COLOR

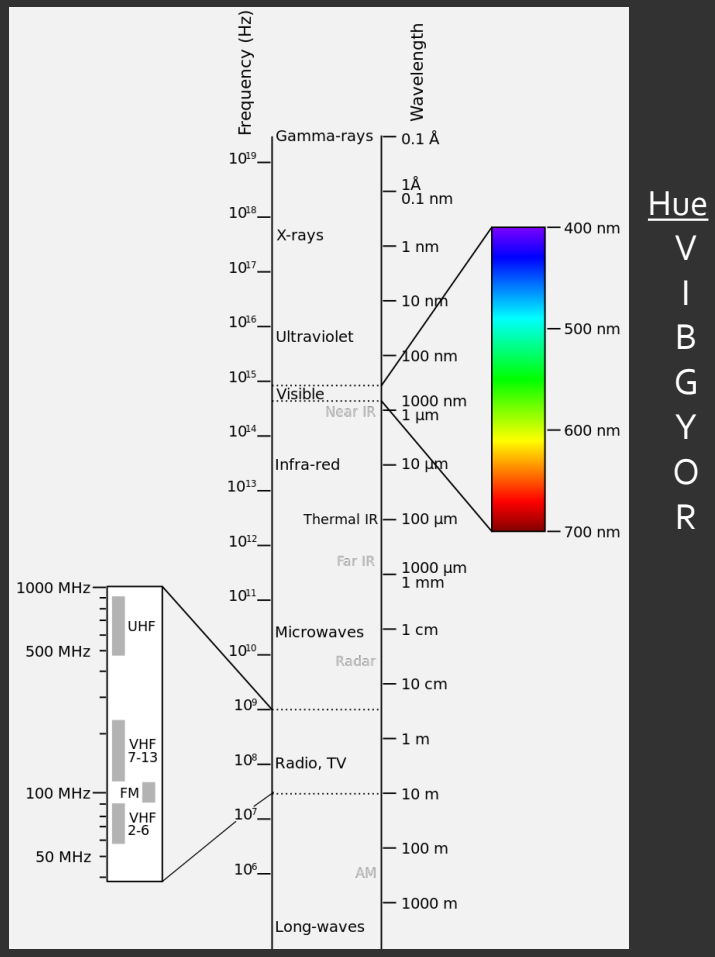
Sandeep Talasila, GISP

BASICS

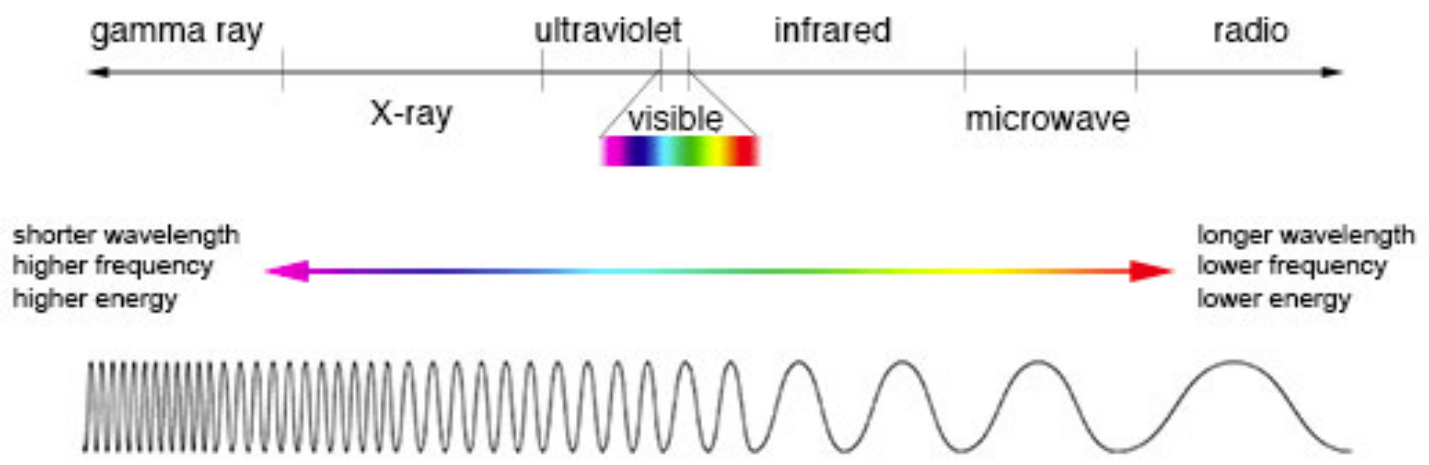
- A perceptual phenomenon
- Subjective rather than objective
- Inappropriate color choices can obscure data and mislead map readers
- Caused by stimulated receptors in human eyes by the electromagnetic radiation of certain wavelengths
- Required elements: light source, object, and viewer (eye-brain)
- Modes: Illuminant mode and Reflective mode

WHAT IS LIGHT?

- Part of the electromagnetic energy spectrum (EMS) that is visible to the human eye
- Visible Spectrum Wavelength: 400nm – 700nm
- Composite of visual spectrum – *White light*
- Primary Colors – Red, Green, and Blue



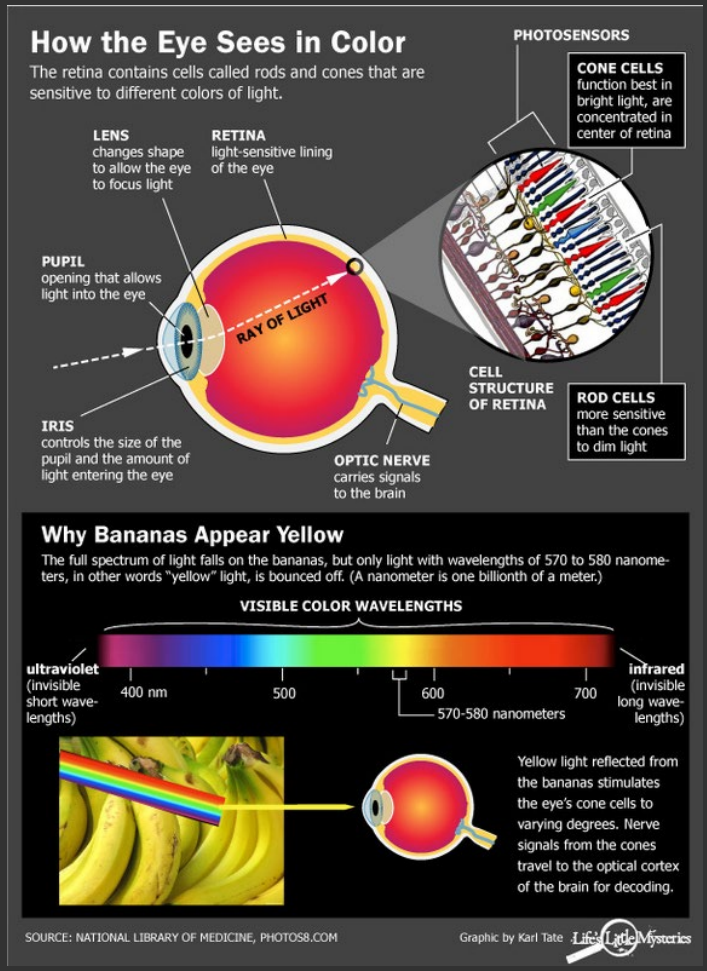
WAVELENGTHS OF VISIBLE SPECTRUM



Comparison of wavelength, frequency and energy for the electromagnetic spectrum.
(Credit: NASA's Imagine the Universe)

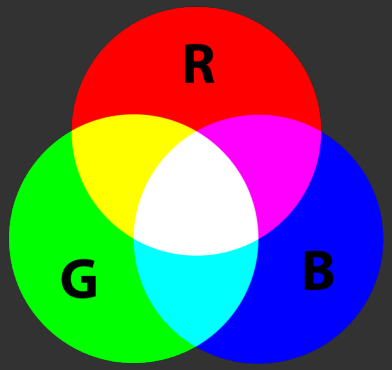
COLOR PERCEPTION

- Light enters through cornea and passed back to retina
- Retina – Light sensitive layer contains Rods and Cones
  - Rod cells – cannot differentiate colors
  - Cone cells – sensitive to the R, G, and B wavelengths
- Ambient light conditions impact the perception of color
- Color blindness
  - Can only see blues and yellows and may have difficulty in perceiving reds, greens, and some yellows
  - Affects more males than females

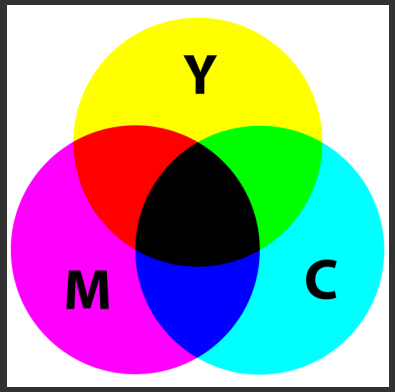


COLOR SYSTEMS

Additive Colors: Red, Green Blue

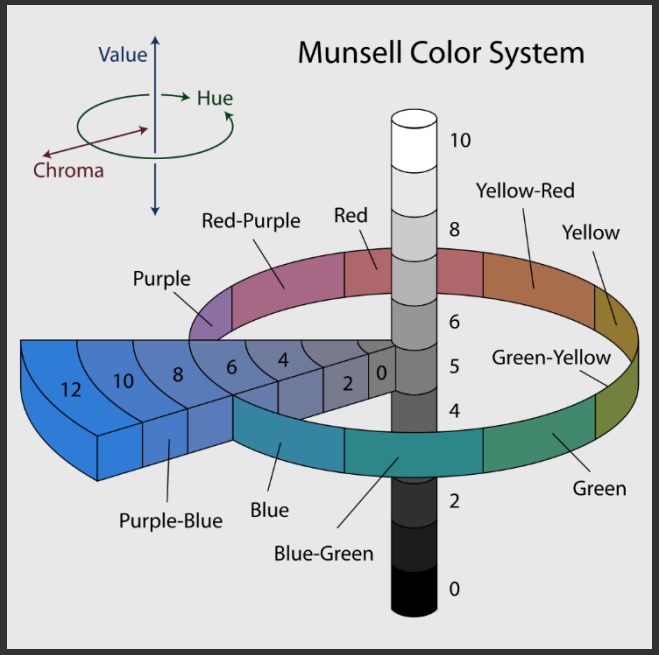


Subtractive Colors: Cyan, Magenta, Yellow

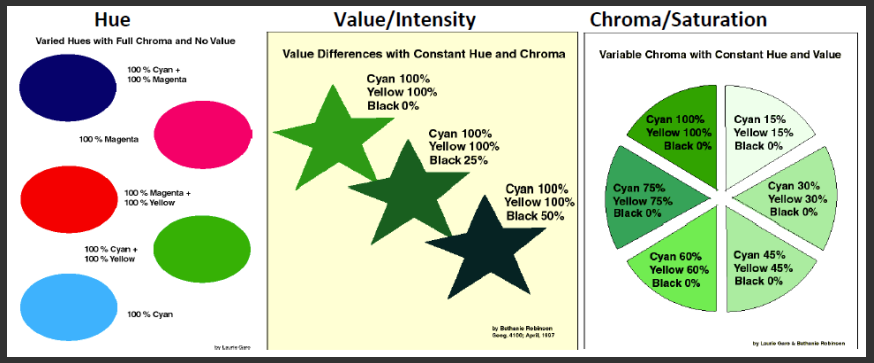


COLOR COMPONENTS

- Name, intensity, and lightness of the color
- Hue
  - Red, Blue, Green, Brown, Red-Orange,…
  - Each hue has its own wavelength in the visible spectrum
- Saturation
  - Chroma, intensity or purity
  - A measure of vividness of a color
- Value
  - Quality of lightness or darkness of a color

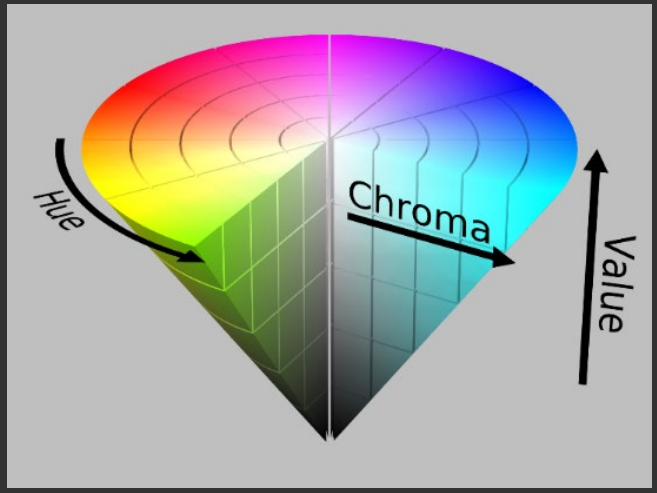


https://commons.wikimedia.org/wiki/File:Munsell-system.svg

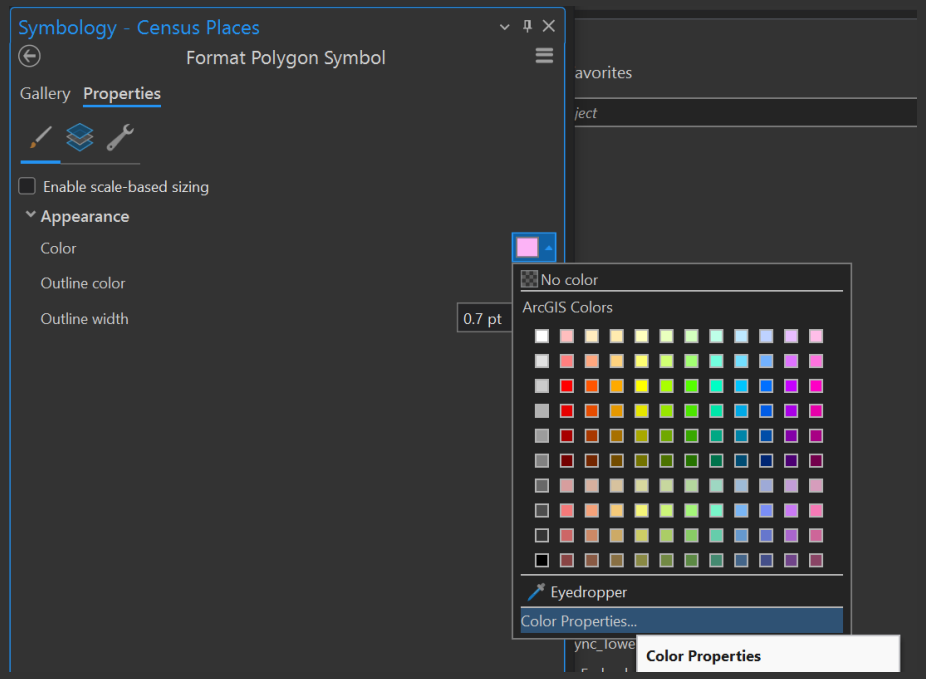


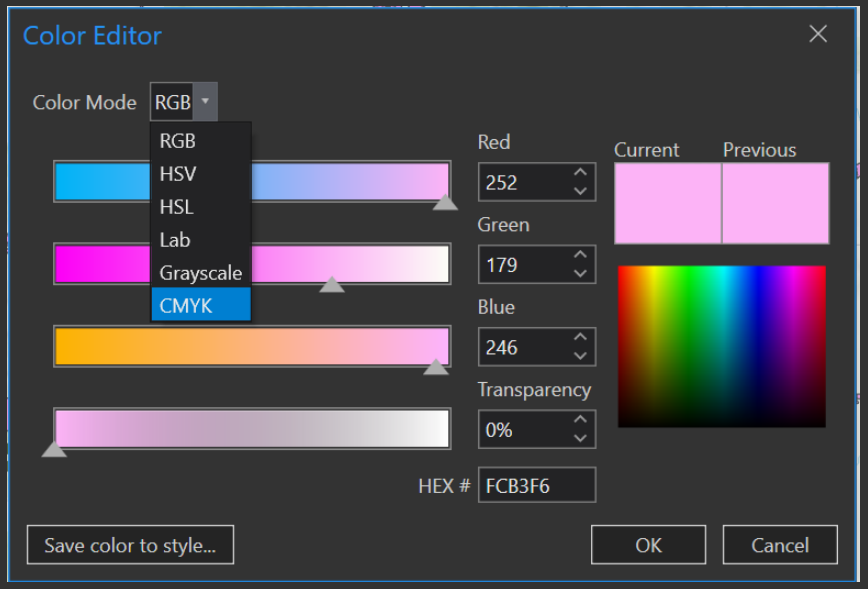
COLOR MODELS

- RGB – Red Green Blue
- CMYK – Cyan Magenta Yellow and Black
- Grayscale
- HSV – Hue Saturation Value
- HSB/HSL – Hue Saturation Brightness/Lightness
- CIE L*a*b *(Commission Internationale de l'Eclairage Lab)*



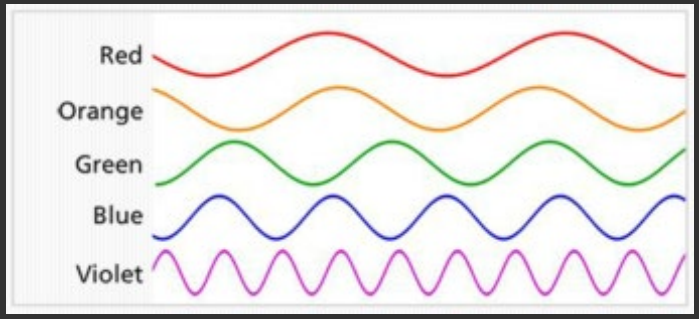
COLOR MODELS IN ARCGIS

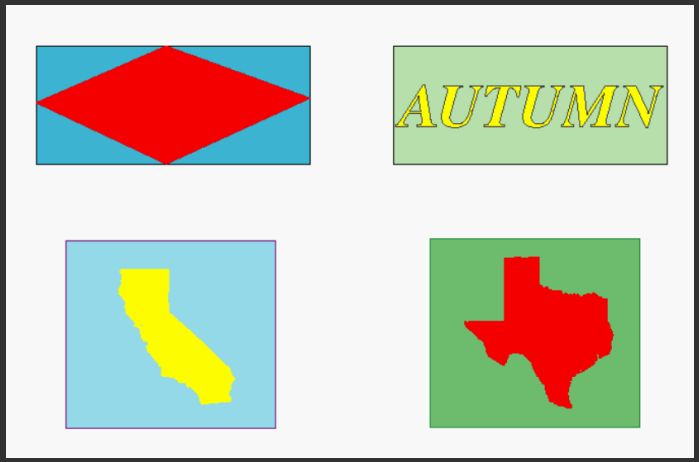




COLOR PREFERENCES

- Subjective to audience preferences and type of map
- Warm and Cool Colors
  - Red is warmer followed by green and blue
- Advancing and Retreating Colors
  - Red appears closer when seen along with a color of shorter wavelength
- General color conventions should overrule broader color preferences
  - Blue for water, green for parks, etc.





WHAT COLORS DO YOU LIKE?

- Young children tend to prefer longer wavelengths whereas Adults prefer shorter wavelengths.
- Men prefer orange to yellow and blue to red
- Women prefer red over blue and yellow over orange
- Children prefer bright colors of red, green, and blue
- Affluent adults prefer subtle, pastel shades
- …

COLOR ASSOCIATIONS

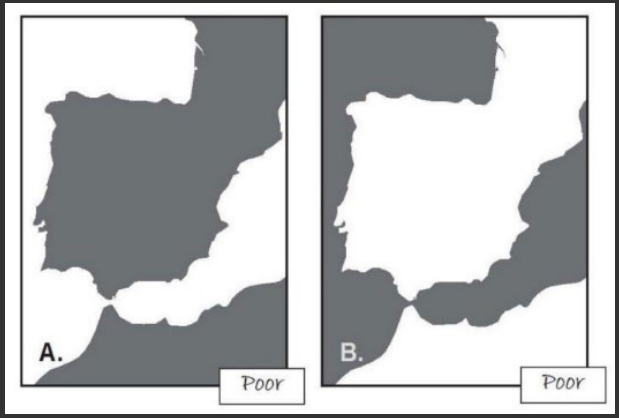
Colour	Positive	Negative
Red	Passion, strength, energy, heat, love	Blood, war, fire, danger, anger, aggression
Green	Nature, spring, fertility, safety, environment	Inexperience, decay, envy, misfortune
Yellow	Sun, summer, gold, harvest, optimism	Cowardice, treason, hazard, illness, folly
Blue	Sky, sea, stability, peace, unity, depth	Depression, obscenity, conservatism, passivity
White	Snow, purity, peace, cleanliness, innocence	Cold, clinical, surrender, sterility, death, banality
Gray	Intelligence, dignity, restraint, maturity	Shadow, concrete, drabness, boredom
Black	Coal, power, formality, depth, solidarity, style	Fear, void, night, secrecy, evil, anonymity

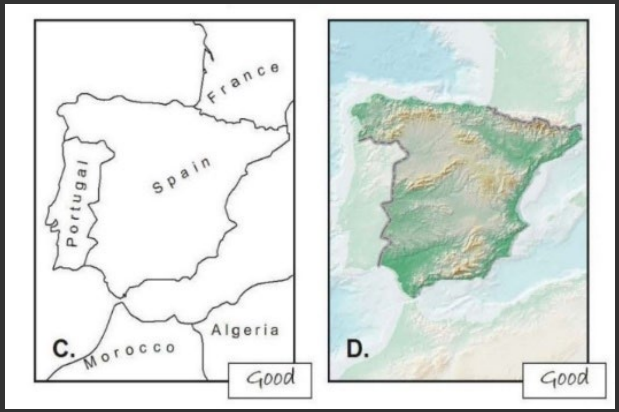
https://dark-star-161610.appspot.com/secured/_book/visual-perception-and-colour.html#colour-associations

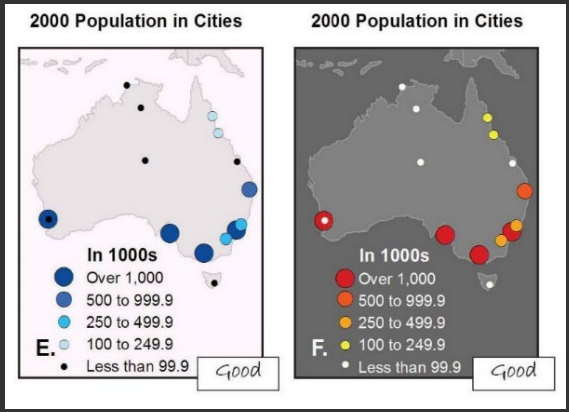
COLORS IN COMBINATION

- Colors have an interesting way of affecting each other when they are placed in proximity and can create a disjointed, confusing, and ugly map.
- Background colors should be light or dark and not intermediate colors.
- Pleasant – Hues in green to blue range, or hues with little gray.
- Unpleasant – hues in yellow to yellow-green, or hues with more gray.
- Vivid colors combined with grayish colors are pleasant.

COLORS IN COMBINATION



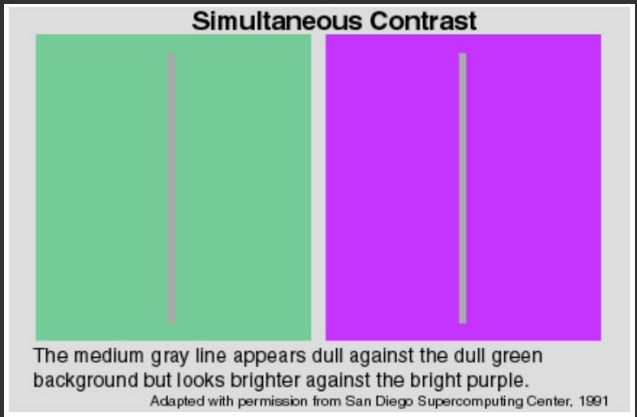


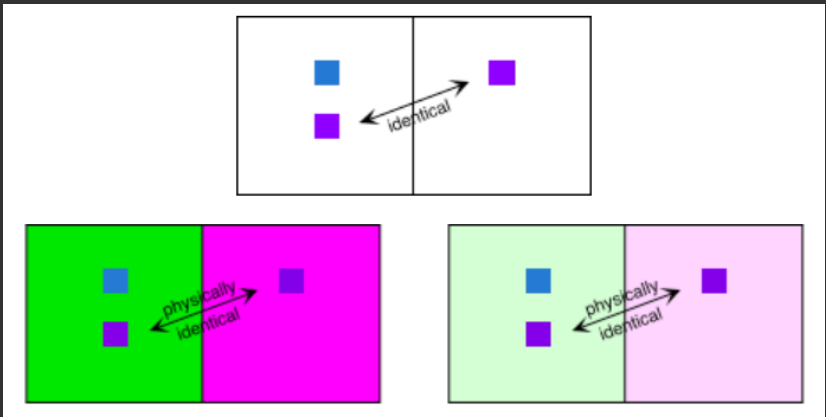


Source: Aileen Buckley, ESRI, ArcUser Winter 2010

COLORS IN COMBINATION

- Simultaneous contrast
  - When a color is surrounded by another color, it begins to appear tinged by the complementary color of surrounding color.
  - Colors might appear lighter when surrounded by a darker color and vice versa.

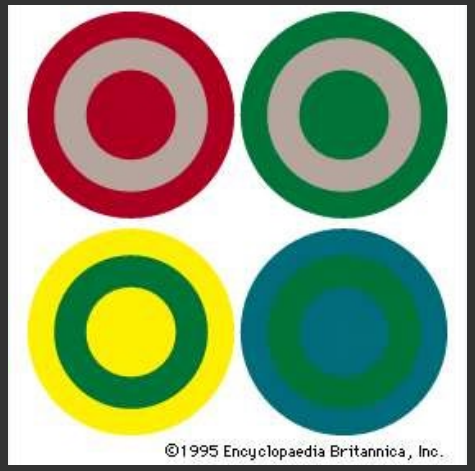


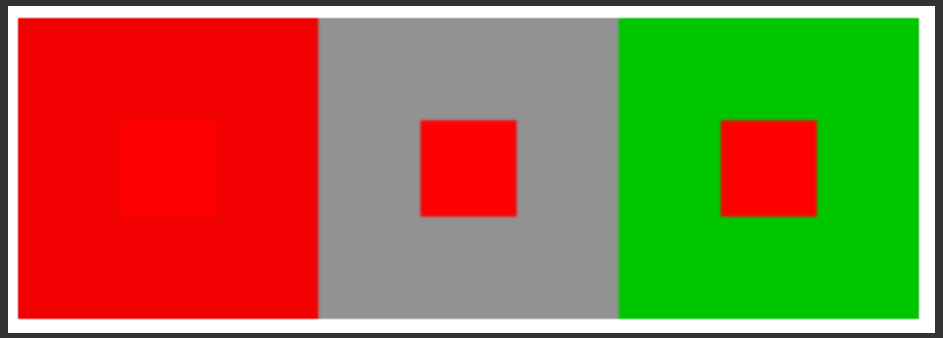


https://colorusage.arc.nasa.gov/Simult_and_succ_cont.php

COLORS IN COMBINATION

- Successive Contrast
  - Occurs when a given color is viewed in one environment (one background) and then another (a different color background) in quick succession.
  - May appear darker or lighter compared to each new environment.
  - Can cause problems regarding interpretation of color on a map.





https://colorusage.arc.nasa.gov/Simult_and_succ_cont.php

Wind Gust Estimates during Superstorm Sandy

New Jersey Department of Environmental Protection
Trenton, New Jersey, USA

By Nick Procopio

Contact

Nick Procopio, nick.procopio@dep.state.nj.us

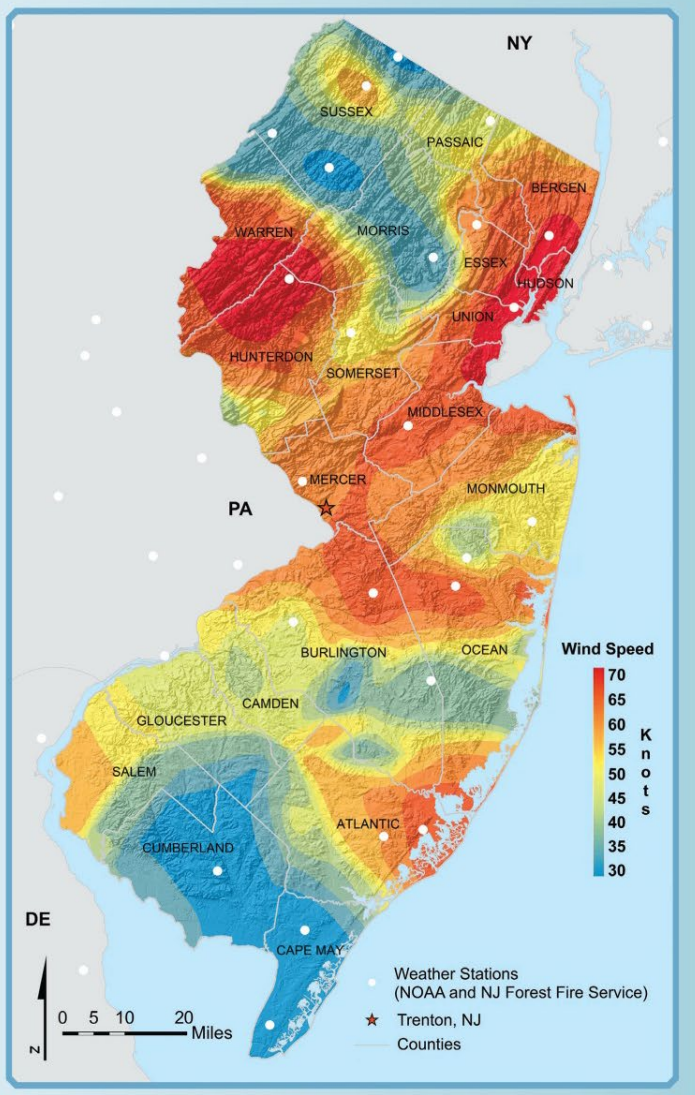
Software

ArcGIS 10.0 for Desktop

Data Sources

New Jersey Department of Environmental Protection, New Jersey Forest Fire Service

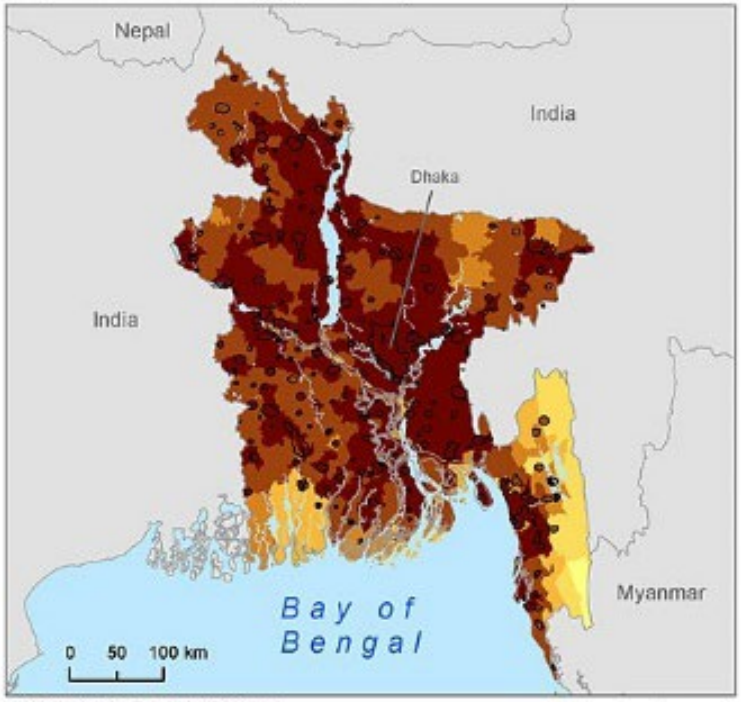
Superstorm Sandy moved across New Jersey October 29–30, 2012. Maximum wind gust speed (knots) was estimated for the period when the storm moved across the region. Data collected at twenty-four weather monitoring stations in New Jersey and twenty-five additional stations neighboring the state was used to estimate the regional wind gusts. Prediction estimates very closely matched the reported value at the forty-nine stations. The average difference was -0.16 percent, while the greatest single deviation was never more than 8.6 percent.



Urban-Rural Population and Land Area Estimates, Version 2, 2010: Bangladesh

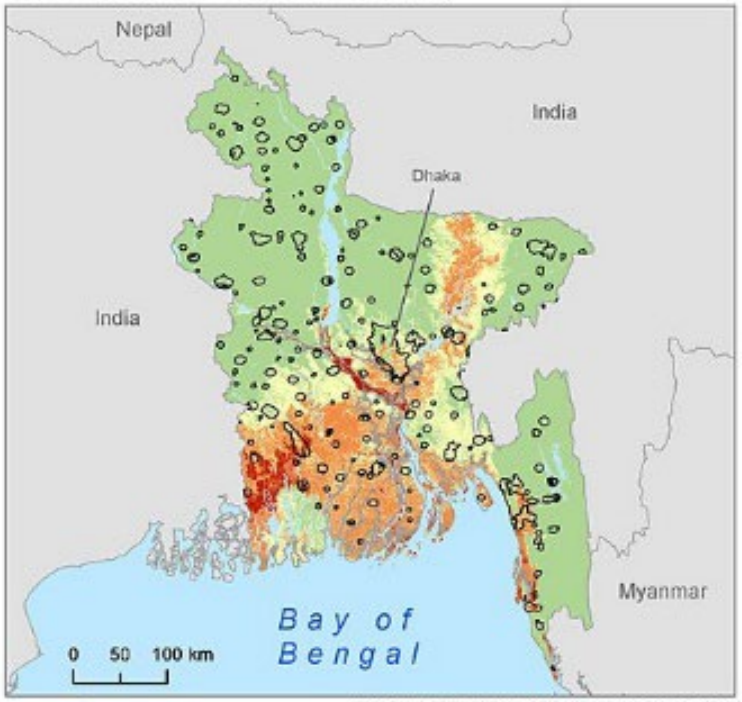
Low Elevation Coastal Zone

Population Density (per km^2)



Lambert Azimuthal Equal Area Projection

Low Elevation Coastal Zone (m)



Map Credit: CIESIN Columbia University, November 2013

Population Density (per km^2)

<25	26–100	101–250	251–500	501–1000	>1000

Urban Extents | Waterbody

Center for International Earth Science Information Network

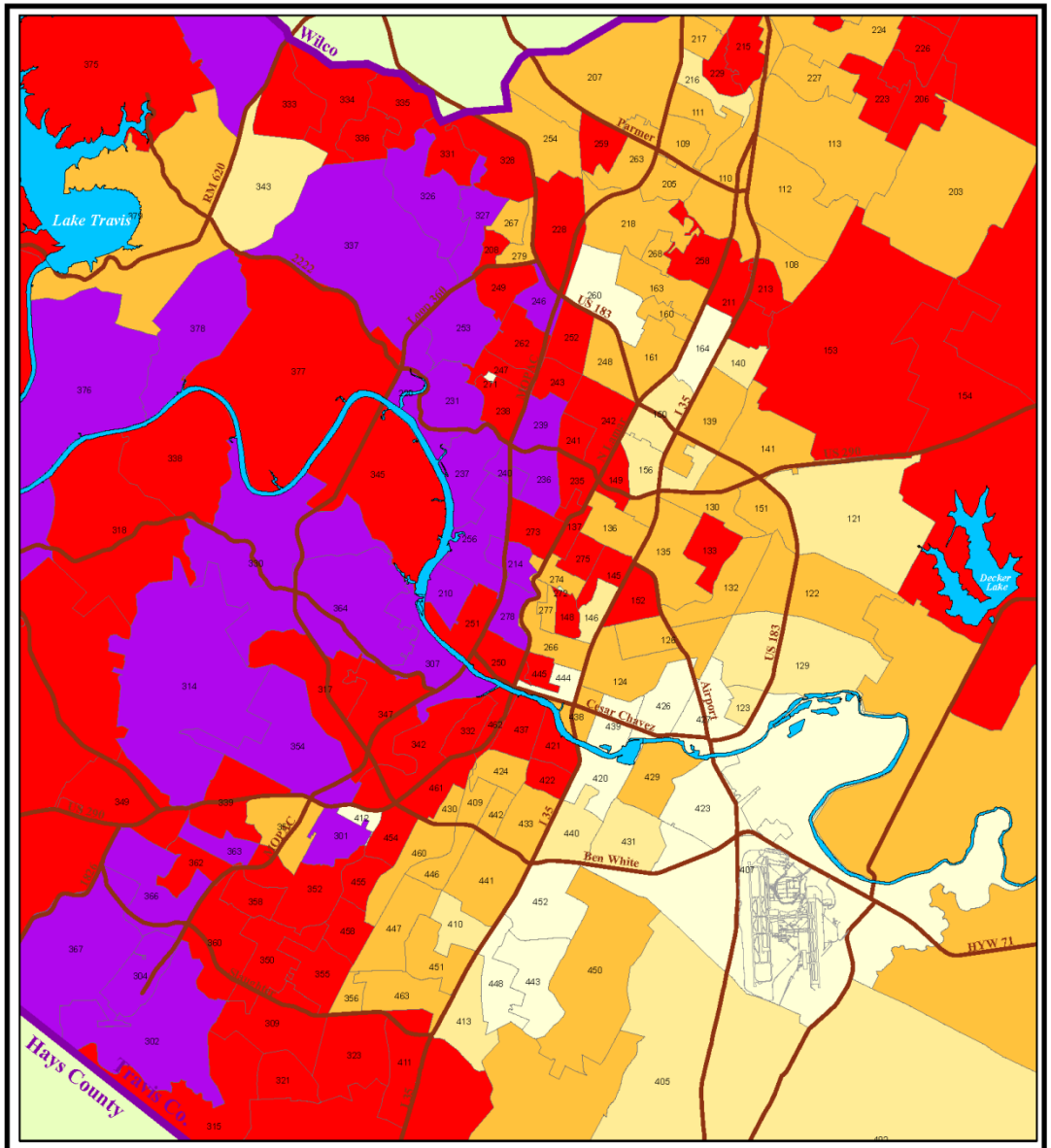
Low Elevation Coastal Zone (m)

0–3	4–7	8–10	>10

Urban Extents | Waterbody

Data Source: Center for International Earth Science Information Network (CIESIN) /Columbia University. 2013. Low Elevation Coastal Zone (LECZ) Urban-Rural Population and Land Area Estimates, Version 2. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://sedac.ciesin.columbia.edu/data/set/lecz-urban-rural-population-land-area-estimates-v2.

The Low Elevation Coastal Zone (LECZ) Urban-Rural Population and Land Area Estimates Version 2 data set provides continent-level and country-level estimates of land area and urban, rural, and total population for 202 statistical areas (countries and other UN recognized territories). Population inputs were derived from Gridded Rural-Urban Mapping Project, version 1 (GRUMPv1). Elevation data were derived from the Shuttle Radar Topographic Mission (SRTM) 90 meter data set.



Presidential Election 08 Turnout

Percent of Registered Voters Who Voted, by Precinct, Travis County. November 2008.

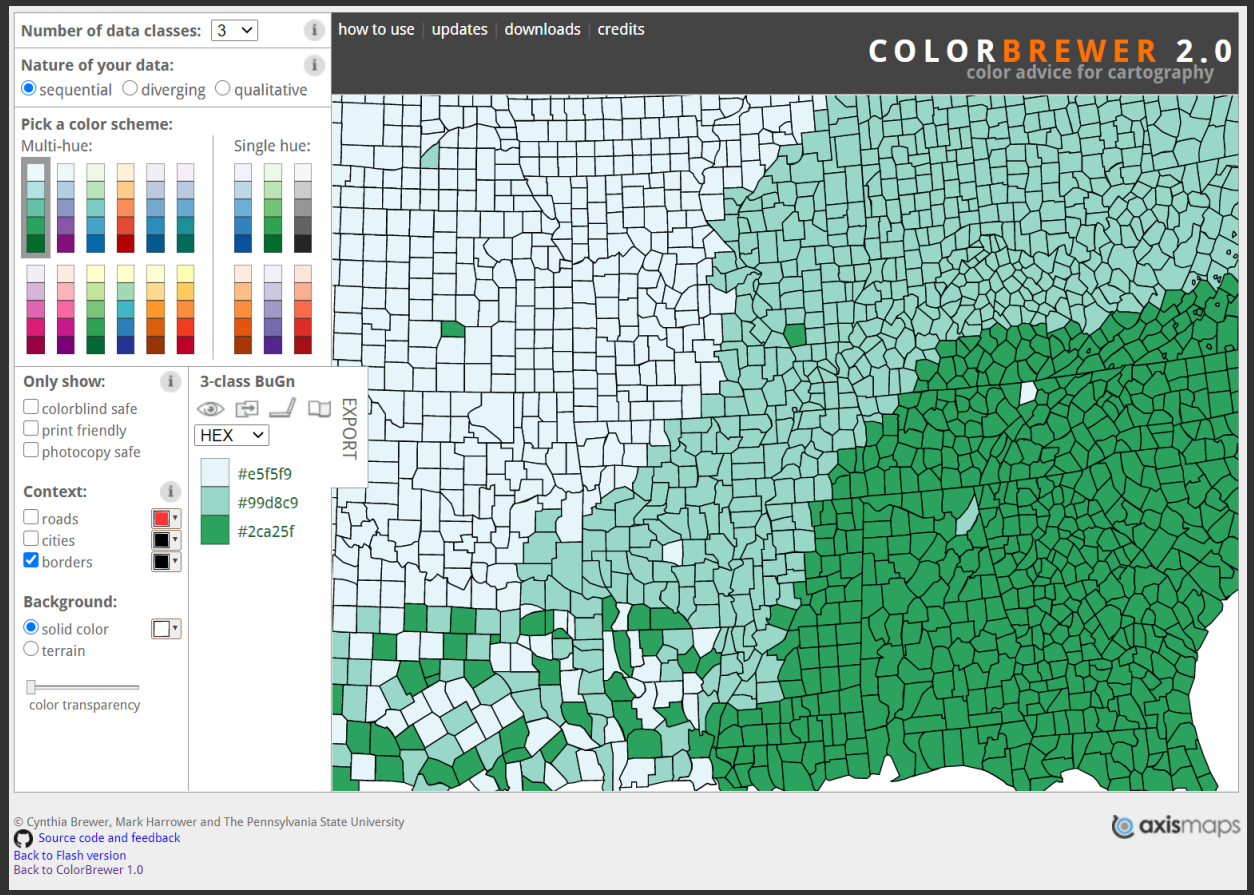
Overall Countywide Turnout: 66.1%

Map produced by: Ryan Robinson, City Demographer, Department of Planning, City of Austin. December 2008.

Percent of Registered Voters

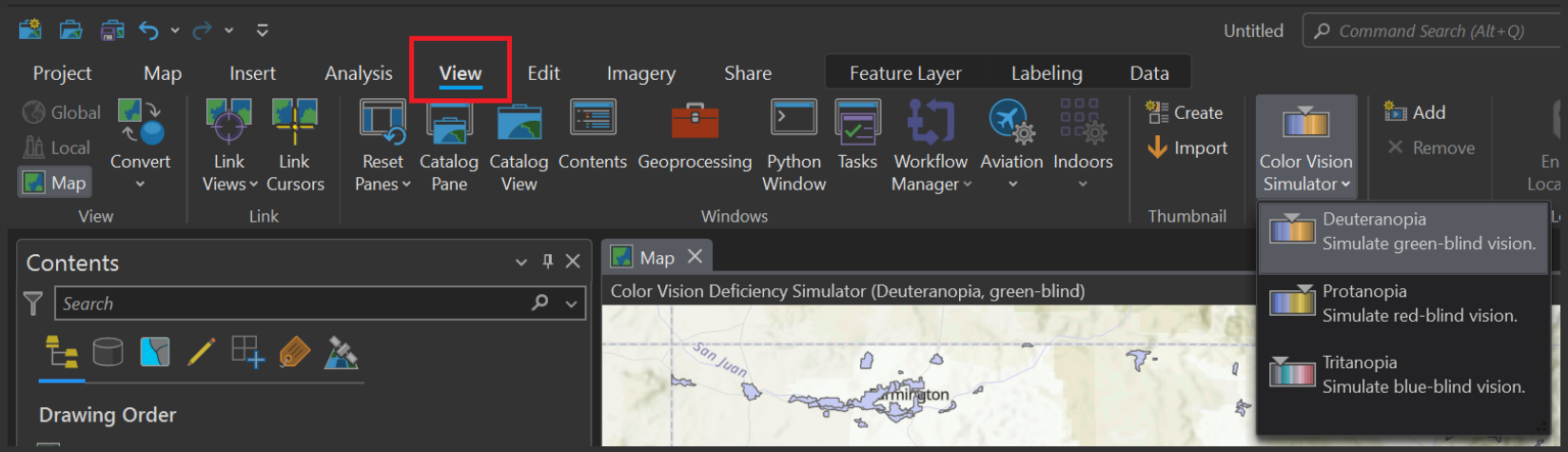
- 75% Plus
- 65% to 75%
- 55% to 65%
- 50% to 55%
- Less than 50%

COLOR BREWER



https://colorbrewer2.org

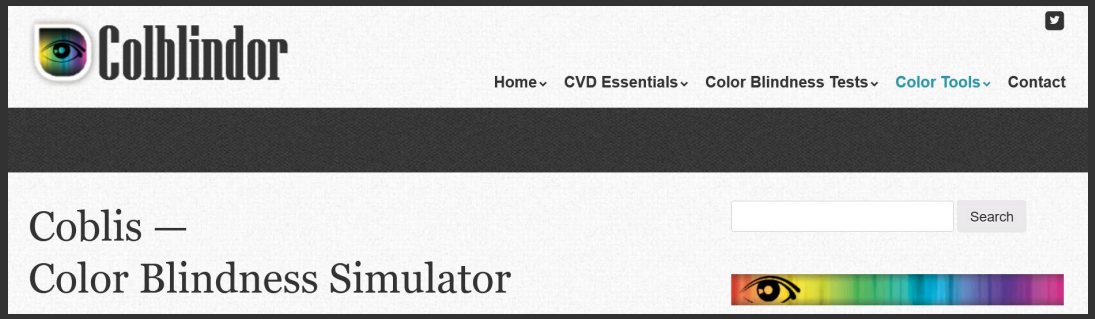
COLOR VISION DEFICIENCY SIMULATOR TOOL



https://pro.arcgis.com/en/pro-app/latest/get-started/color-vision-deficiency-simulator.htm

COBLIS — COLOR BLINDNESS SIMULATOR

- https://www.color-blindness.com/coblis-color-blindness-simulator/

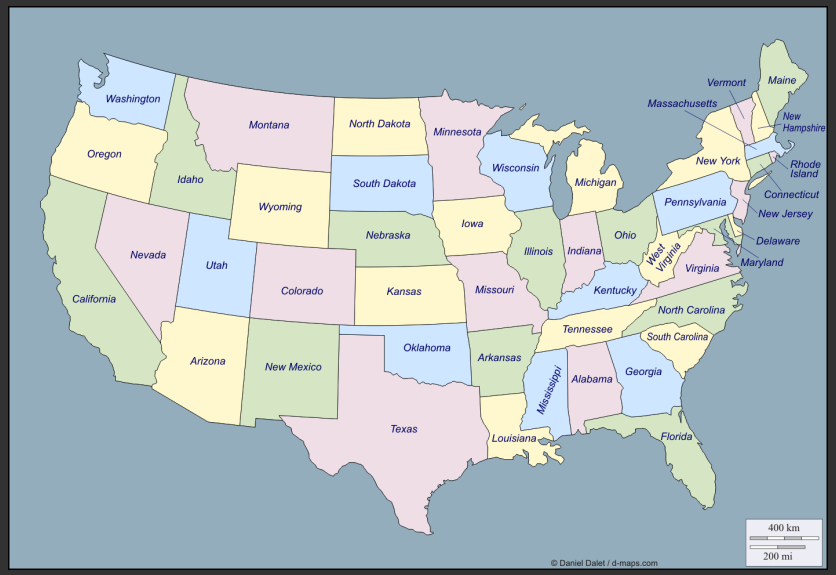


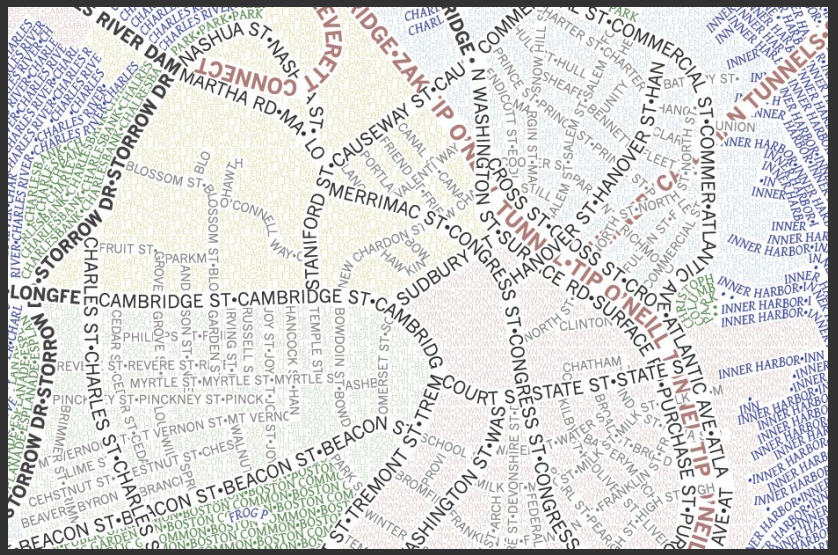
TYPOGRAPHY

Styling and Placement of Text on a map

DEFINITION

- The process of designing and placing type on a map.
- Includes title, source information, and other ancillary text





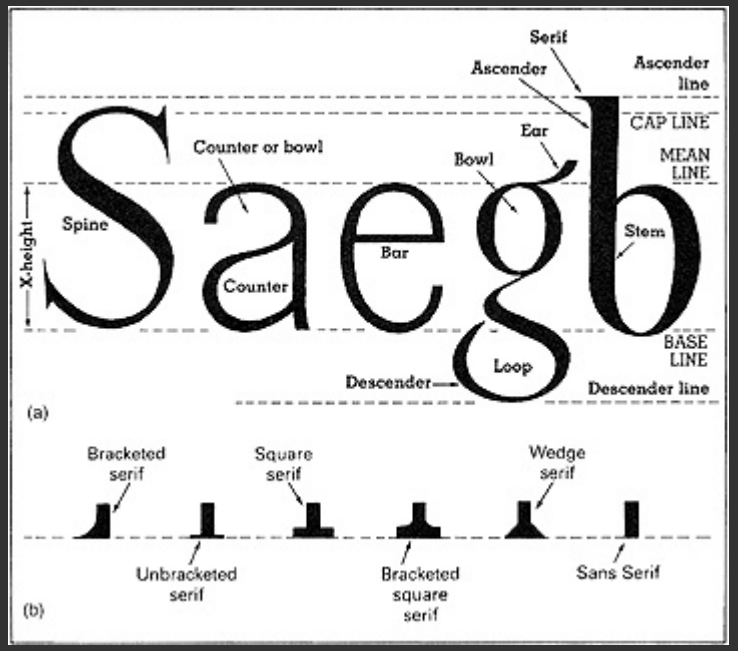
https://www.axismaps.com/blog/2014/11/2nd-edition-of-the-boston-typographic-map/

TYPE CHARACTERISTICS

- Typeface/Font
  - Times New Roman, Arial, Verdana,…
- Type Style
  - Design variation of a typeface
  - Roman (normal), *Italic*, **Bold**, ***Bold Italic***
- Type Size

TYPE ELEMENTS

- Case - UPPERCASE, lowercase, Sentence case, camelCase,…
- Serif and sans serif
- x-height
- Kerning
- S p a c i n g
- Leading



Kerning

Spacing

TEXT CASE

- Title Cases (most commonly used for feature labels)
- Upper case lettering inhibits reading speed and also perceived as "shouting" at the map reader.
- Serif vs. Sans Serif (be consistent with the case selected for same features)
- Word and Letter Spacing (uppercase require word spacing)
- Type to Avoid – Decorative and hard to read types
- Italics – Used for water features, publications in a data source, or for emphasis
- Type Size – reasonable upper and lower limit (easily readable)

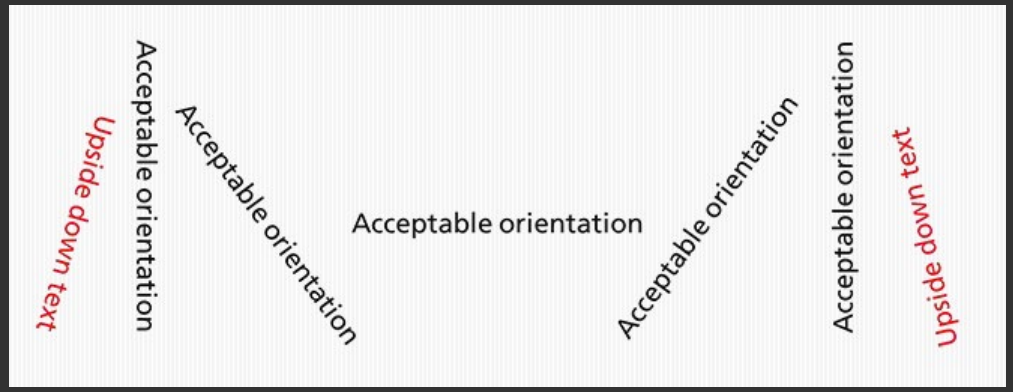
*** Be consistent***

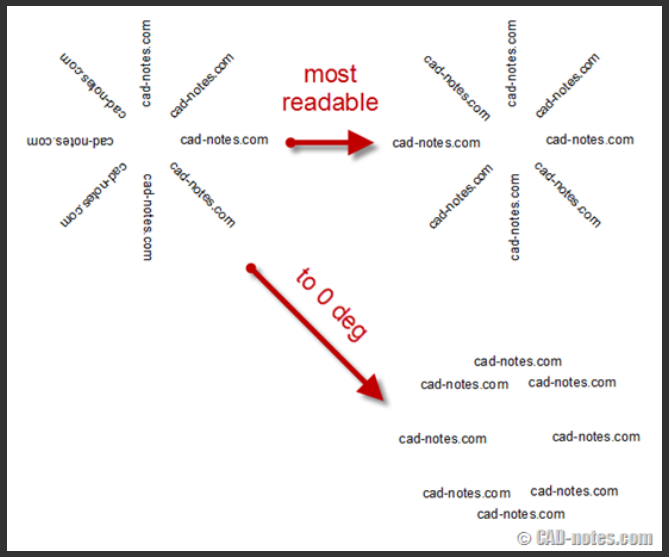
LEGIBILITY

- The characteristic of smooth and easy reading in regard to the design of a typeface and how groups of characters read – *Sinclair 1999.*
- Mask – Same color as the base feature color
- Halo – Different color from the background
- Callout/Leader line
- Spell Check

ORIENTATION

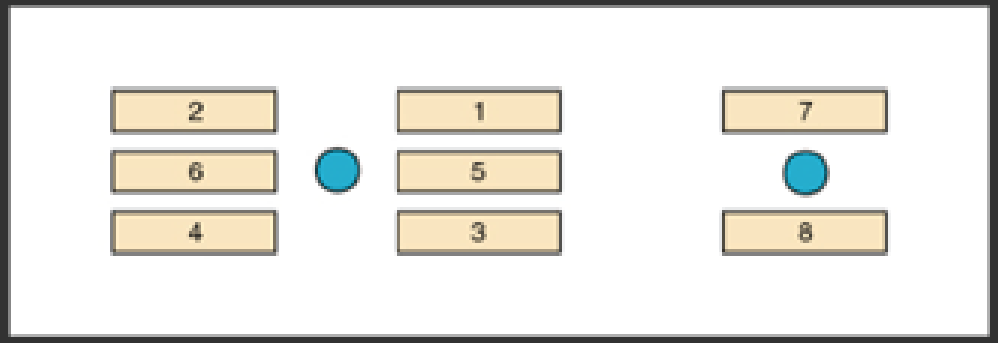
- Type should never be upside down on a map.





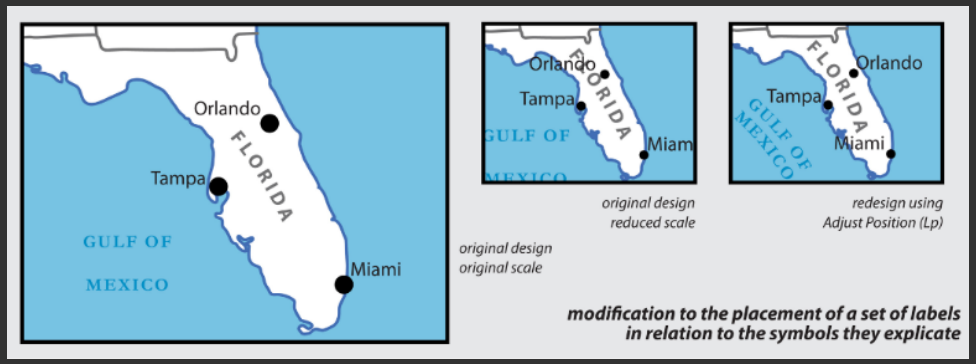
LABEL PLACEMENT

- Labels communicates location information along with identifying the feature
- Time-taking process

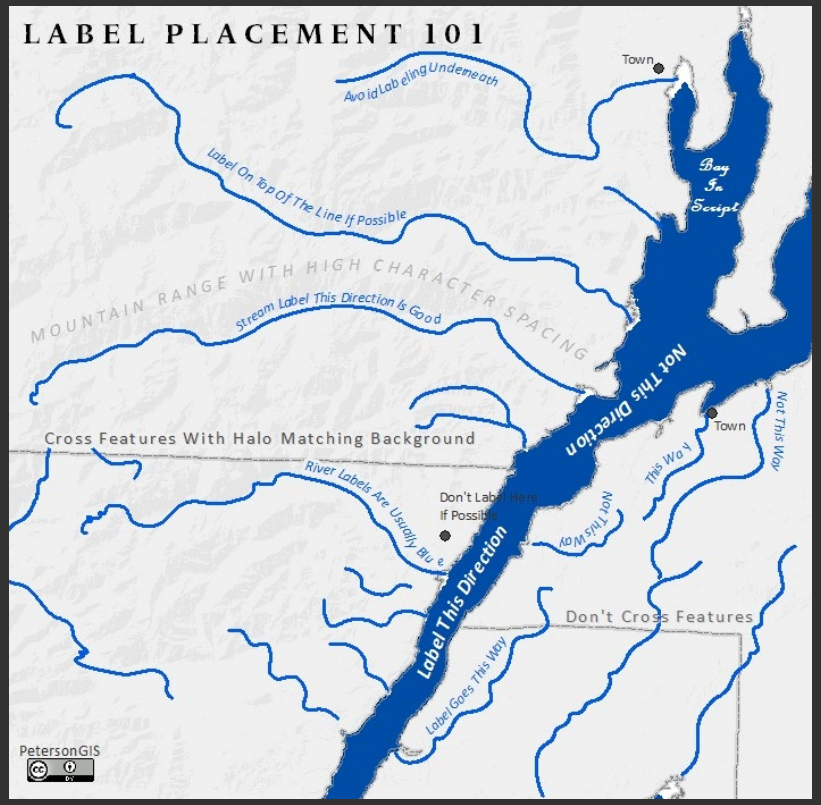


Point label placement priorities (Yoeli 1972). Image Credit https://www.e-education.psu.edu/geog486/

LABEL PLACEMENT



http://cartographicperspectives.org/index.php/journal/rt/printerFriendly/cp68-roth-et-al/18



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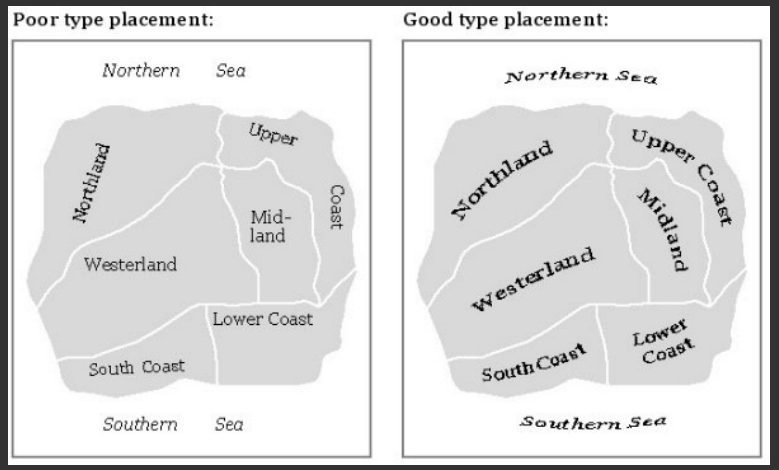

http://go.owu.edu/~jbkrygie/krygier_html/

ESRI Mapping Center

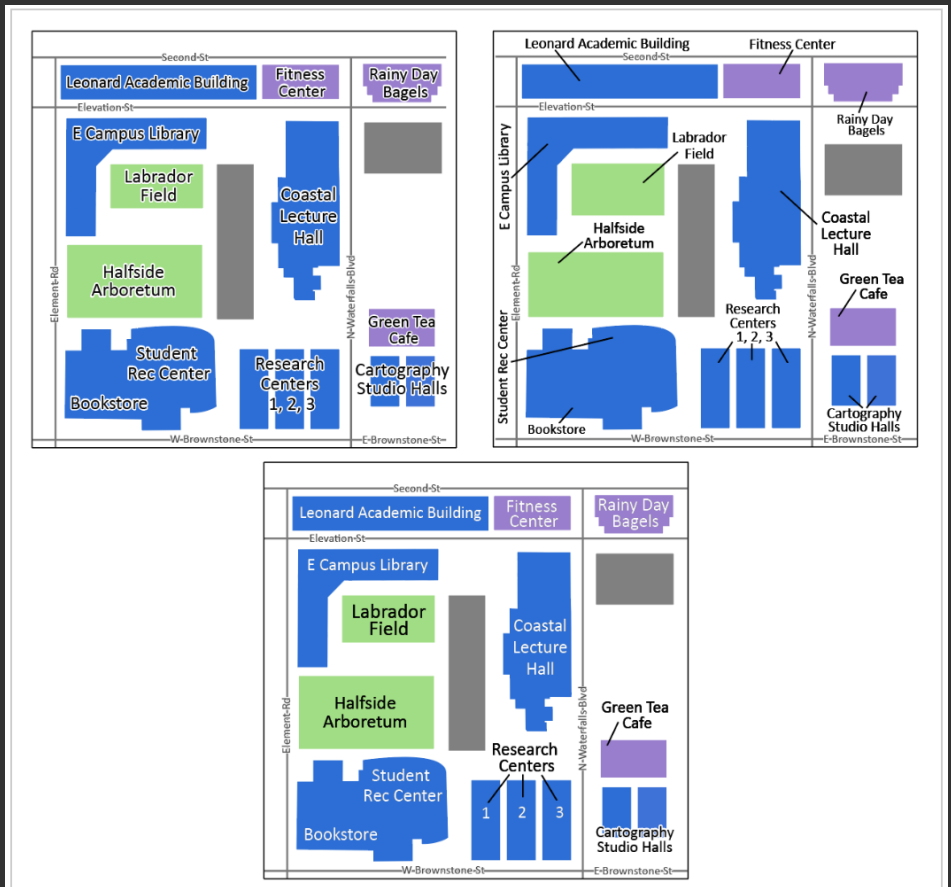

Figure 2.4.13 Techniques for labeling feature-dense locations.

Credit: Cary Anderson, Penn State University.

https://www.e-education.psu.edu/geog486/node/557

Seafloor Map of Hawaii (partial map)

Image credit: Tom Patterson, Shadedrelief.com