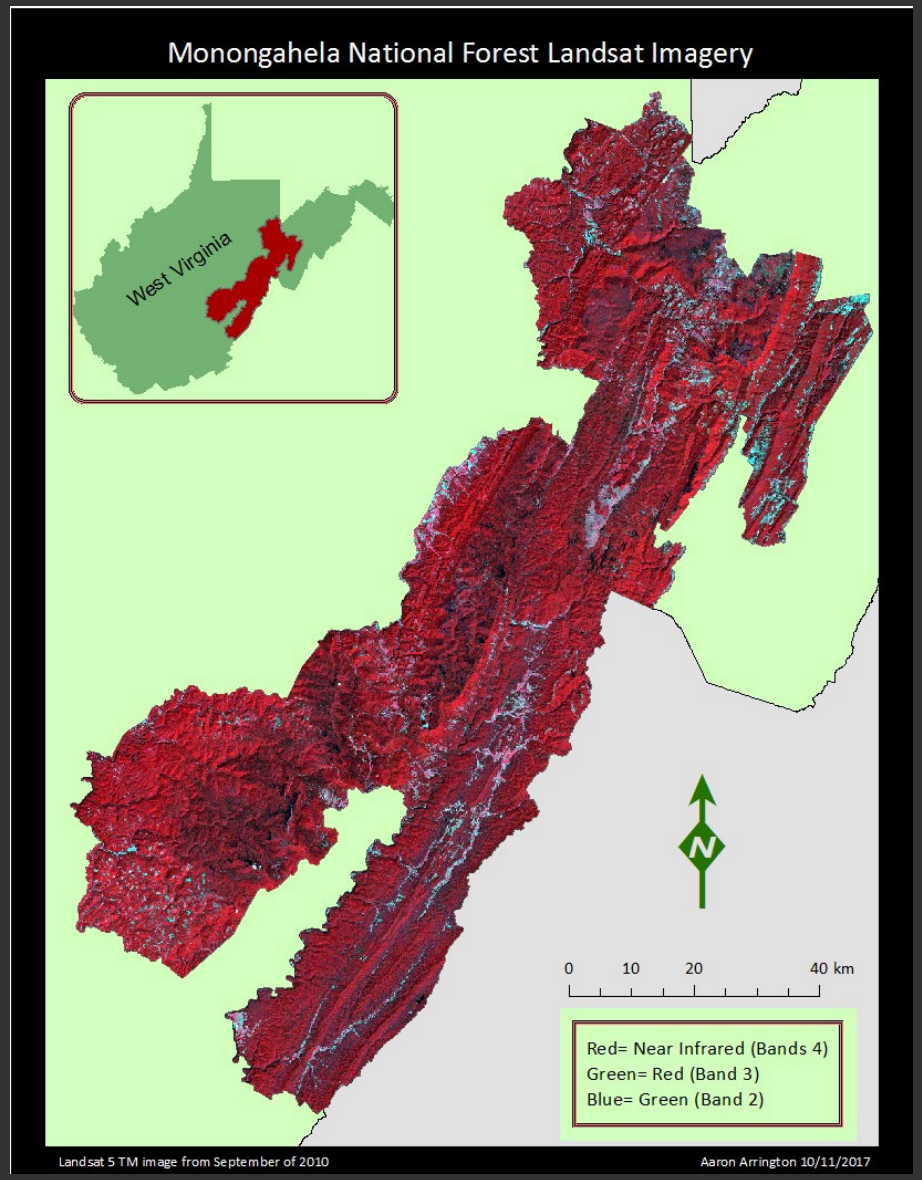


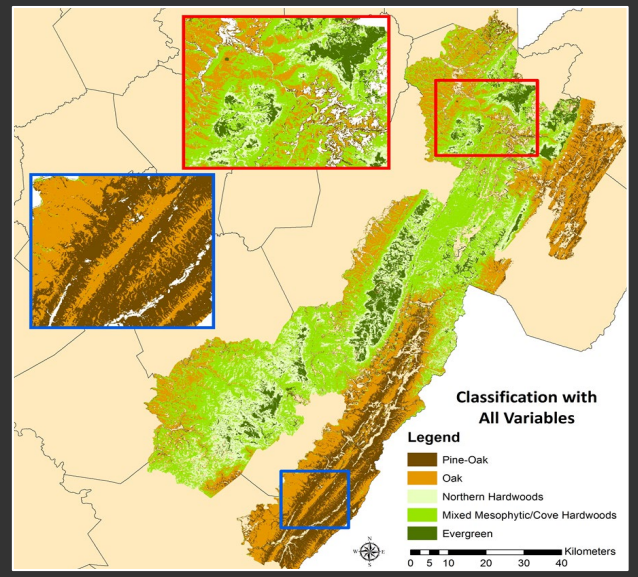
Reference Grid

Legend Tips

1. You do not need to include all information
2. Often can leave out base map data
3. Never have file names in the legend
4. Never label the legend as “legend”
5. Make sure units are clear
6. Place elements in a logical order
7. Use the same font as other map elements
8. Should fit within the visual hierarchy of your map
9. Think about the size and positioning of your legend
10. Legends can be converted to graphics
11. Legend elements can be ungrouped
12. Legends can be edited in graphics software
13. Legends can have frames, backgrounds, and specified gaps

Inset Maps



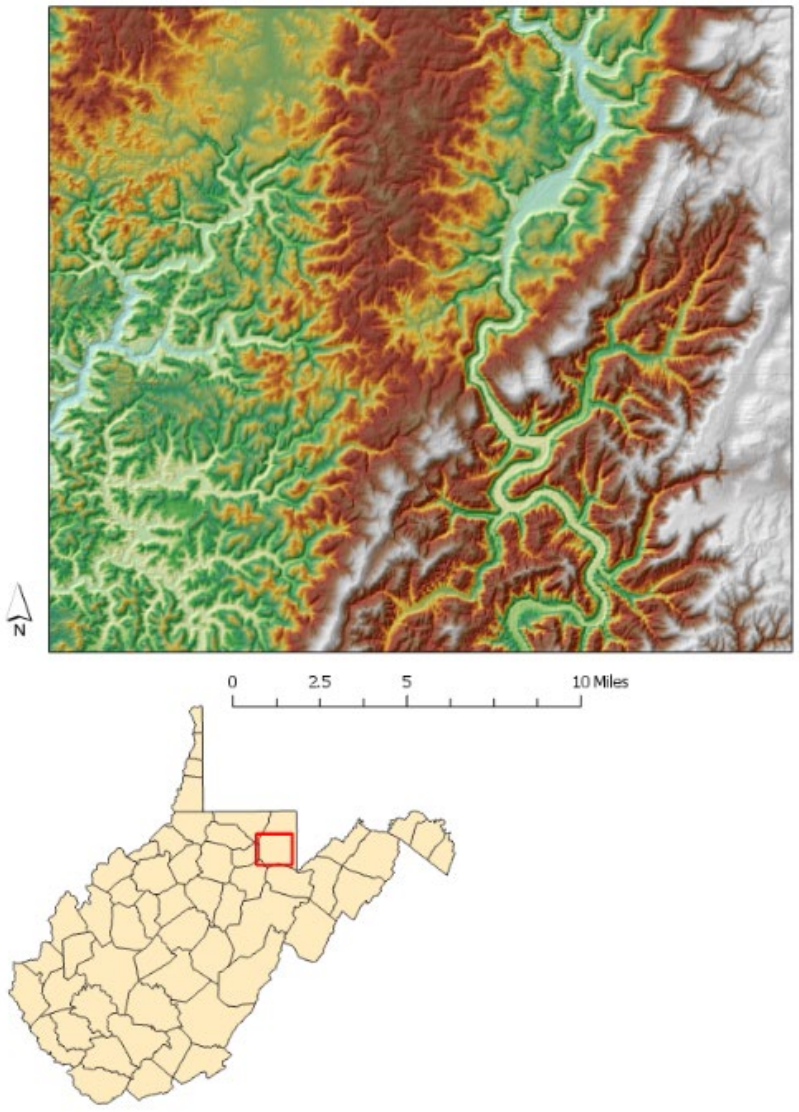


Map by Aaron Arrington

Map by Adam Sharp

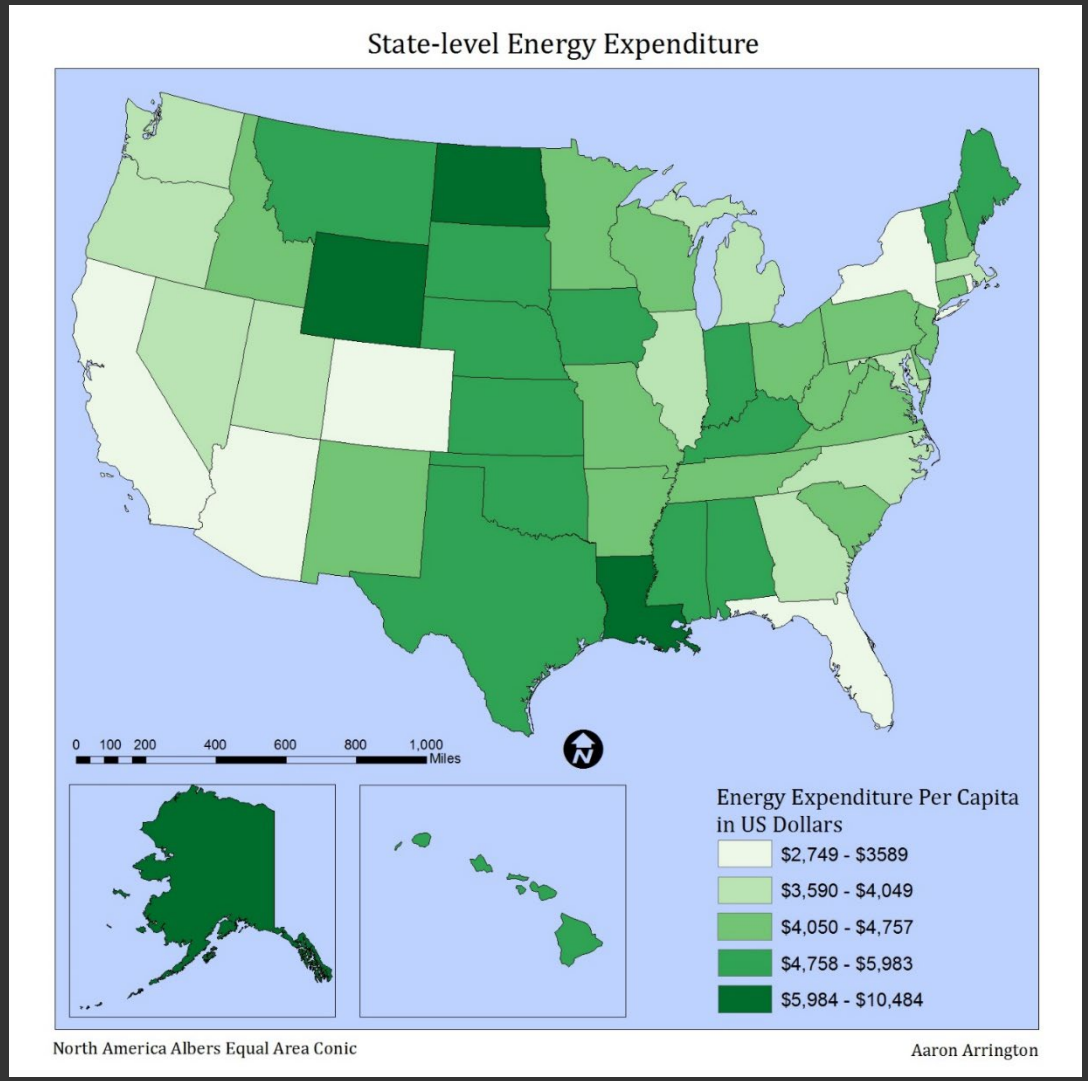
- Locator
- Enlarge important areas
- Show related topics
- Show different areas

Extent Indicators



- Show the extent of one map on another map

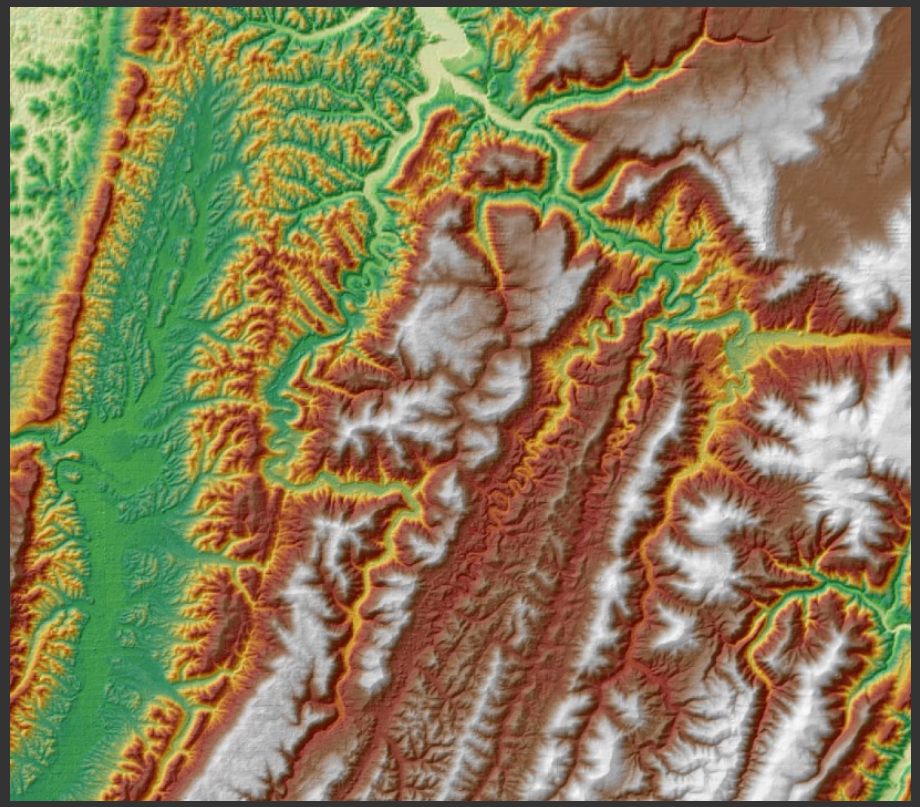
Frames and Neatlines



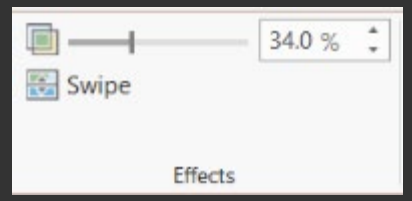
- Divide space
- May be useful for providing visual hierarchy

Map by Aaron Arrington

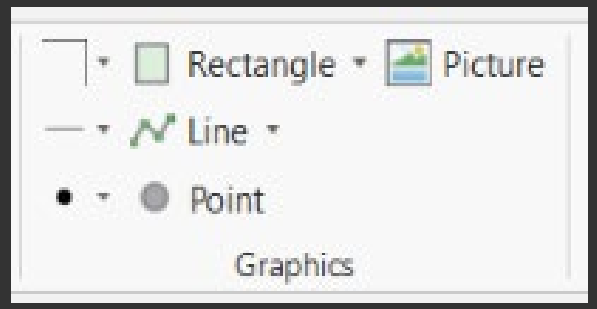
Transparency



- Transparency can be effective in overlay



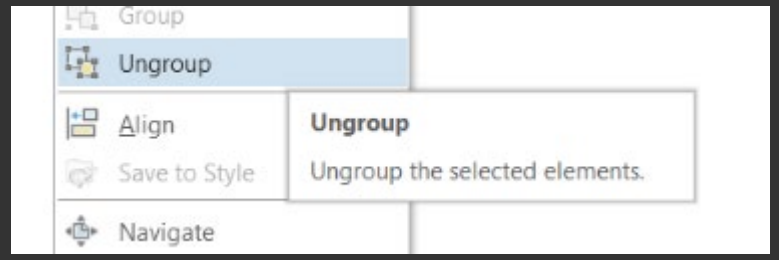
Insert Graphics

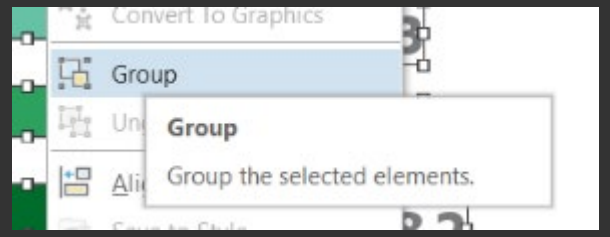


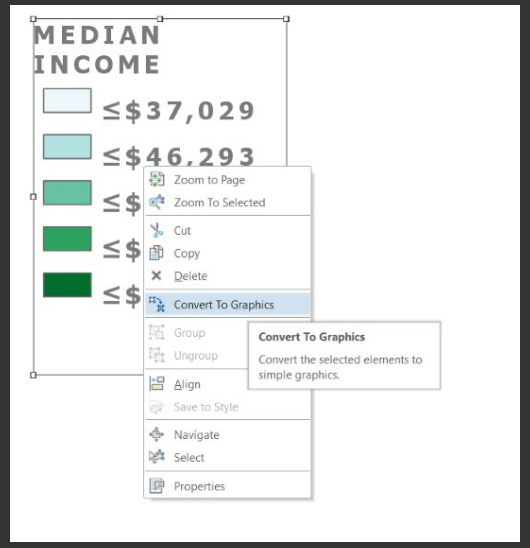
- Make sure graphics are of adequate quality
- Make sure you have permission to use the graphic

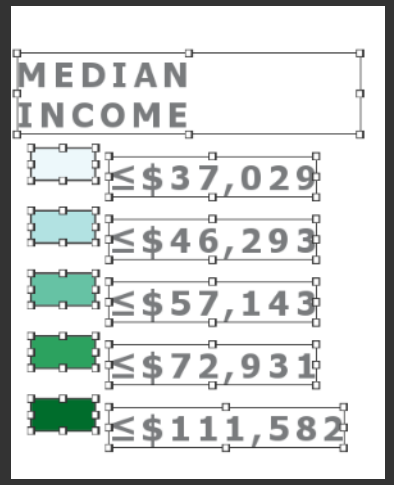
Convert to Graphic/Group/Ungroup

- Can convert map element to graphics for further editing
- Can group and ungroup map elements









Legend Classification

Non-Spatial Data in GIS

Attributes = non-spatial characteristics associated with spatial data

Categorical

- Nominal = A unique identifier or unique types
- Ordinal = Ranked data

Numeric

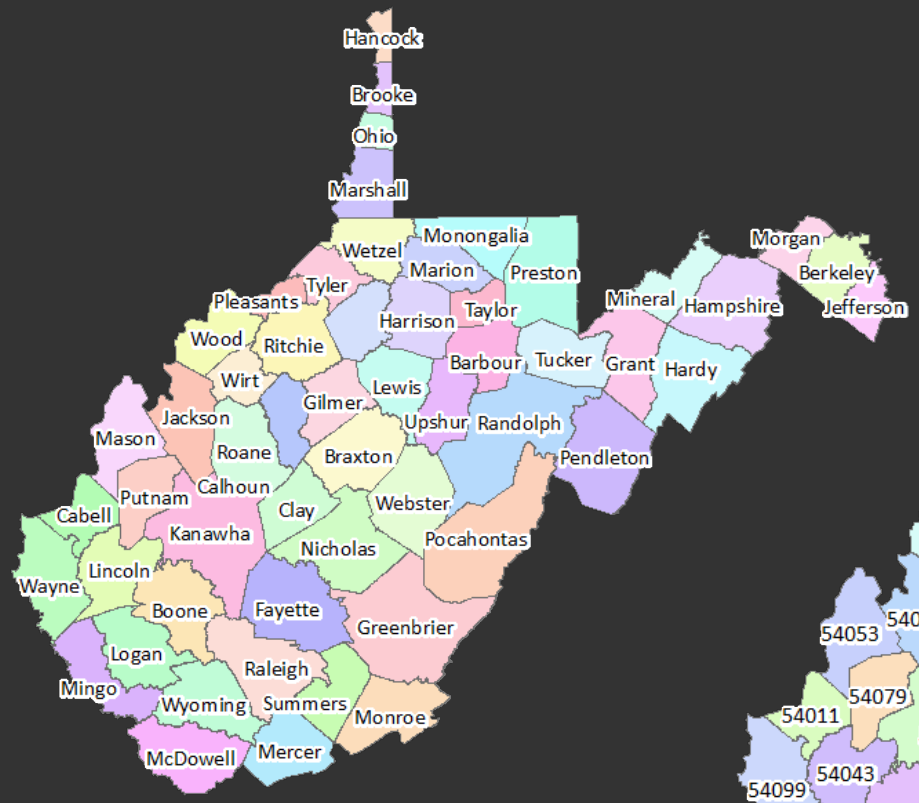
- Interval = Difference between numbers is significant, but no fixed, non-arbitrary zero point
- Ratio = Difference between numbers is significant, and there is a fixed, non-arbitrary zero value

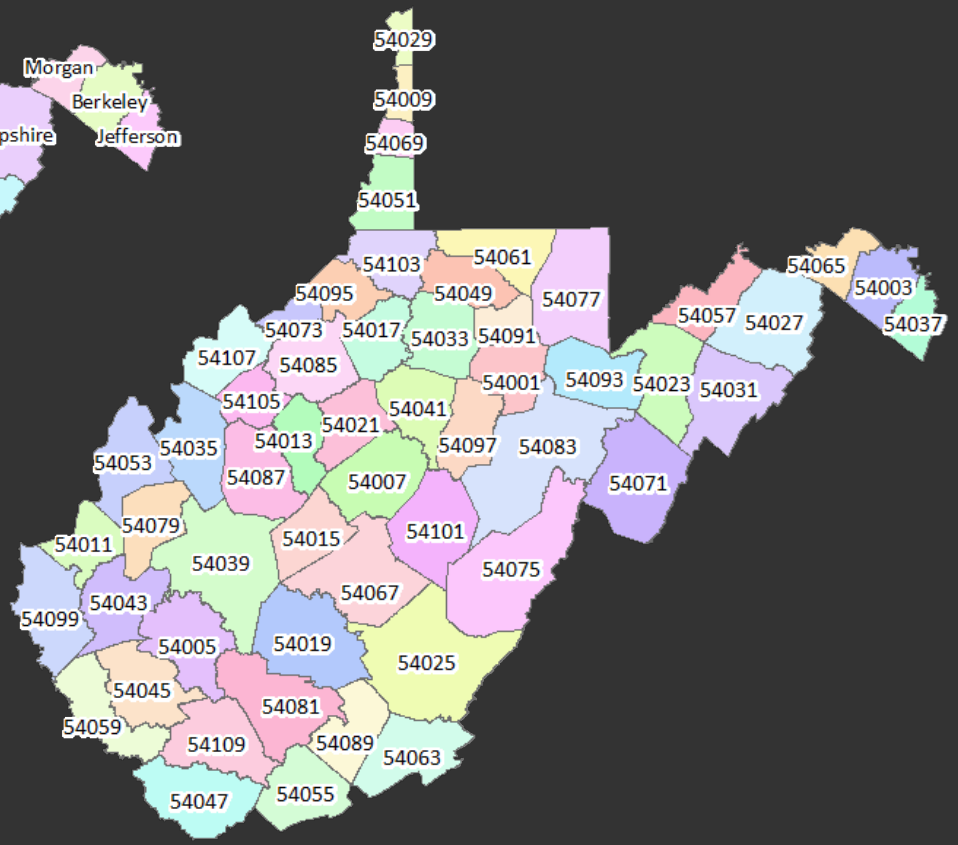
counties_detailed

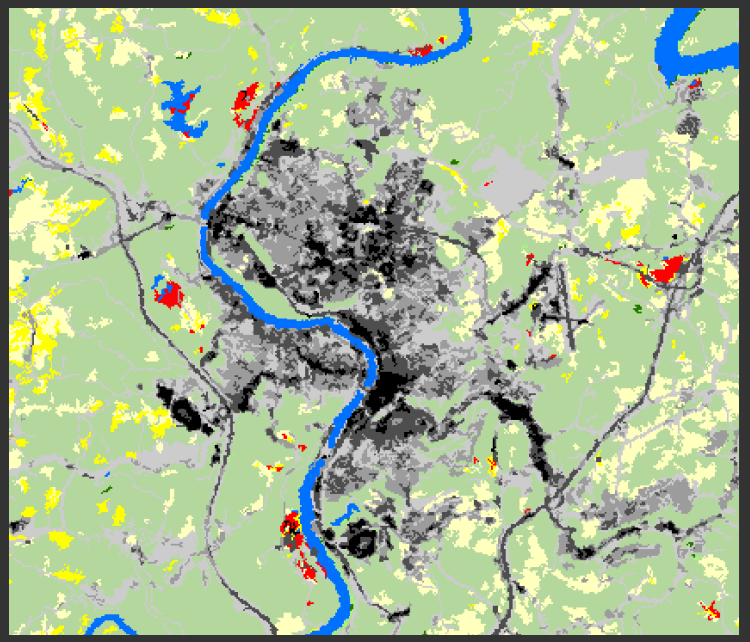
Field: Add Delete Calculate Selection: Zoom To Switch Clear Delete

FID	Shape	AREA	PERIMETER	NAME	STATE	FIPS	STATE_ABBR	SQUARE_MIL	POP2000	POP00SQMIL	MALE2000	FEMALE2000	MA
0	Polygon	281936384.193	69539.619328	Ohio	54	54069	WV	106.176	47427	446.7	22177	25250	
1	Polygon	807157354.71	125167.039523	Marshall	54	54051	WV	306.994	35519	115.7	17288	18231	
2	Polygon	1686168096.7	179373.536795	Preston	54	54077	WV	648.324	29334	45.2	14535	14799	

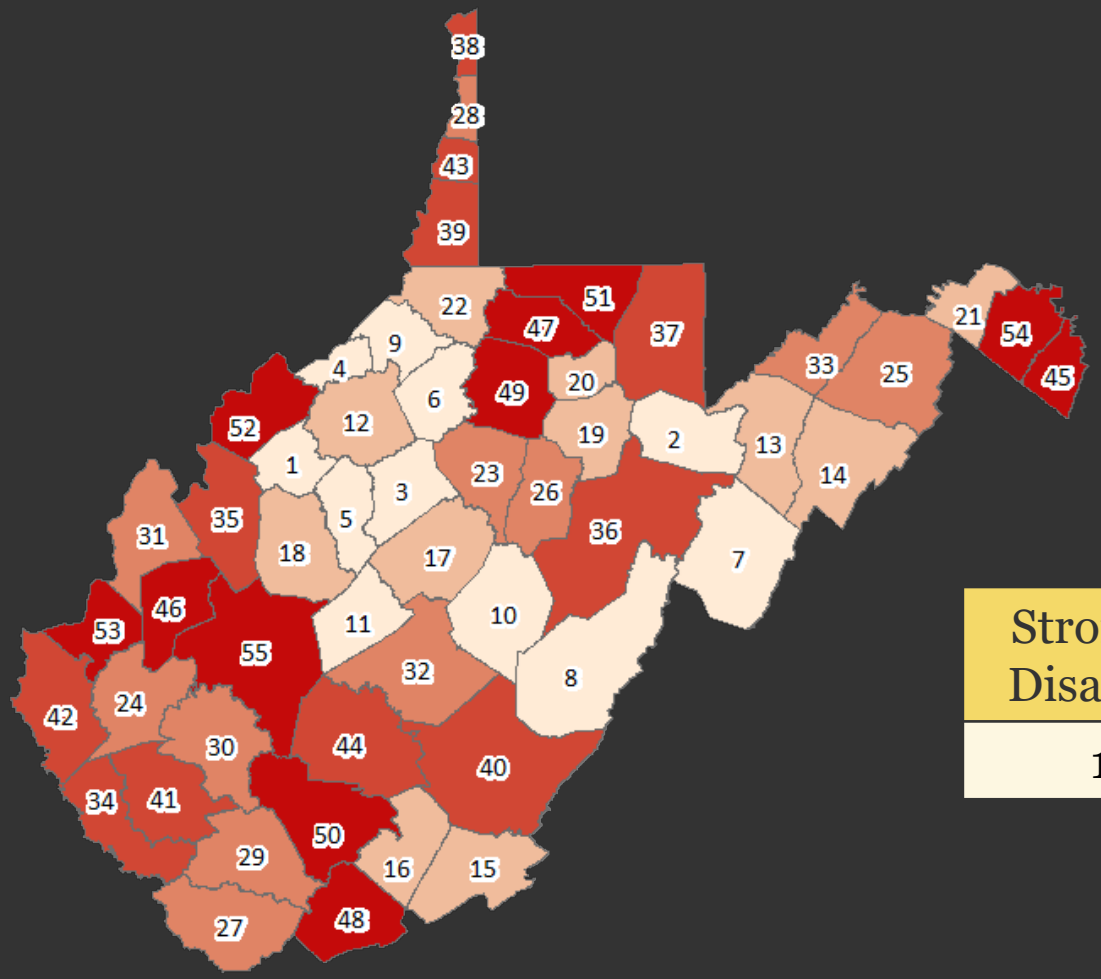
Nominal Data







Ordinal Data



Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

Interval Data

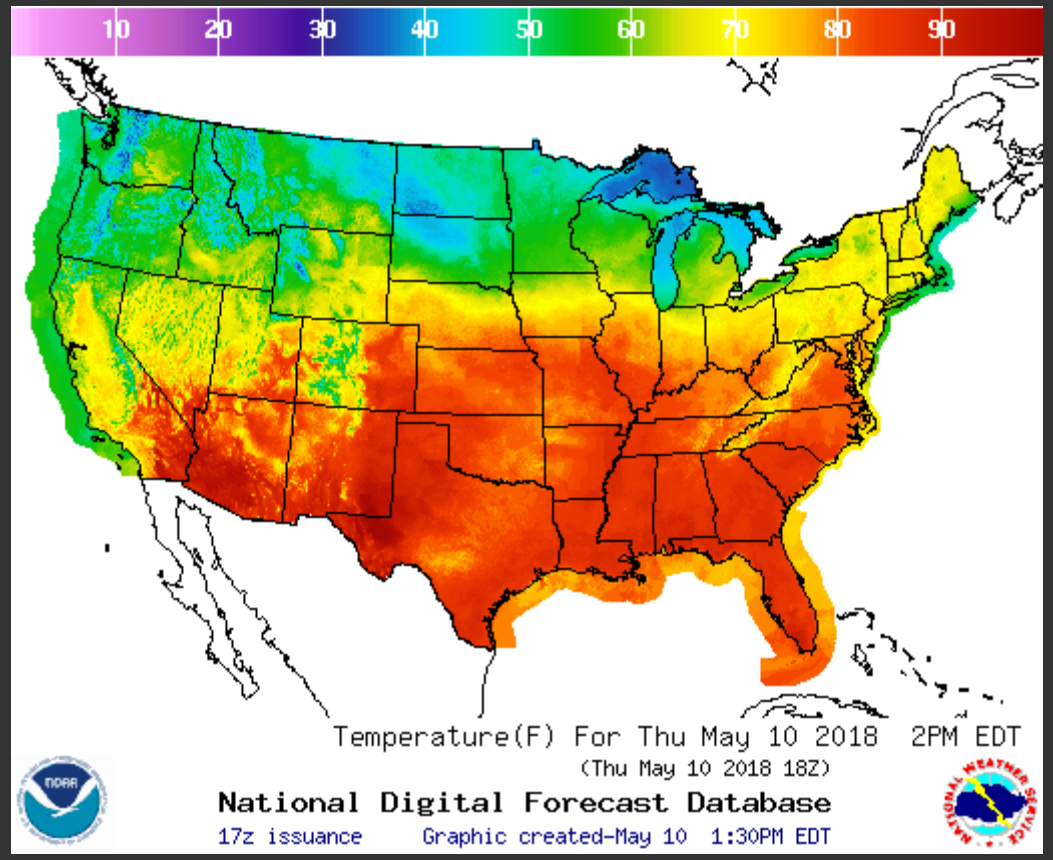
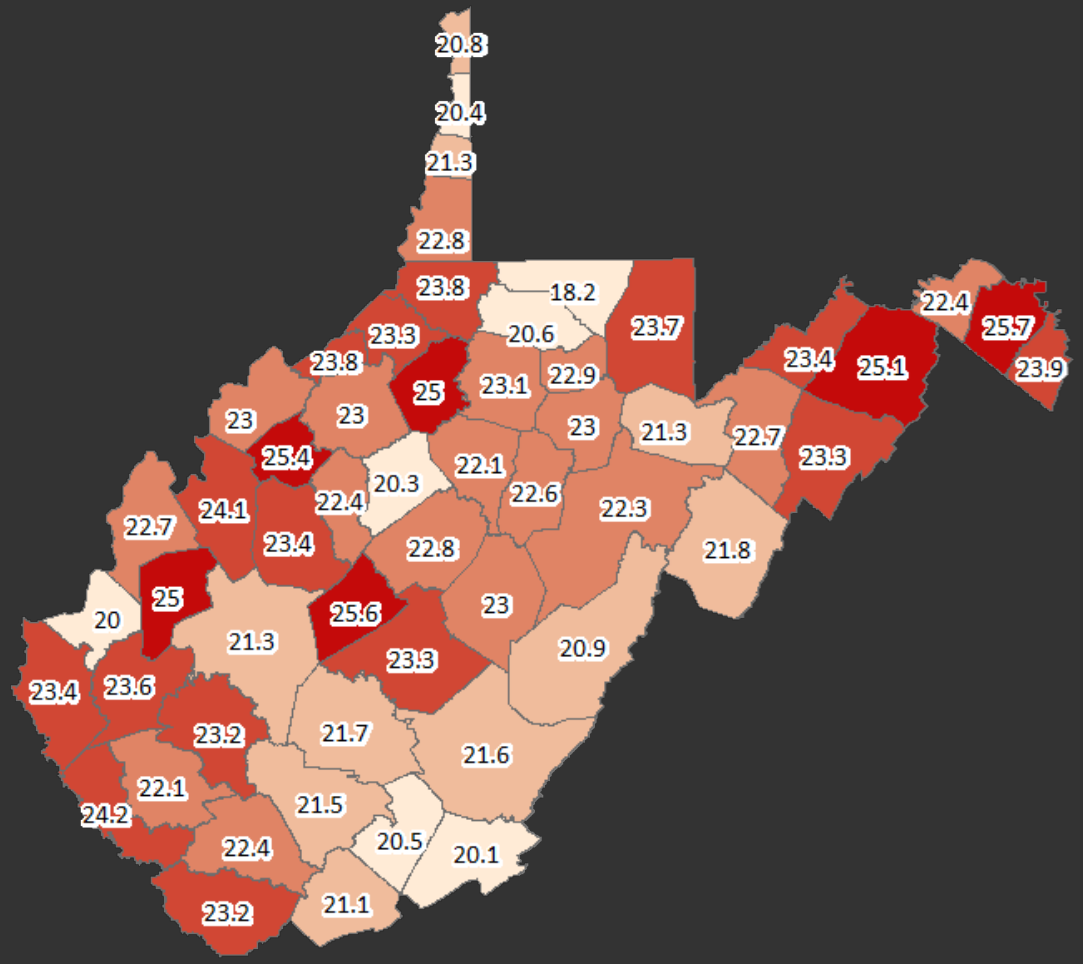
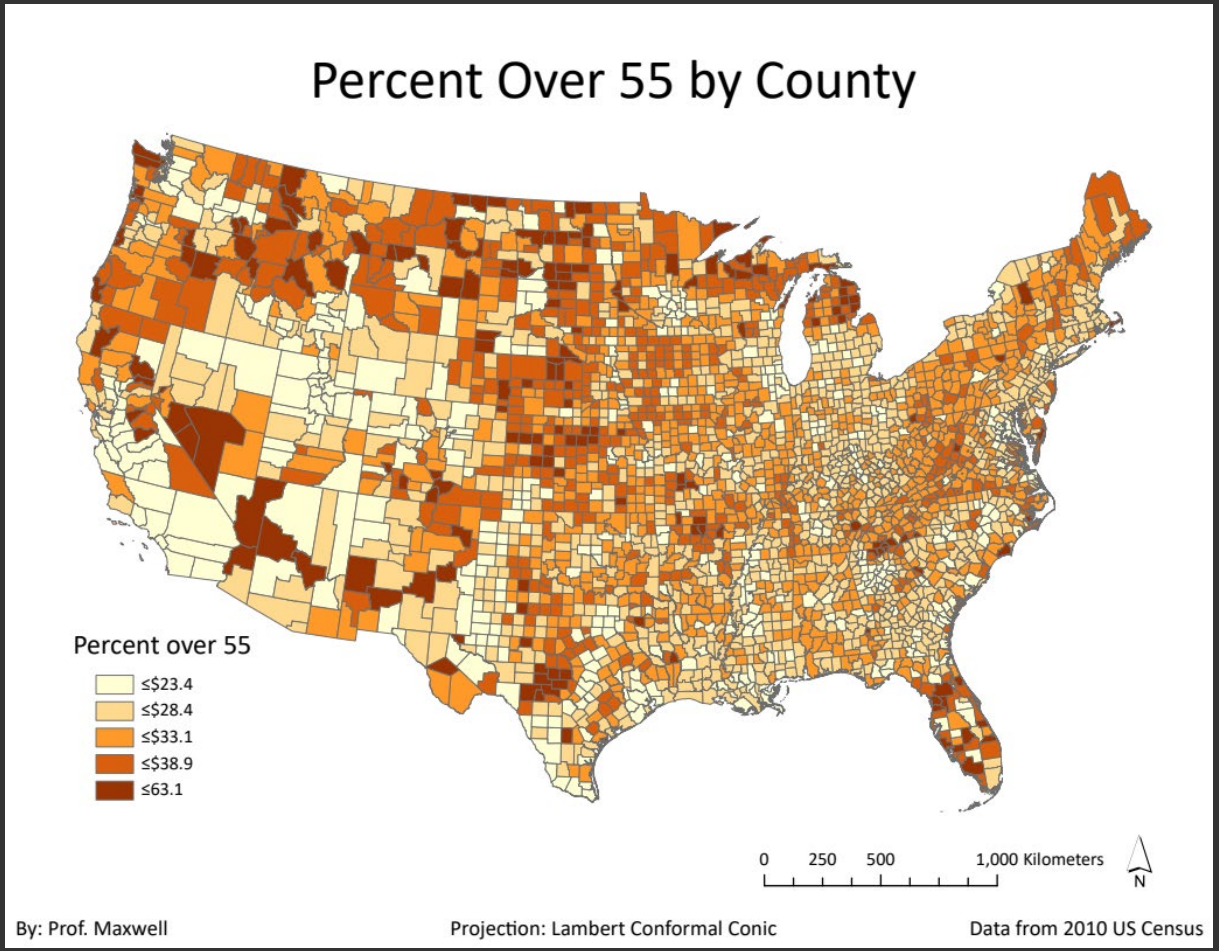


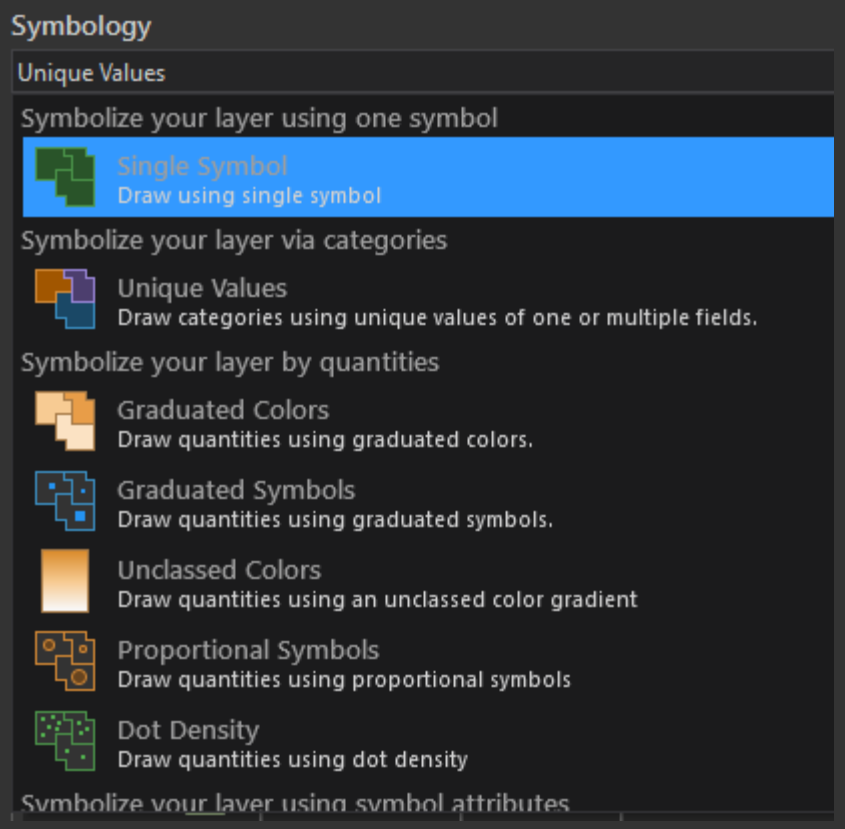
Image from the National Weather Service

Ratio Data


20.8
20.4
21.3
22.8
23.8
18.2
23.7
22.4
25.7
23.9
23.3
20.6
23.8
25
23.1
22.9
23.4
25.1
23
23
23
21.3
22.7
23.3
25.4
22.1
20.3
22.4
22.6
22.3
24.1
22.7
23.4
22.8
21.8
25
20
25.6
23
21.3
23.3
20.9
23.4
23.6
23.2
21.7
21.6
22.1
24.2
21.5
22.4
20.5
20.1
23.2
21.1

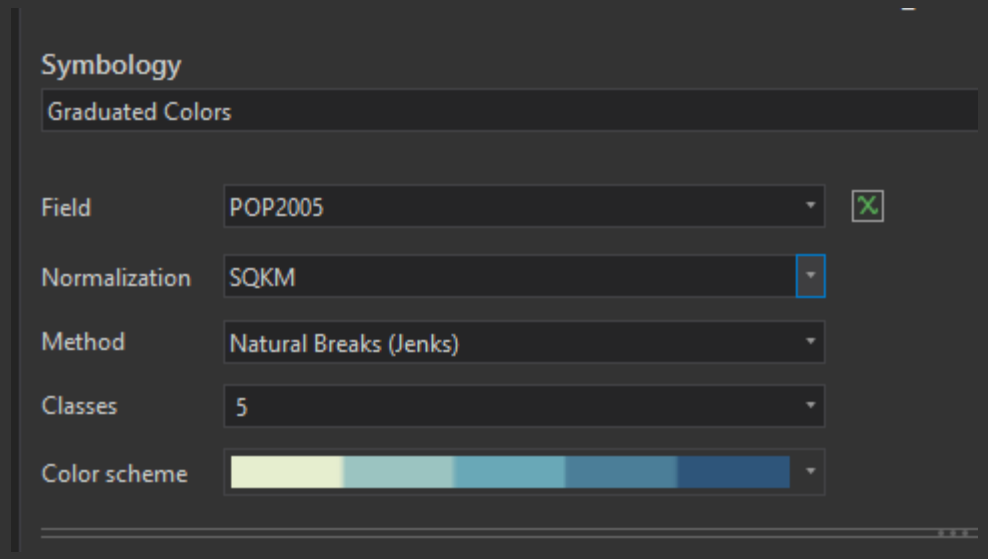

Percent Over 55 by County
Percent over 55
≤$23.4
≤$28.4
≤$33.1
≤$38.9
≤63.1
0 250 500 1,000 Kilometers
N
By: Prof. Maxwell
Projection: Lambert Conformal Conic
Data from 2010 US Census

Layer Symbology in ArcGIS



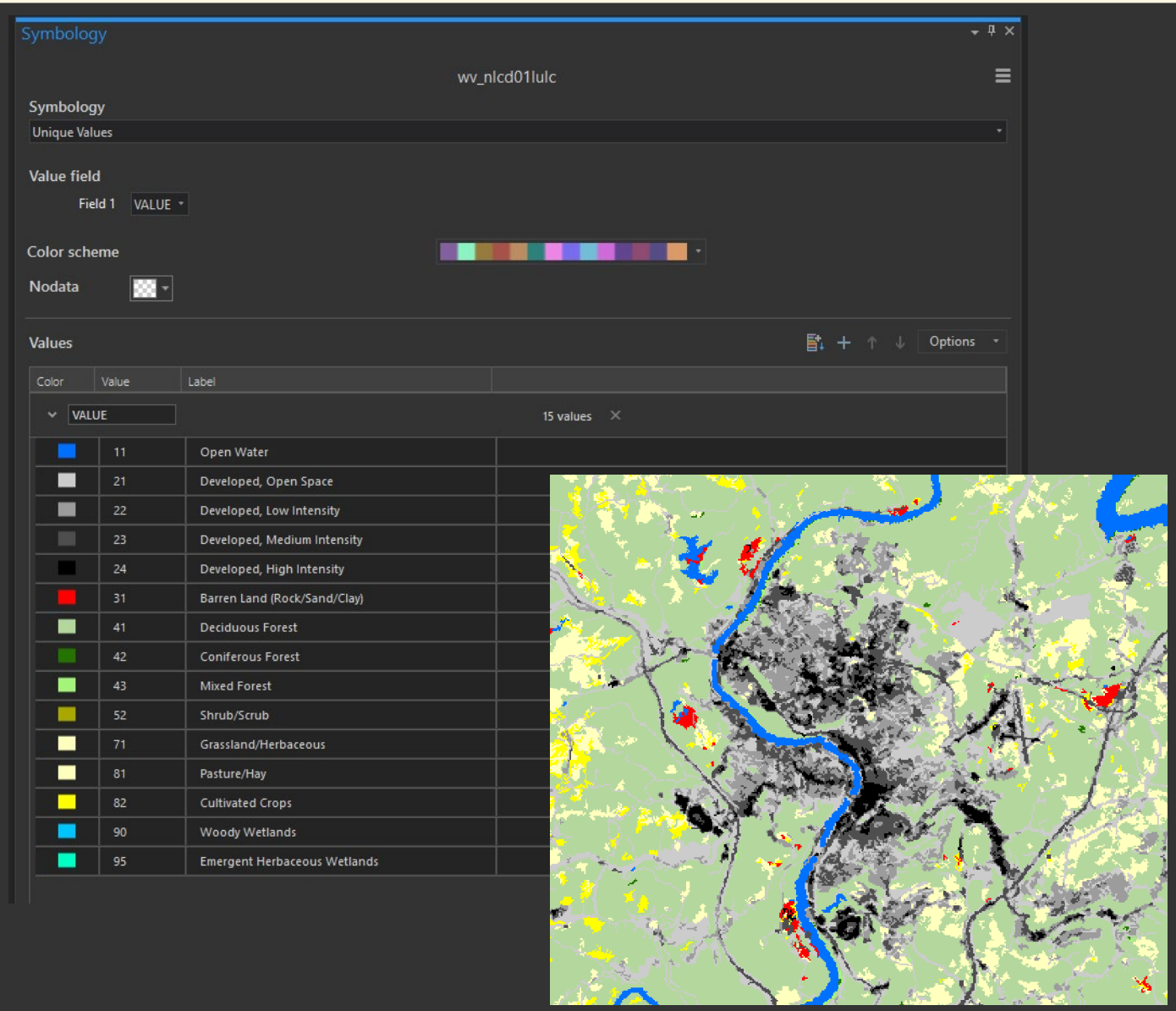
- Same symbol for all features
- Different symbol for each category or unique value
- Graduated colors
- Unclassified colors
- Graduated symbols
- Proportional symbols
- Dot Density

Normalization



- Divide value by another value to normalize the measurements
- For example: population vs. population per square kilometers
- Provides for a fairer comparison
- Should normalize when producing choropleth maps

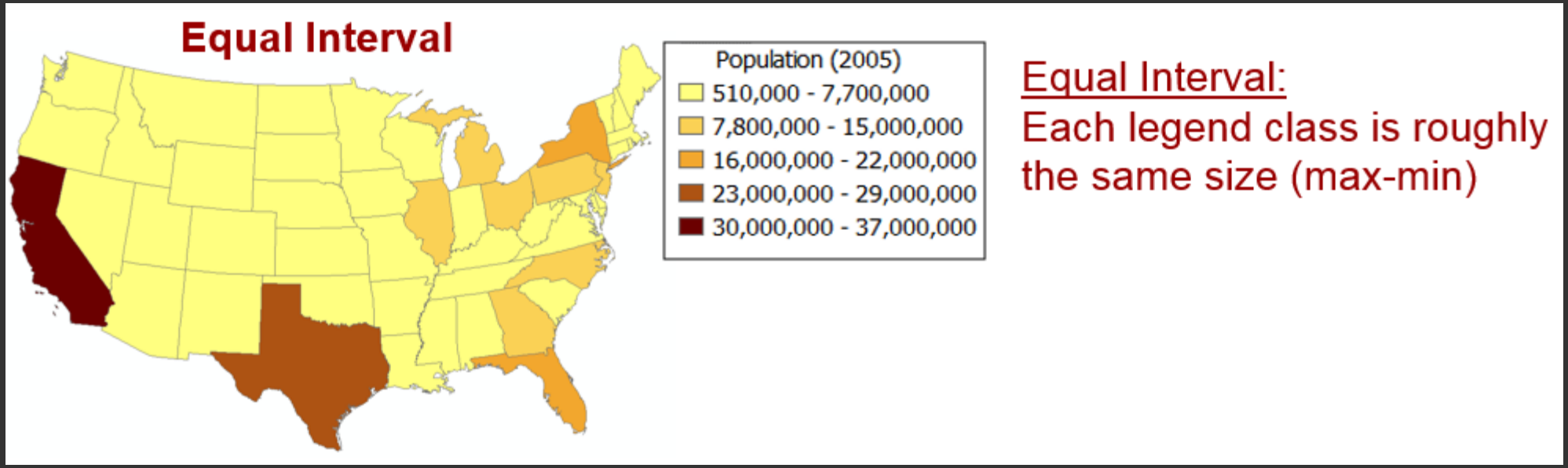
Symbolizing Categories



- Land cover type, private vs. public, urban vs. rural, soil types, etc.
- Use colors that make sense for the category (if appropriate)
- Colors should not be ordered

Equal Interval

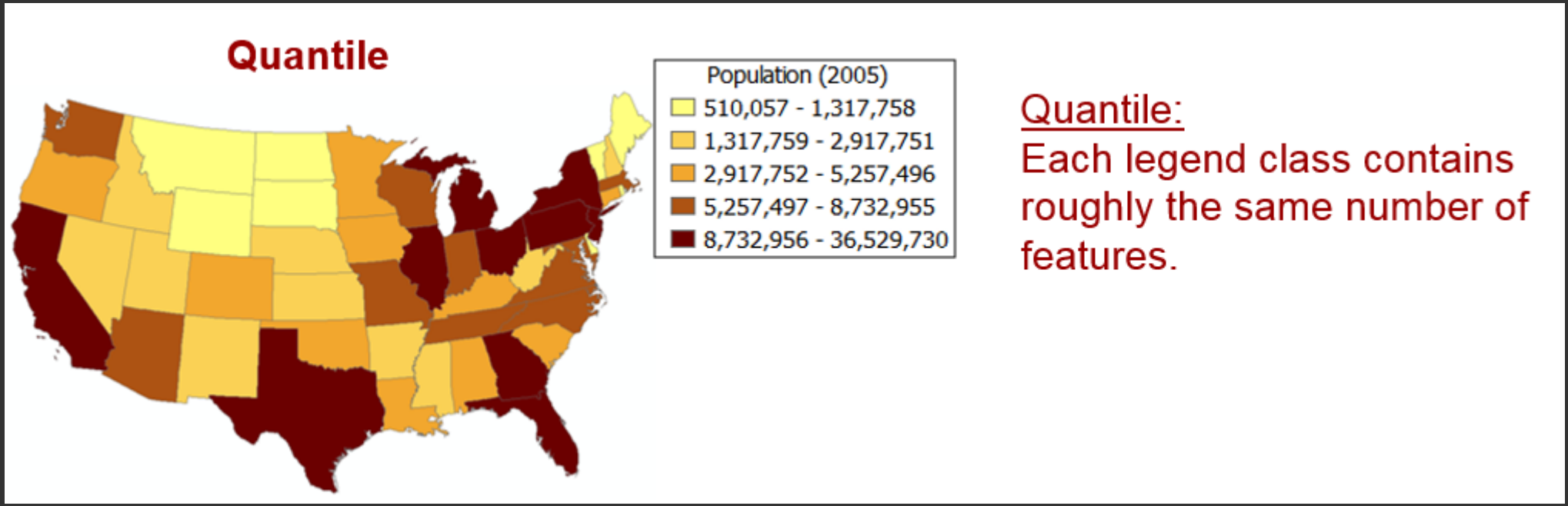
- Breaks data range into equal intervals
- Does not take into account natural breaks in the data



Created by Mike and Jackie Strager

Quantiles

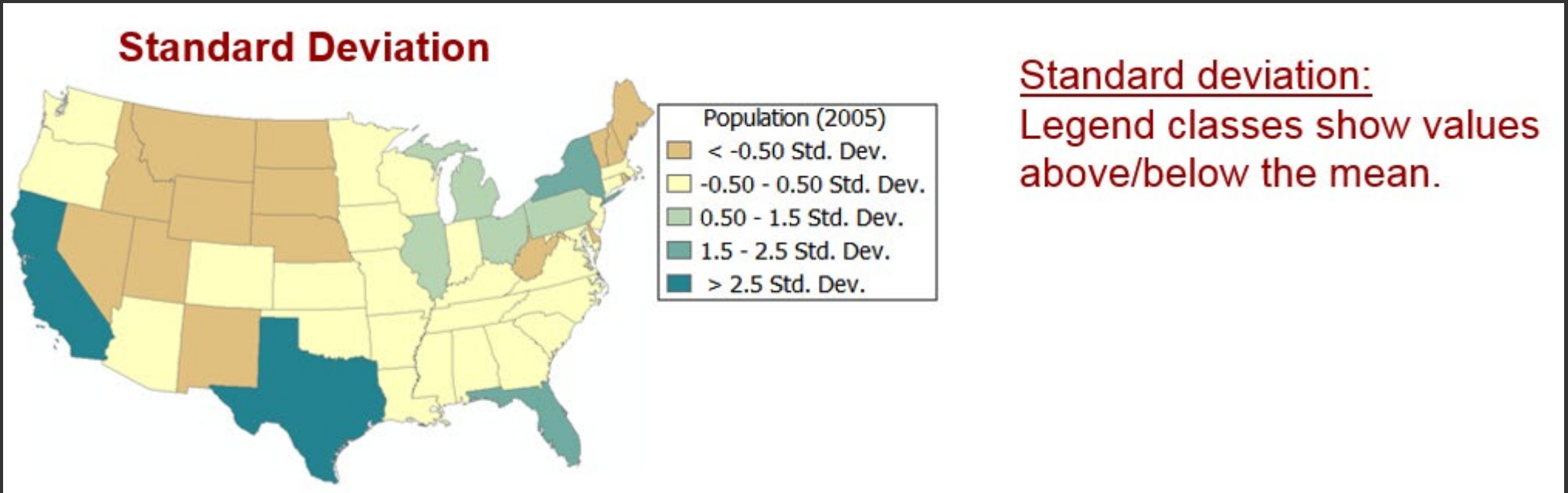
- Same number of features in each bin
- Does not take into account natural breaks in the data



Created by Mike and Jackie Strager

Mean-Standard Deviation

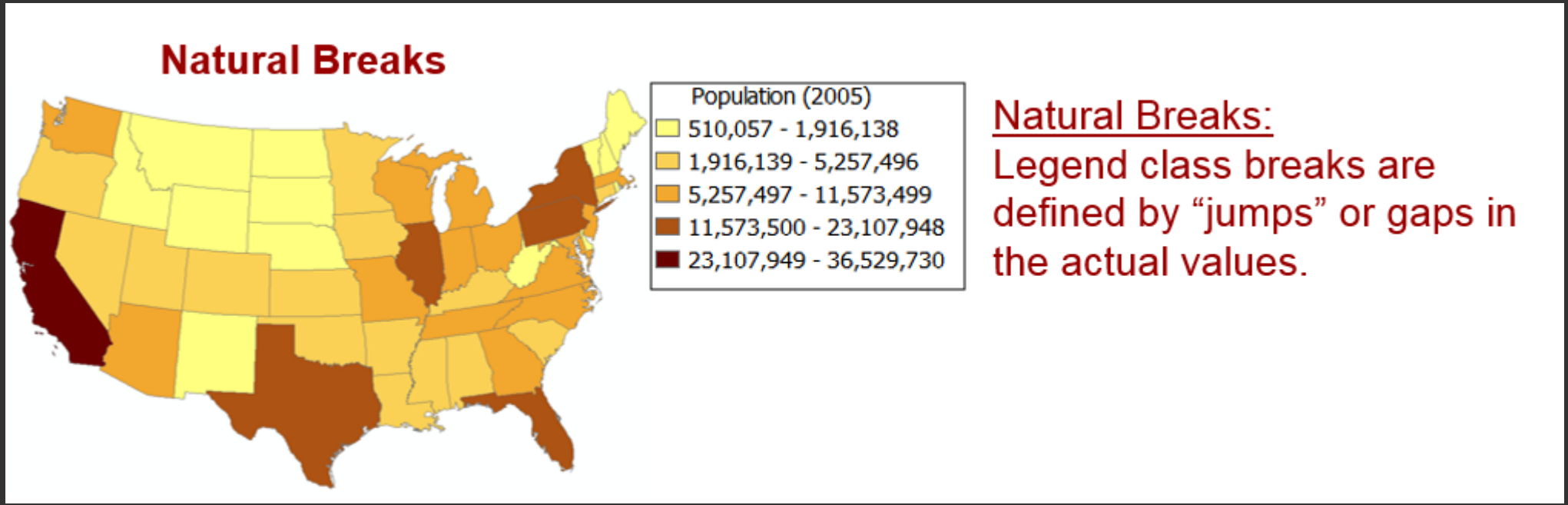
- Bins defined based on standard deviation of data subtracted or added to mean



Created by Mike and Jackie Strager

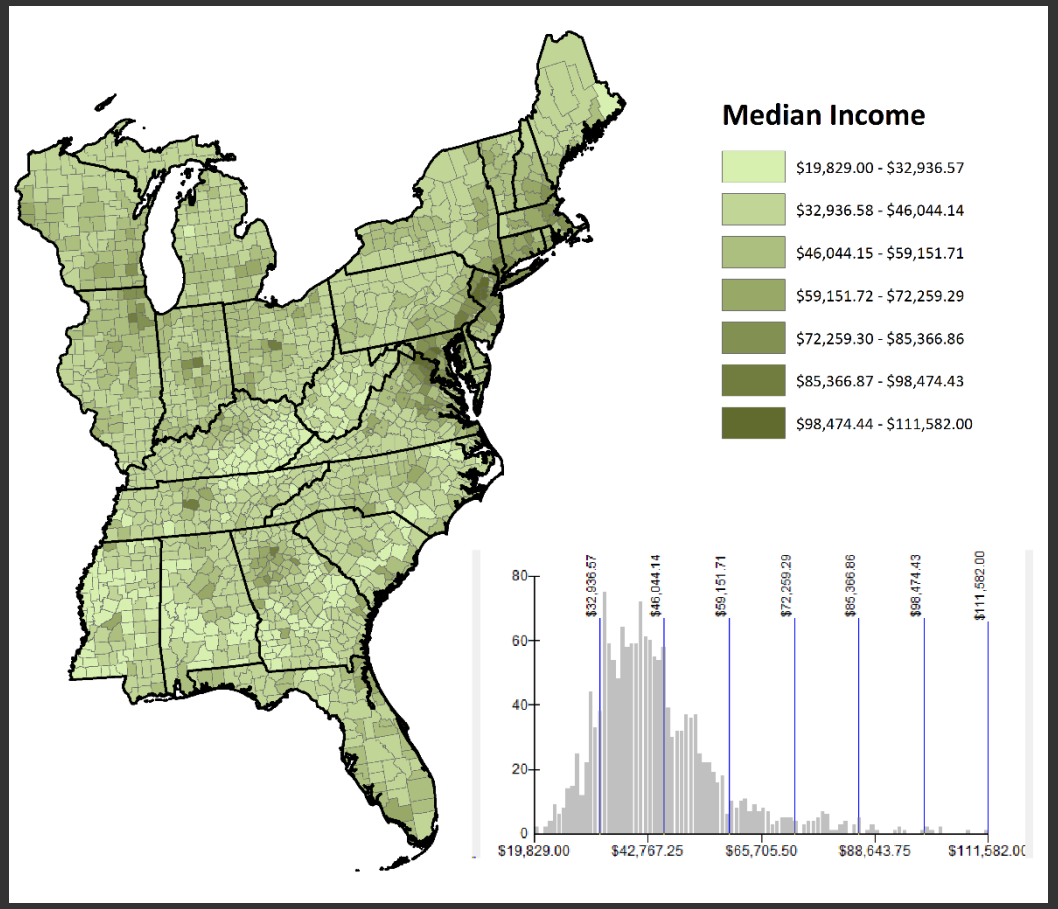
Jenks-Caspell/Fisher-Jenks

- Algorithms that attempts to find “natural breaks” in the data
- ArcGIS uses an implementation of Fisher-Jenks

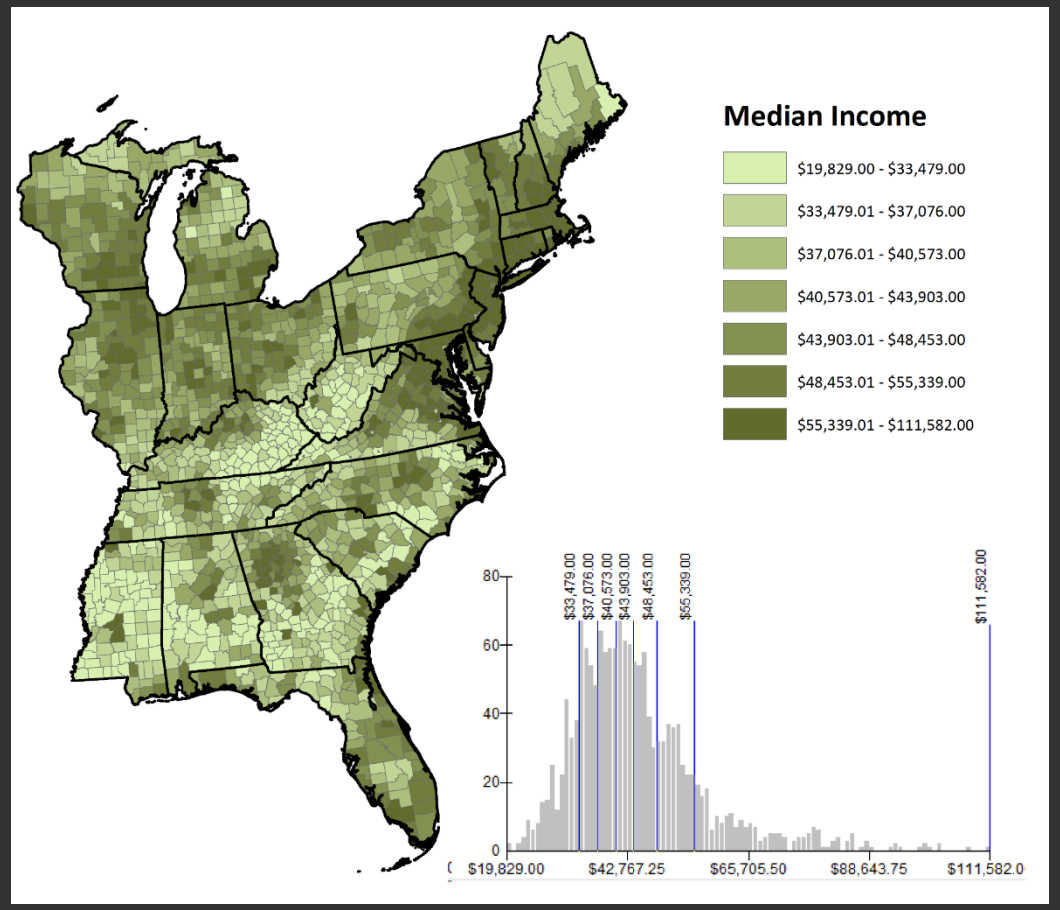


Created by Mike and Jackie Strager

Classification Methods Compared

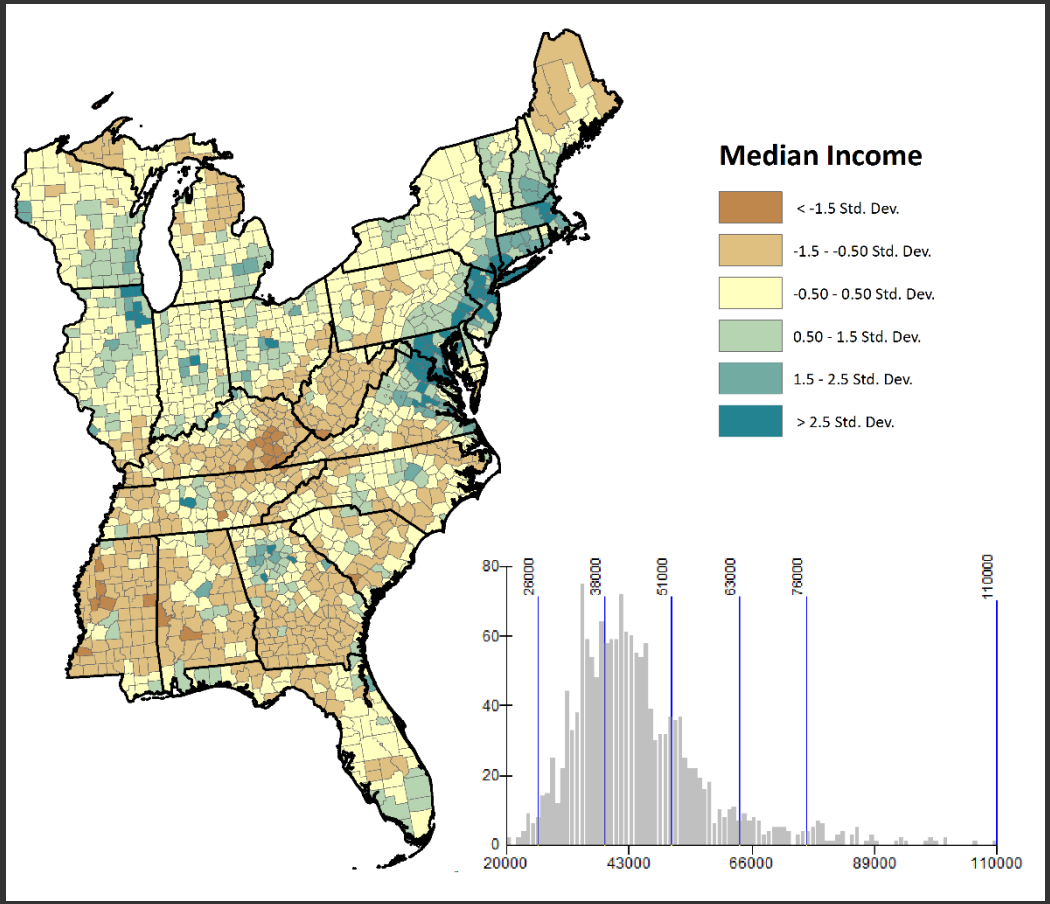


Equal Interval

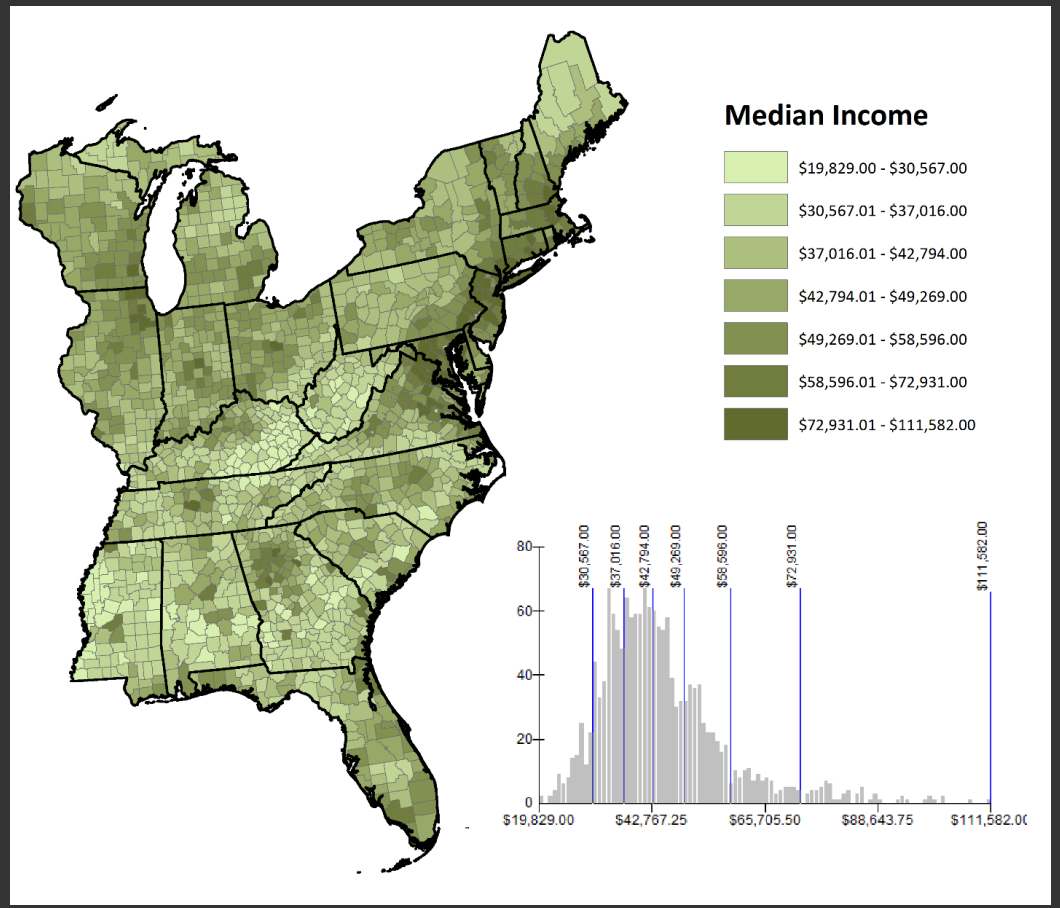


Quantile

Classification Methods Compared

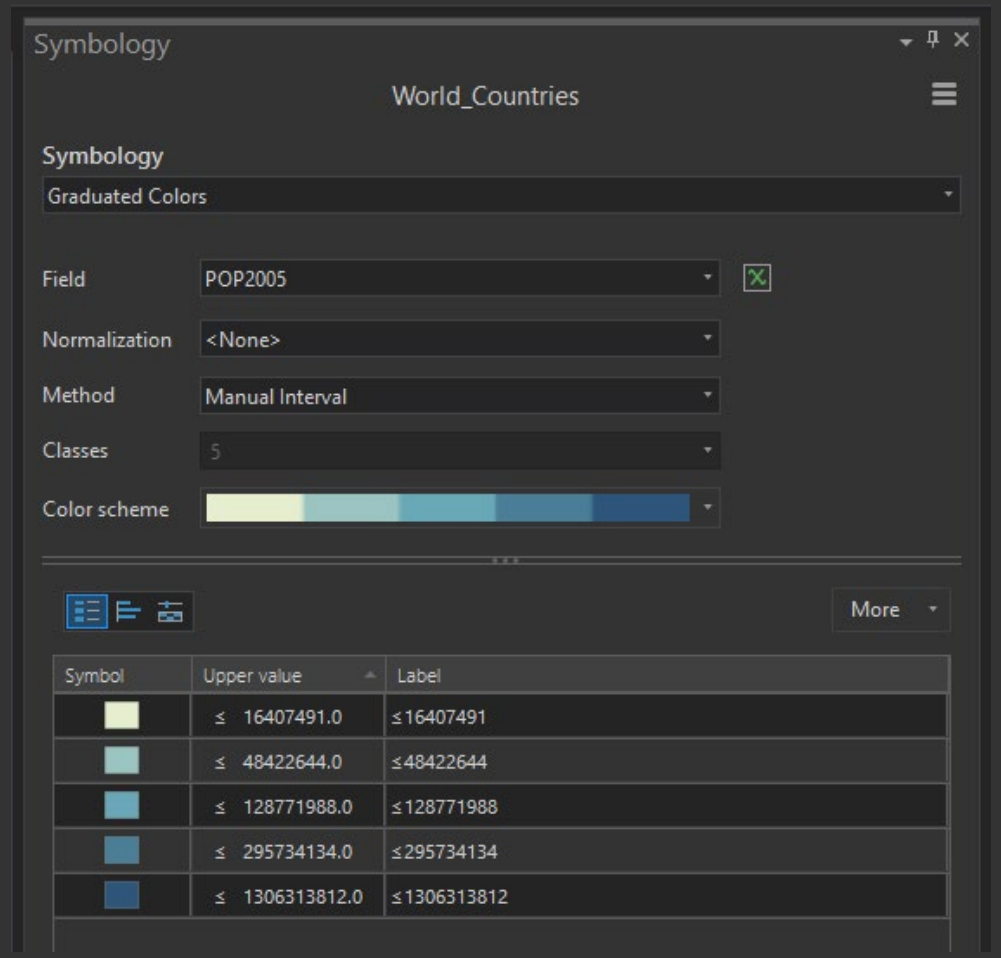


Mean-Standard Deviation



Natural Break

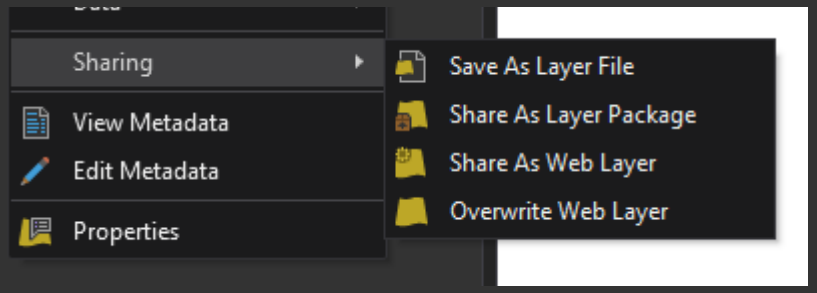
Manual Classification



- Define your own breaks

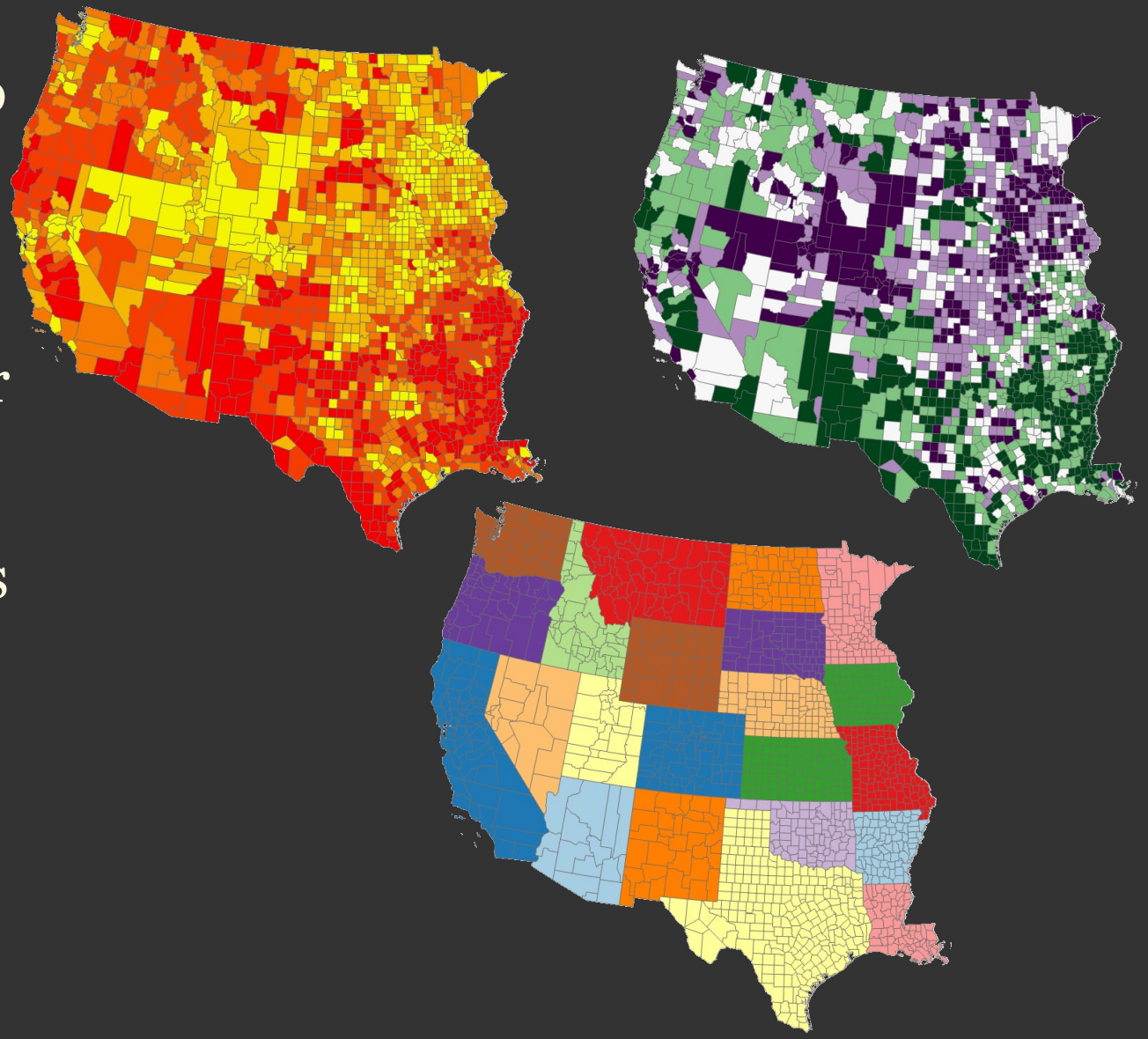
Layer Files (ArcGIS)

- Can be used to save layer symbology for later use

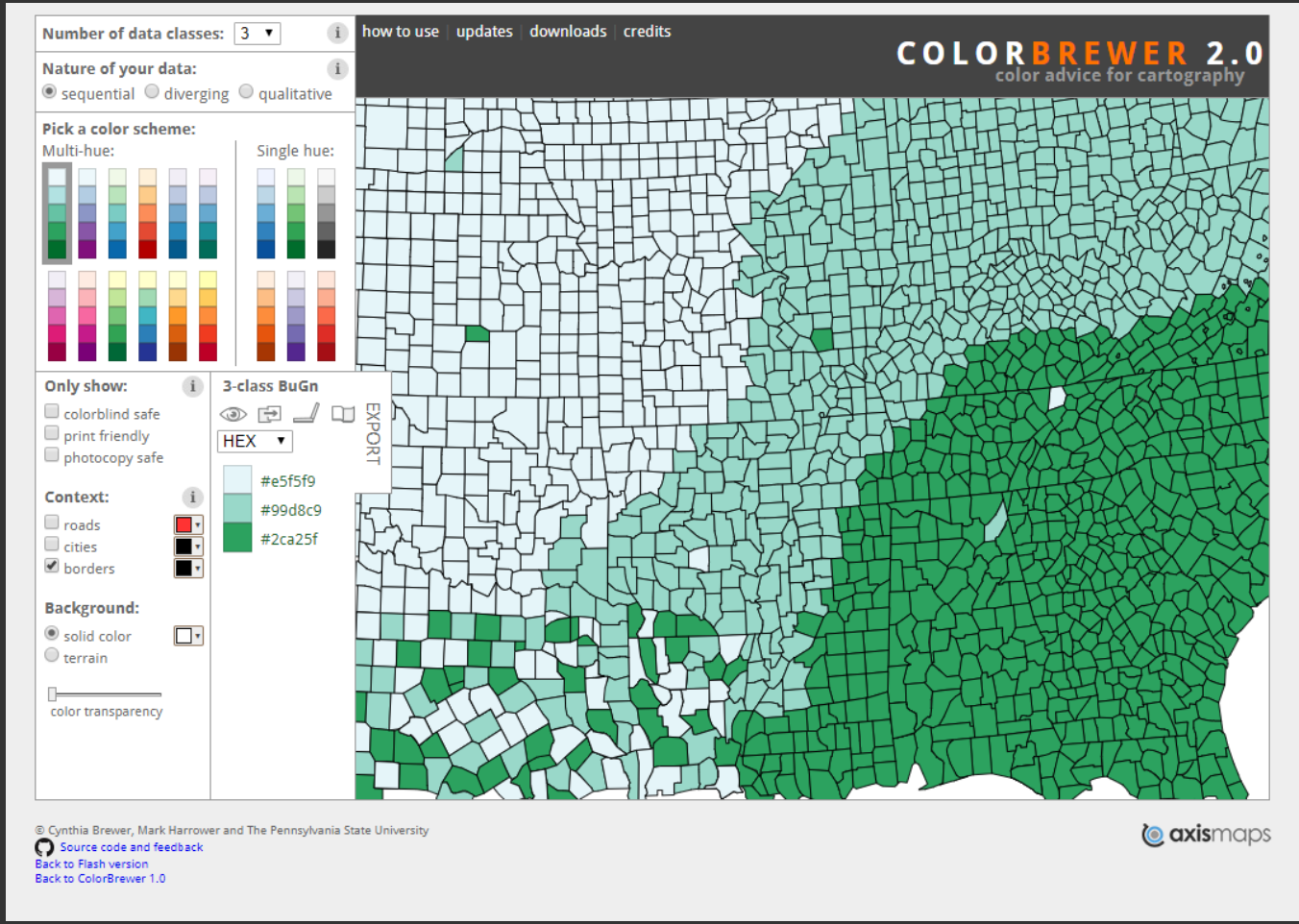


Color Ramp

- You can change the colors used to symbolize your data
- You can also change the number of categories
- Nominal Color Scheme = used for categorical data (not ordered)
- Sequential Color Scheme = used for continuous data that increases in one direction
- Diverging Color Scheme = used for continuous data that diverges
- Think about how we perceive colors



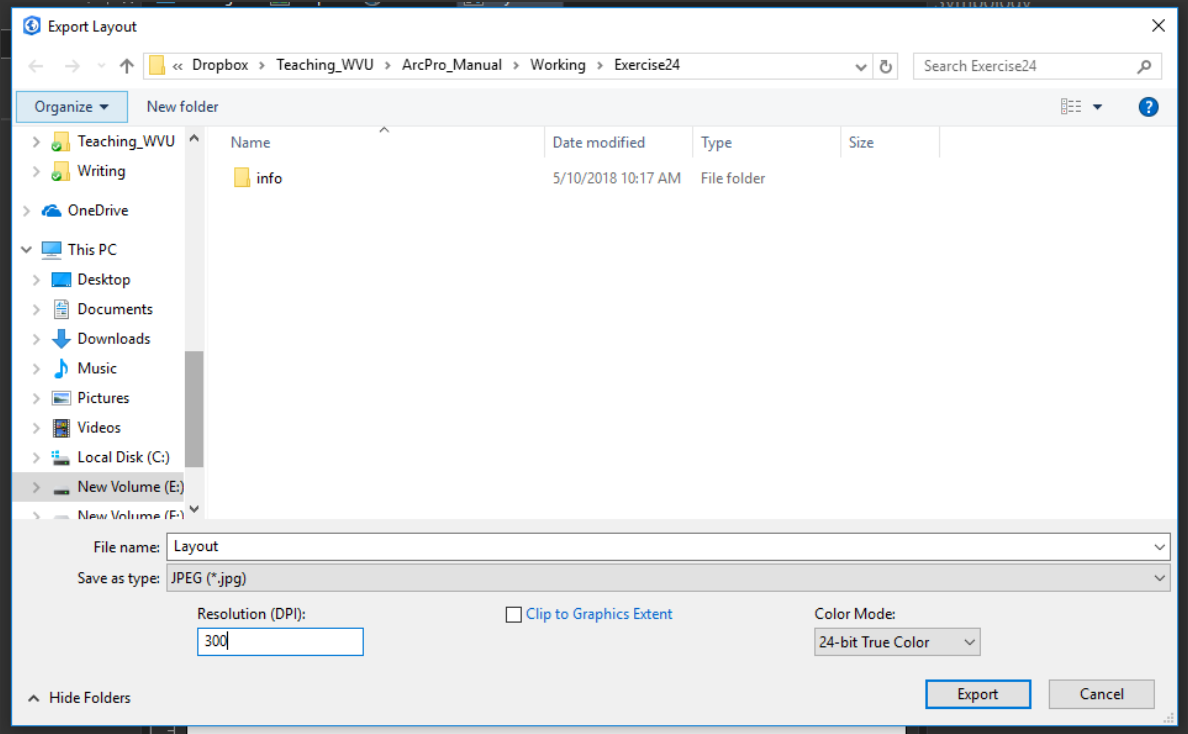
ColorBrewer 2.0



http://colorbrewer2.org/#type=sequential&scheme=BuGn&n=3

Map Export and Sharing

Export Resolution

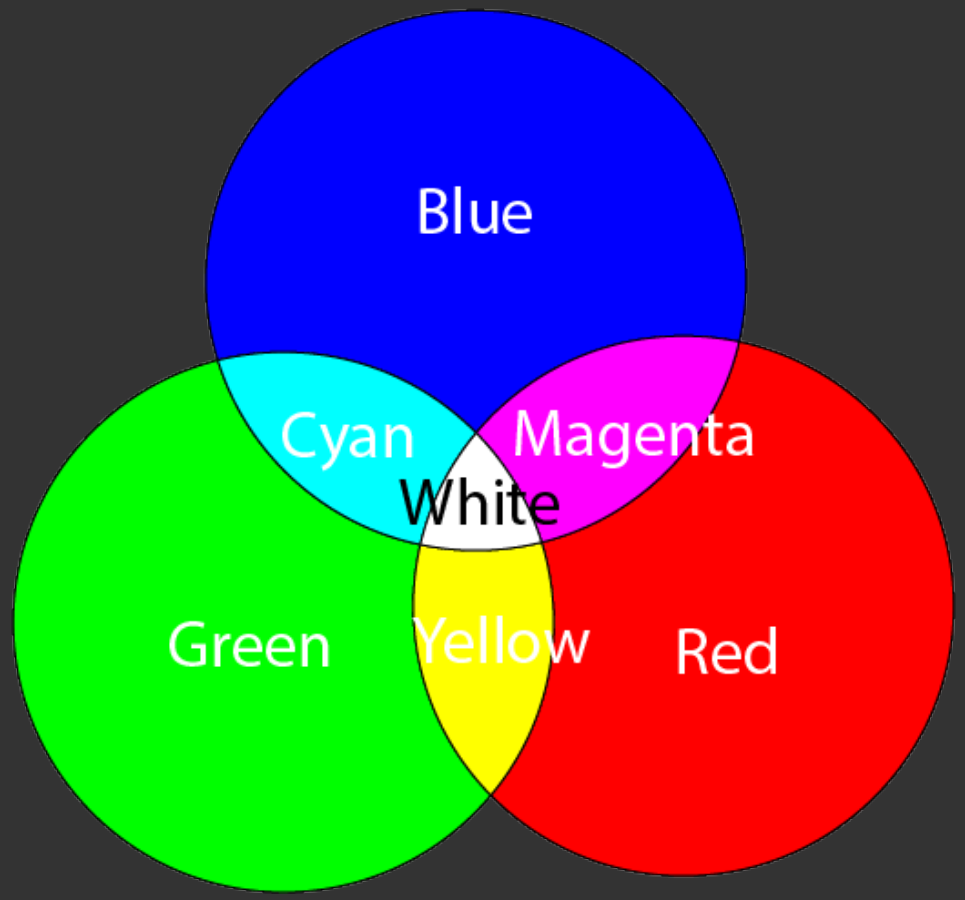


- Measured in dpi (dots per square inch)
- Pixels per square inch for screens
- In this class, 300 dpi is good

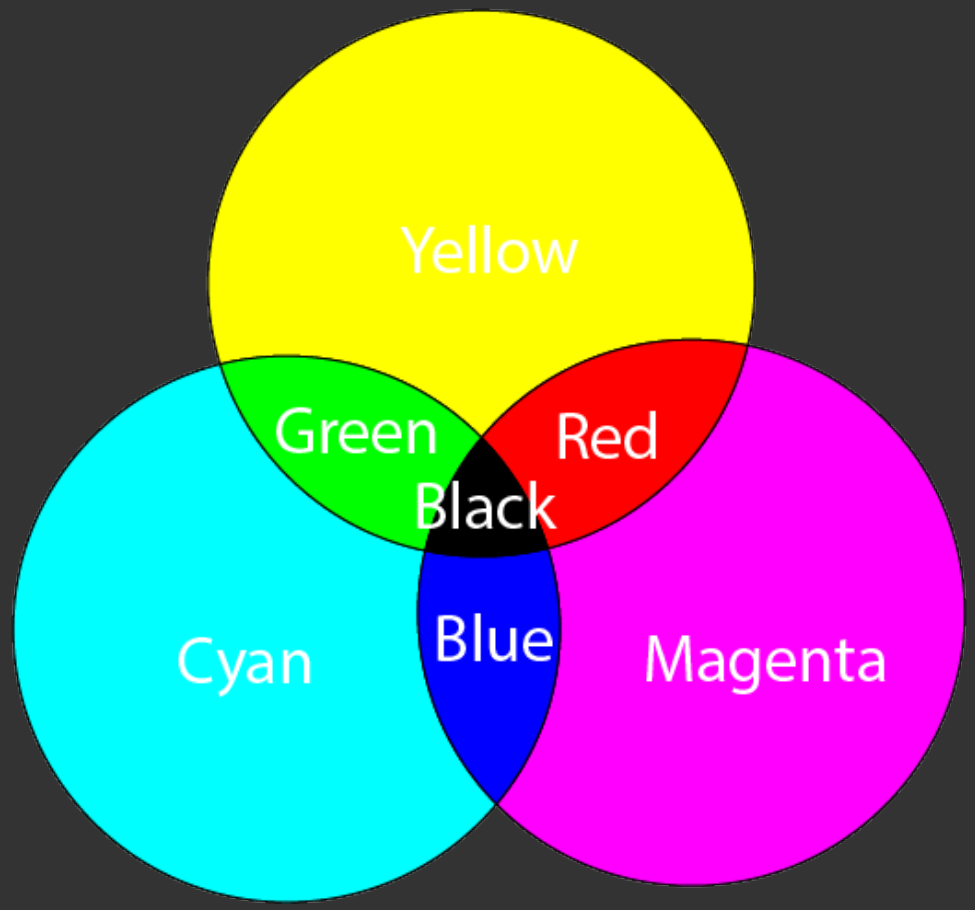
File Formats

- JPEG (Joint Photographic Exerts Group)
- TIFF (Tagged Image File Format)
- PDF (Portable Document Format)
- AI (Adobe Illustrator)
- PNG (Portable Network Graphics)
- BMP (Bitmap)
- EPS (Encapsulated PostScript)
- EMF (Enhanced MetaFile)
- SVG (Scalable Vector Graphic)

Color Space



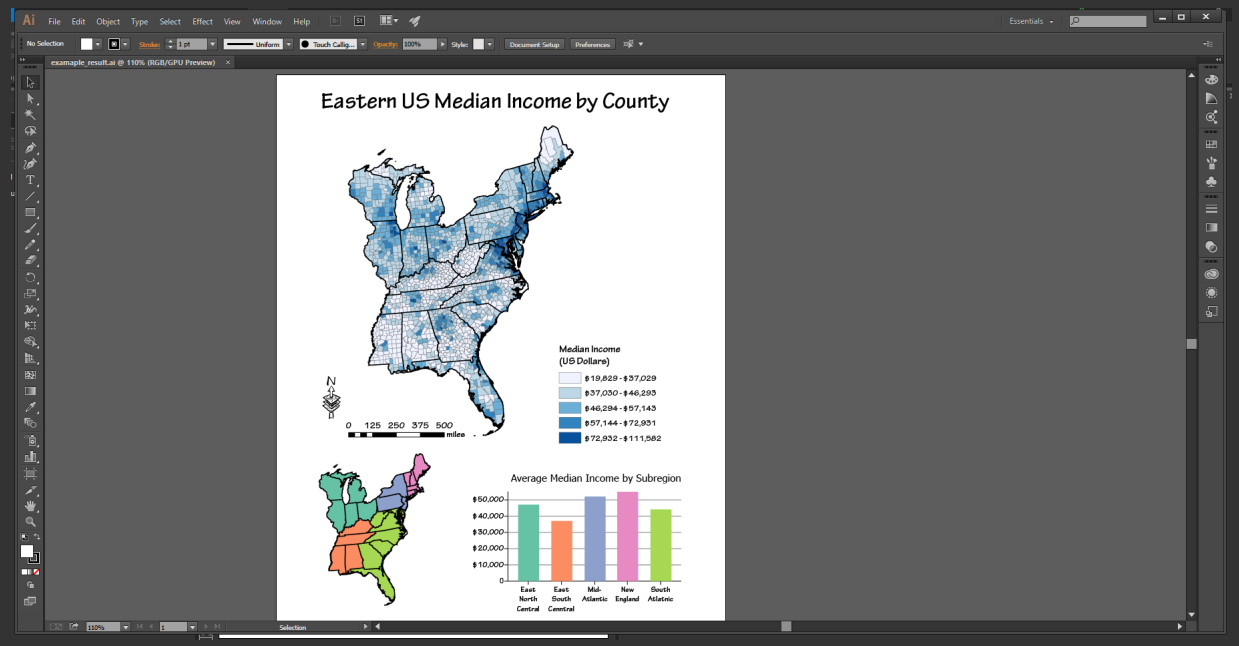
Additive Colors = used with computer monitors



Subtractive Colors = used in printing

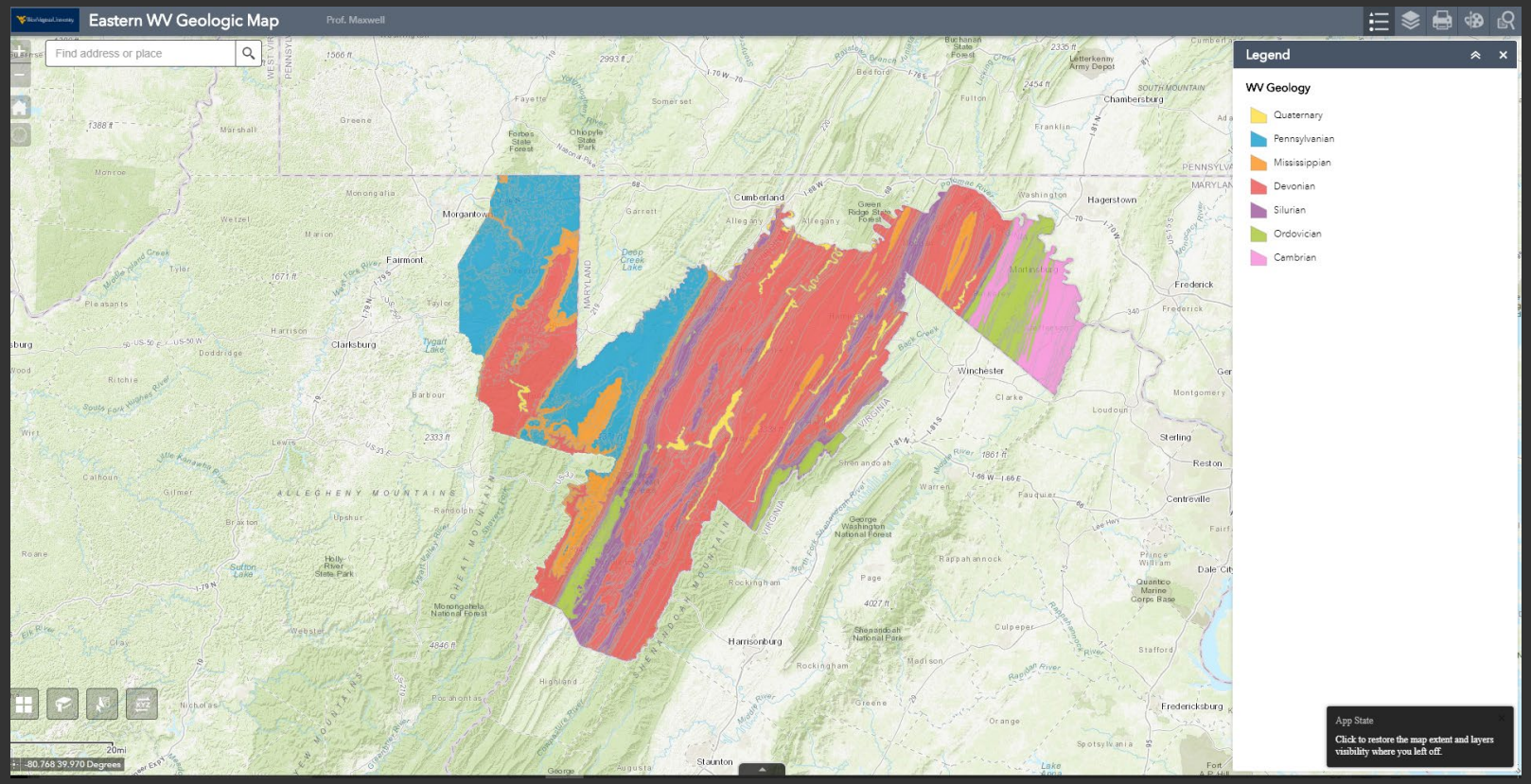
Vector Graphics

- Allows you to edit your map in a graphics software such as Adobe Illustrator in a vector environment
- Important export option when you want to further edit your map in graphics software
- AI, EPS, or SVG formats are a good choice
- Vector graphics editing software:
  - Adobe Illustrator: https://www.adobe.com
  - Inkscape: https://inkscape.org/en/

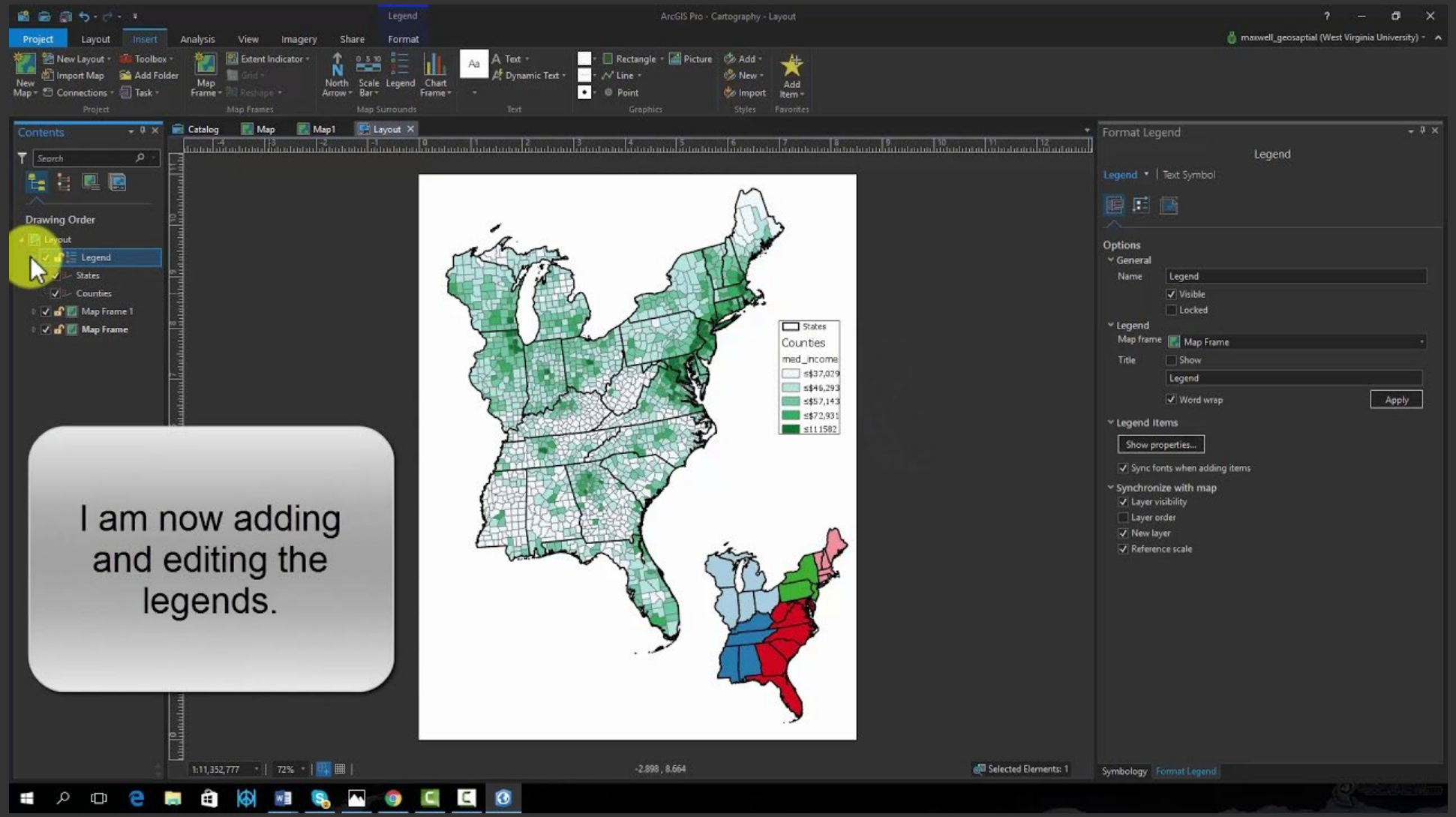


Web Maps

- We will discuss this in more detail later



Video: Map Design Example



This is the end of this lecture module.

Please return to the West Virginia View Webpage for additional content.