

geography



**Please!**  
Turn **OFF** cell phones  
and paging devices



# ArcGIS ArcMap: Making Professional Quality Thematic Maps

*Charlie Frye, ESRI Redlands*  
*Aileen Buckley, ESRI Redlands*



geography

gis  
communicating our world

# ArcGIS ArcMap: Making Professional Quality Thematic Maps

*Charlie Frye, ESRI Redlands*

*Aileen Buckley, ESRI Redlands*

# Key Concepts

- Visual Clarity
- Basemap layers vs. operational or focus layers
  - Basemap should be:
    - Correct
    - Unobtrusive
    - Minimalistic
  - Operational or Focus layer should be:
    - Obvious
    - Makes your point graphically (legend should explain, not define)
- Graphical Professionalism
  - Cartographic Representation examples
  - Color choices that reinforce visual hierarchy and variables

# Thematic Maps

- A map related to a topic, theme or subject – these maps emphasize a single topic
- A map showing statistical rather than topographical information about a place

# Examples

# Natural Environment Topics

- Oregon in the World
- Legal and Routes Relief
- Historical Maps
- Public Sector Employment
- Indians, Glaciers
- Taxation, Revenue and the Lottery
- Exploration 1800-1840s
- Manufacturing
- Oregon Trail
- Lumber and Wood Products
- Epidemics Wars and Reservations
- High Technology
- Donation Land Claims, Public Land
- Business Activity
- Boundaries
- County Investments
- Land Grants
- Ecological Evolution
- Place Names
- Land Ownership
- County Populations
- City Populations
- Cities 1860-2000
- Minerals and Mining
- Historic Portland
- Willamette Valley Population
- Monthly Precipitation
- Population Growth and Density
- Monthly Temperature
- Agricultural Sectors and Projections
- Immigration
- Race and Ethnicity
- Game and Crops
- Income
- Specialty Crops and Wine
- Religious Basins
- Energy Sources
- Politics Quality and Dams
- Energy Distribution
- School Districts
- Development of the Road Network
- Education
- Highway Traffic
- Colleges and Universities
- Endangered Species
- Railroads
- Prisons
- Public Transportation and Airports
- Health Care, Vegetation
- Newspaper and Broadcasting
- European Exploration to 1800

# Presentation outline

- Choropleth maps
- Graduated Symbol maps
- Proportional Symbol maps
- Multivariate maps
- Line width maps
- Prism maps

# Choropleth maps

- Transparent vignettes
- Custom legend design – longer legend box areas to denote amount of data in classes
- Text – black and white in areas
- Drop shadows
- Custom color ramps
- Small multiples
  
- Choropleth map example (single symbol – p. 87)



# Graduated Symbol maps

- Variable depth masking
- Custom legend design – Cindy's histogram method
- Leader lines
- Background hillshades

# Proportional Symbol maps

- Tables
  - Extent rectangles
  - Custom legend design or NO legend but lots of text
  - Drop shadows
  - 3D symbols
- 
- Proportional Symbol map examples (p. 74 for background info, 3D symbols p. 80)

# Multivariate maps

- Custom legend design – pie chart legend = total area values
- Paragraph text
- 4 color theorem
  
- Multivariate maps examples (pie charts, bar charts, combined methods) (cubes with colors p. 74; bar charts p. 74; prop symbols and colors p. 76)

# Line width maps

- Symbol level drawing
- Line width map examples (p. 106, changing the width to equal the value)

# Prism maps

- Border shadows
  - Perspective view parameters (angle, azimuth)
  - Z factor
  - 3D symbols
- 
- Prism map examples – Alex Tait's Sports Atlas

# Other things

- Feature outline masks – Tom Patterson’s effect for transparency behind text on maps
- Flow arrow map – produced manually
- Prism maps
- Drop shadows
- Change perspective
- Perspective view maps
- Multivariate maps
- Adding charts and tables
- Dot density to show tree patterns

# World thematic map

- Show the labeling for the graticule and how you slice the lines to show where you want the labels
- Show the calc statement to densify the lines so they bend when you project them

# Dasymetric Mapping

- The dasymetric map is a method of thematic mapping, which uses areal symbols to spatially classify volumetric data. The method was developed and named by Tyan-Shansky and popularized by J.K. Wright.
- Cartographers use dasymetric mapping for population density over other methods because of its ability to realistically place data over geography. Similar to choropleth maps, a dasymetric map utilizes standardized data, but places areal symbols by taking into consideration actual changing densities within the boundaries of the map. To do this, ancillary information is acquired, which means the cartographer steps statistical data according to extra information collected within the boundary. If appropriately approached it is far superior to choropleth maps in relaying statistical data within areas of interest. Dasymetric mapping corrects for error, termed 'ecological fallacy', that may occur with choropleth mapping.
- Like other forms of thematic mapping, the dasymetric method was created and historically used because of the need for accurate visualization methods of population data. Dasymetric maps are not widely used because of the difficulty in producing them with automated tools such as Geographic Information Systems. Although fields such as public health still rely on choropleth maps, dasymetric maps are becoming more prevalent in developing fields, such as conservation and sustainable development. Researchers in various fields of science are pushing the way for use of so-called critical GIS and to make dasymetric mapping techniques more easily applicable with modern technology.
- (From Wikipedia)



# 3D symbols

- Use volume formulas instead of area formulas
- Select appropriate symbology



cube =  $a^3$

rectangular prism =  $a b c$

irregular prism =  $b h$

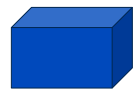
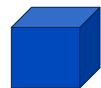
cylinder =  $b h = \pi r^2 h$

pyramid =  $(1/3) b h$

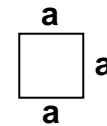
cone =  $(1/3) b h = 1/3 \pi r^2 h$

sphere =  $(4/3) \pi r^3$

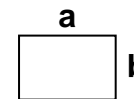
ellipsoid =  $(4/3) \pi r_1 r_2 r_3$



square =  $a^2$



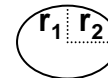
rectangle =  $ab$



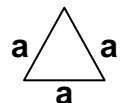
circle =  $\pi r^2$



ellipse =  $\pi r_1 r_2$

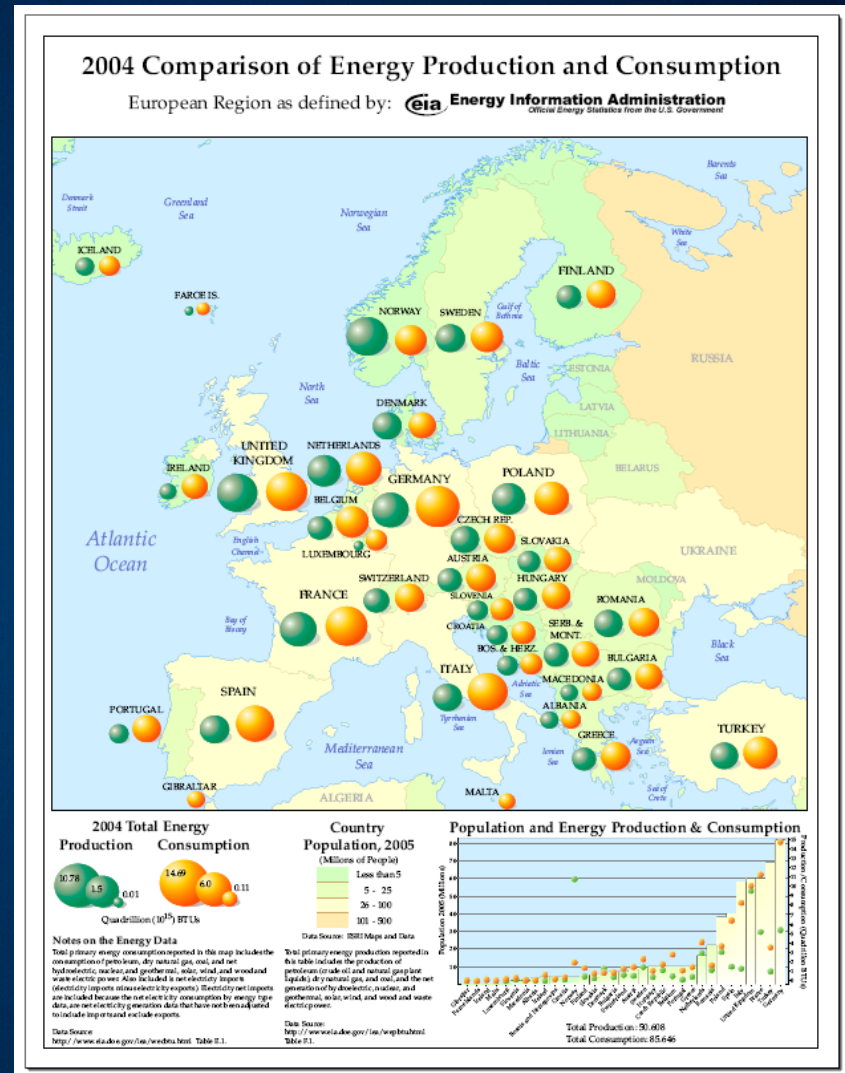


equilateral triangle =  $\frac{\sqrt{3}}{4} (a^2)$



# 2004 Comparison of Energy Production and Consumption Map

- Overview/Goal:
  - Three variables:
    - Energy Consumption: 3D Graduated Symbol
    - Energy Production: 3D Graduated Symbol
    - Population: Choropleth
  - Two Visualizations:
    - Map
    - Graph
  - One map with “Visual Pop” and “Graphical Panache”



# Challenges in the Energy Map

- Size of Spheres for production and consumption must be relative
- Drop Shadows for 3D symbols
- Graph
- Legend
- Choropleth Map Classes
- Country Name Labels
  - Figure ground Issues
  - For countries with and without data
- Map Design

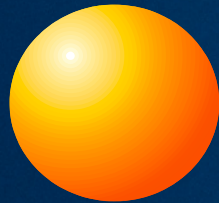
# Challenge #1: Relative Size, Spheres vs. Circles

- Scaling Spherical Symbols

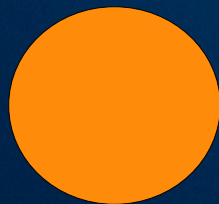
- Spheres are volumes or cubic measures

- ArcMap symbols are sized linearly (vs. geometric or cubic)

- $\frac{4}{3} \pi r^3$  ... or  $r = (([<field>] / 3.141592) * 0.75)^{(1/3)}$



- $\pi r^2$  ... or  $r = ([<field>] / 3.141592)^{(1/2)}$



# Challenge #1: Finding the Correct Relative Size

		Energy Production	Energy Consumption
Actual Values (converted for sphere)	Min	0.062035	0.137965
	Max	1.370557	1.519407
Default Symbol Sizes	Min	7.0	7.0
	Max	32.9	23.23
Correct Symbols Sizes	Min	7.0	10.5
	Max	32.9	34.85

- Each field (production & consumption) have different data ranges, therefore, the symbols should too

# Challenge #1: Finding the Correct Relative Size

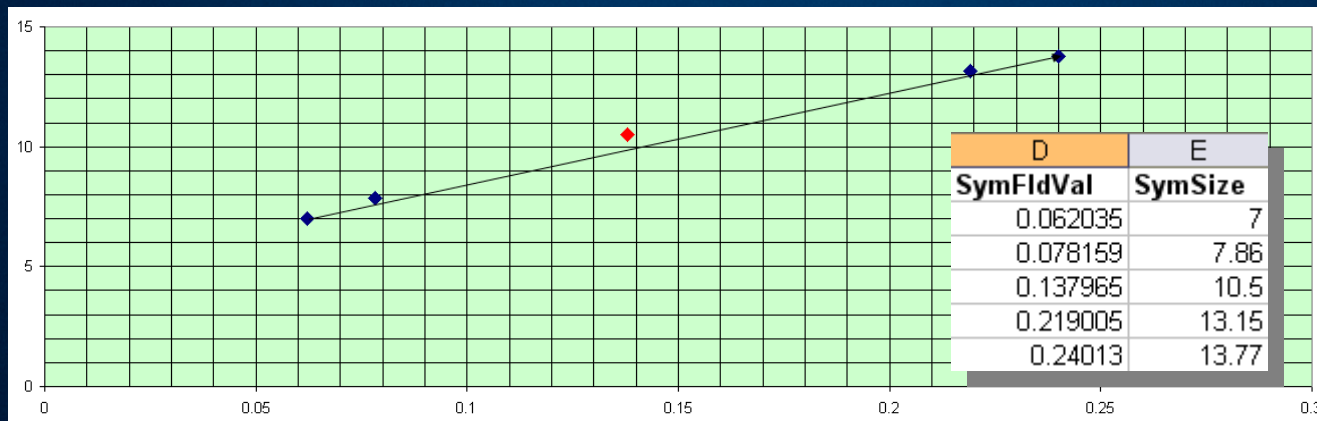
		Energy Production	Energy Consumption
Actual Values (converted for sphere)	Min	0.062035	0.137965
	Max	1.370557	1.519407
Default Symbol Sizes	Min	7.0	<b>7.0</b>
	Max	32.9	<b>23.23</b>
Correct Symbols Sizes	Min	7.0	<b>10.5</b>
	Max	32.9	<b>34.85</b>

- Each field (production & consumption) have different data ranges, therefore, the symbols should too

# Challenge #1: Finding the Correct Relative Size

Set proportional symbology for field with the range that has the smallest non-zero value

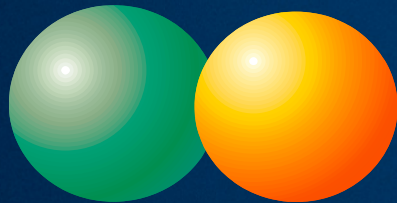
- If the other field has values that are significantly larger than the highest value in this field, then trend to smaller symbols
- Convert to graphics
- Get the symbols that correspond the two values on either side of the smallest value in the second table and graph this



Red dot, is at size for smallest symbol in the other layer

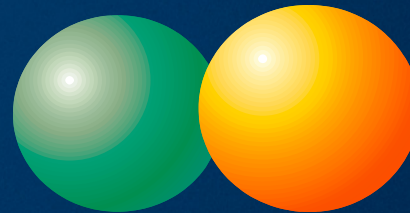
# Challenge #1: Finding the Correct Relative Size

- Check your work and, if needed, fine-tune
  - Create the graphics for both fields
  - Find a place where the values are similar
  - Compare the symbols
  - If wrong, micro-adjust the size until this works



1.02 vs. 0.99  
15.23 vs. 16.0

**WRONG!**



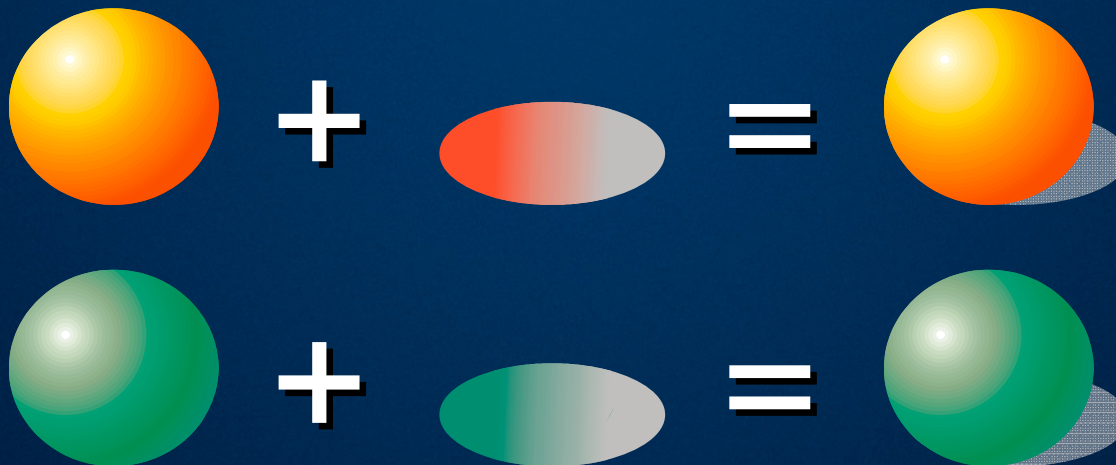
1.02 vs. 1.08  
15.23 vs. 16.0

**RIGHT!**



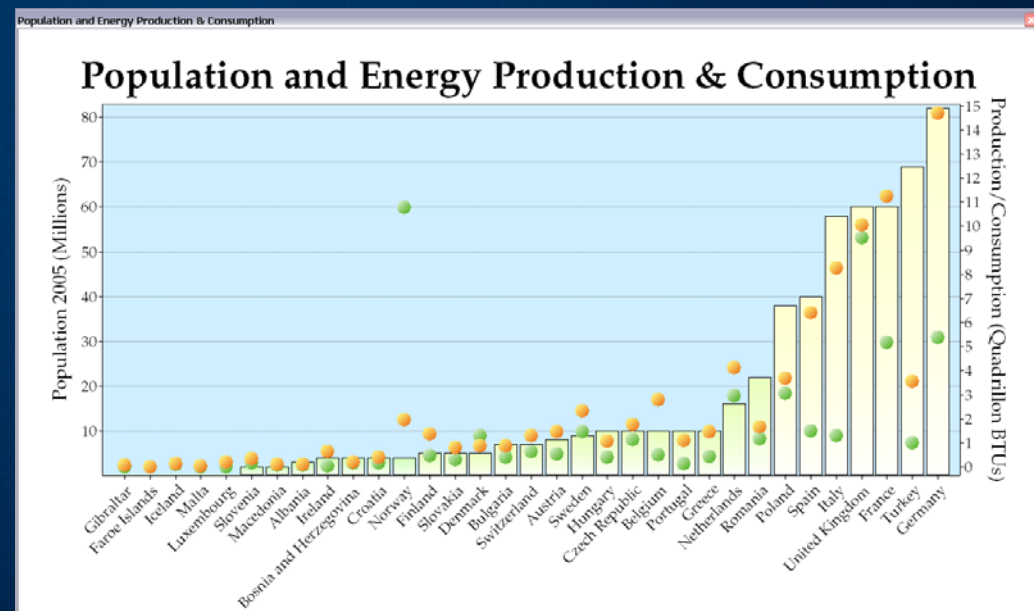
## Challenge #2: Drop Shadows

- Spheres are stored as graphics
  - Easy access to size information and for legend construction
- Shadows are on custom feature layers (point)
  - So they can have a transparency value
- Edit the position of each sphere and shadow to align properly.



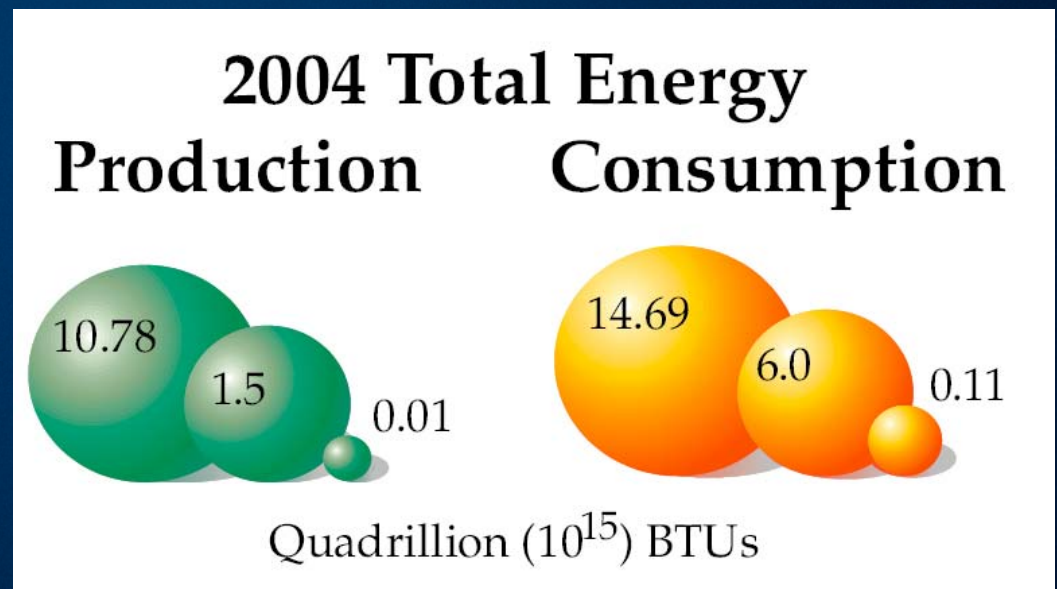
# Challenge #3: Graph

- Use ArcGIS 9.2
  - The graphing software ESRI licensed has been upgraded
    - Better graphics
    - Matches ArcGIS Colors
    - Rich editing environment
  - See the team in the demo area



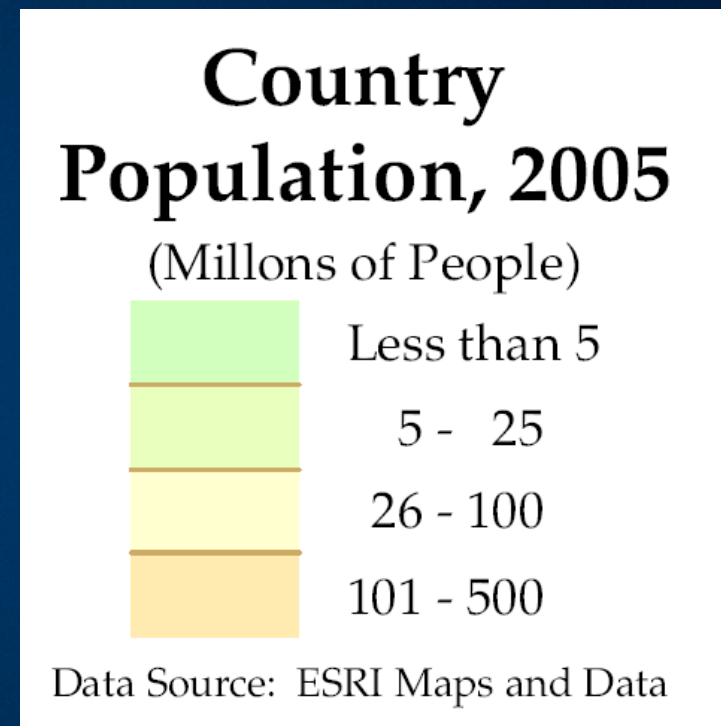
## Challenge #4: Proportional Symbol Legend

- Copy the largest, smallest, and representative mid-size sphere for each color out of the data frame and paste into the layout
- Get their corresponding data values; not the converted values, but the raw values
- Arrange the graphics



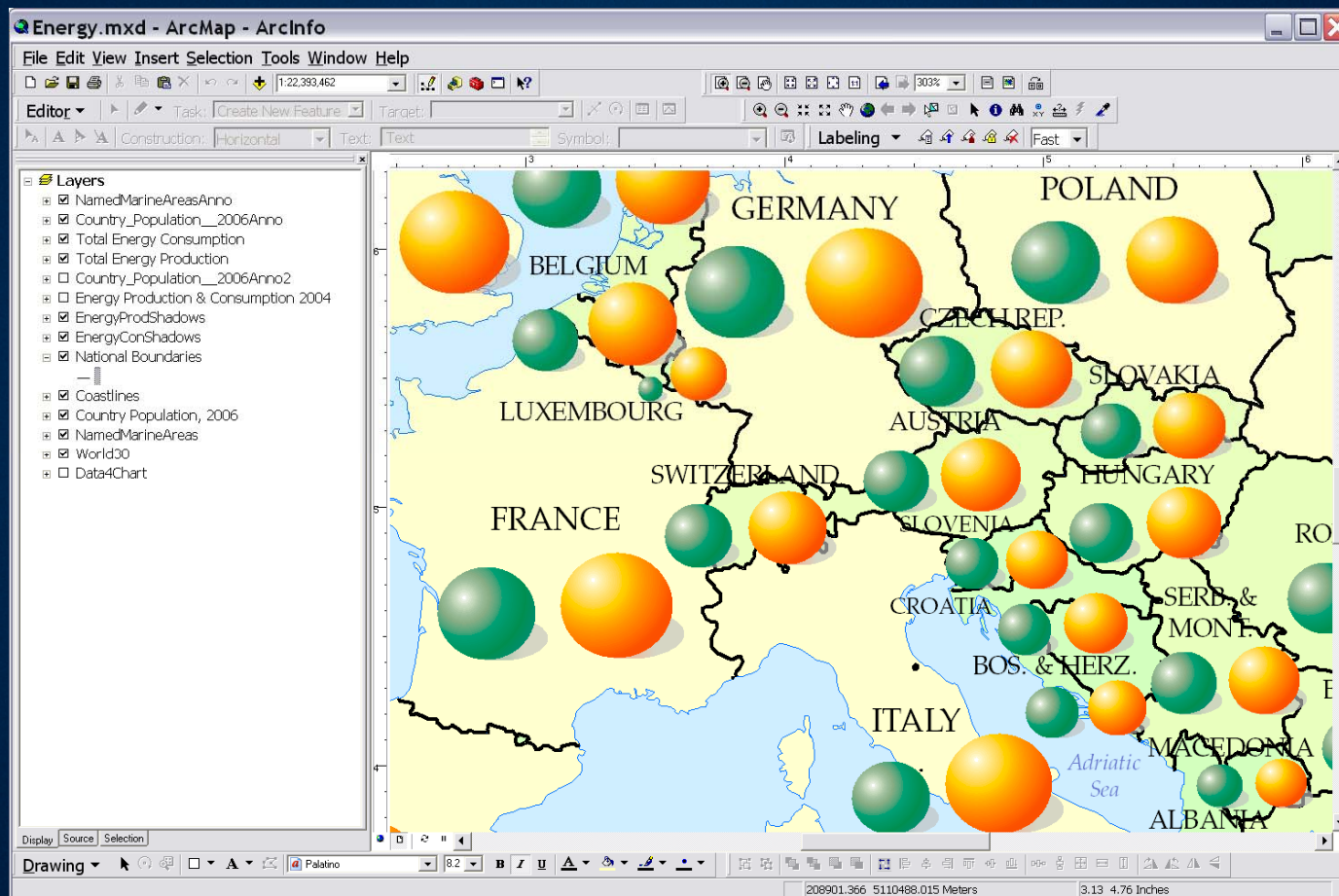
# Challenge #5: Choropleth Map Classes

- Custom field for abbreviated population
  - Long Integer
  - Calc: [*<popfield>*]/1000000
  - Also used for left graph axis
- Custom spacing of labels
  - Right Aligned Columns
- Custom legend boundary
  - Drawn by hand
  - Copied
  - Left Aligned



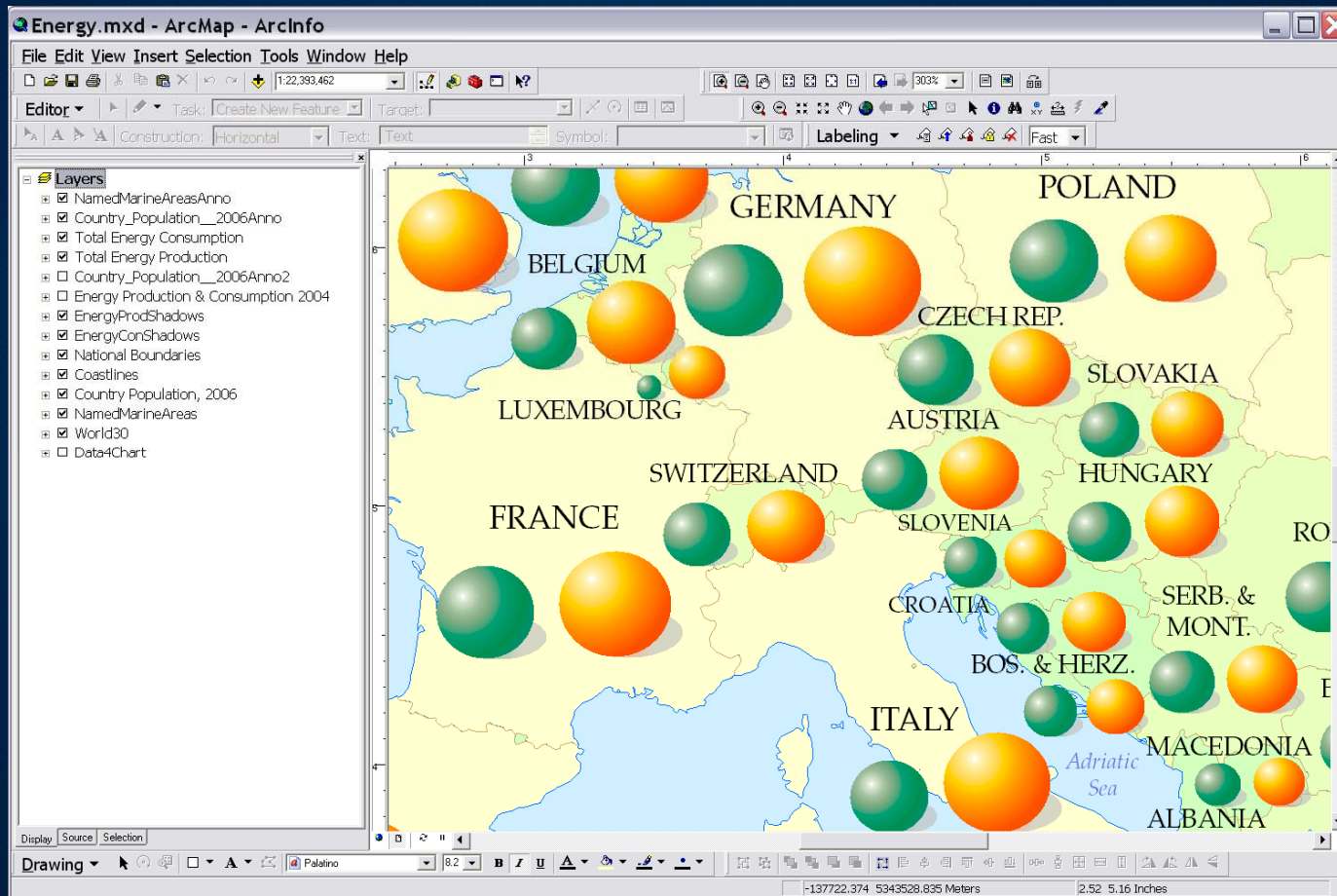
# Challenge #6: Country Name Labels

- National boundary lines do not intermingle well with text



# Challenge #6: Country Name Labels

- Reduce and soften national boundary symbol



## Challenge #6: Country Name Labels

- Medium to light brown line (0.4 pts) works very well
  - Just need to know where the boundary is, rather than follow traditional map design that typically involves hierarchies of boundaries
- Produce boundary lines with Polygon to Line tool
  - Different tool than “Feature to Line”
  - Edit to “Split” lines at coasts
  - Optionally delete or keep coast lines
- Or, use the boundaries datasets on the ESRI Maps & Data CD

# Challenge #7: Map Design

- Don't want: A map that everybody else can make
- Graphic Panache:
  - Select a better font
    - This map uses Palatino
      - Bold for titles
      - Italic for water body names
      - Normal case for all other text
  - Don't use the defaults; instead find correct convention and procedure and use it
    - Symbology (thematic mapping convention)
    - Legend (tailored and efficient)
    - Symbols (custom)
      - For this map, a graphic artist was asked to create vector based .EMF files for picture markers of the spheres and drop shadows; about 1 hour of work.



# Thank You

- Please fill out your surveys