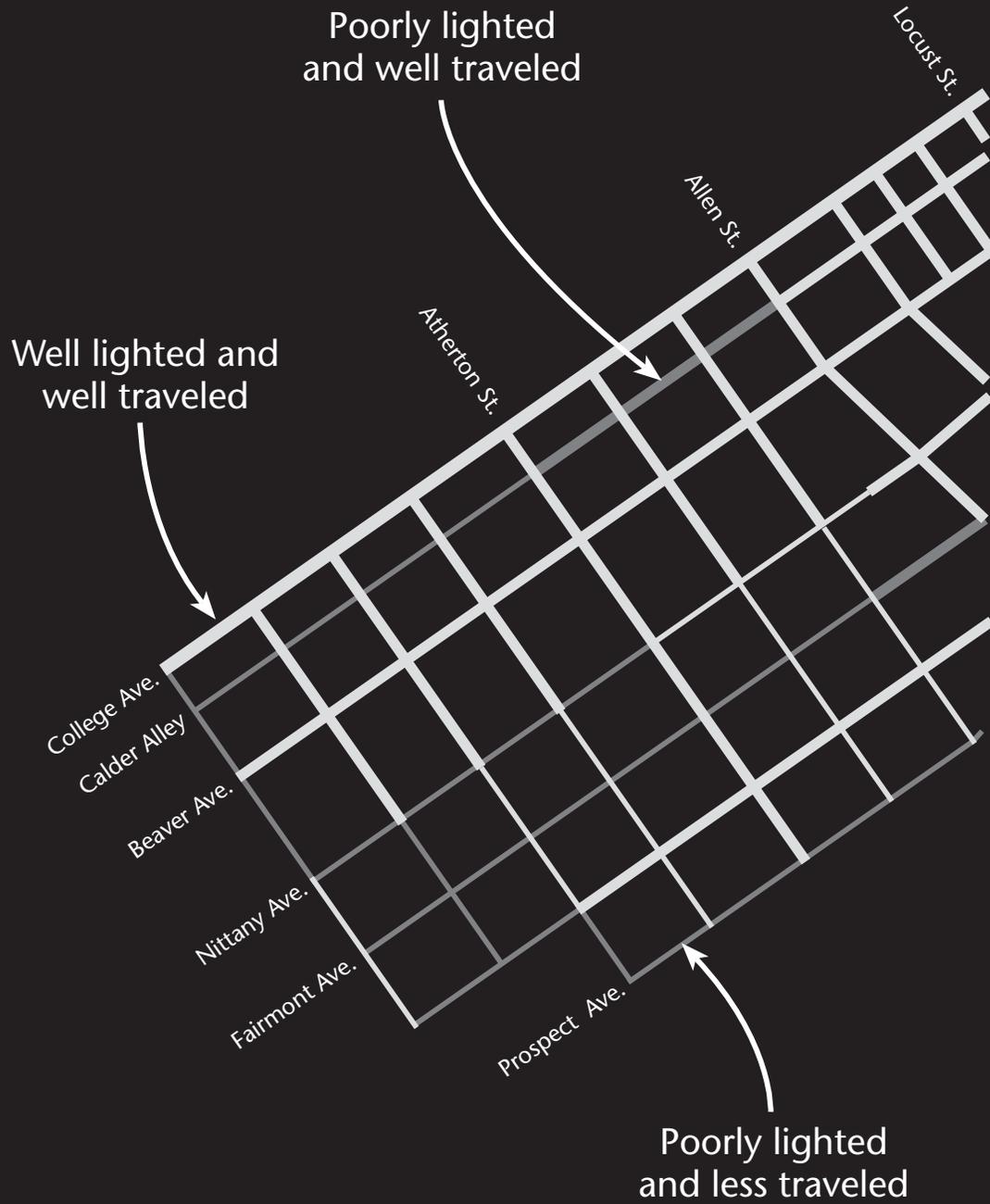
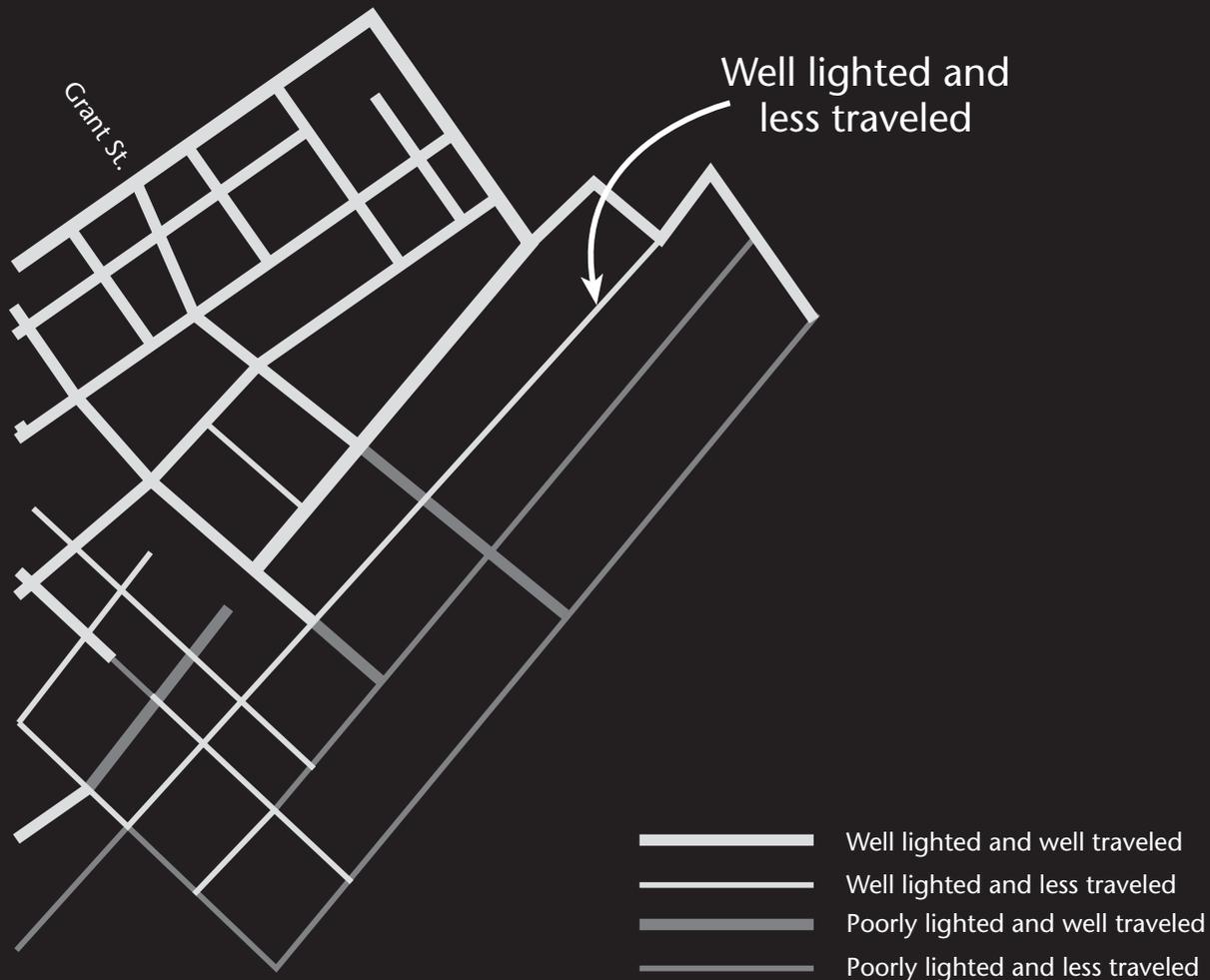




Do you need to move beyond  
black and white?

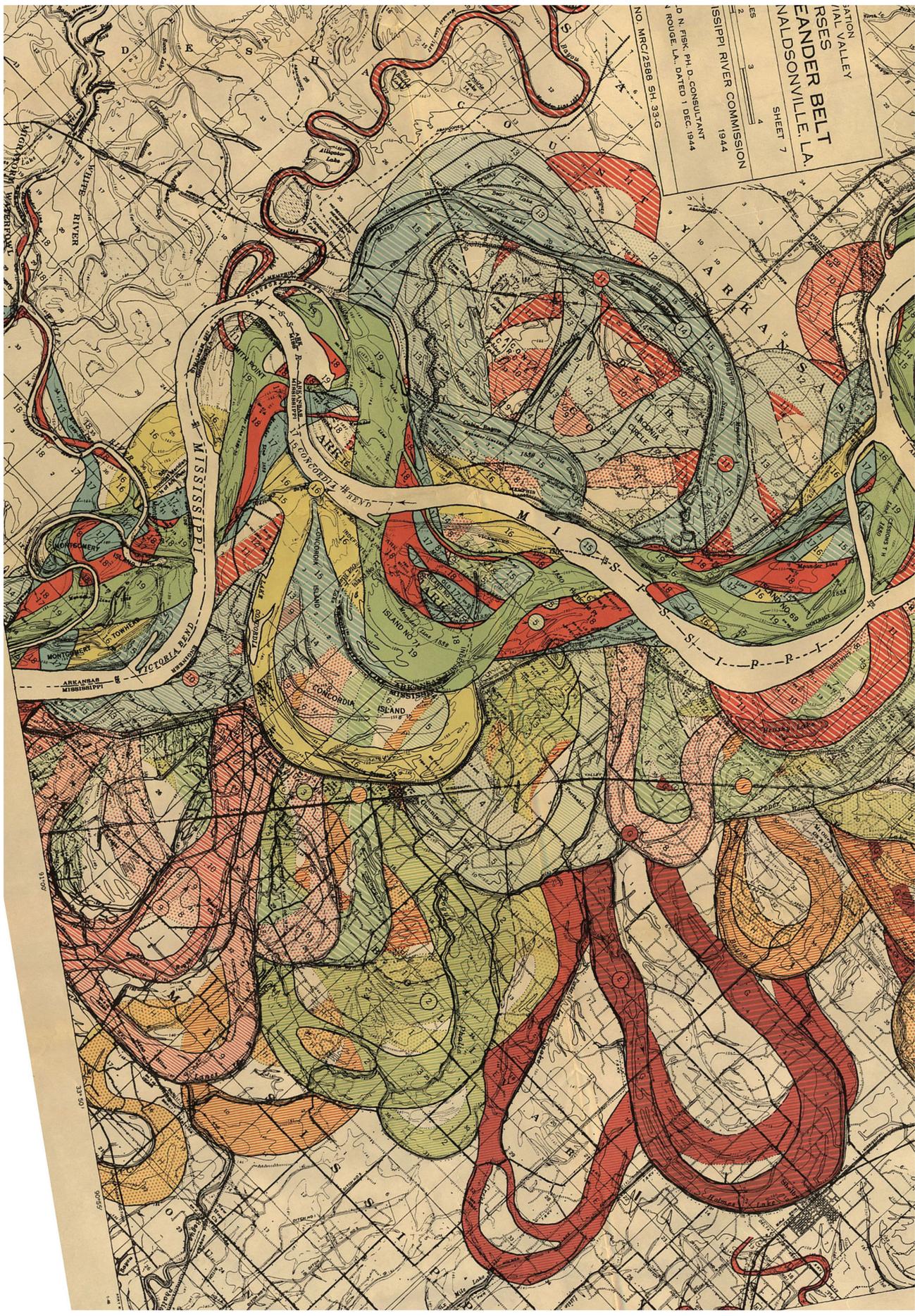




## CHAPTER 11 Color on Maps

You don't need color to make excellent maps. This "night" map of State College, Pennsylvania, shows how well streets are lighted at night and how many people are around. The map helps people choose a safe route, and the map wouldn't do that any better if color were used.

STATION  
VALLEY  
RESERVOIR BELT  
EANDER BELT  
WALDSONVILLE, LA.  
MISSISSIPPI RIVER COMMISSION  
1944  
SHEET 7  
NO. MRC/2588 SH. 33-G  
D. N. FISK, PH. D. CONSULTANT  
ROUGE, LA., DATED 1 DEC. 1944





# Thinking about Color on Maps

Color has a huge impact – positive or negative – on the design of your map. When used well, color vastly extends the effectiveness of your map. When used poorly, it easily draws attention away from your data and your goals for the map. Tufte’s idea of graphical excellence and the visual variables provide ways to think about appropriate color choices on your map.

## Graphical Excellence with Color

“Above all, do no harm” is the adage of Edward Tufte in *Envisioning Information*. Tufte’s color Tufteisms, in part drawing from the work of cartographer Eduard Imhof, serve as a guide to excellence of color use on maps.

Graphical excellence is the well-designed presentation of interesting data – a matter of substance, of statistics, and of design.

Use color with an awareness that adjacent colors perceptually modify each other.

Use strong color for important data in small areas against a muted background.

Use color redundancy to reduce perceptual color shifts and ambiguity.

Use color to distinguish and differentiate features on your map.

Use muted color for less important or background data.

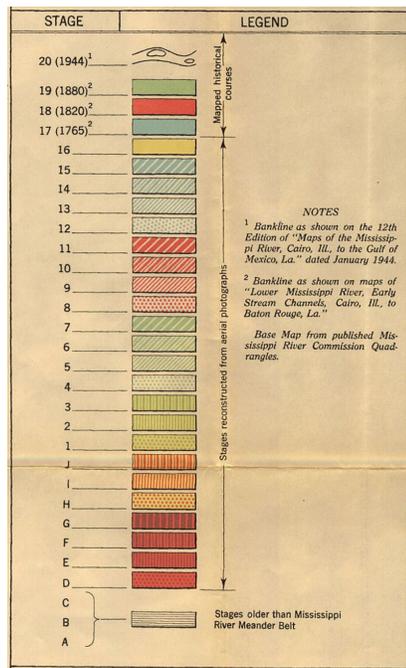
Use color to distinguish order in quantitative data.

Use color to mimic the color of phenomena.

Use muted color over large adjacent areas.

Use color to engage your map’s viewers.

Use color palettes found in nature.



*Ancient Courses, Mississippi River Meander Belt, Cape Girardeau, Missouri, to Donaldsonville, Louisiana, Sheet 7*

Sheet 7 of the *Ancient Courses of the Mississippi River* map series was published in Harold Fisk’s *Geological Investigation of the Alluvial Valley of the Lower Mississippi River* (1944). This spectacular map, expressing engaging data with graphical excellence, reveals changes in the course of the Mississippi River over thousands of years. The map maker differentiates 27 stages of the river. Color (and texture) are used to effectively reveal the tangled knot that is the lower Mississippi. It would be impossible to communicate this complex data without the use of color.

The choice of colors along with the interesting data **engage viewers**, making the subject of fluvial geomorphology seem quite fascinating.

The range of earthy, warm hues used on the map evoke **the phenomena** of ancient river courses.

Color (as well as texture) is chosen to help **distinguish and differentiate** the 27 historical river courses. The challenge is in the sheer number of categories and their complex spatial patterns.



Data of natural phenomena mapped with **natural color palettes** are true to the phenomena, visually engaging, and reveal the complexity of the phenomena.

The **muted** tan background color allows the historical river beds to stand out as the most vital part of this map.

Because the riverbed data are chronological, color value could have been used to **distinguish order**. Instead, the choice was to distinguish qualitative differences, as with the use of color on geologic maps.

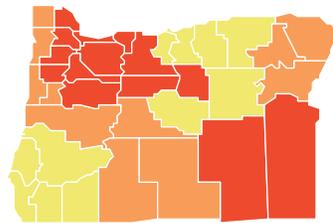
## Visual Variables and Color

Particular color visual variables suggest particular characteristics of your data. Color hue suggests qualitative differences, color value ordered, quantitative differences. These guidelines apply to point, line, and area map symbols.

Mapping Qualitative Data

☹ qualitative colors (value)

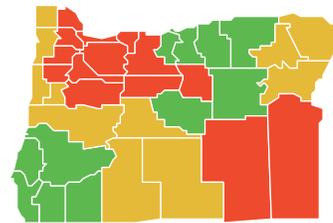
**Favorite Hotdog Condiment**  
Plurality Opinion, Oregon, 2009



■ Ketchup    This value series suggests an order in the data that does not exist  
■ Mustard  
■ Relish

☺ qualitative colors (hue)

**Favorite Hotdog Condiment**  
Plurality Opinion, Oregon, 2009

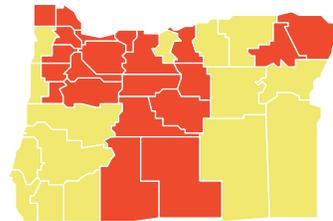


■ Ketchup    Hues suggest no order and reflect actual condiment color  
■ Mustard  
■ Relish

Mapping Binary Data

☹ binary colors (value)

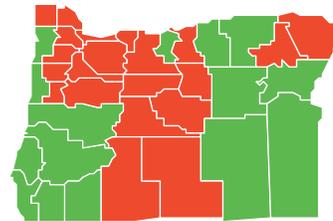
**Jacko Is Dead?**  
Plurality Opinion, Oregon, 2009



■ Yes    This pair of values suggests that Yes opinions are more important than No  
■ No

☺ binary colors (hue)

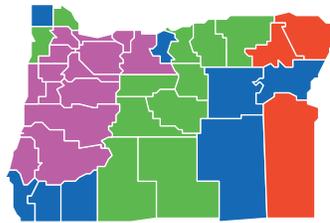
**Jacko Is Dead?**  
Plurality Opinion, Oregon, 2009



■ Yes    Two hues suggest both opinions are important. But are they?  
■ No

☹️ ordered colors (hue)

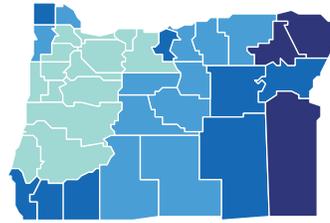
Fallen, Can Get Up  
per 1000 population, Oregon, 2009



<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: red; margin-right: 5px;"></span> 78 to 109</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: blue; margin-right: 5px;"></span> 53 to 68</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: green; margin-right: 5px;"></span> 25 to 47</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: purple; margin-right: 5px;"></span> 2 to 20</li> </ul>	<p>This hue series masks the order in the data</p>
--	--

😊 ordered colors (value)

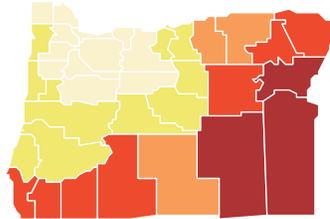
Fallen, Can Get Up  
per 1000 population, Oregon, 2009



<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: darkblue; margin-right: 5px;"></span> 78 to 109</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: blue; margin-right: 5px;"></span> 53 to 68</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: lightblue; margin-right: 5px;"></span> 25 to 47</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: cyan; margin-right: 5px;"></span> 2 to 20</li> </ul>	<p>This value series reveals the order in the data</p>
---	--

☹️ ordered colors (value)

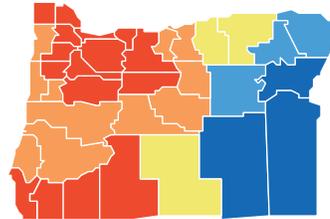
Interested in Worm Rooping  
Percent Change, Oregon, 2000-2009



<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: red; margin-right: 5px;"></span> 26% to 58%</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: orange; margin-right: 5px;"></span> 1% to 25%</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: yellow; margin-right: 5px;"></span> 0 to -99%</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: lightyellow; margin-right: 5px;"></span> -100% to -499%</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: paleyellow; margin-right: 5px;"></span> -500% to -1000%</li> </ul>	<p>This value series does reveal the ordered data, but...</p>
--	---

😊 ordered colors (value)

Interested in Worm Rooping  
Percent Change, Oregon, 2000-2009



<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: blue; margin-right: 5px;"></span> 26% to 58%</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: lightblue; margin-right: 5px;"></span> 1% to 25%</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: yellow; margin-right: 5px;"></span> 0 to -99%</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: orange; margin-right: 5px;"></span> -100% to -499%</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: red; margin-right: 5px;"></span> -500% to -1000%</li> </ul>	<p>A diverging value series reveals the diverging data but may be confusing.</p>
--	--

# Seeing Color on Maps

A diversity of factors, some of which the map maker can control, shape how colors on maps are seen. Attention paid to the light source under which a map is viewed, the surface the map is displayed on, and the basics of human color perception help guide the effective choice of colors when making maps.

## Light Source

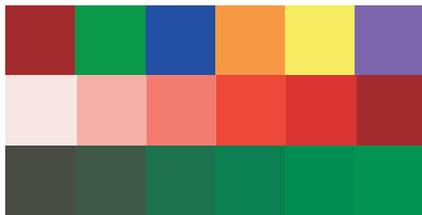
The colors on a map vary as the light source varies. The same colors will look different when viewing a map

Under daylight, incandescent, or fluorescent lighting  
As the intensity of the light varies  
On a computer monitor, which emits light – thus the colors will be brighter and more saturated than on paper maps

When selecting colors for a map, consider the conditions under which your map will be viewed.

Low-intensity lighting: use more intense, saturated colors  
High-intensity lighting: use less intense, less saturated colors  
Computer monitor: use less intense, less saturated colors  
Look critically at your map under lighting conditions similar to those of your map's audience, and adjust the colors to suit

Look at the colors below. Then move to a darker room and look at the colors again. They change. Choose colors for maps that work under appropriate lighting conditions.



## Map Surface

The colors on a map vary as the surface the map is displayed on varies. The same colors will look different when viewing a map

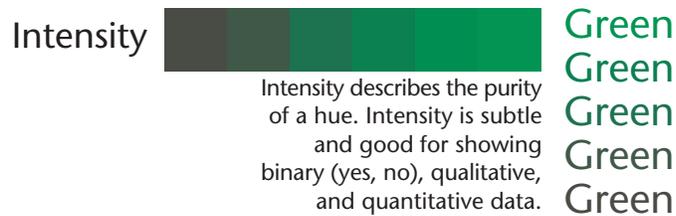
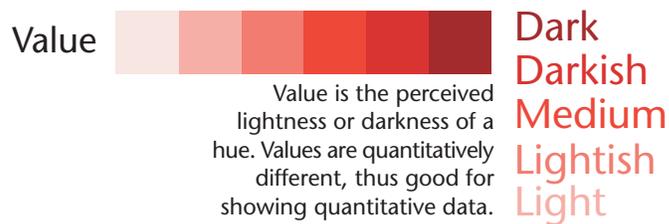
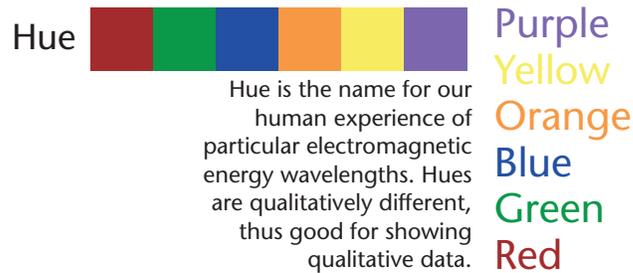
On glossy versus matte-surfaced paper  
On paper versus projected versus on a computer monitor

When selecting colors for a map, consider the effect of the map surface.

Glossy paper will make colors more intense and vibrant  
Matte paper will make colors less intense and dulled  
Projectors, depending on the intensity of the bulb, may reproduce colors much more or less intense than you expect  
Computer monitors will make colors intense and vibrant, as the color on computer monitors is emitted rather than reflected (as is the case with paper)  
Look critically at your map on the medium the map will be presented on, and adjust the colors if necessary

## Color Dimensions

Our eyes are sensitive to blue, green, and red wavelengths of energy with overlap so we can sense the entire spectrum (red, orange, yellow, green, blue, indigo, violet). One way to think about how people perceive colors is in terms of three dimensions of color perception: hue, value (lightness), and intensity (saturation, chroma).

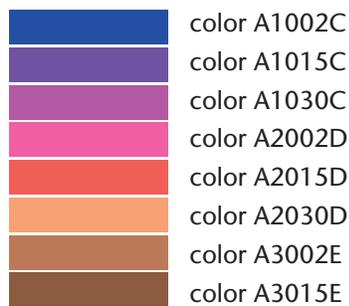


# Creating Color on Maps

The specification and production of colors are often very different from the way in which we see them. Color specification systems are schemes that organize and help produce different colors. There are many different color specification systems, and map makers will encounter many of them. Three major categories of color specification systems are important: predefined color systems, perceptual color systems, and process color systems.

## Predefined Color

Predefined color specification systems are like paint chips from the paint store. Thousands of predefined colors are specified by names or codes. Predefined colors ("spot" colors) are used by some commercial printers and are commonly used when mapping data with set color conventions (such as on geology maps).

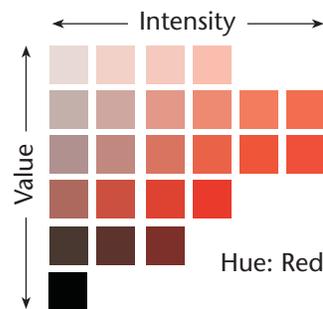


Predefined colors will be converted to another color system when printing on a computer printer or when using a commercial printer who uses process color.

Pantone is a common predefined color system used in mapping.

## Perceptual Color

Perceptual color specification systems, such as Munsell, are based on human perceptual abilities. Perceptual tests have produced a set of colors that the average person can differentiate. Thus, no two colors in the Munsell system look exactly alike. The Munsell system consists of a series of color samples, each a single hue with varying value and intensity.

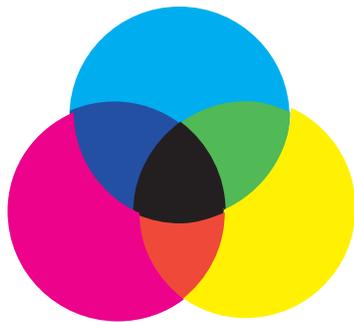


The Munsell system is excellent for selecting appropriate colors for your map, but it will be converted to another system in order to print.

Munsell colors are used as the basis of the ColorBrewer site ([colorbrewer.org](http://colorbrewer.org)) created by Cindy Brewer and Mark Harrower. The site converts Munsell colors into other color specification systems so you can easily use the colors in most mapping software.

## Process Color: Printing

Process color specification systems use three or four colors to create all other colors. Printed colors typically use the subtractive primaries and rely on reflected light. When you combine cyan (C), magenta (M), and yellow (Y), you produce black – all light is absorbed (subtracted) from your vision. Thus cyan, magenta, and yellow are the subtractive primaries.

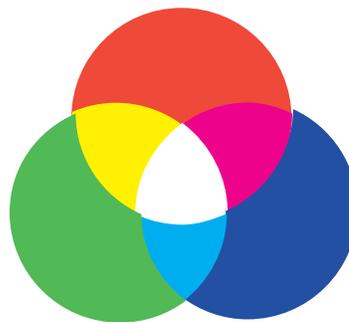


Black is added as a fourth “color” (K, thus CMYK) to avoid the muddy dark brown that is the result of combining cyan, magenta, and yellow.

Subtractive primaries are often used by commercial printers and are common on inkjet computer printers. Different amounts of CMY and K produce thousands of other colors. The CMYK color system should be used for most commercially printed maps.

## Process Color: Monitors

Computer monitors also use three colors to create all other colors. Monitor colors typically create color with the additive primaries and rely on emitted light. Because the light is emitted, the colors are more intense. When you combine red (R), green (G), and blue (B), they add up to pure white. Thus red, green, and blue are the additive primaries.



The hexadecimal color specifications used in HTML (hypertext markup language) are RGB. The first two digits are red, second two digits green, and third two digits blue. 00 is no color and FF is maximum color.

The RGB color system should be used for maps printed with computer printers. RGB will have to be converted into CMYK or predefined color if you plan to print with a commercial printer.

# Complicating Color on Maps

The use of color on maps is complex: colors interact with surrounding colors, there are perceptual differences among map viewers, and color has symbolic connotations.

## Color Interactions

The appearance of any color on a map depends on surrounding colors. This optical illusion, called simultaneous contrast, makes the left gray dot (below) look slightly darker than the right gray dot (for most people).



Different colors can also look the same, depending on their background. Color subtraction makes the two small squares below look similar.



Yet, they are not.



If the background of a map has varying colors, check that symbols that are supposed to be the same color look the same everywhere on the map.



Carefully consider the visual difference between different colors on your map. If you intend for your map to distinguish specific data from other data, use colors that have a high visual difference. Less visual difference is useful if your goal is to suggest less difference between data.

## Perceptual Differences

The appearance of color on a map varies, depending on the particular eye-brain system looking at it.

### Older map viewers

- Benefit from more saturated colors
- Have particular difficulty in differentiating shades of blue
- Benefit from increasing the type size a bit

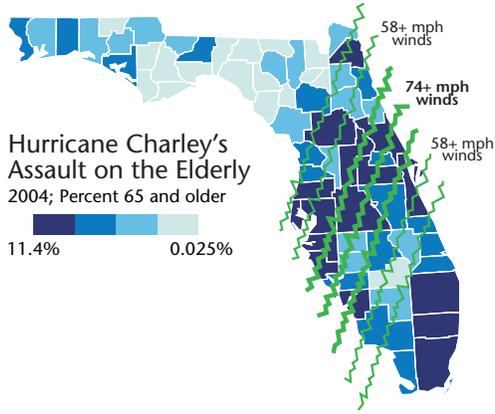
### Younger map viewers

- Like brighter, saturated colors – but not too saturated
- Dislike dull, gray, or mixed colors like brown
- Perform tasks well with maps that use saturated and unsaturated colors
- Understand quantitative, ordered data shown with color value by age 7 or 8

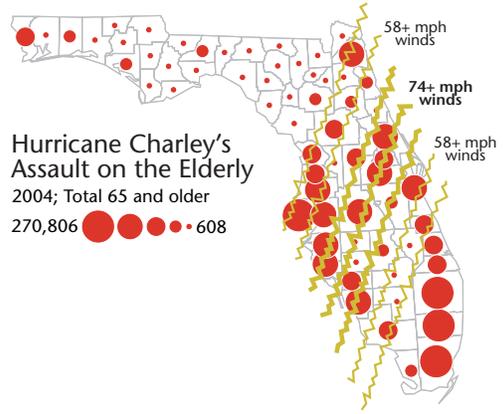
Color-blind viewers typically see red and green as the same. In the U.S., 3% of females and 8% of males are color-blind.

- If reds and greens show important differences on your map, a significant number of viewers will not see these differences
- Consider using reds and blues or greens and blues instead
- Check internet resources for selecting color-blind safe colors

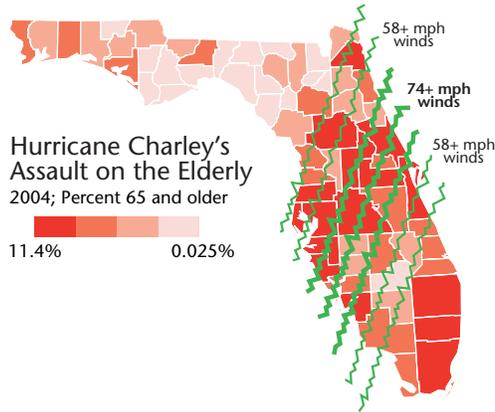
☹️ for older viewers



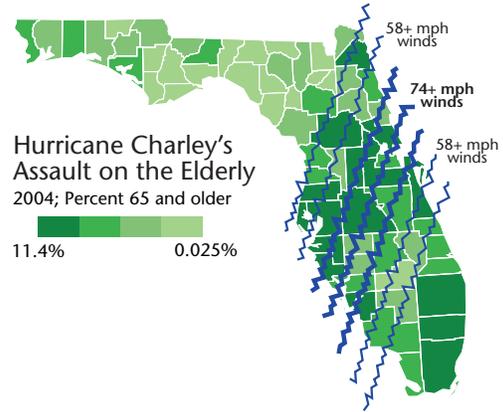
😊 for older viewers



☹️ for color-blind viewers



😊 for color-blind viewers



## Symbolic Color Connotations

Color has symbolic connotations. Such connotations subtly shape viewer reactions and should be guided by your goals for your map. Generic Western cultural color connotations include:

**Blue:** water, cool, positive numbers, serenity, purity, depth

**Green:** vegetation, lowlands, forests, youth, spring, nature, peace

**Red:** warm, important, negative numbers, action, anger, danger, power, warning

**Yellow/tan:** dry, lack of vegetation, intermediate elevation, heat

**Orange:** harvest, fall, abundance, fire, attention, action, warning

**Brown:** landforms (mountains, hills), contours, earthy, dirty, warm

**Purple:** dignity, royalty, sorrow, despair, richness, elegant

**White:** purity, clean, faith, illness, life, clarity, absence, light

**Black:** mystery, strength, heaviness, death, nighttime, presence

**Gray:** quiet, reserved, sophisticated, controlled, light, bland, dull

## Cultural Color Connotations

The symbolic connotations of different colors varies from culture to culture, further complicating the use of color on maps. Check for cultural color connotations if you are mapping for a global audience.



**Blue:** safe cross-cultural color, because it is the color of the sky, which stands over all peoples



**Green:** fertility and paganism in Europe, sacred for Muslims, mourning and unhappiness in Asia



**Red:** Bolsheviks, communists, and other politically left organizations, purity in India



**Yellow/tan:** peaceful resistance movement associated with Carazon Aquino in Philippines



**Orange:** pro-Western activists in Ukraine, Protestants in Ireland, sacred Hindu color



**Brown:** mourning in India, Nazis in West, ceremonial for Australian Aboriginals



**Purple:** death and crucifixion in Europe, mysticism, prostitution in the Middle East



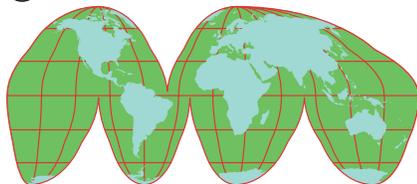
**White:** unhappiness in India, mourning in China, royalists and traditionalists in Western

**Black:** fascists, anarchists, and other extremists in Western world, death, mourning in West



**Gray:** corporate culture in the West (also blue), dead and dull in Feng Shui

☹️ color conventions



😊 color conventions

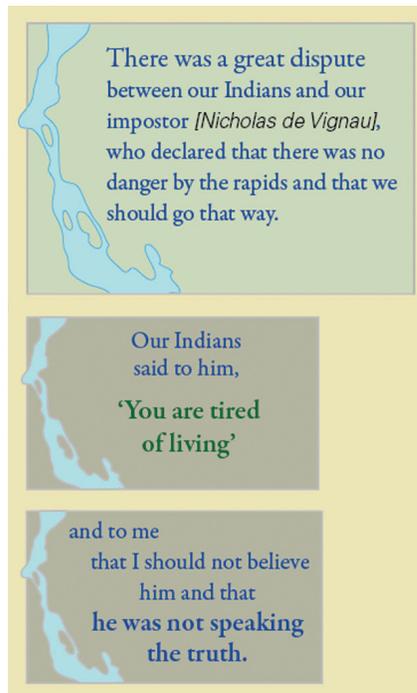


# Emotion, Experience, and Color on Maps

Color used as mere decoration on maps is an agnostic sin. With a critical eye cast upon the conventions of traditional maps, Margaret Pearce and Michael Hermann designed and produced a narrative map of the travels and experiences of Samuel de Champlain in Canada. Their goal, to design a map expressing the emotions, voices, and multiple experiences of Champlain, his men, and indigenous peoples: interesting data and complex ideas presented with clarity and intelligence. Graphical excellence with color.

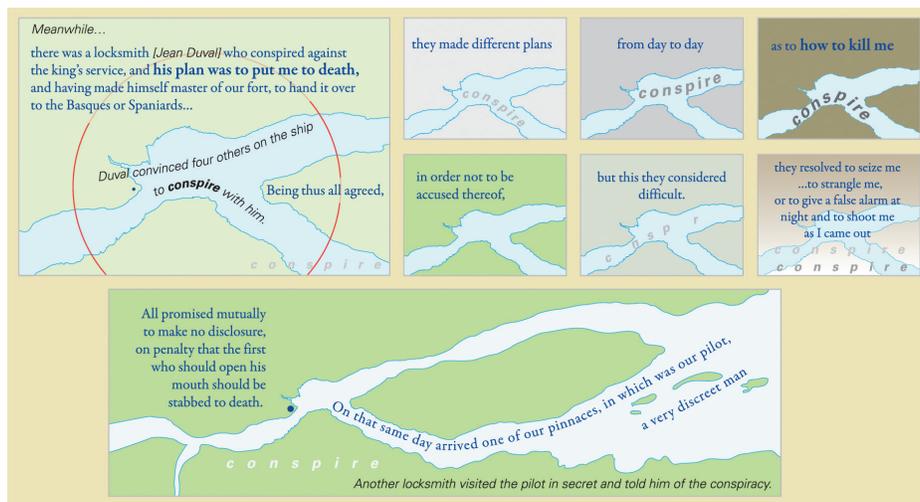
## Color and Experience

Different voices and experiences lead to different maps of the same place, issue, or phenomenon, or you can embed them in one map. Pearce and Hermann use color hue (right) to map the multiple voices and experiences in the Champlain narrative. Champlain in blue, indigenous people in green, and the voice of the map maker, from a future time and place, in gray.



## Color and Emotion

Color is emotive: angry red, calm green, depressed gray, happy yellow. Pearce and Hermann use color hue to express shifting emotions from panel to panel on the Champlain map. Below, Champlain learns of an assassination plot against him, and the colors differentiate the different voices and shifting emotions of Champlain and the assassins.



If we don't want to see the map of Central America covered in a sea of red, eventually lapping at our own borders, we must act now.

Ronald Reagan (1986)

*Fozzie Bear:* Kermit, where are we?

*Kermit the Frog:* [looking at a map] Well, let's see. We're just traveling down this little black line here, and uh, just crossed that little red line over here.

*Fozzie Bear:* [takes his eyes off the road to focus on the map] Look, why don't we just take that little blue line, huh?

*Kermit the Frog:* We can't take that. That's a river.

*Fozzie Bear:* Oh. I knew that.

*Kermit the Frog:* Yeah, sure.

*The Muppet Movie* (1976)

I do not advance that the face of our country would change if the maps which Philadelphia sends forth all over the Union were more decently colored, but certainly it would indicate that the Graces were more frequently at home on the banks of our lovely rivers, if the engravers were able to sell their maps less boisterously painted and not as they are now, each county of each state in flaming red, bright yellow, or a flagrant orange dye, arrayed like the cover produced by the united efforts of a quilting match. When I once complained of this barbarous offensive coloring of maps, the geographer assured me that he would not sell them unless bedaubed in this way; "for," said he, "the greatest number of the large maps are not sold for any purpose of utility, but to ornament the walls of barrooms. My agents write continually to me to color high." This reason was given me by one of the first geographers of the United States, who has himself a perfectly correct idea of the tasteful coloring of maps.

Francis Lieber, "On Hipponomastics: A Letter to Pierce M. Butler," *Southern Literary Messenger*, 3:5 (1837).  
Thanks to Penny Richards for this quote.

## More...

Cindy Brewer's research on color for maps has been integrated into the very useful [colorbrewer.org](http://colorbrewer.org) website. It is a great way to select effective color for maps.

A great article on natural color maps is Tom Patterson and Nathaniel Vaughn Kelso's "Hal Shelton Revisited: Designing and Producing Natural-Color Maps with Satellite Land Cover Data," available with a bunch of other cool stuff at the [shadedrelief.com](http://shadedrelief.com) website.

Color Oracle is a very useful free software application that simulates three types of color blindness on your computer screen ([colororacle.cartography.ch](http://colororacle.cartography.ch)).

Edward Tufte engages color in all of his books, including a whole chapter on "Color and Information" in *Envisioning Information* (Graphics Press, 1990).

For some solid background on the history and theory of color: John Gage, *Color and Culture: Practice and Meaning from Antiquity to Abstraction* (University of California Press, 1999) and *Color and Meaning: Art, Science, and Symbolism* (University of California Press, 2000); and Charles A. Riley II, *Color Codes: Modern Theories of Color in Philosophy, Painting and Architecture, Literature, Music, and Psychology* (University Press of New England, 1995).

*Sources:* The State College night map was redrawn from the original created in the Deasy GeoGraphics Lab (now the Gould Center) at Penn State. The *Ancient Courses, Mississippi River Meander Belt* maps are available in digital form from the *Lower and Middle Mississippi Valley Engineering Geology Mapping Program* ([lmvmapping.erd.usace.army.mil](http://lmvmapping.erd.usace.army.mil)). The idea for the hurricane maps came from a map published in the *News & Observer* (Raleigh-Durham, NC) on August 19, 2004. Excerpts of Pearce and Hermann's map "They Would Not Take Me There: People, Places and Stories from Champlain's Travels in Canada, 1603-1616" are used by permission. See Margaret Pearce and Michael Hermann, "Mapping Champlain's Travels: Restorative Techniques for Historical Cartography." 2010. *Cartographica* 45:1, pp. 32-46. The map is available from the Canadian-American Center at the University of Maine ([www.umaine.edu/canam](http://www.umaine.edu/canam)).

