

GIS Cartography

A Guide to Effective Map Design

Gretchen N. Peterson



CRC Press
Taylor & Francis Group

Second Edition

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*A guide to
effective map
design*

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Chapter 1

Introduction

Scale



Small Scale



Medium Scale



Large Scale

Good design matters

Chapter 2

Creative inspiration

Your creativity

- Participate in other kinds of creative work such as drawing
- Visit art museums - a great source of inspiration
- Look at maps you like and note the specifics that draw you to that map

Chapter 3

Layout design

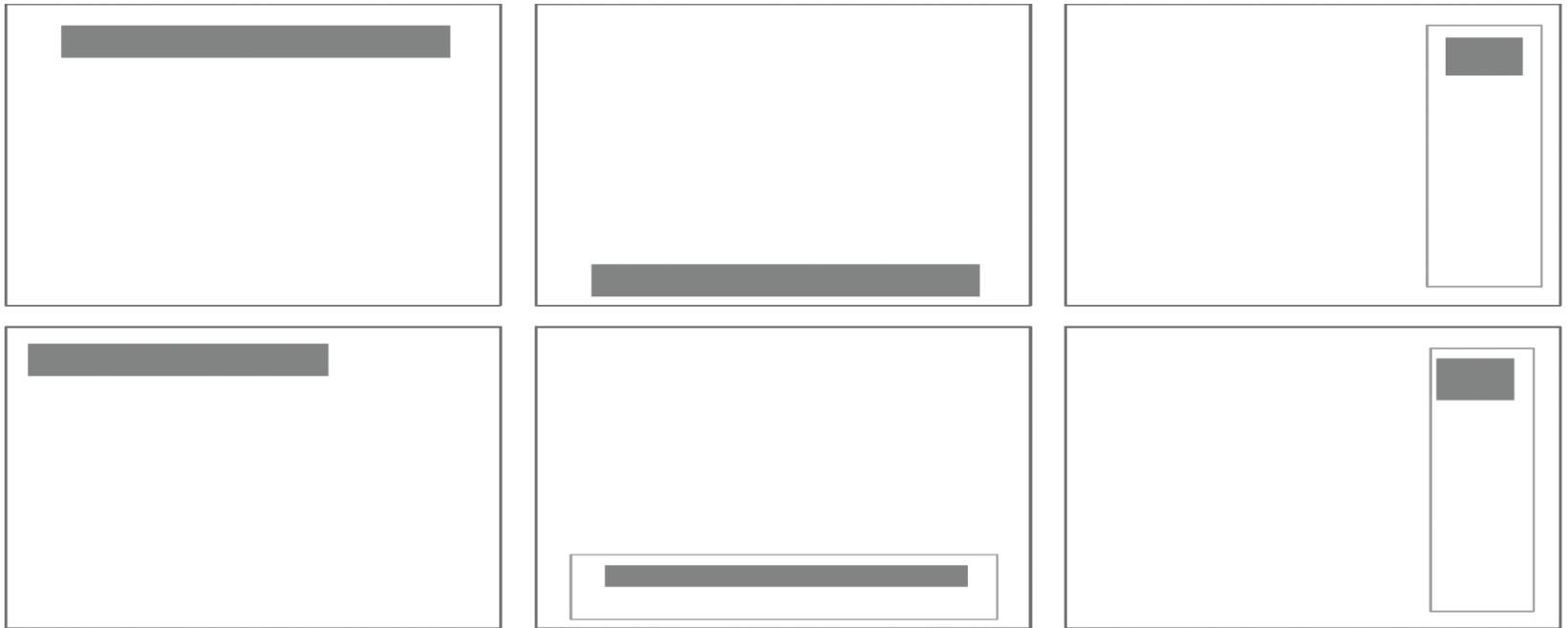
Which is the better title?

**Schmoe County Land Consortium's Analysis of Purple
Toad Habitat in Northwest Hooktown**

OR

Purple Toad Habitat Greater Than Previously Thought

Map Title Placement Options



Bringing the title to life examples

Estimating Impervious Cover Under Full Buildout

: Riverine Habitat Inventories (leading dots)

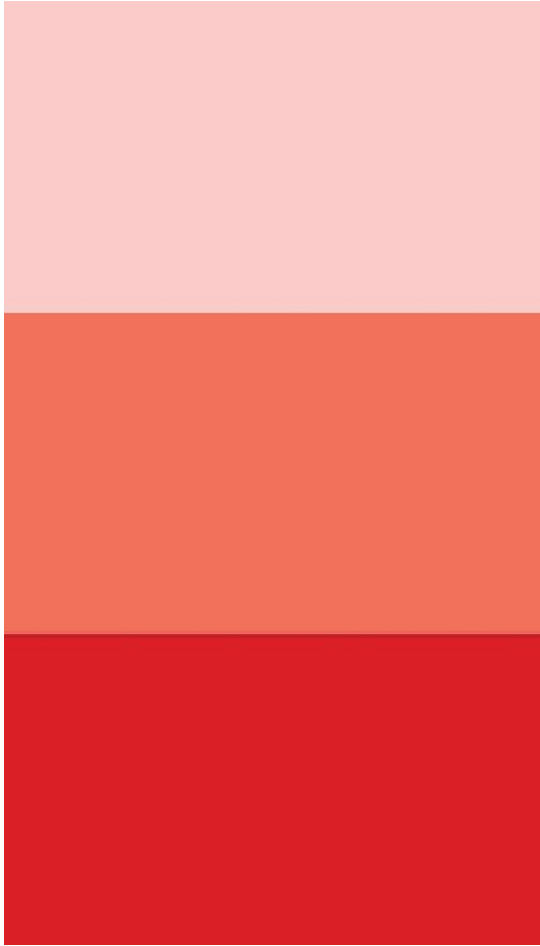
Best Sites For Ground Mounted Solar Systems

Fast Food Chains Per Capita

D I S A P P E A R I N G B I R D S

(expanded character spacing)

Legend color gradient; choropleth



No white space between gradient colors



Legends

MAP KEY

OWNERSHIP



-  National Forest
-  National Park
-  State
-  Federal

- ★ Places
-  Highways
-  Hydrology

MAP KEY

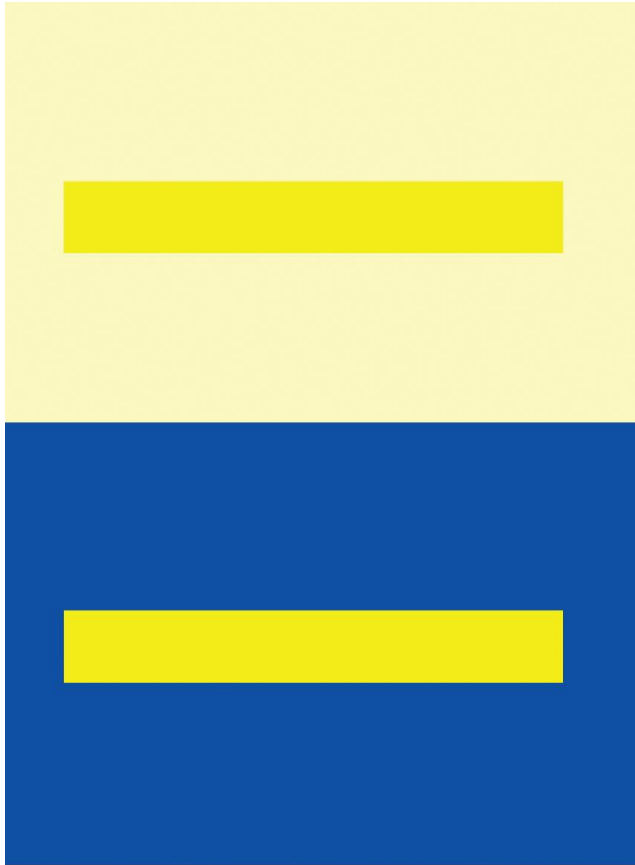
OWNERSHIP

-  National Forest
-  National Park
-  State
-  Federal

- ★ Places
-  Highways
-  Hydrology

Less clutter
here; title
can be
omitted,
also

Chromatic contrast



Matching background
color of legend to map
background color
assures other colors
will appear the same

North arrow

- Keep the north arrow small, simple and unobtrusive for most modern layouts
- Do not include a north arrow on any map that uses a spherical projection

Other elements

- Frame
- Date
- Authorship

Scale bars

Compact Form:



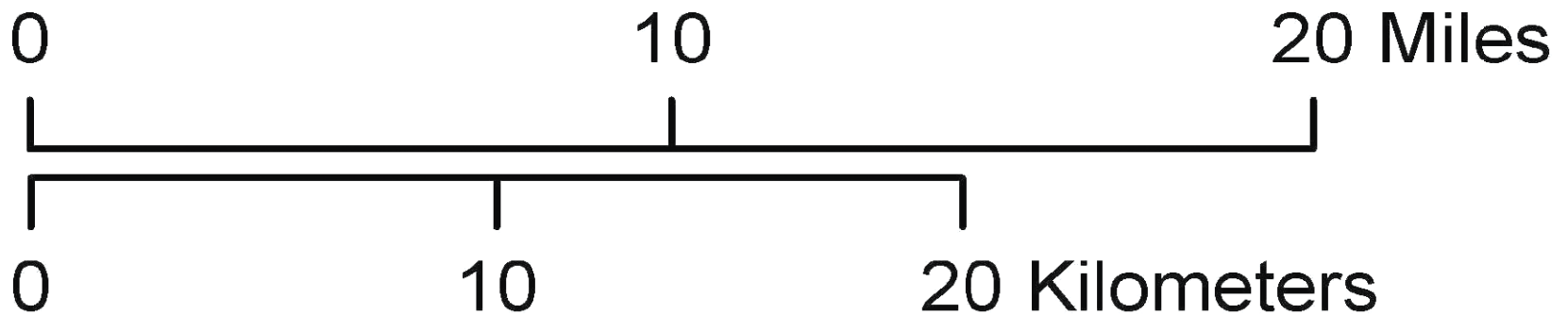
Linear Form:



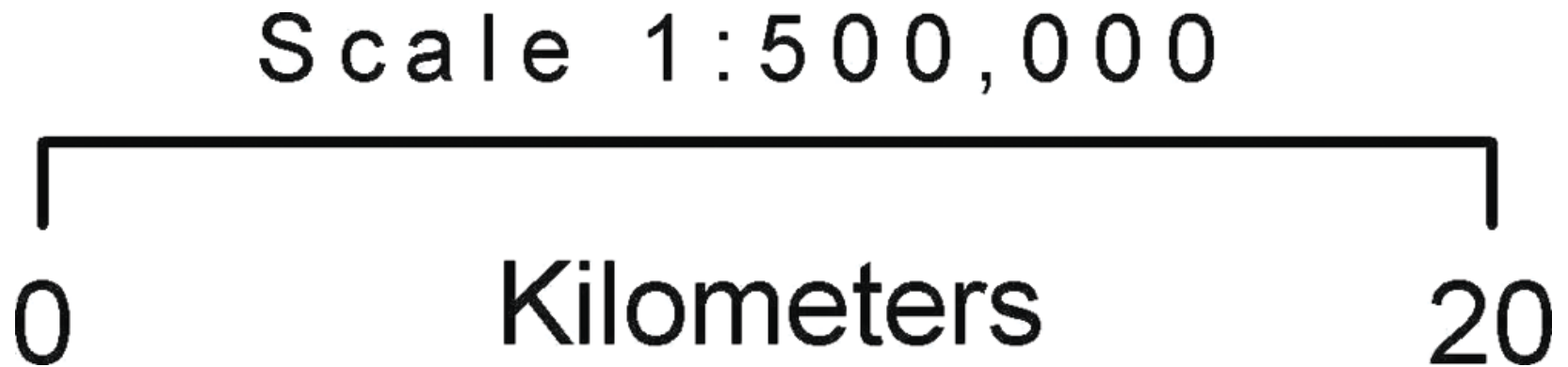
Compact form is more modern

When 2 scales are required



Place them close together



Scale bar with a representative fraction



Other scale types

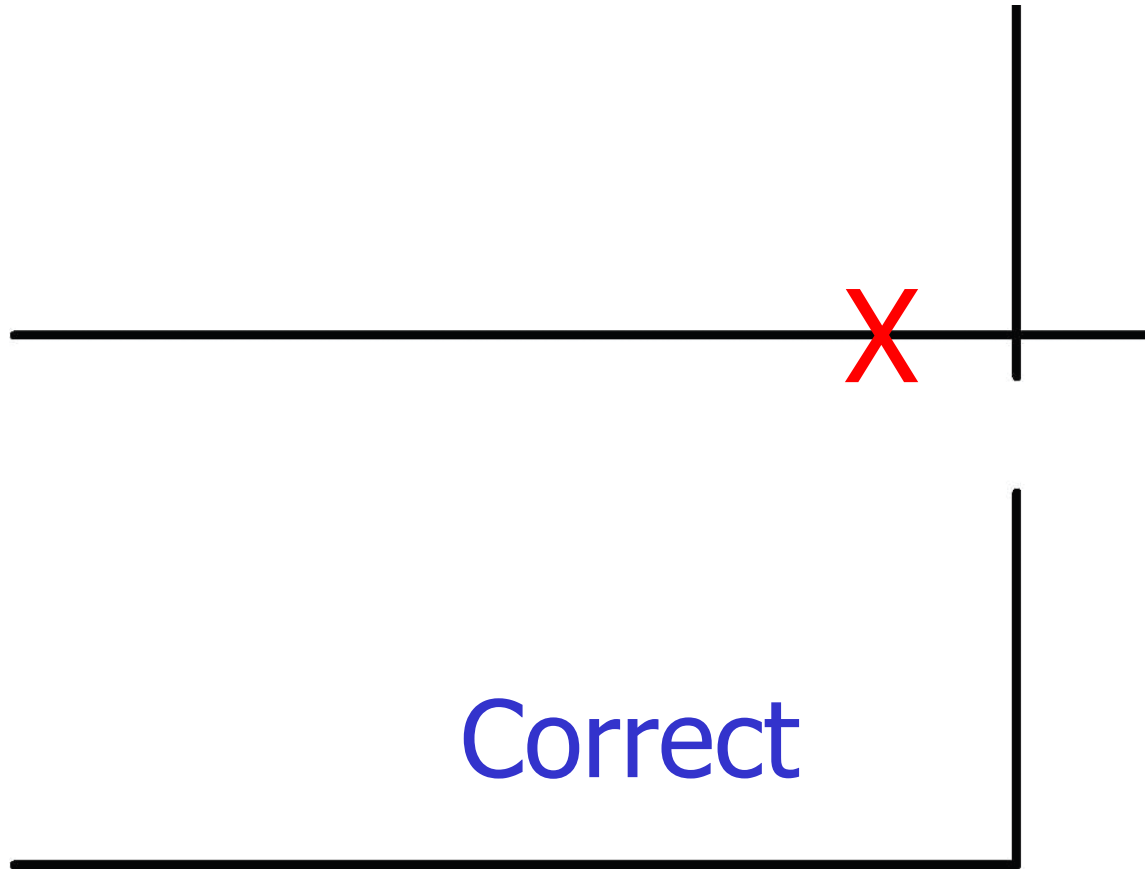
1 Square Kilometer  1 Kilometer Radius 

Architectural margin boxes



Less visual clutter in this example

Lines must snap together



Graticules on a navigational map



Placed
beneath the
land masses

Network path

\\ServerName\Share\ProjectResults\ConferencePoster

For internal workgroup use or to refer
public to a public data repository

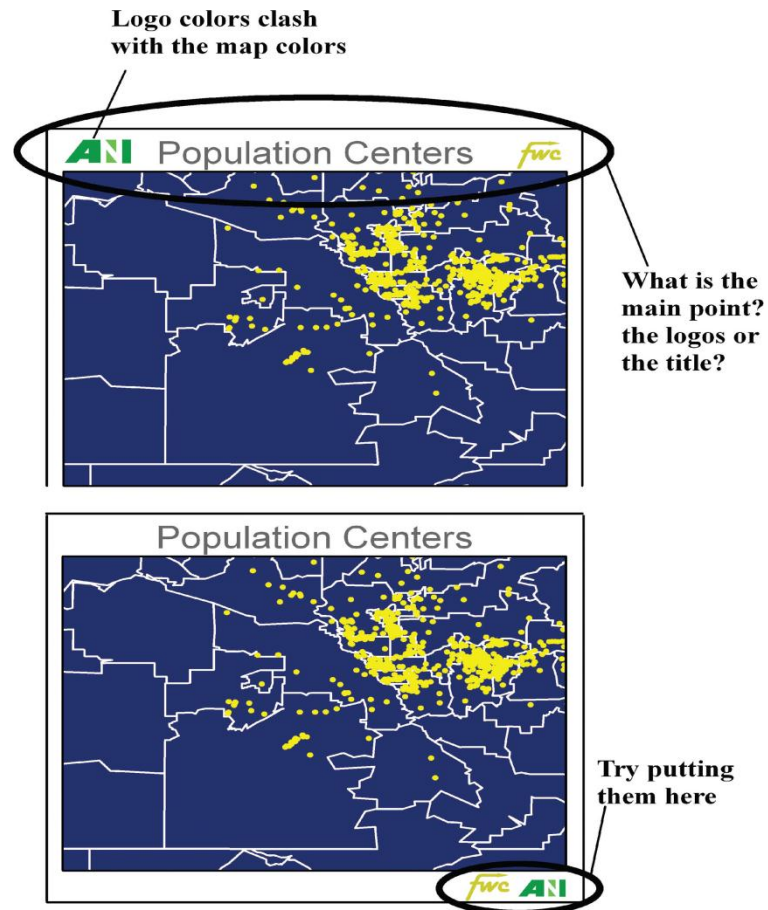
Data sources information

High altitude aerial photo courtesy of the U.S.
Geological Survey's Earth Resources
Observation and Science data center

Elevation courtesy of the National Agriculture
Imagery Program; 2006 imagery

No abbreviations used (except U.S. for
United States) – avoids confusion later

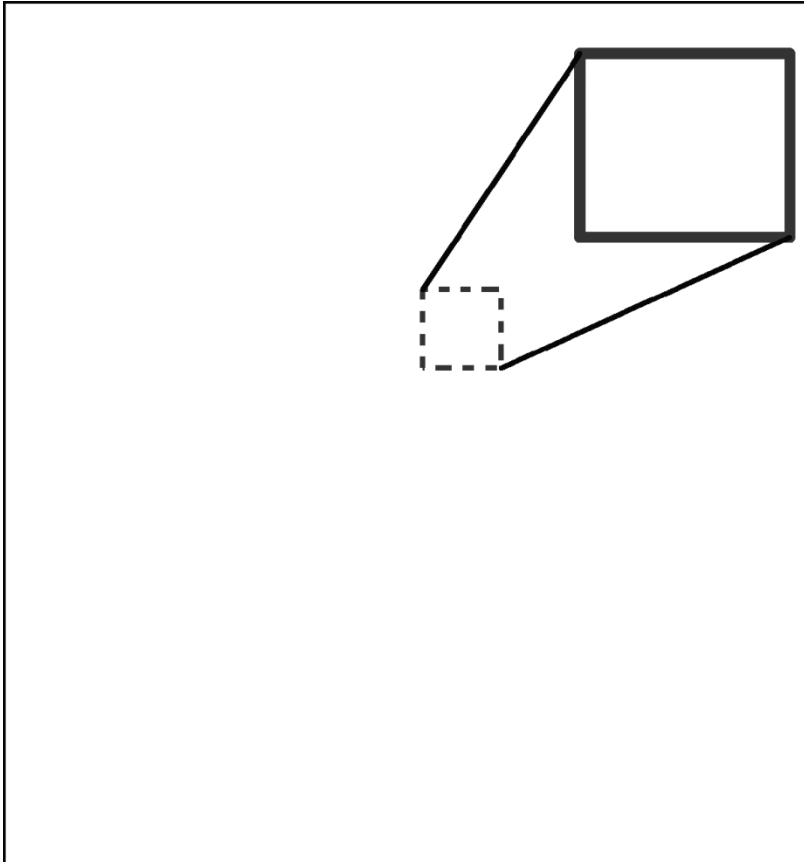
Logos



Tables – patterns and data

| | | |
|-------------|-----------|--|
| Fish Creek | 25 150 | Red circle signals an anomaly in the data |
| Barberville | 340 180 | |
| Granton | 50 200 | |
| Lakeland | 62 250 | |
| Upwater | 124 320 | |

Inset maps

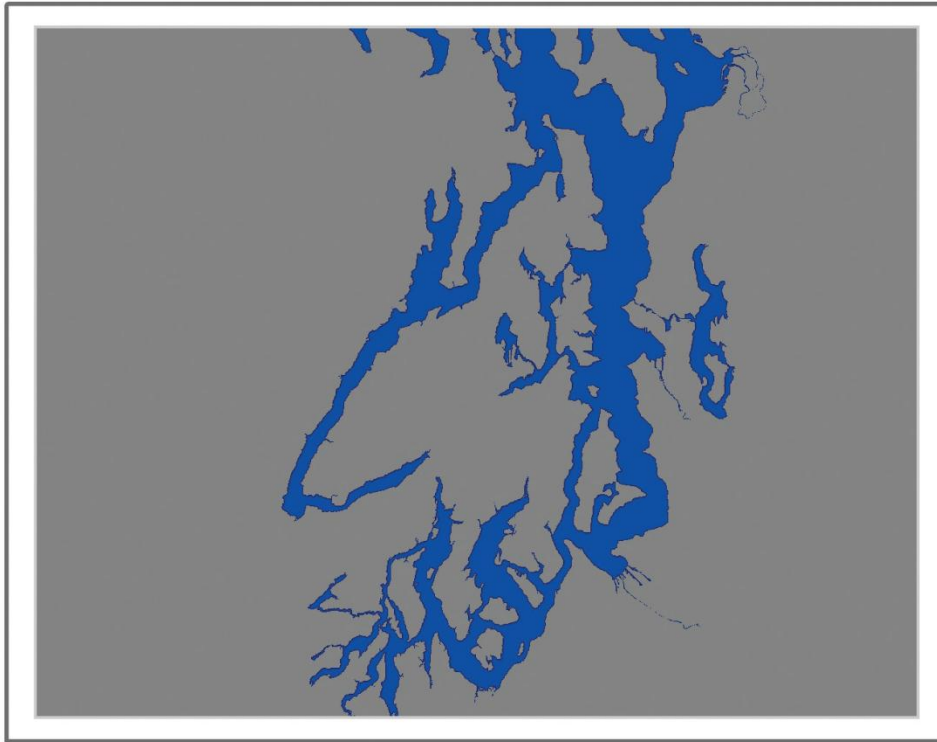


Connect the inset to the corresponding portion of the larger map

Context – visibility of the map at a site – where will it hang?

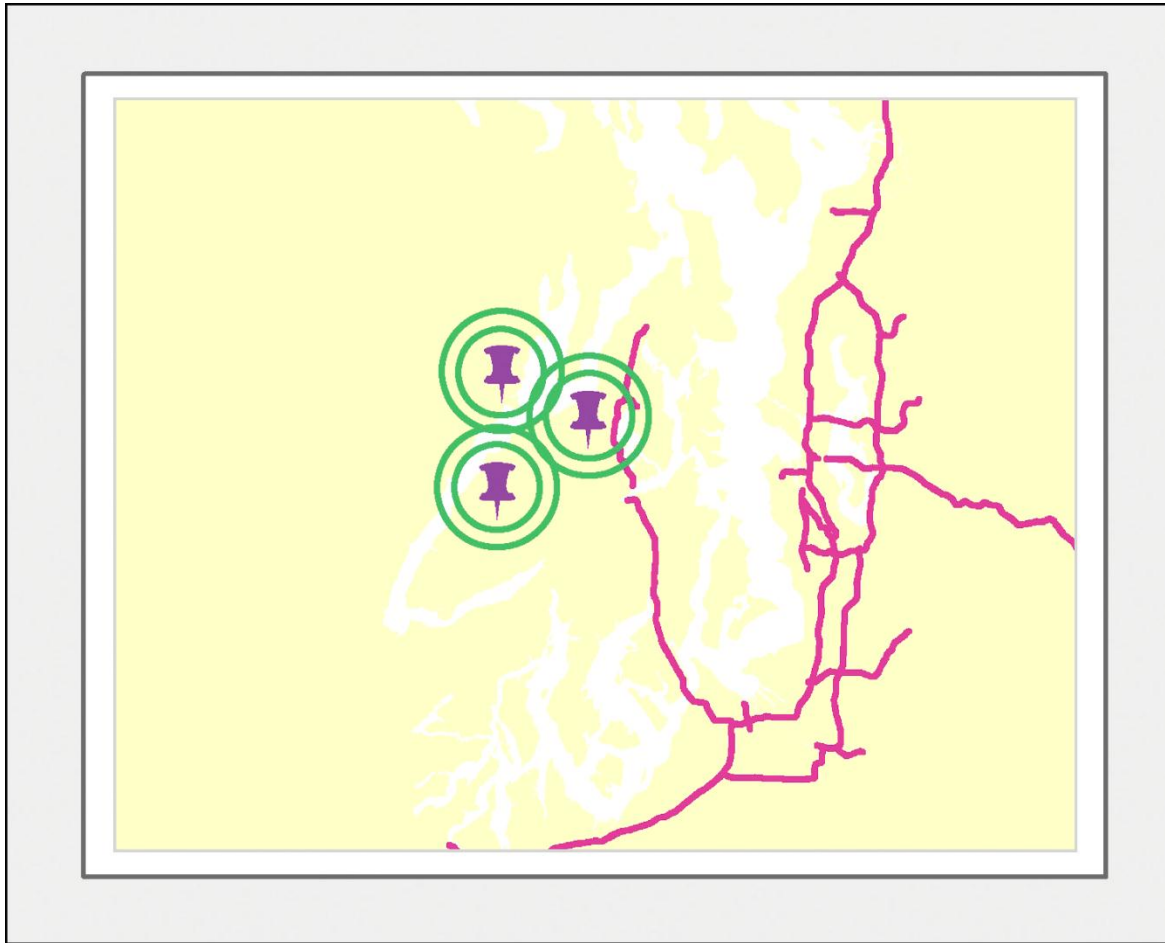


Context



Dark color
contrasts with
plain office
walls

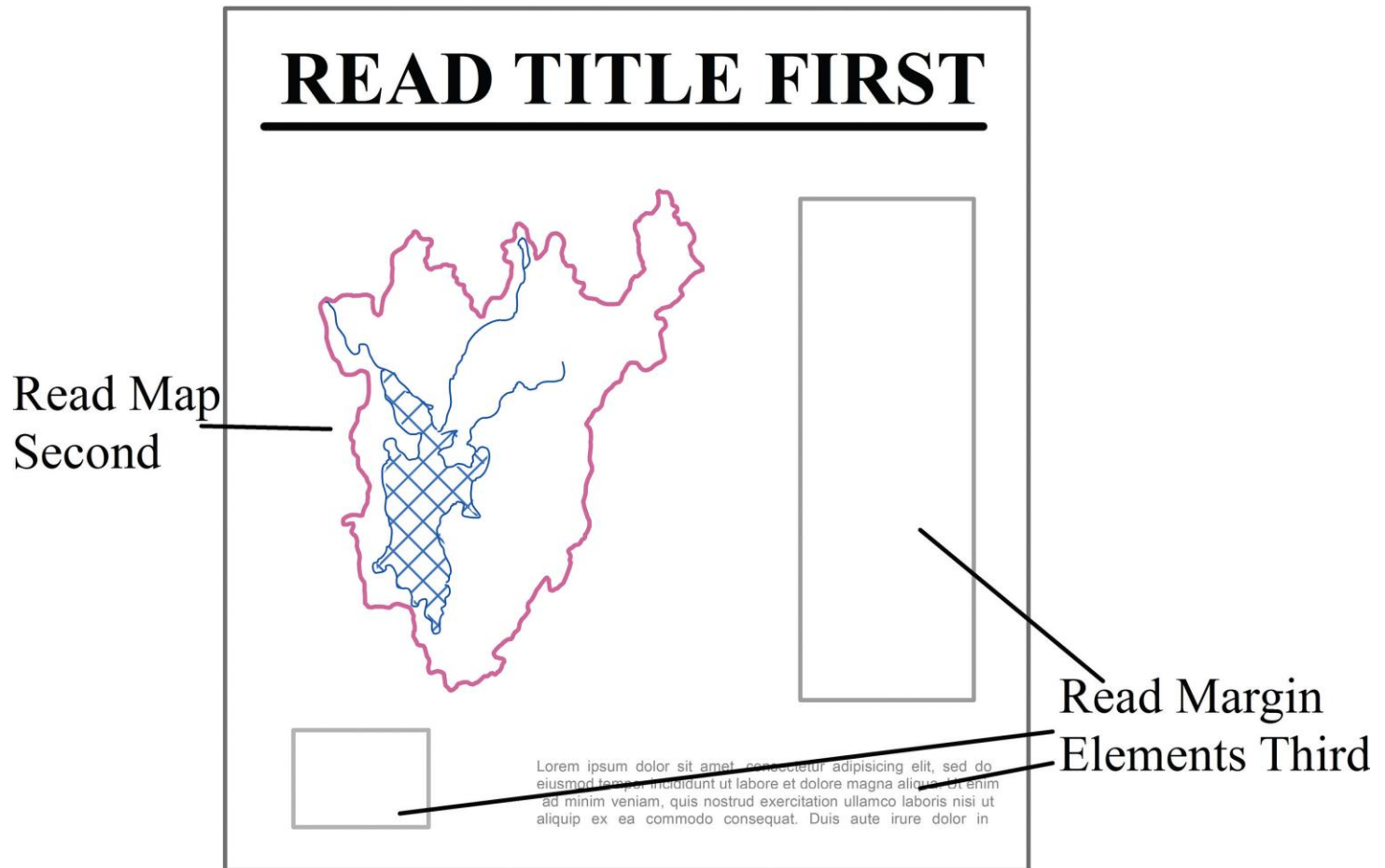
Context



Candy shop
colors get
attention on a
gray cubicle
wall

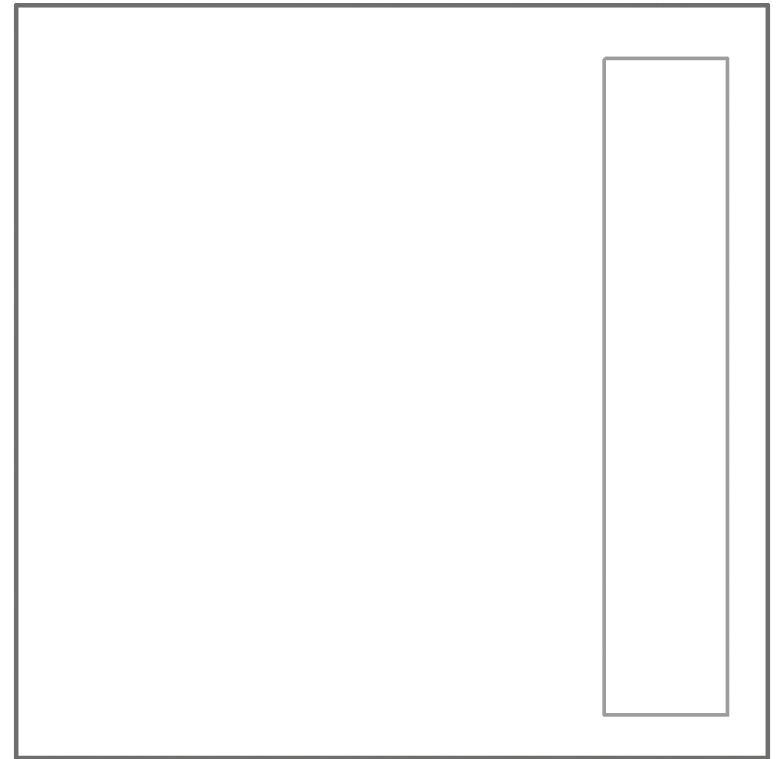
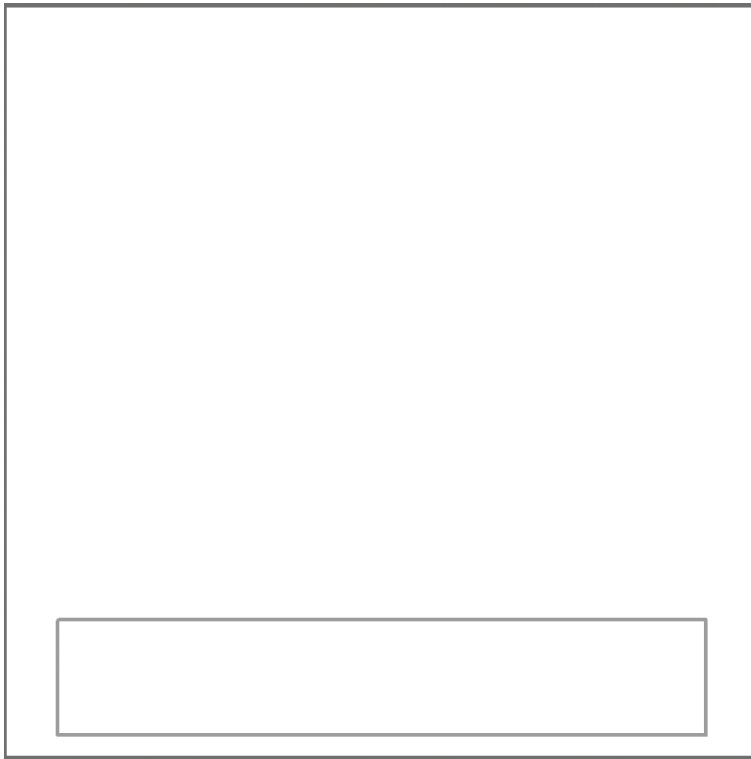
Emphasis map

An important planning sketch



Margin elements

Common placements



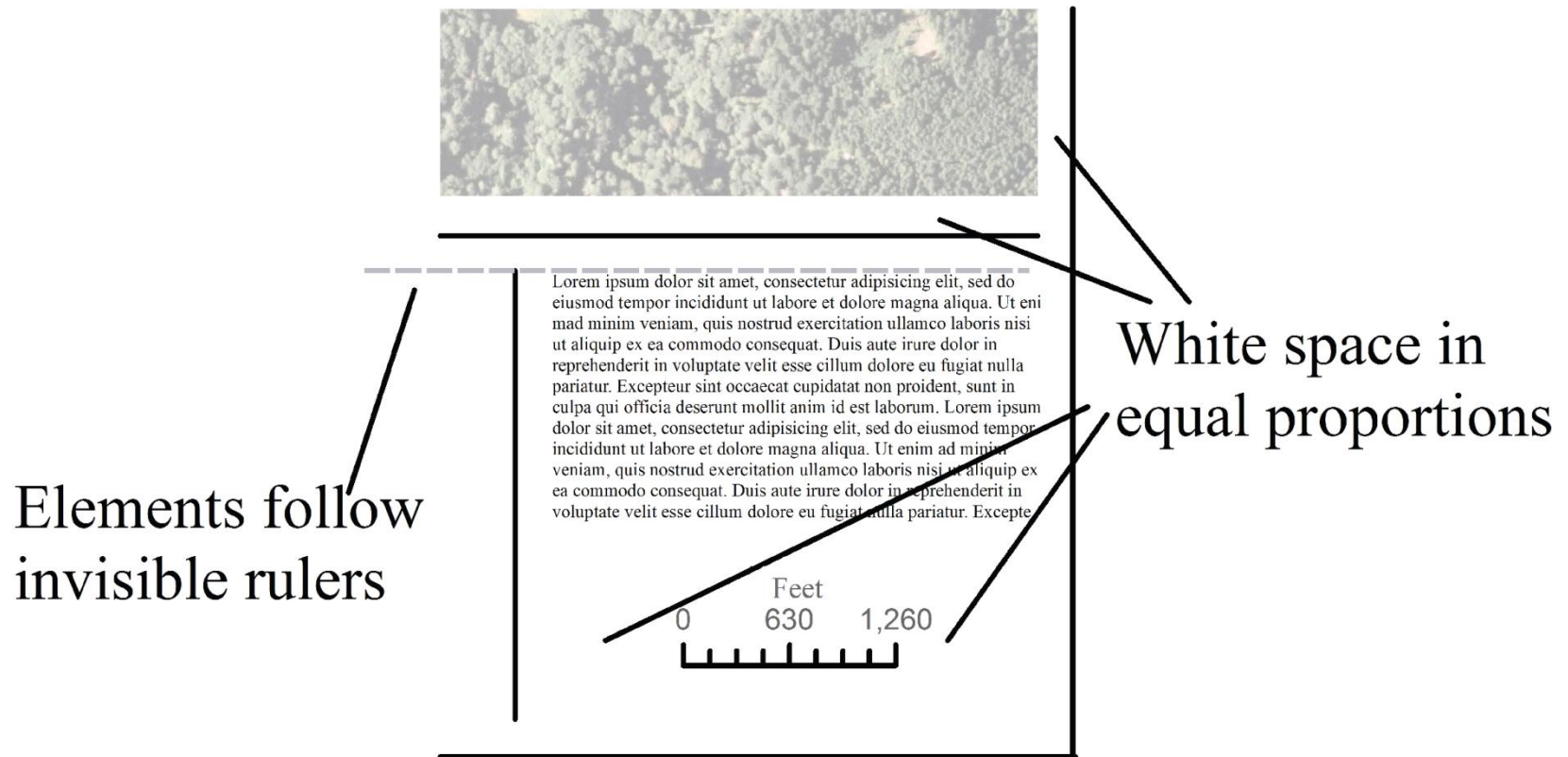
Architect's box

Split into 3 segments



TITLE

Balance = harmony



Font style matches content

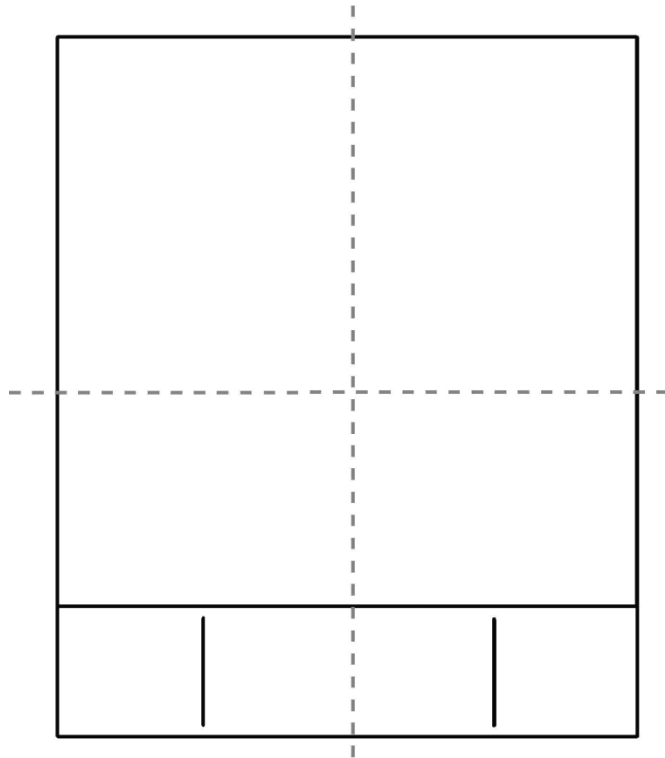
Contemporary

Casual

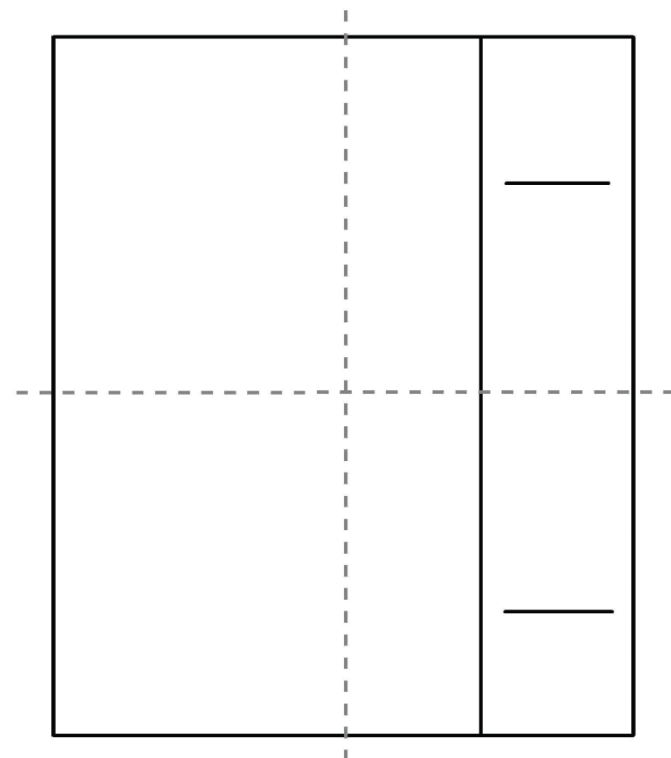
Historic

Formal

Symmetry and asymmetry



Symmetry along vertical axis
Asymmetry along horizontal axis

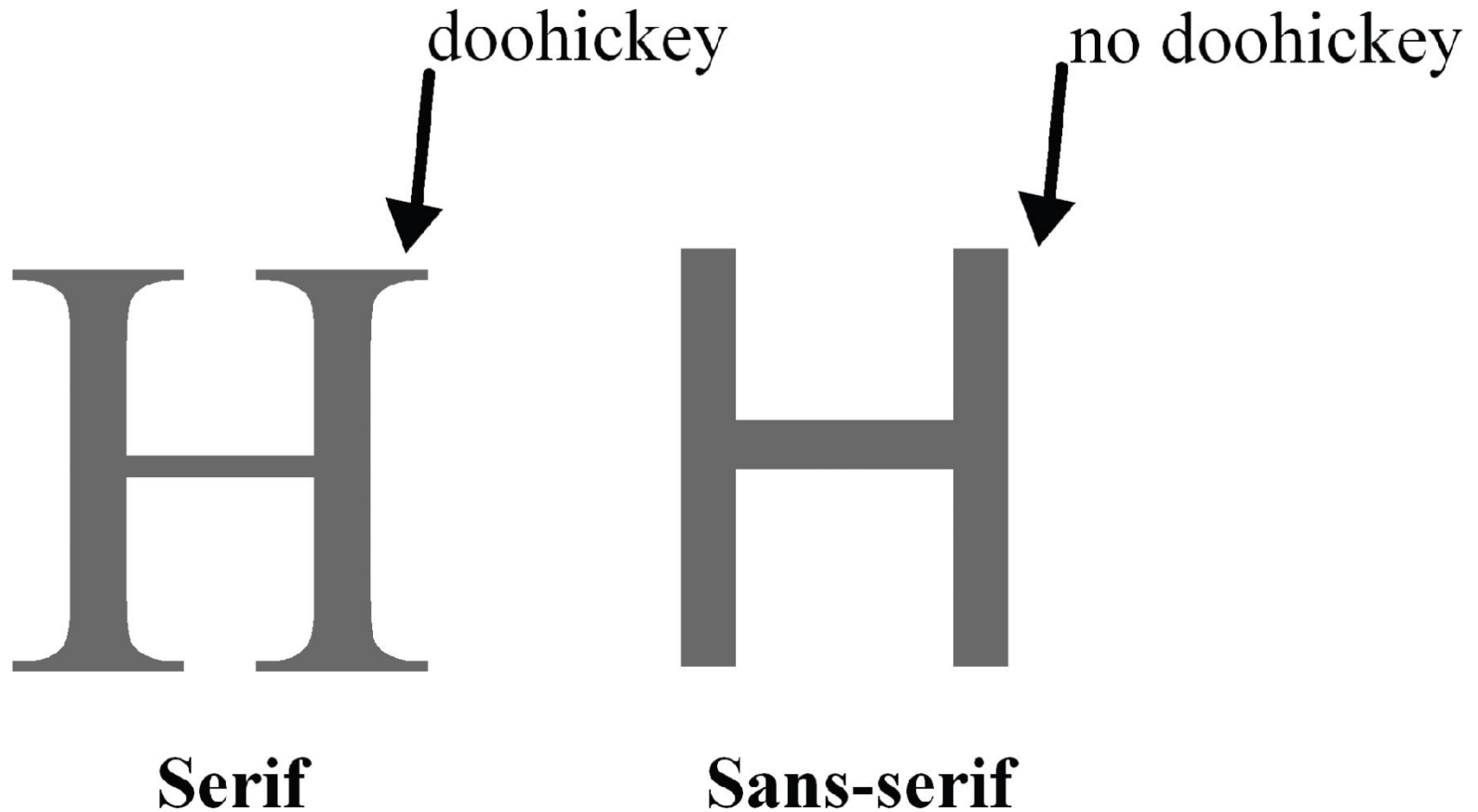


Asymmetry along vertical axis
Symmetry along horizontal axis

Chapter 4

Fonts

Serif or sans-serif



Font examples

Illustration

Serif

(Times New Roman)

Illustration

Sans-serif

(Arial)

Decorative fonts

1 2 3 4 5 6 7 8 9 .

A decorative serif font is displayed with the digits 1 through 9 and a period. The characters are bold and elegant, with thick strokes and fine details. Below the text is a horizontal line composed of a series of short, thick, rectangular dashes, creating a textured, brick-like appearance.

Decorative fonts cont.

Olde English

OUTER SPACE

THE WILD WEST

Script-type fonts

The Freestyle Script

An elegant script called Exmouth

An elegant script called CommScriptTT

Same point size variation



Font comparison

is

Times

New Roman

Monotype font

is

Courier

New

Monotype font - easier to read for blocks of numbers

433509

256798

613257

659310

Times
New Roman

4 3 3 5 0 9

2 5 6 7 9 8

6 1 3 2 5 7

6 5 9 3 1 0

Courier (Monotype)
New

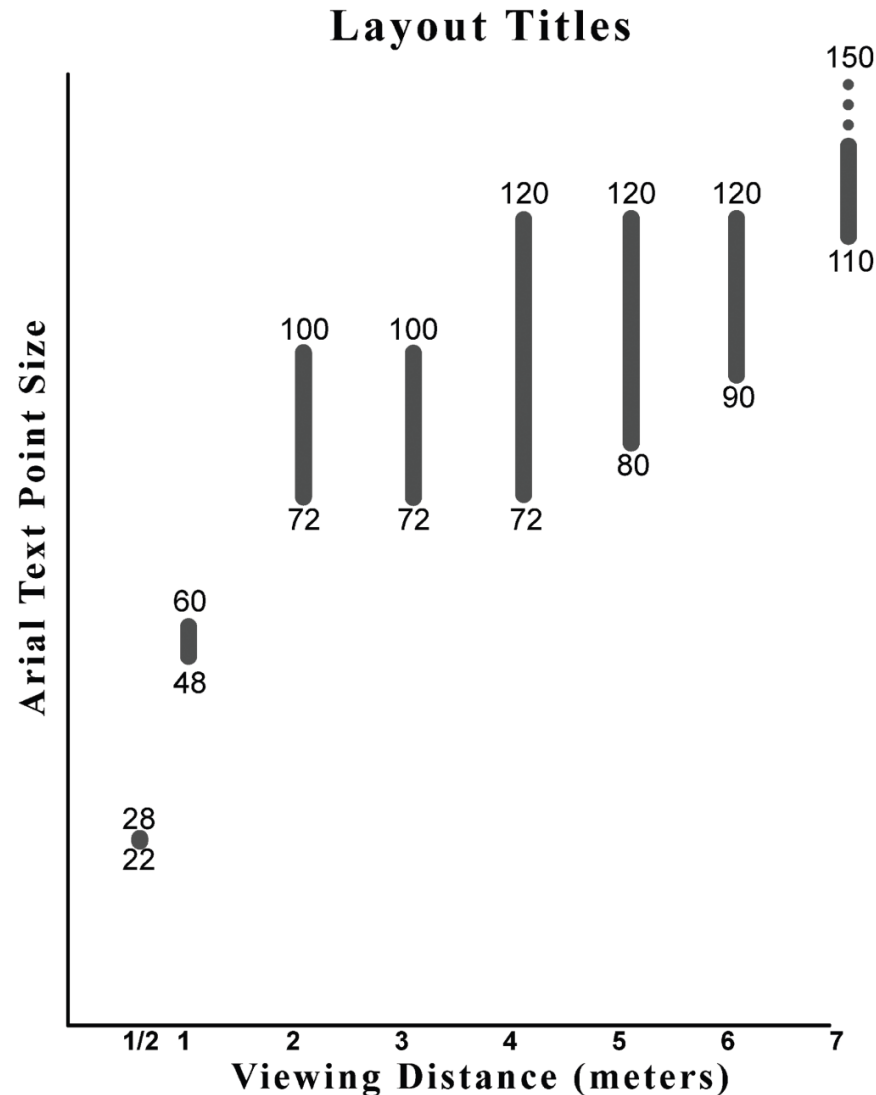
Point size



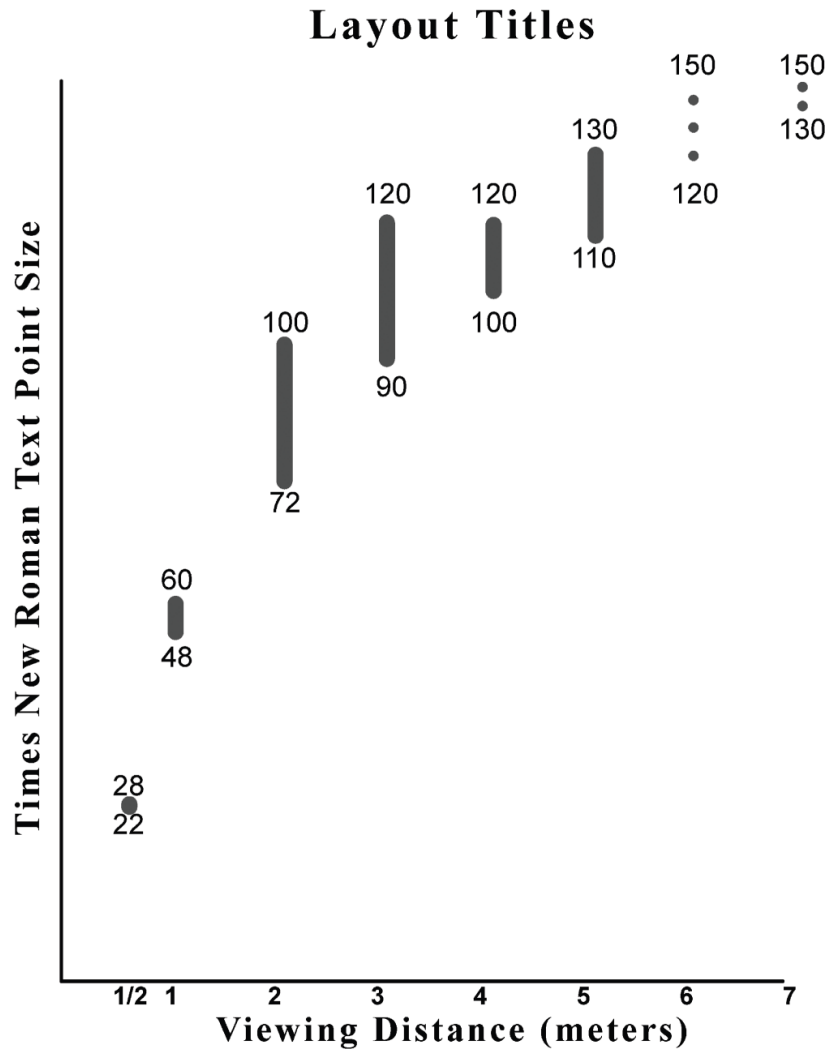
Height

~ 1 inch

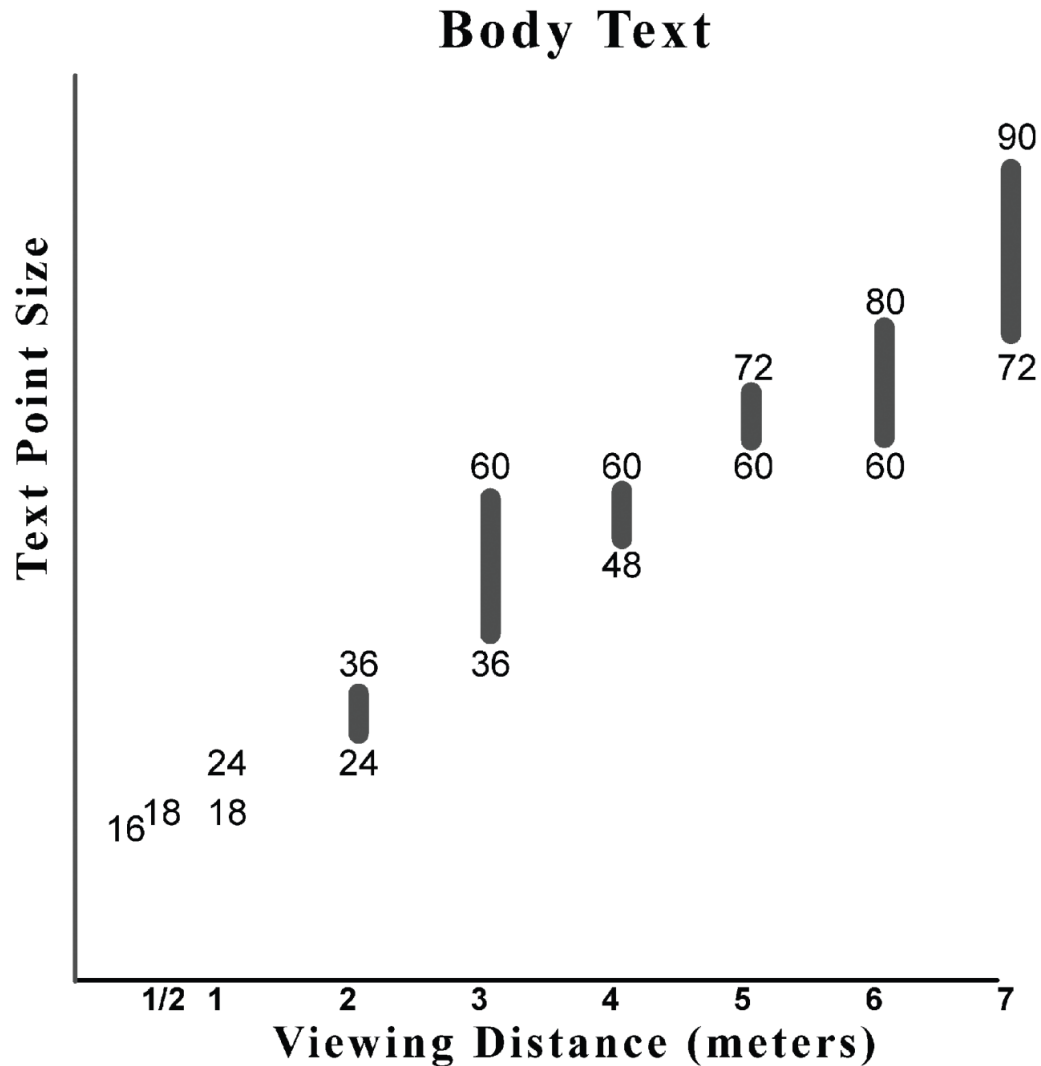
Point size & viewing distance



Size in Times New Roman



Body text point size



Spacing, cont.

Default Character Spacing



Expanded Character Spacing



This is easier
to read

Spacing relative to size of element

Default
Character Spacing



Expanded
Character Spacing



Subtitles

The Many Places of Roy Rogers *Cities and Towns in Roy Roger's Westerns, Scaled by Number of Movie Mentions*

De-emphasize margin text

Use of italics

PetersonGIS

Standard conventions

Know the standards and consider carefully
before you veer away from them

DISCLAIMER: Joe County does not . . .

versus

DISCLAIMER: Joe County does not . . .

United States Geological Survey (USGS) data were downloaded in 2008

versus

United States Geological Survey (USGS) data were downloaded in 2008

(De-emphasizing the uppercase words by
using a slightly smaller point size)

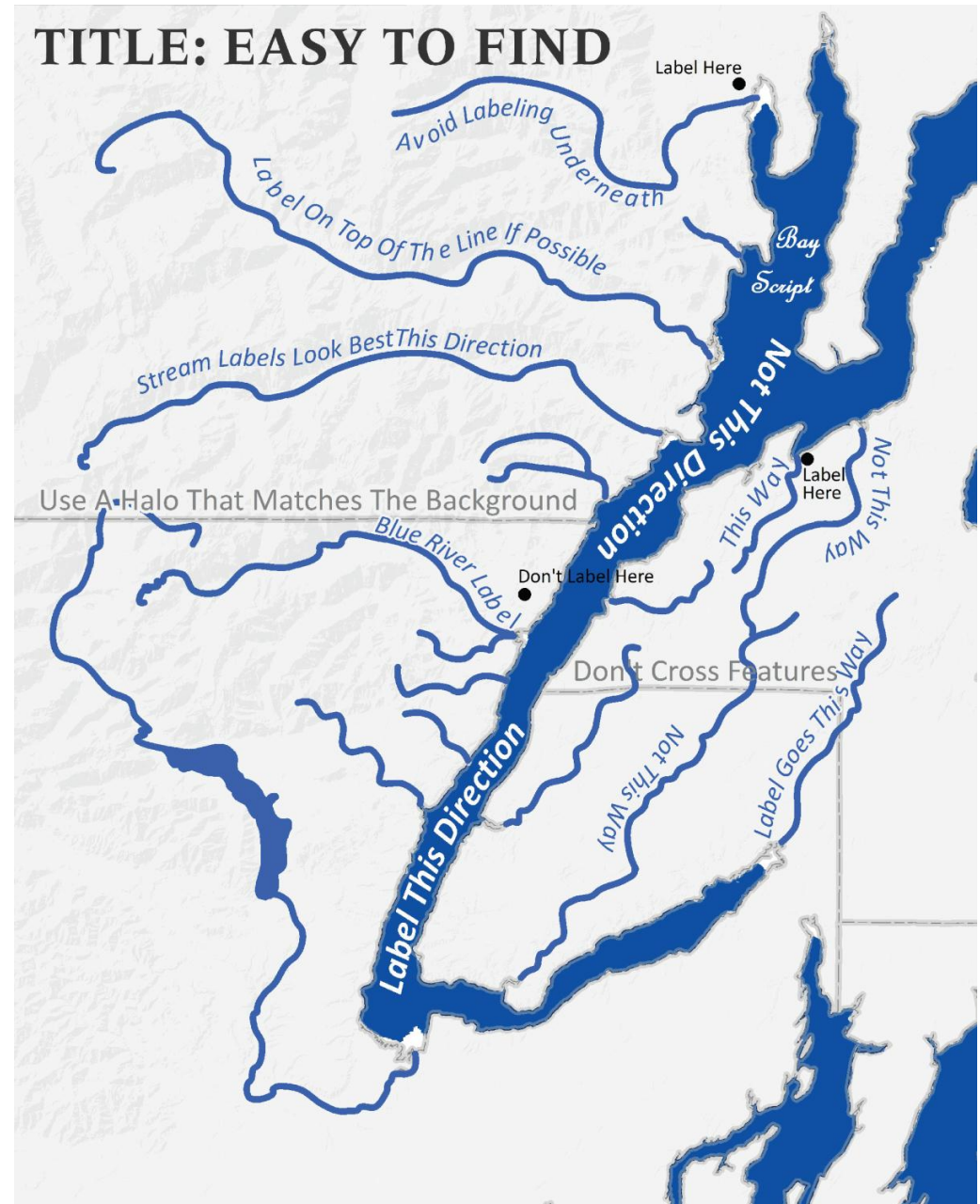
Placing labels next to map features



Readability tool



Common labeling standards



Halos



A visual disaster

Halos

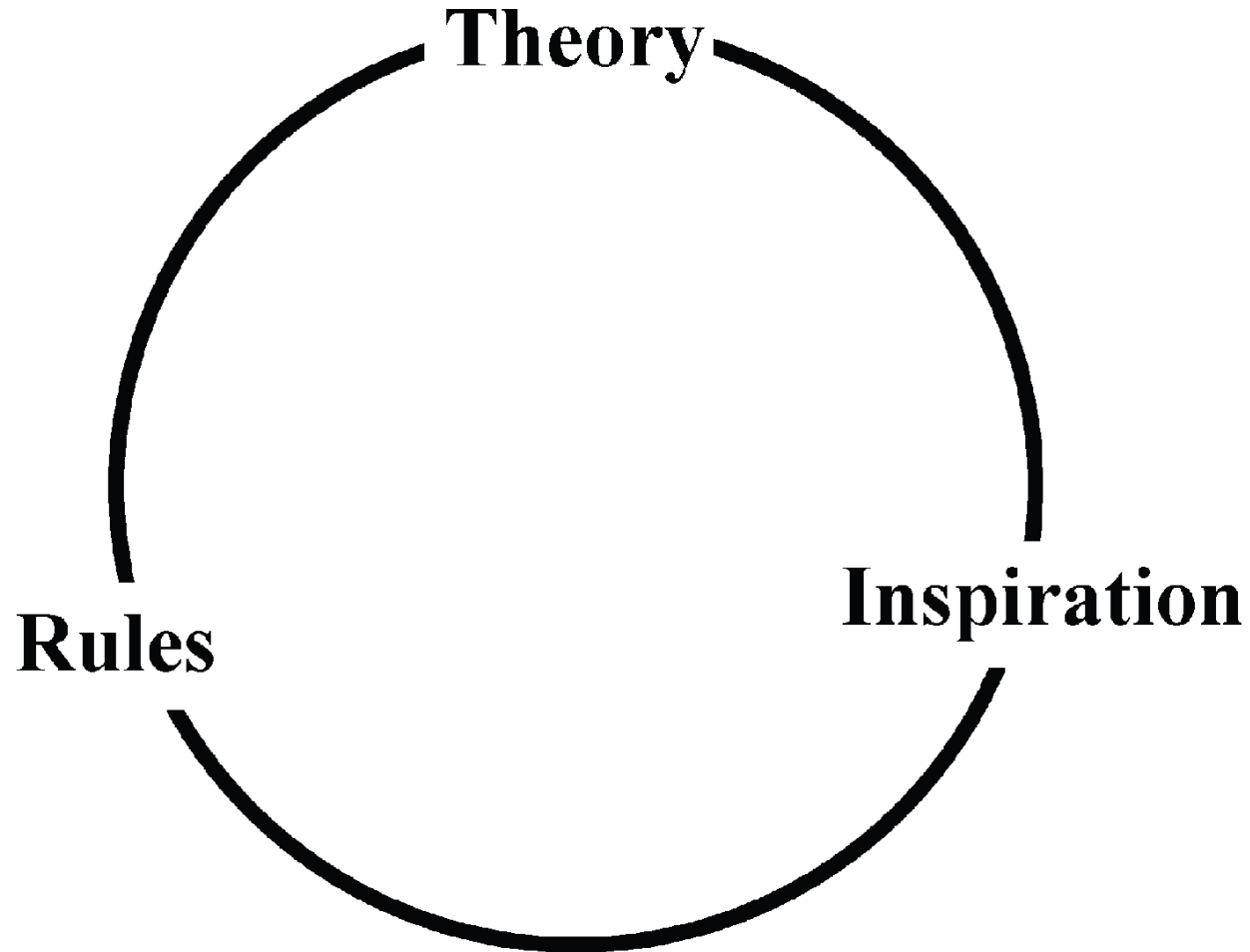


Better: halo matches underlying color

Chapter 5

Color

Three concepts of color



Color harmonies



Combinations of colors
based on their positions in
the color wheel

Color harmonies

- Analogous
- Complementary
- Polychrome
- Neutral

RGB triplets

R: 255

G: 255

B: 0



R: 212

G: 212

B: 212



R: 0

G: 0

B: 255



Hex notation

#00FF7F



#800000



#808080



HSV notation

H: 100

S: 100

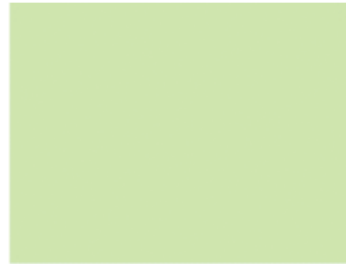
V: 100



H: 100

S: 30

V: 100



H: 100

S: 100

V: 30



CMYK

C : 100

M : 0

Y : 0

K : 0



C : 100

M : 100

Y : 0

K : 0

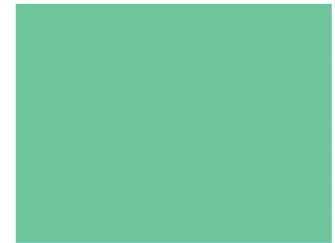


C : 100

M : 0

Y : 30

K : 0



CIELAB

L: 100

a: 0

b: 0



L: 60

a: 0

b: 0



L: 69

a: 39

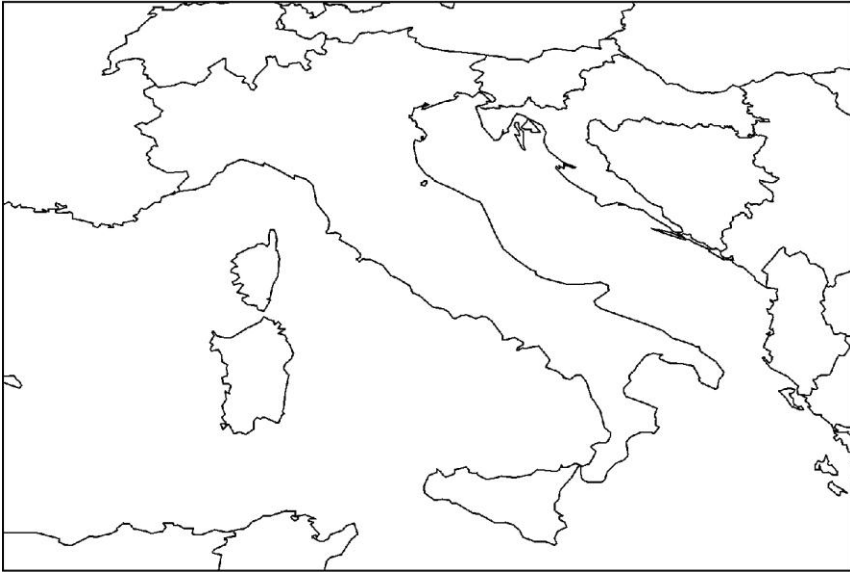
b: 66



2 important color rules in GIS

- **Figure-ground** – to differentiate an object from its background
- **Viewer's perception** – a series of rules

Using color



Not enough contrast



Color, highlighting

Vignette or gradual fade-out



Contrast between water and land

5 shade rule

The human eye can only distinguish among 5 shades of the same color

5 shade rule



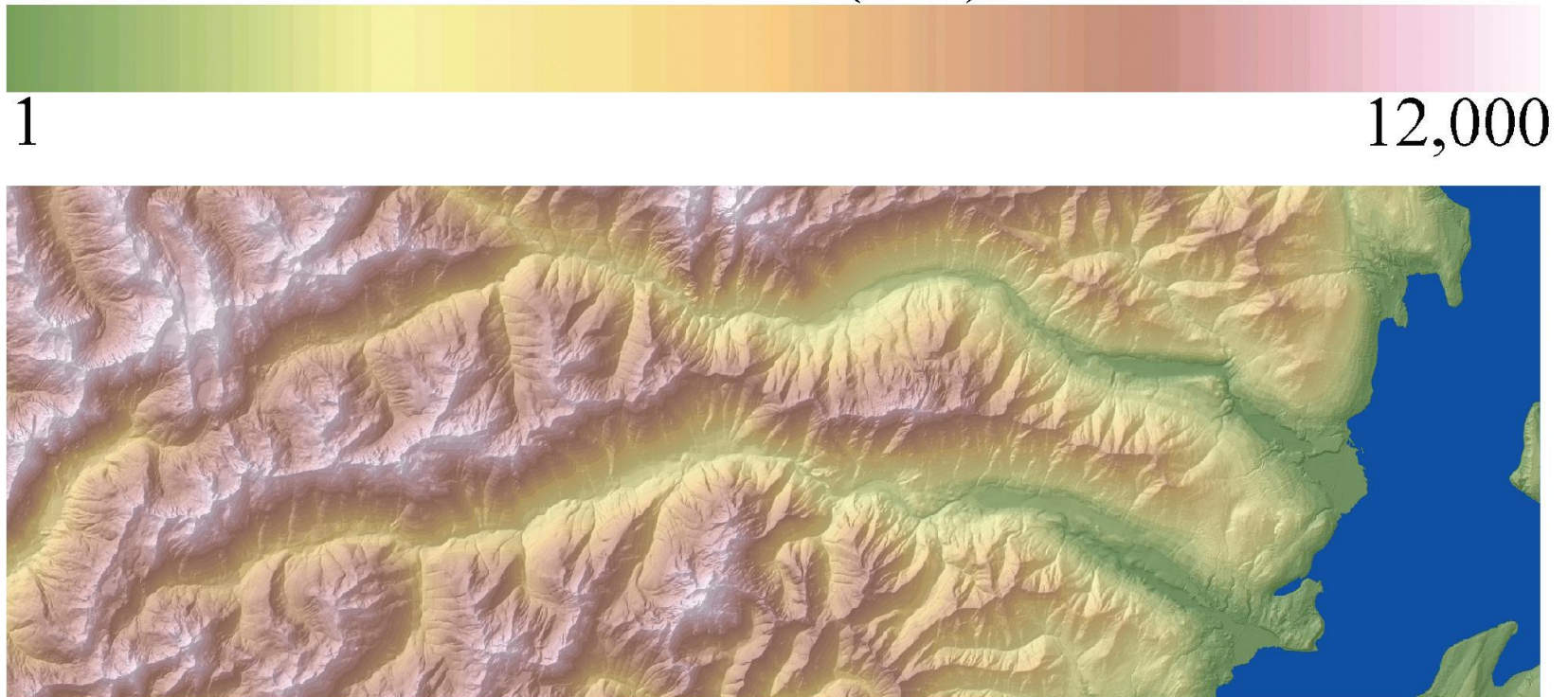
Too many intervals



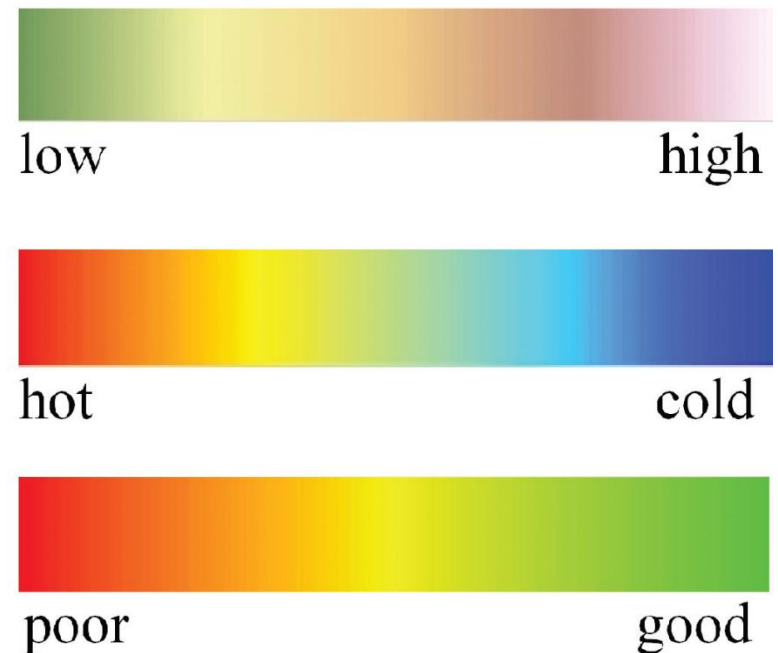
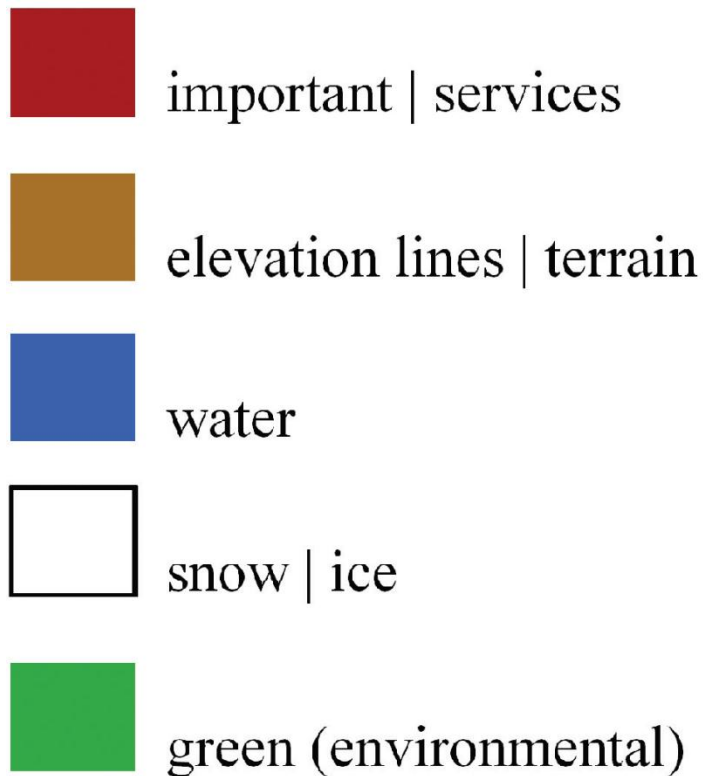
Better

Color gradients

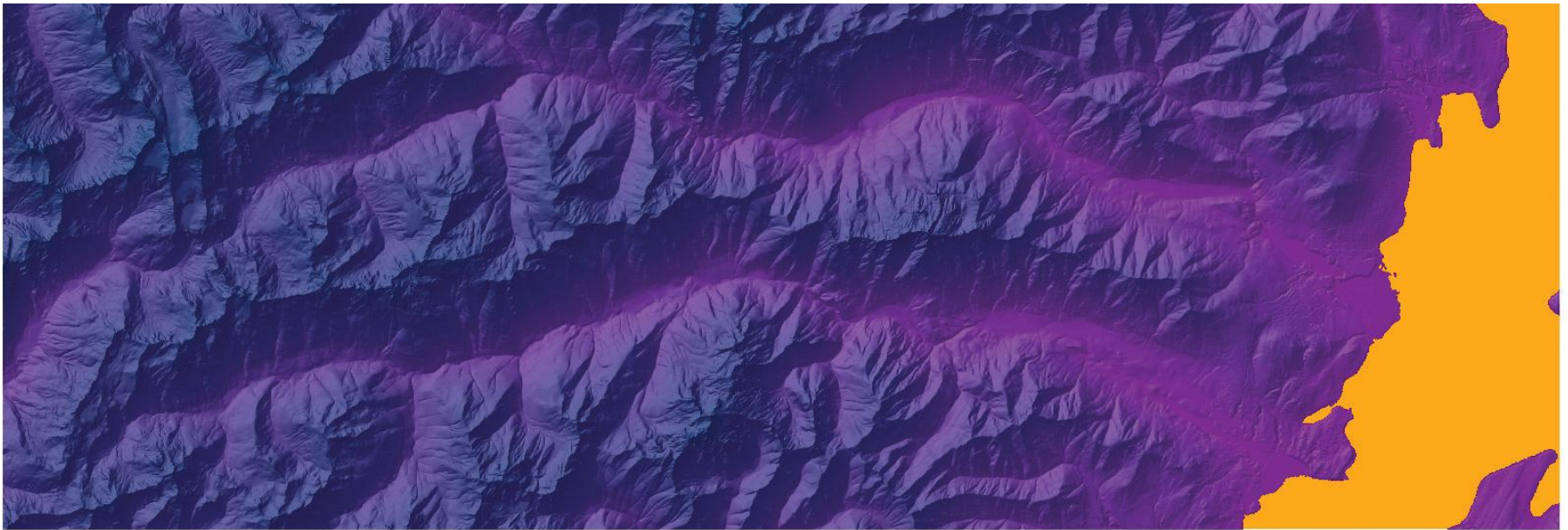
Elevation (feet)



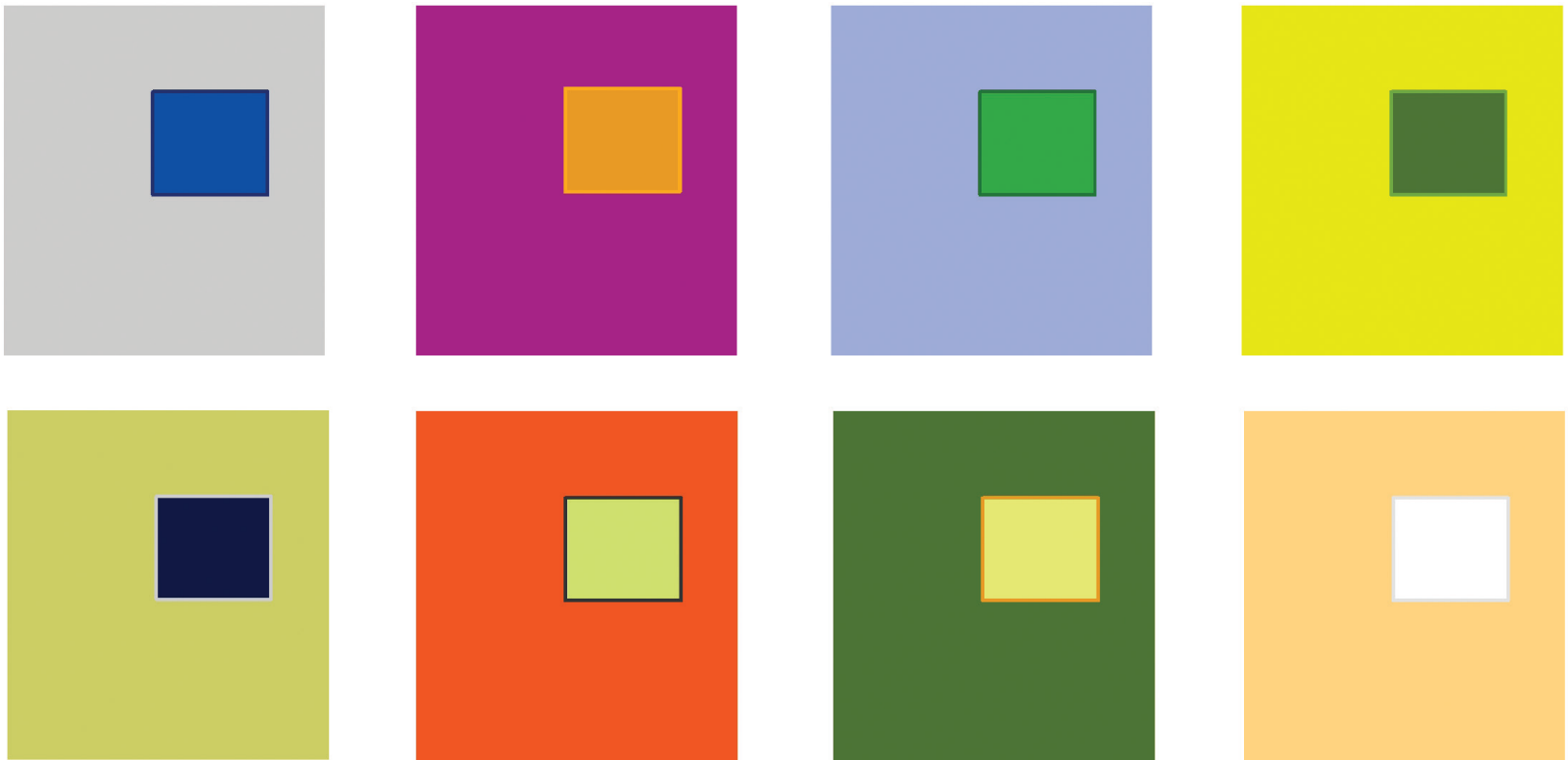
Color connotations (feelings)



Odd color ramping=surreal map



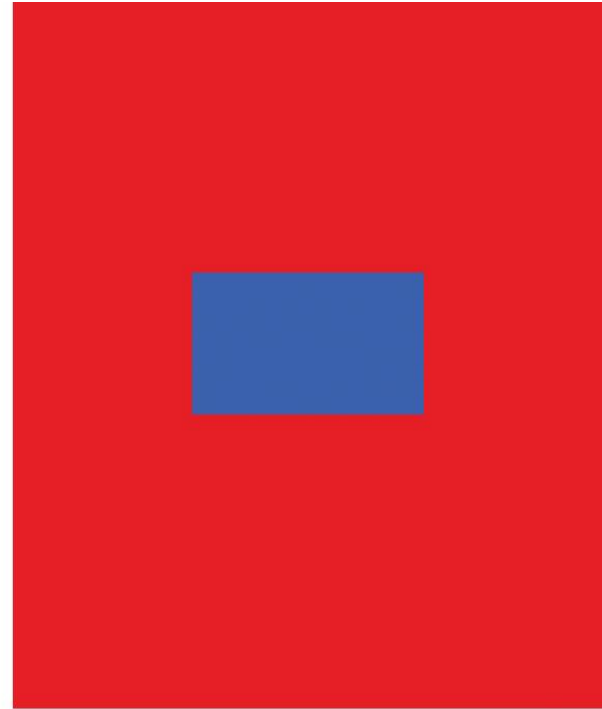
Sample color boxes



These can make you dizzy

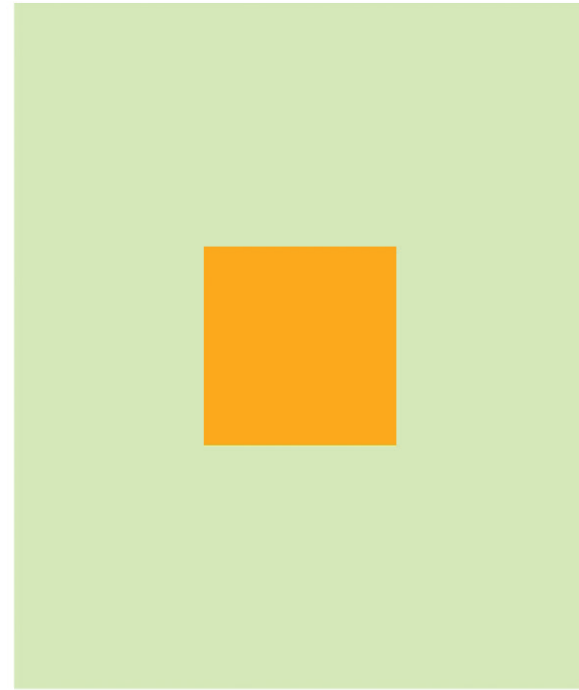


Warm on Cool



Cool on Warm

Foreground and background color effects



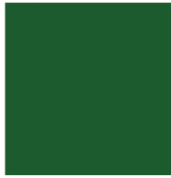


A dark background is less commonly used



Consider red-green color deficiency

Avoid These Color Pairs

| | | | | |
|-------|---|-----|-------|---|
| R 0 |  | AND | R 190 |  |
| G 0 | | | G 0 | |
| B 255 | | | B 255 | |
| R 0 |  | AND | R 0 |  |
| G 255 | | | G 90 | |
| B 0 | | | B 0 | |
| R 255 |  | AND | R 255 |  |
| G 0 | | | G 90 | |
| B 0 | | | B 0 | |

Chapter 6

Features

A cased road symbol with outline in dark color



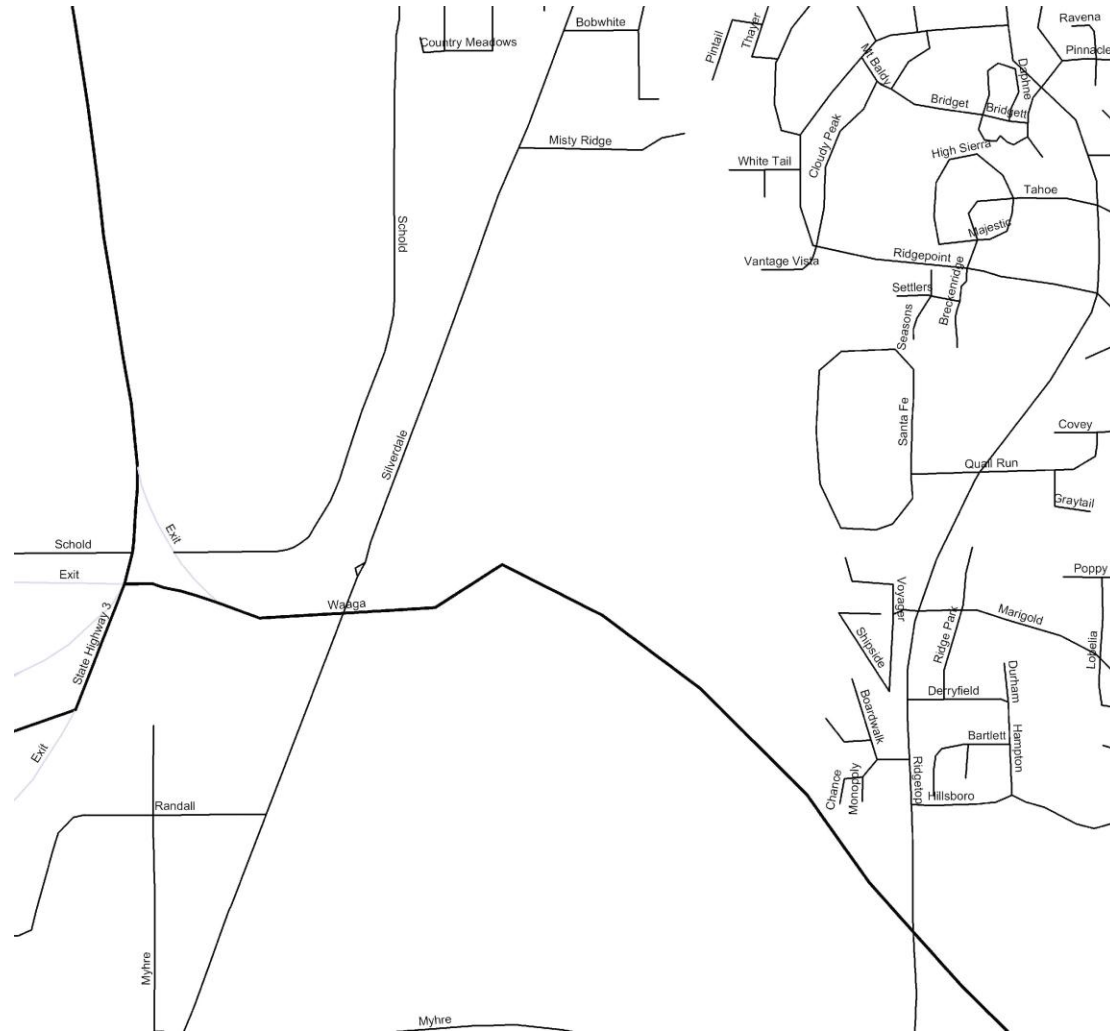
A classic land background



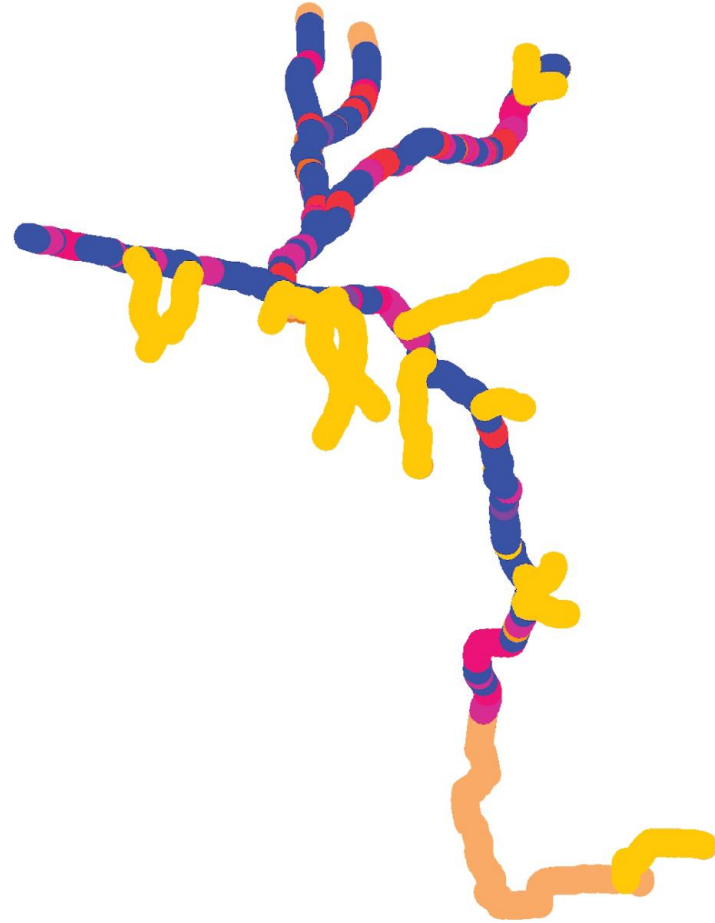
Land is RGB:209
224 115

Minor roads are
white with gray
casing

Conventional road map



Hard to understand what this says about the stream



Use of a spline text algorithm



Basic stream map



Using variation



Stream lines are 2
different colors and
2 different styles

Wide character
spacing in splined
text

Showing hot spots on a map



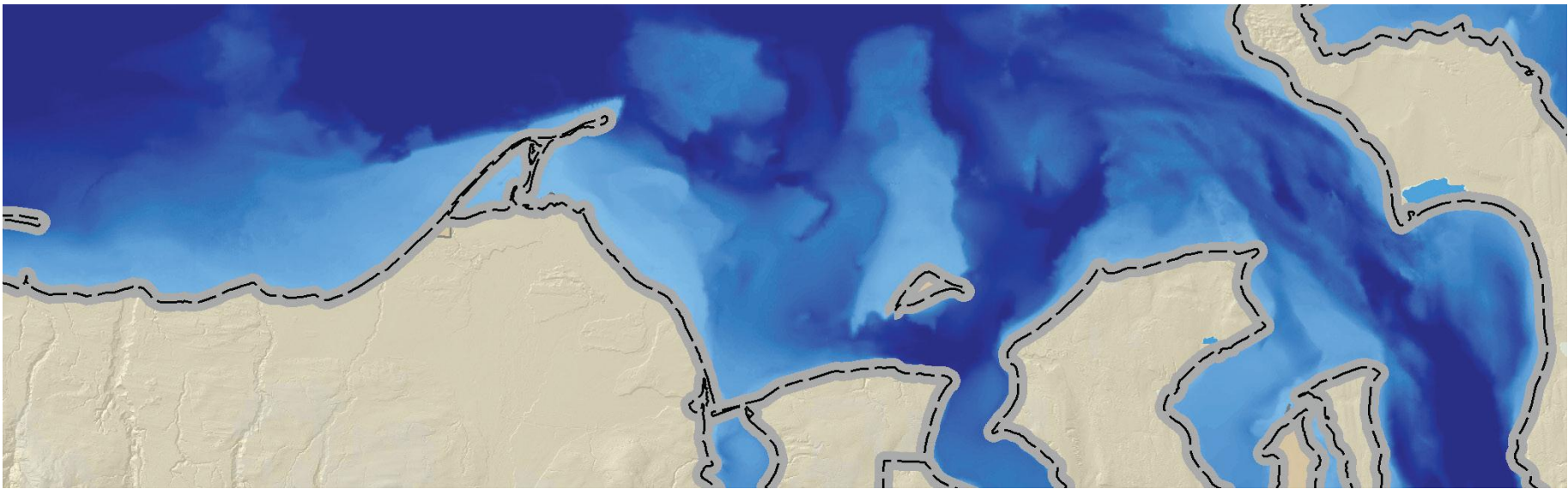
Buffering for emphasis



Political
boundaries are
layered on top
of the rivers

Bathymetric map

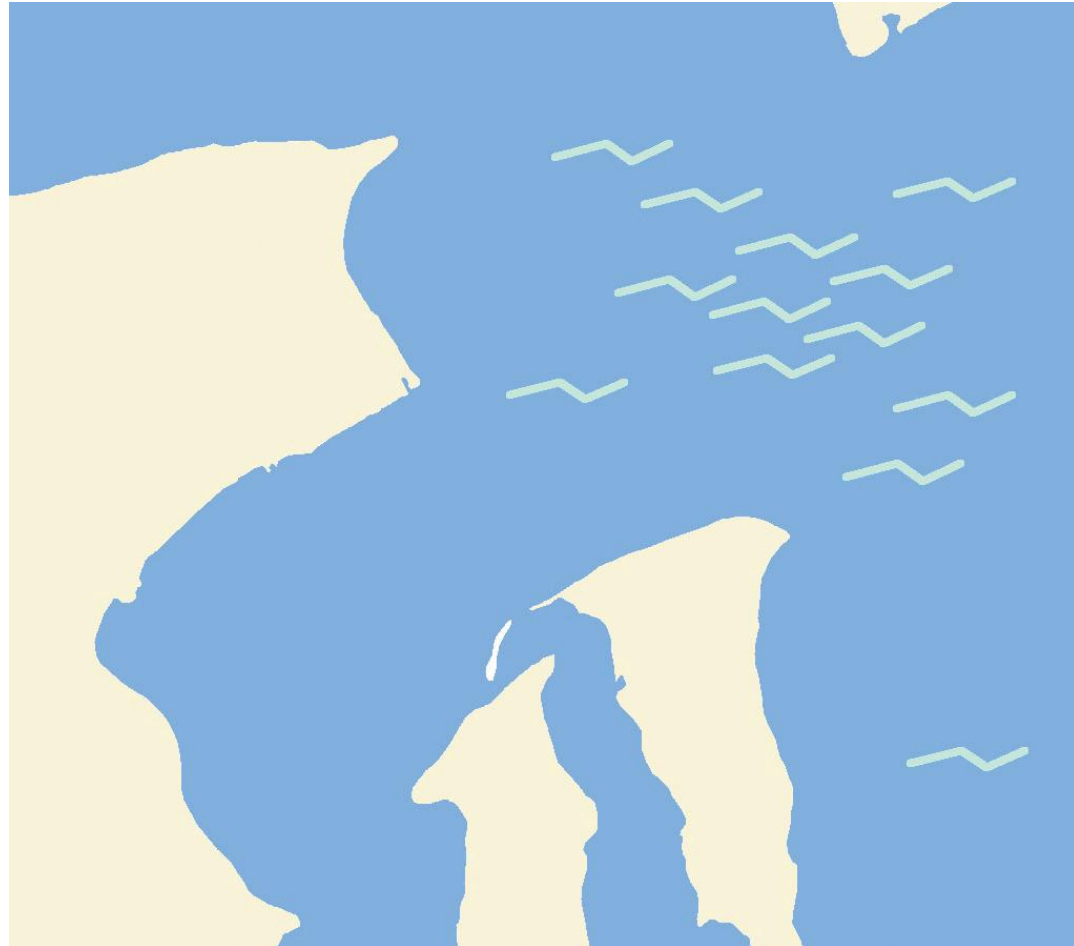
Adds richness to large bodies of water



Another bathymetric map



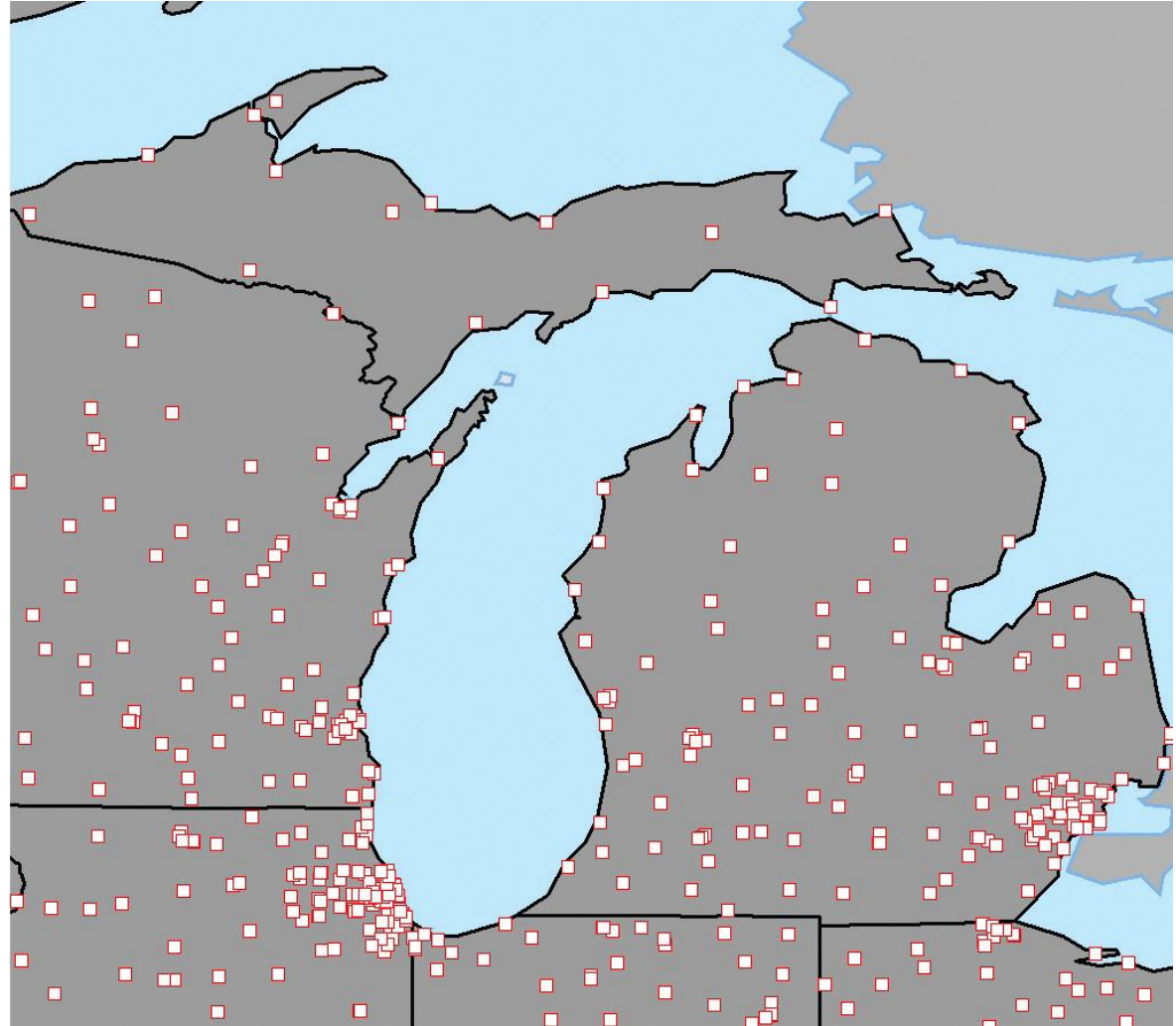
Graphics, such as the wave crest here, can be a nice touch



Stippling used for texture



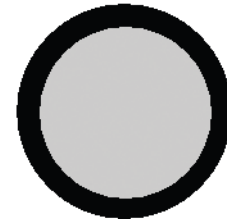
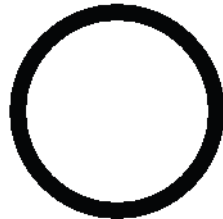
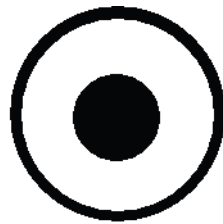
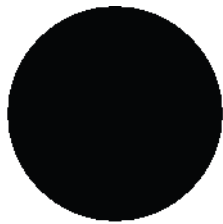
Light color used to demphasize the lakes



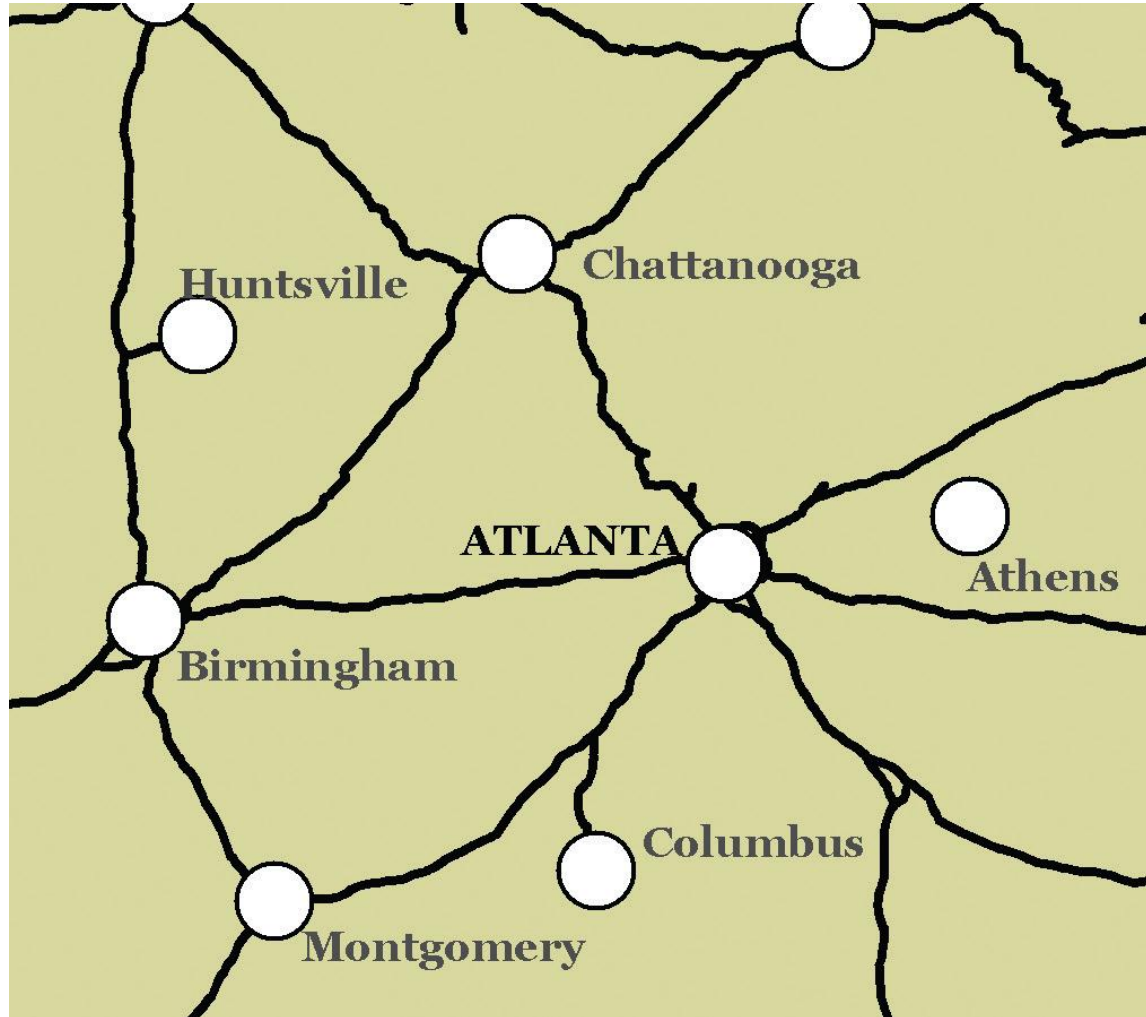
Dark color used to emphasize the lakes



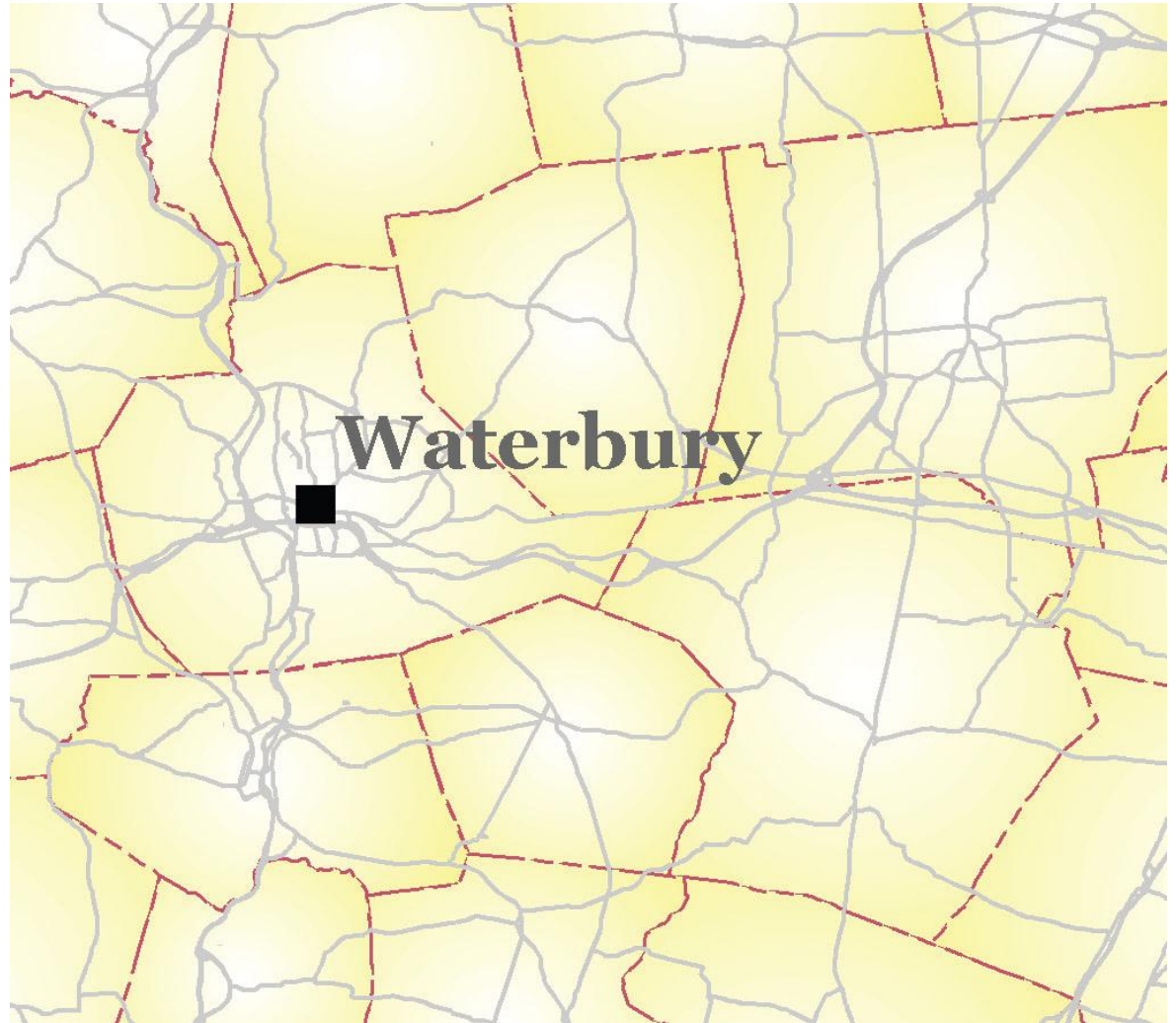
Standards for city and town points



City points using white circles with black borders



Gradient fill



Modifying color value to provide information



Differentiation by symbol type and size

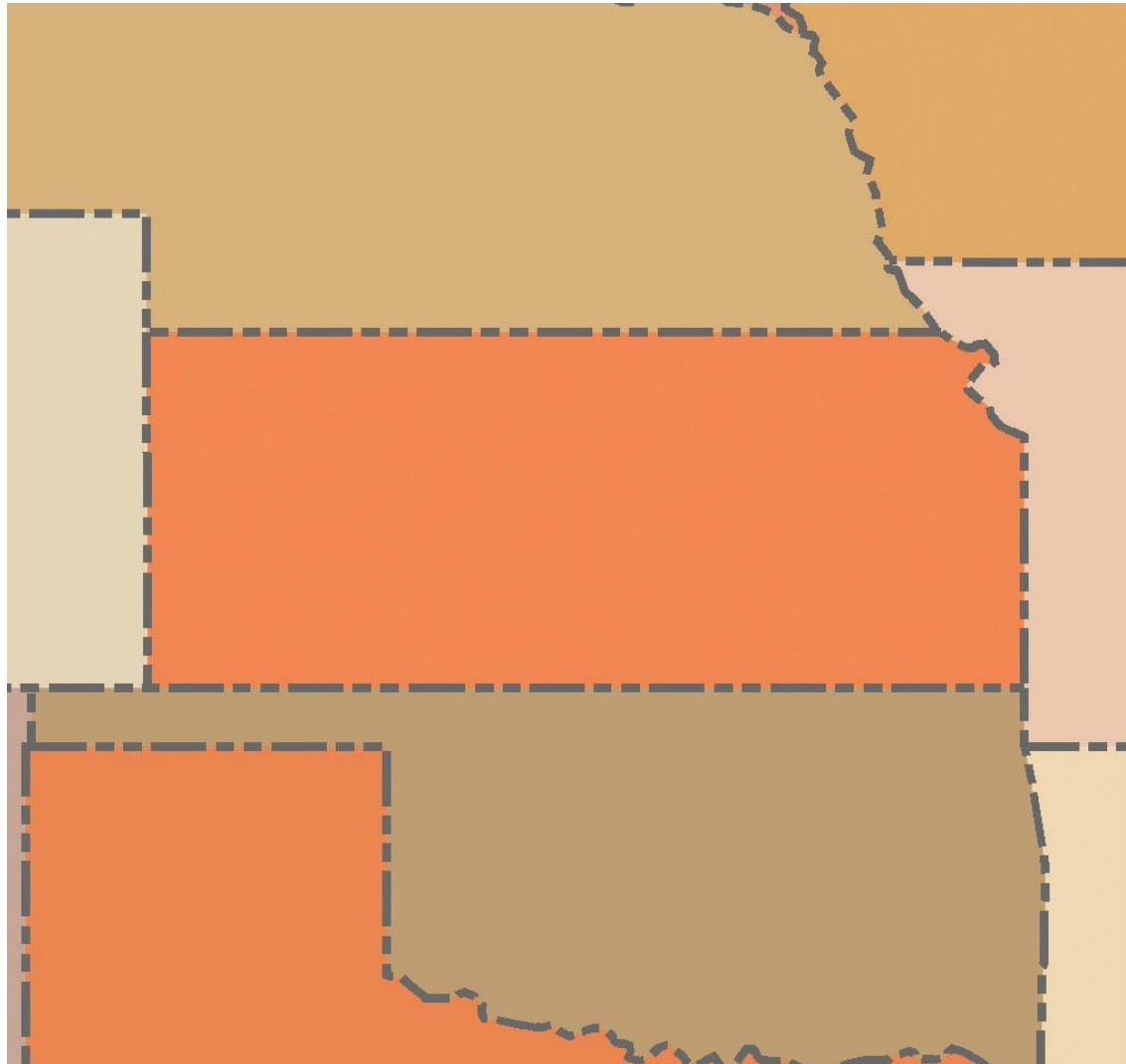


Stars are usually reserved for capitals

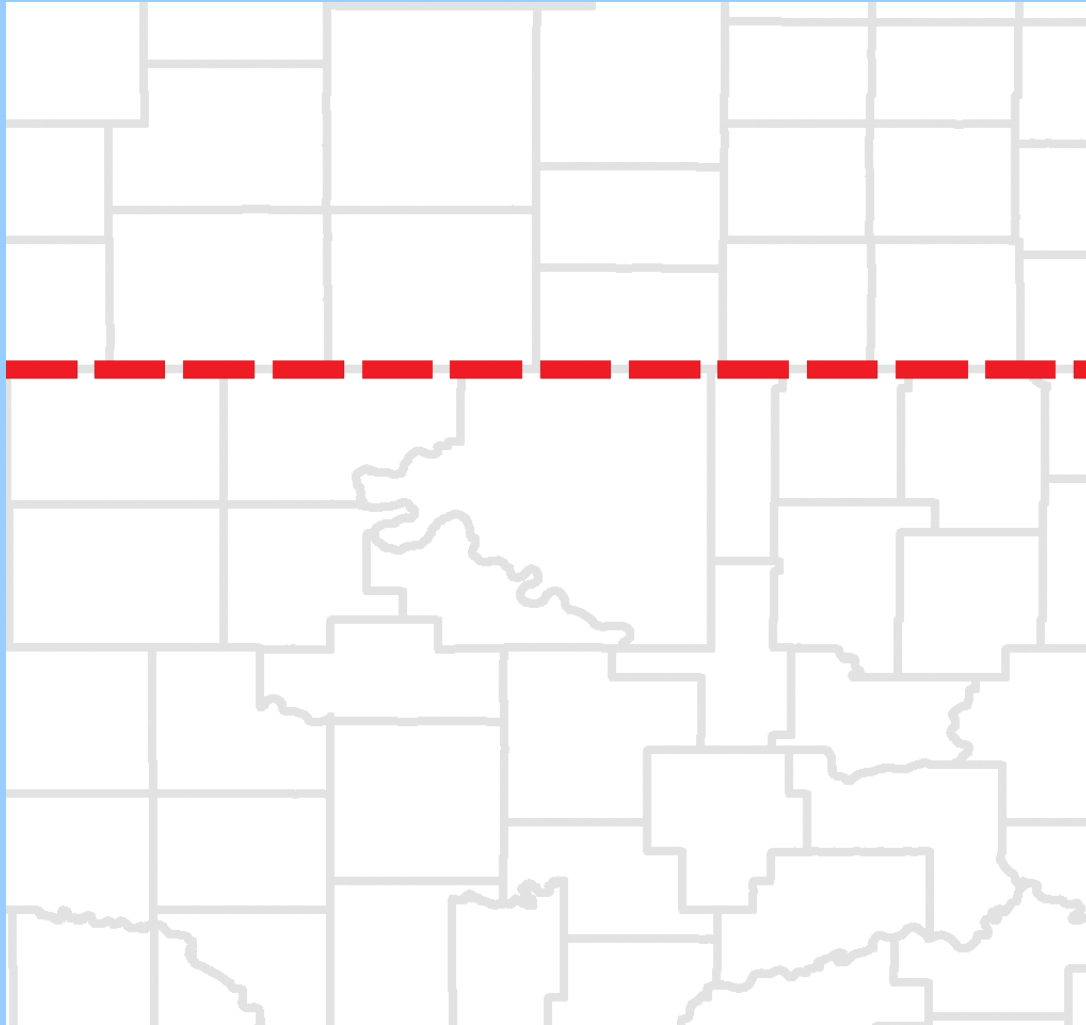
Political boundaries shown with color



Fill colors and dashed lines



Nested hierarchy

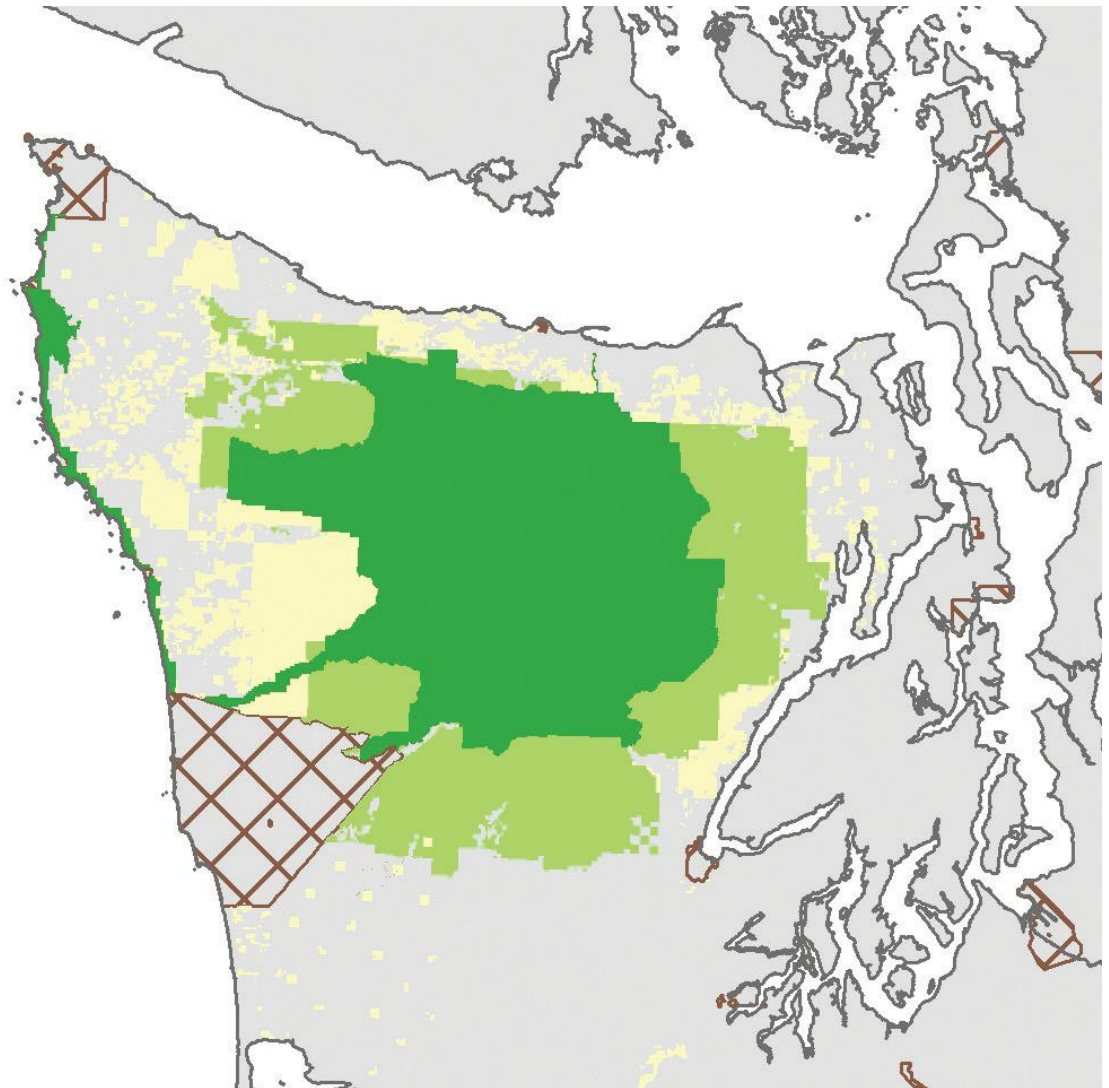


Showing boundaries that are not hierarchical

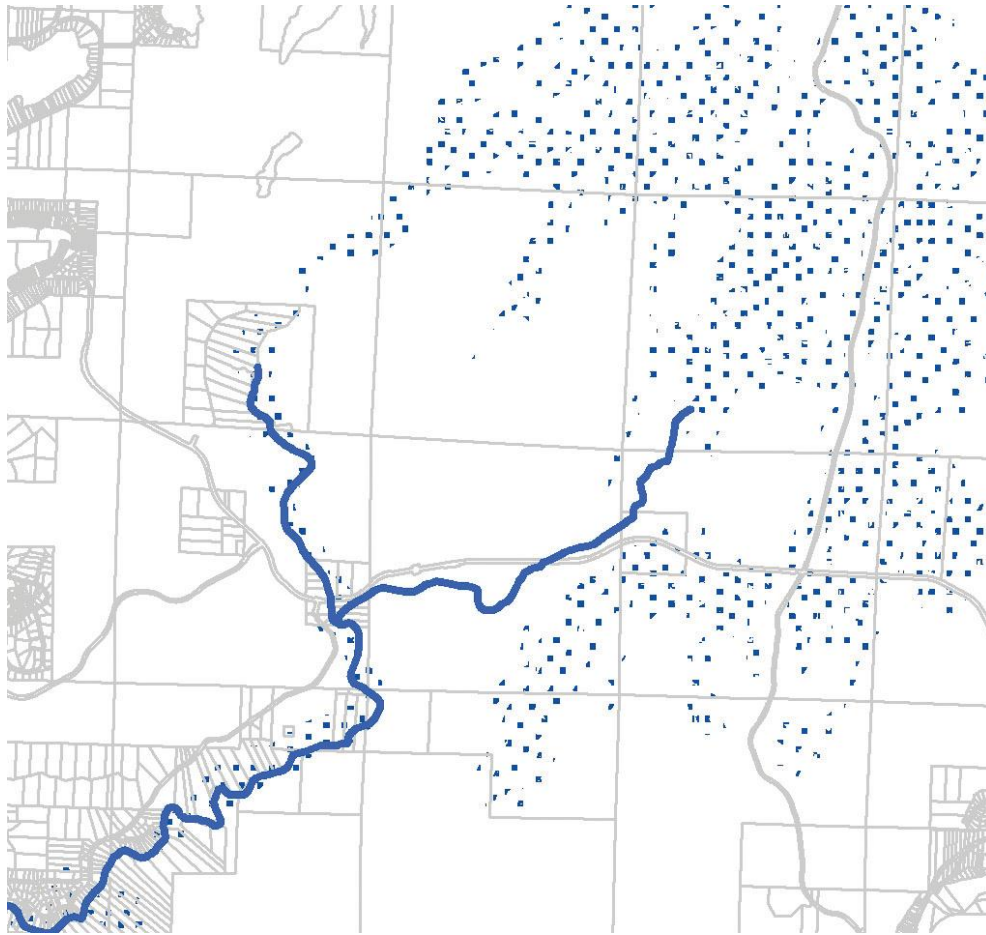
Fill color

Hashing

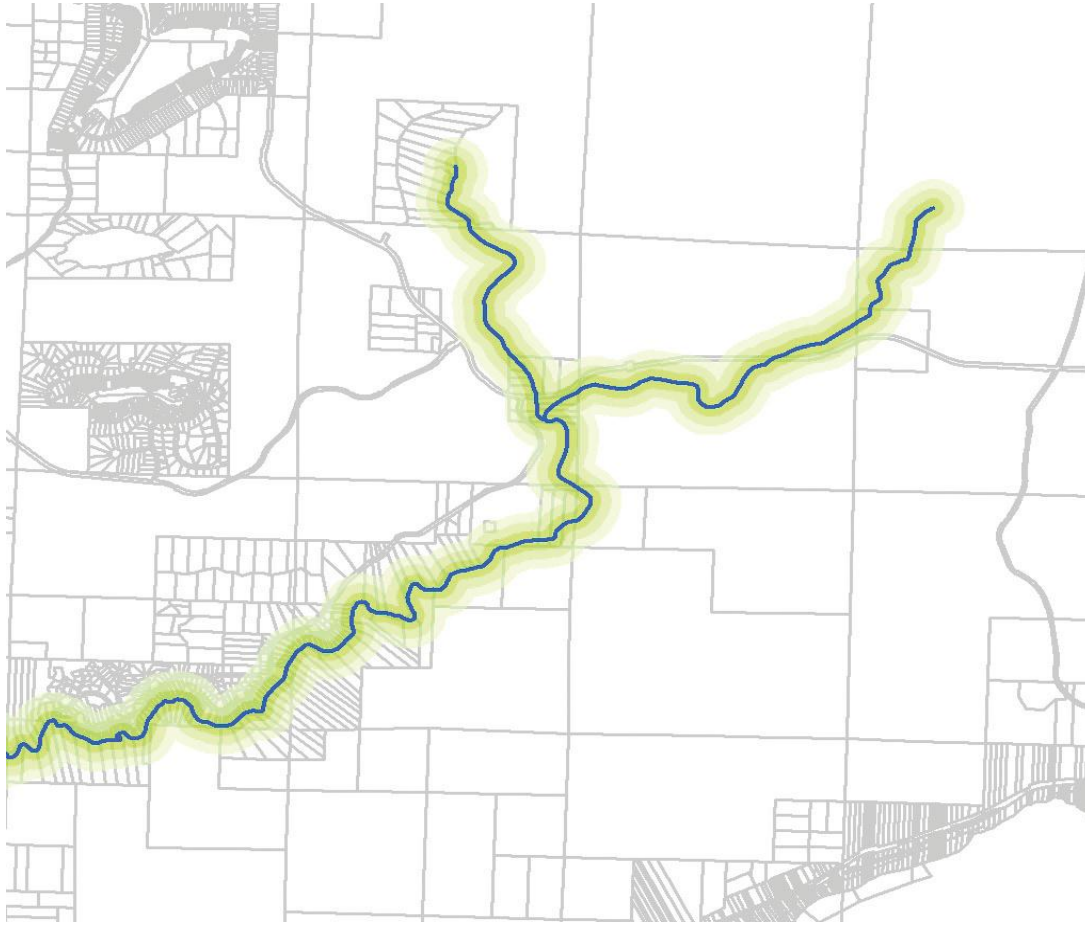
Outlines



Dot pattern shows nature of imprecise boundaries

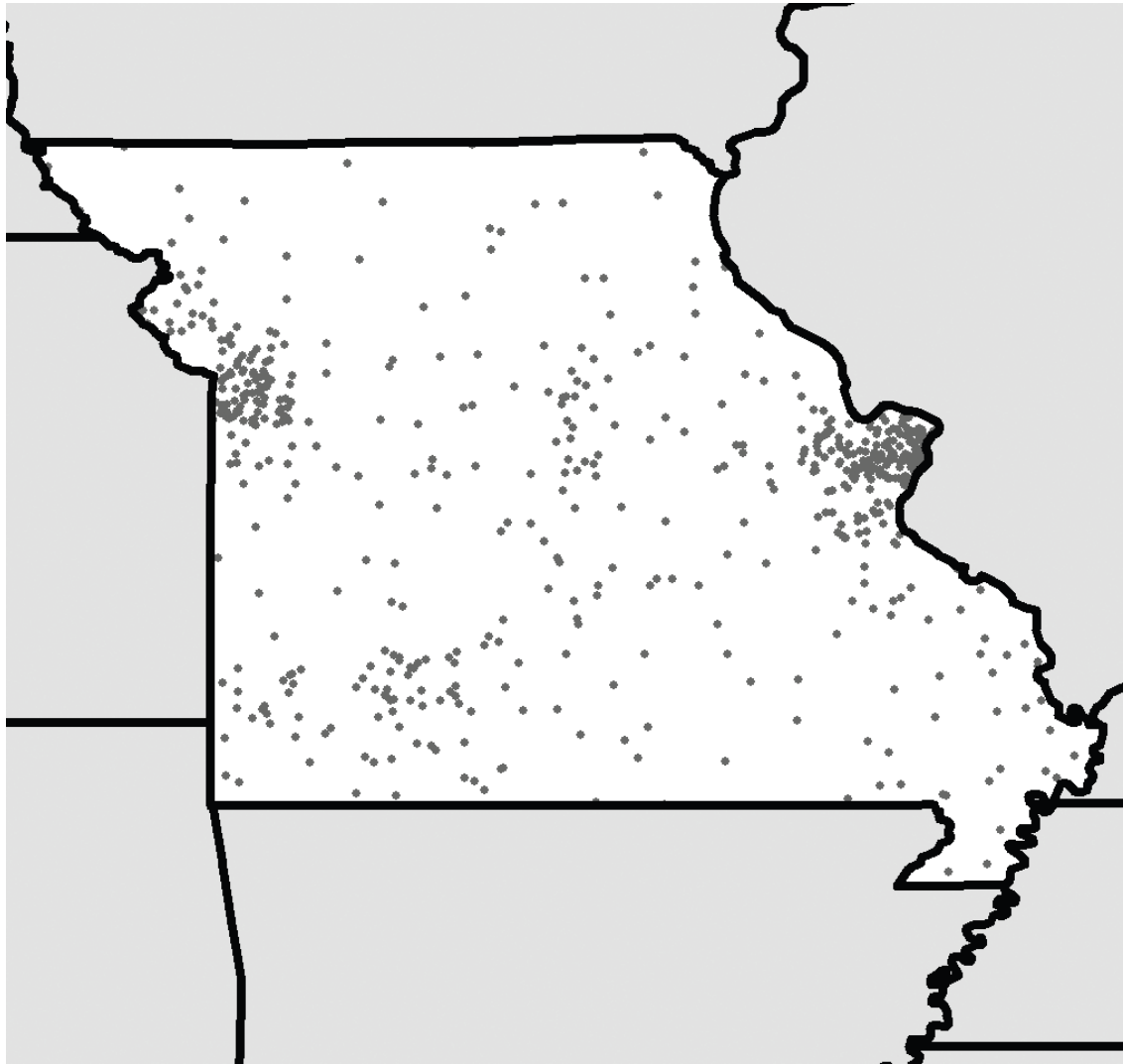


A multi-ring buffer for a stream

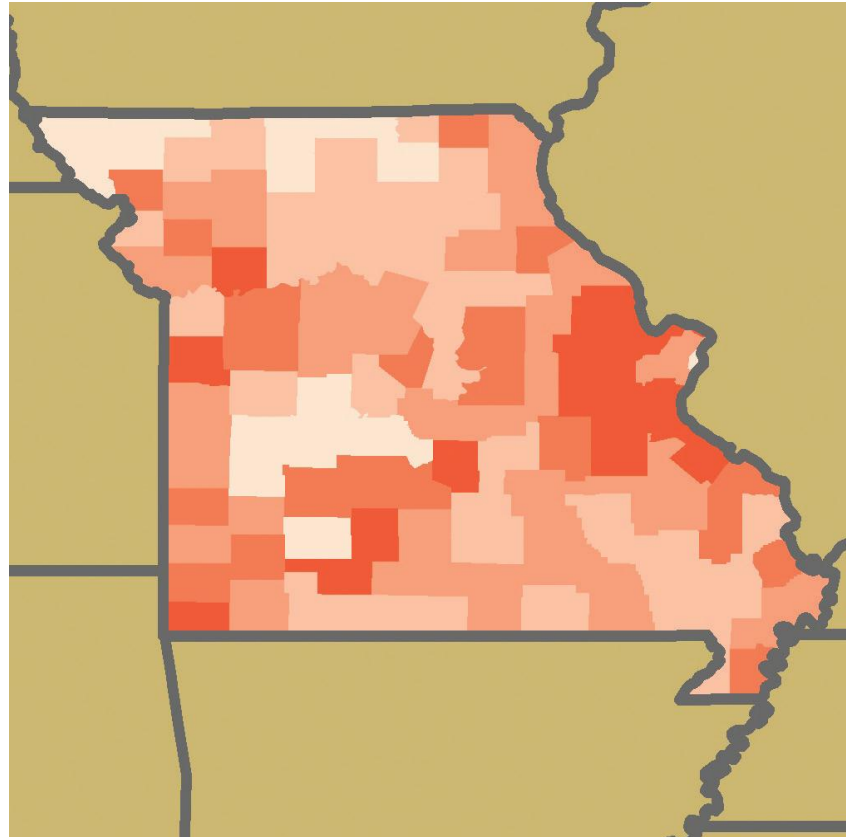


Depicts the
stream buffer's
inherent
fuzziness

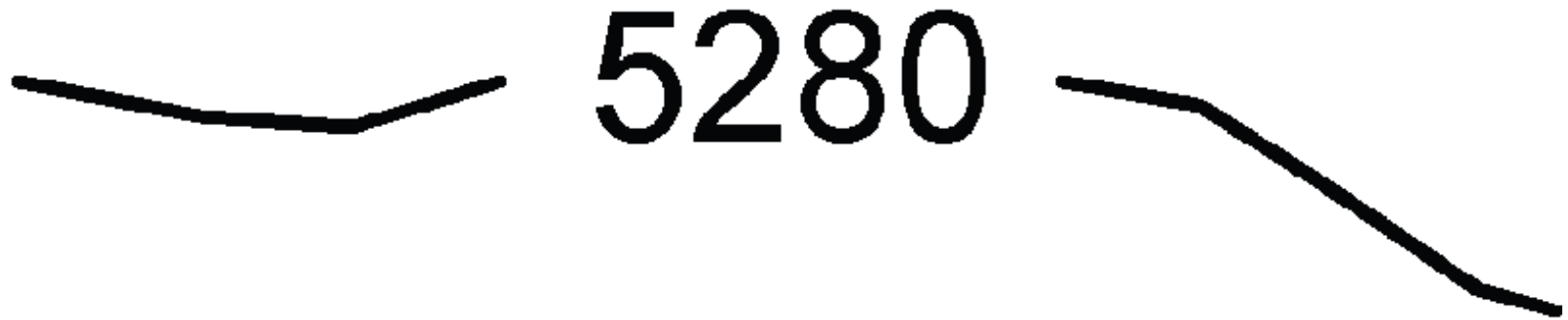
Dot map without boundary lines



Another way to deemphasize boundaries



Contour label



Label the elevation for every 5 or 10 contour lines

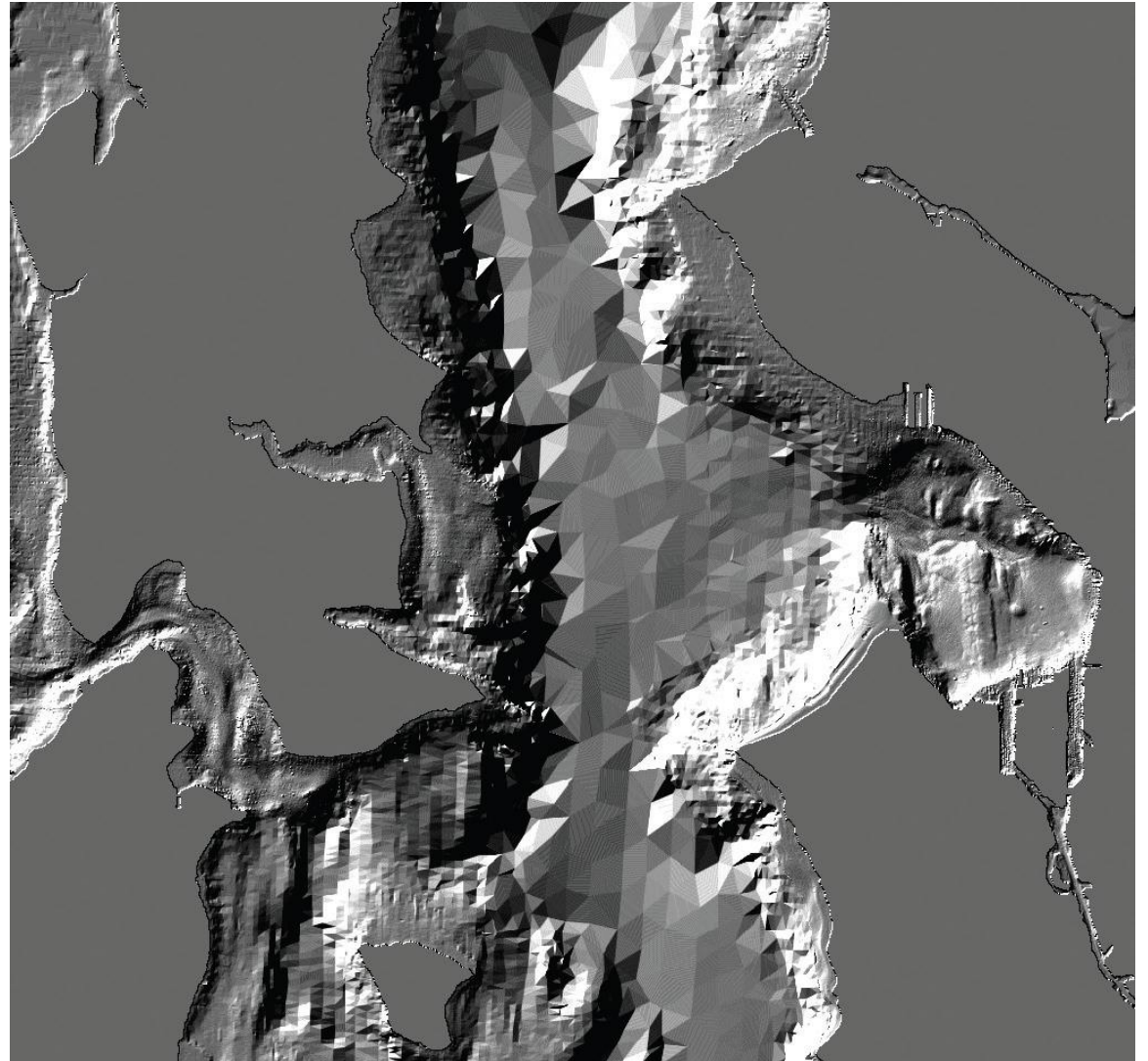
Hypsometric tinting



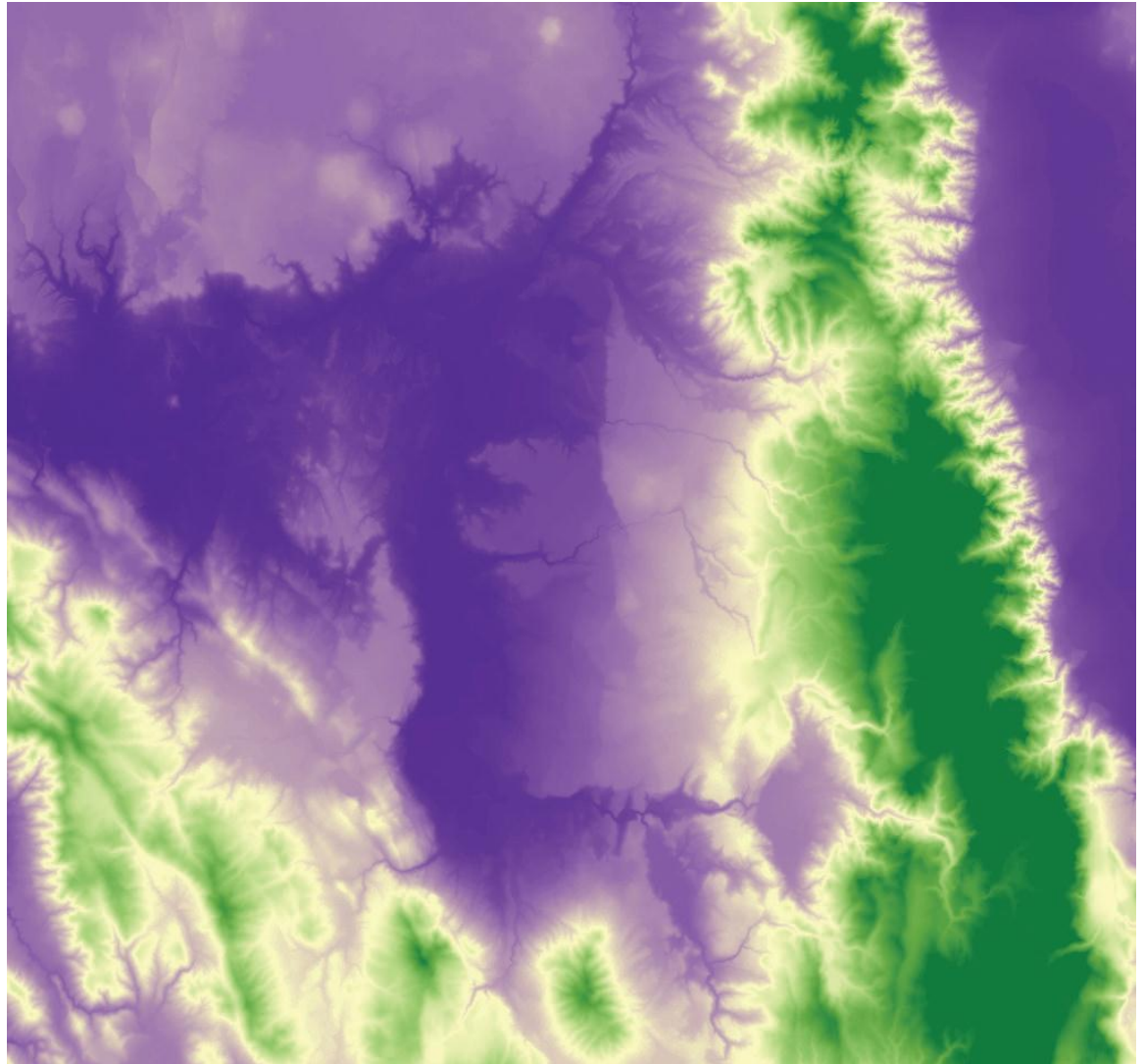
Shaded contour
map

Data rich

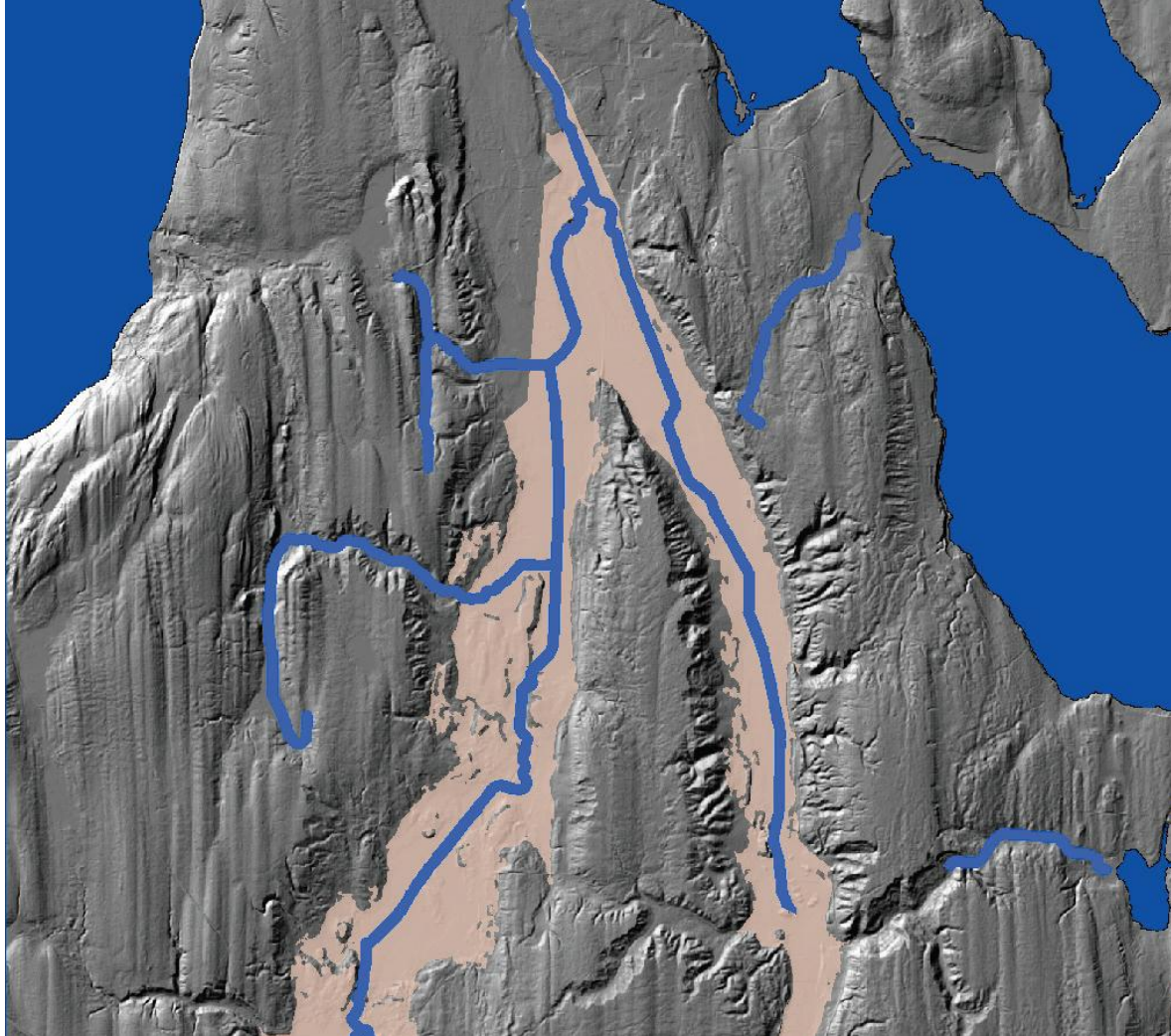
Hillshading



Uncommon color scheme

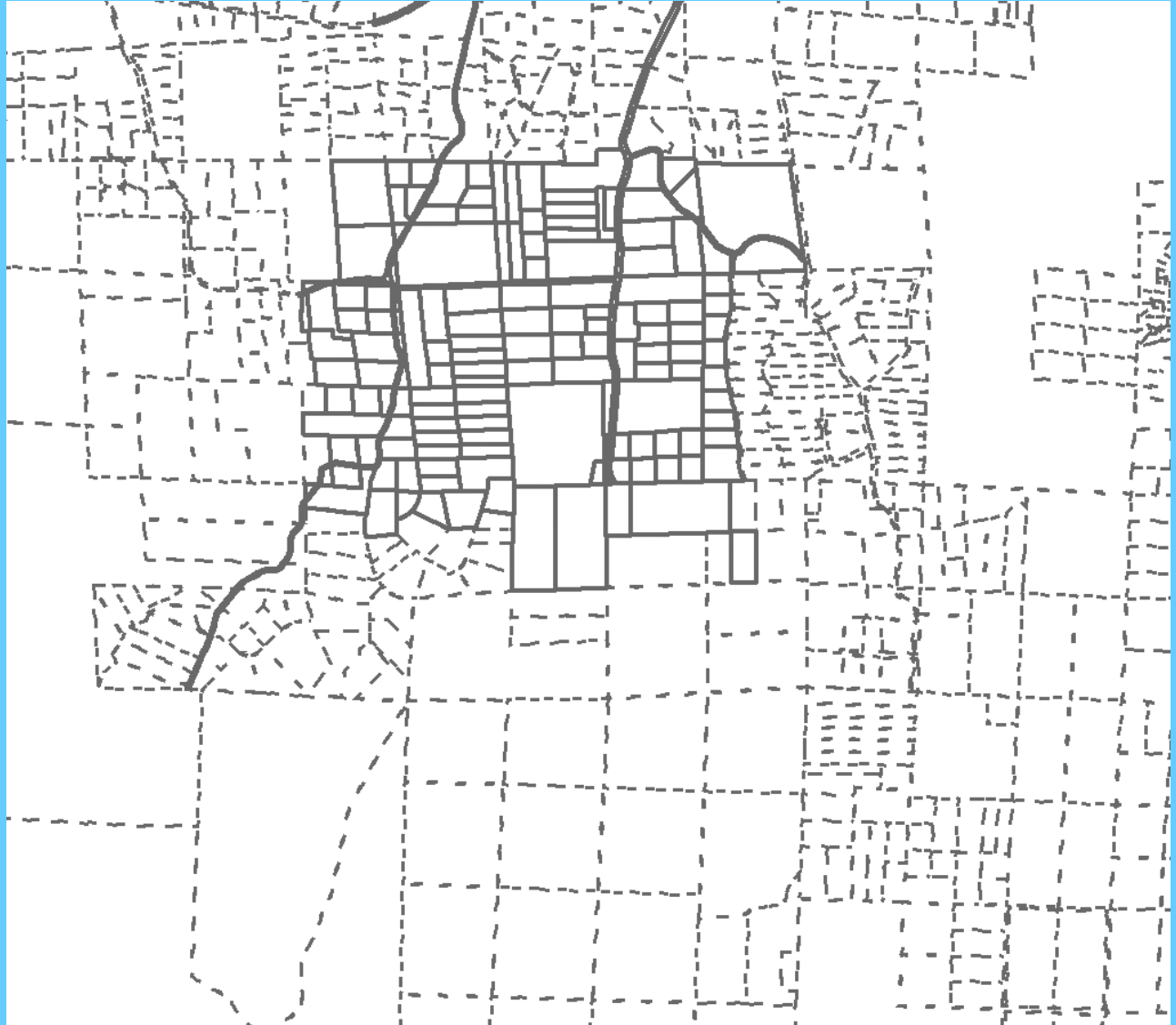


Hillshade for hydrological features

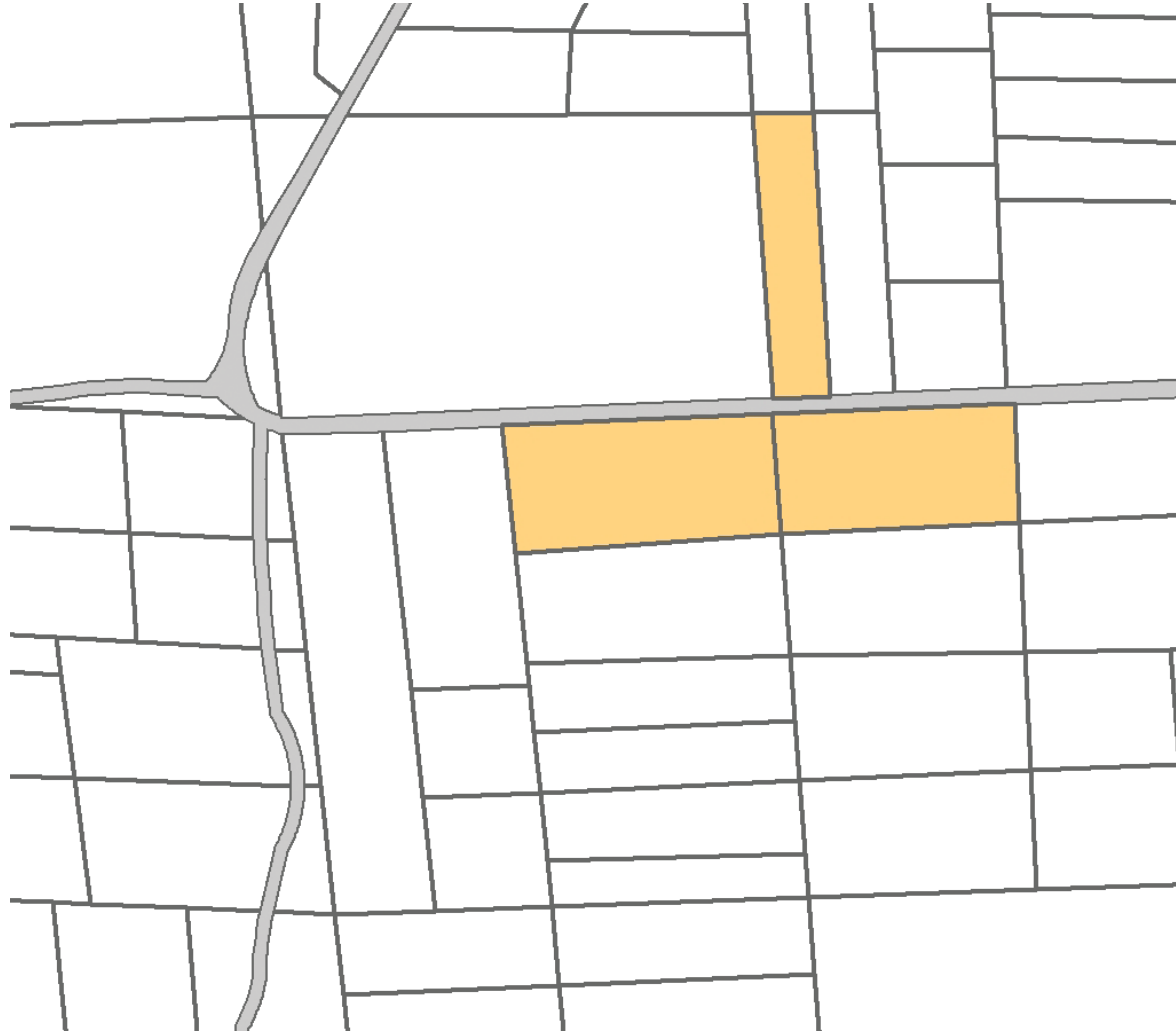


Showing the
relationship
between
floodplain and
elevation

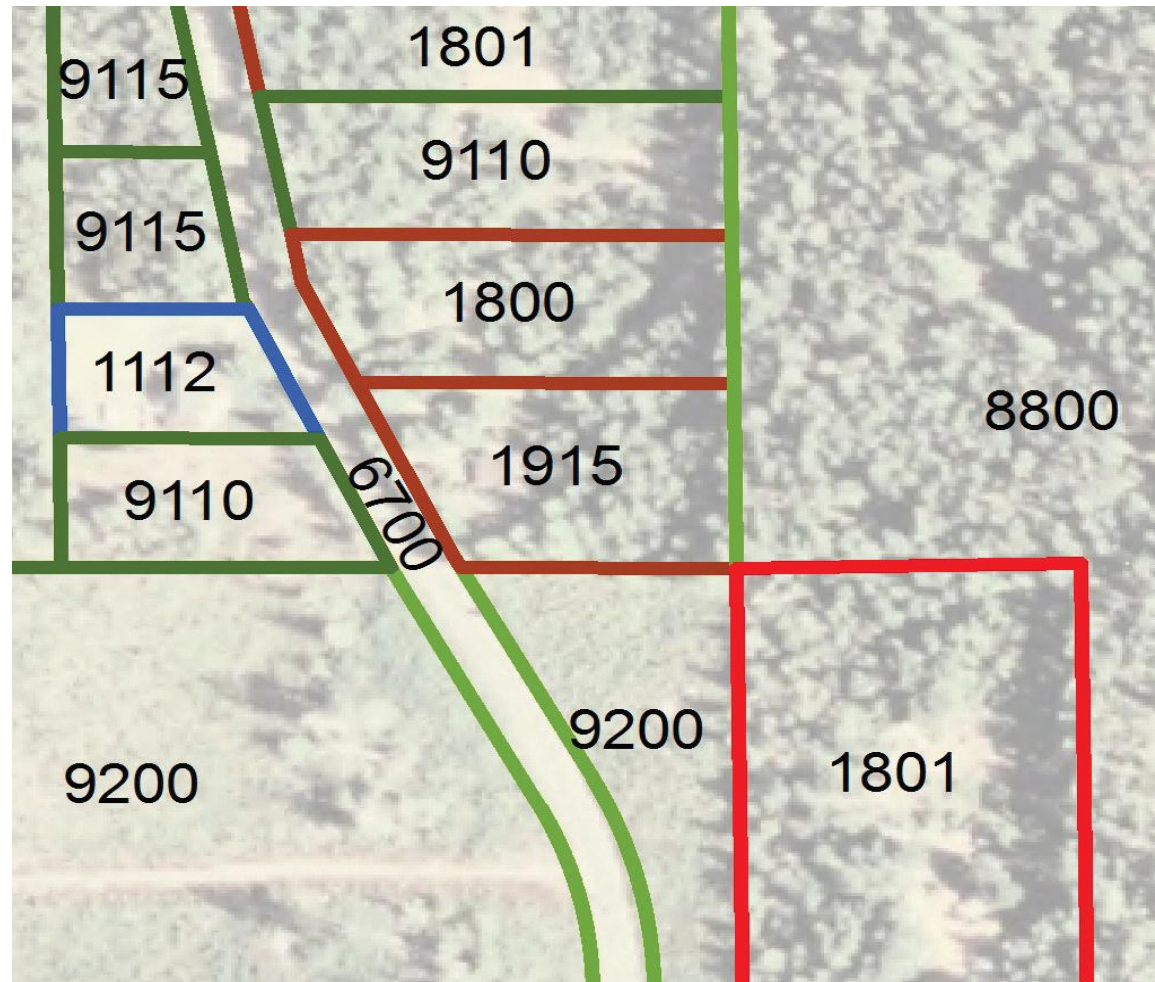
Parcel map –surveyed and hand-drawn



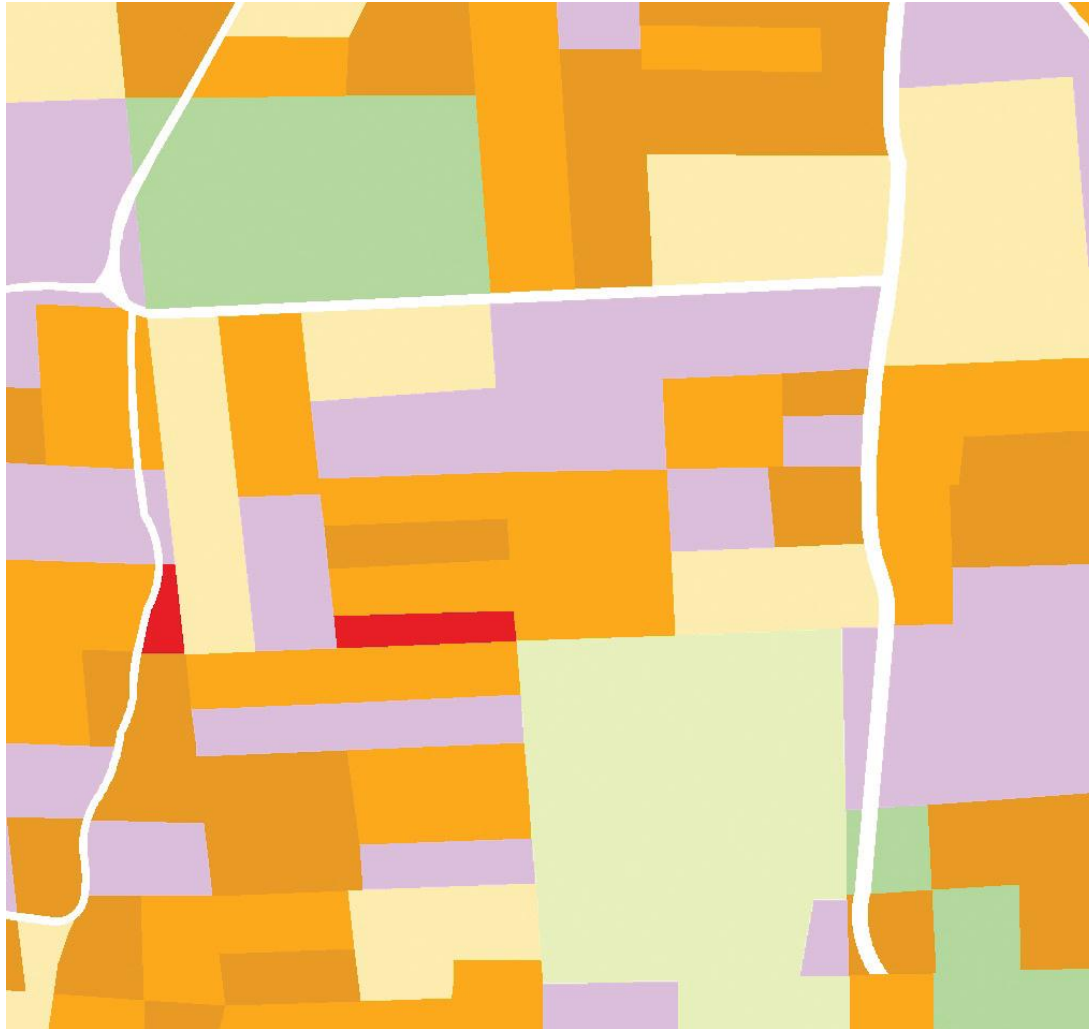
Highlighted parcel map



Colored lines overlaid on an aerial photograph



Land use parcel map



Green – forest

Orange –
residential

Tan – public
space

Bay currents – 3 symbol sizes to show velocity and direction



Smaller scale view of the same map

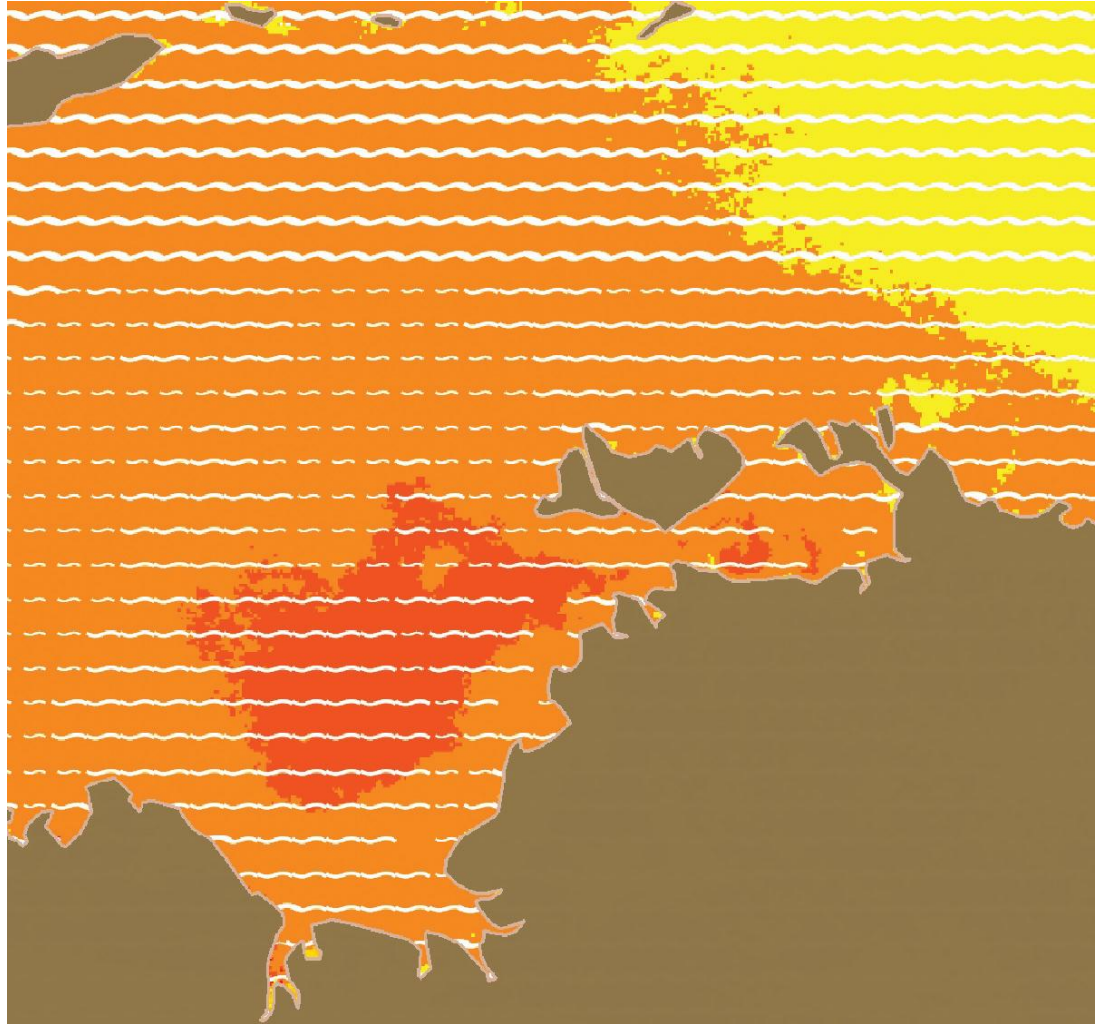


To show currents in small scale

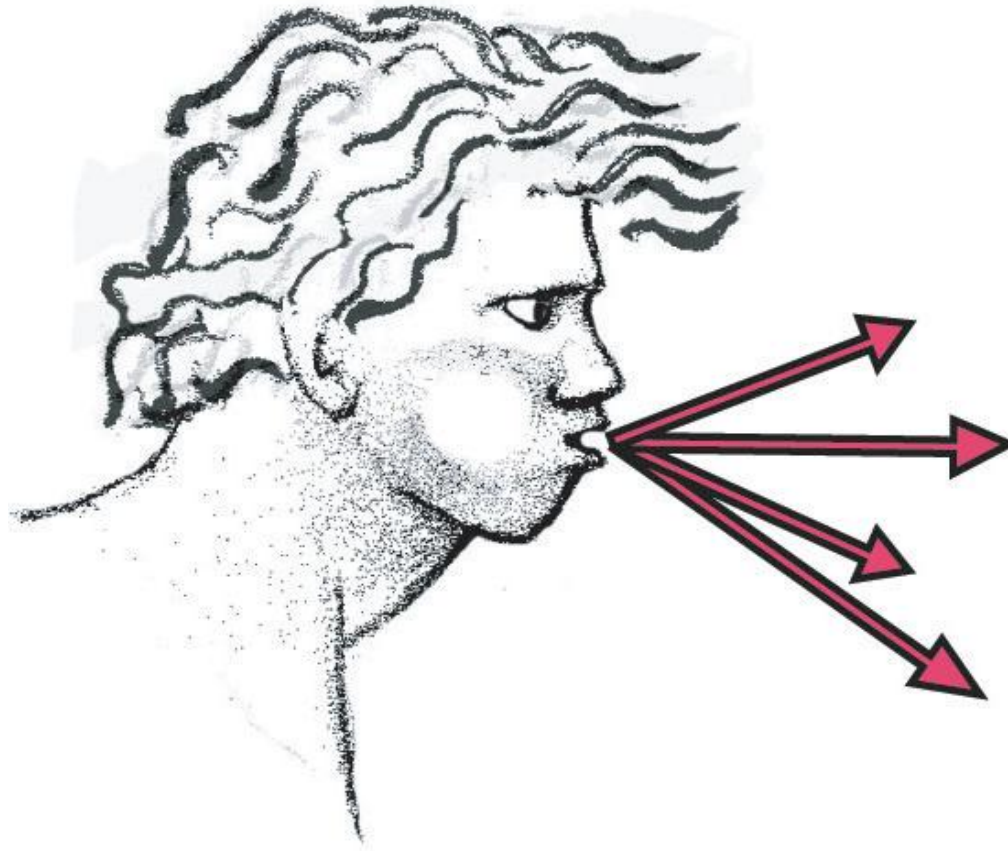


Elongated arrow

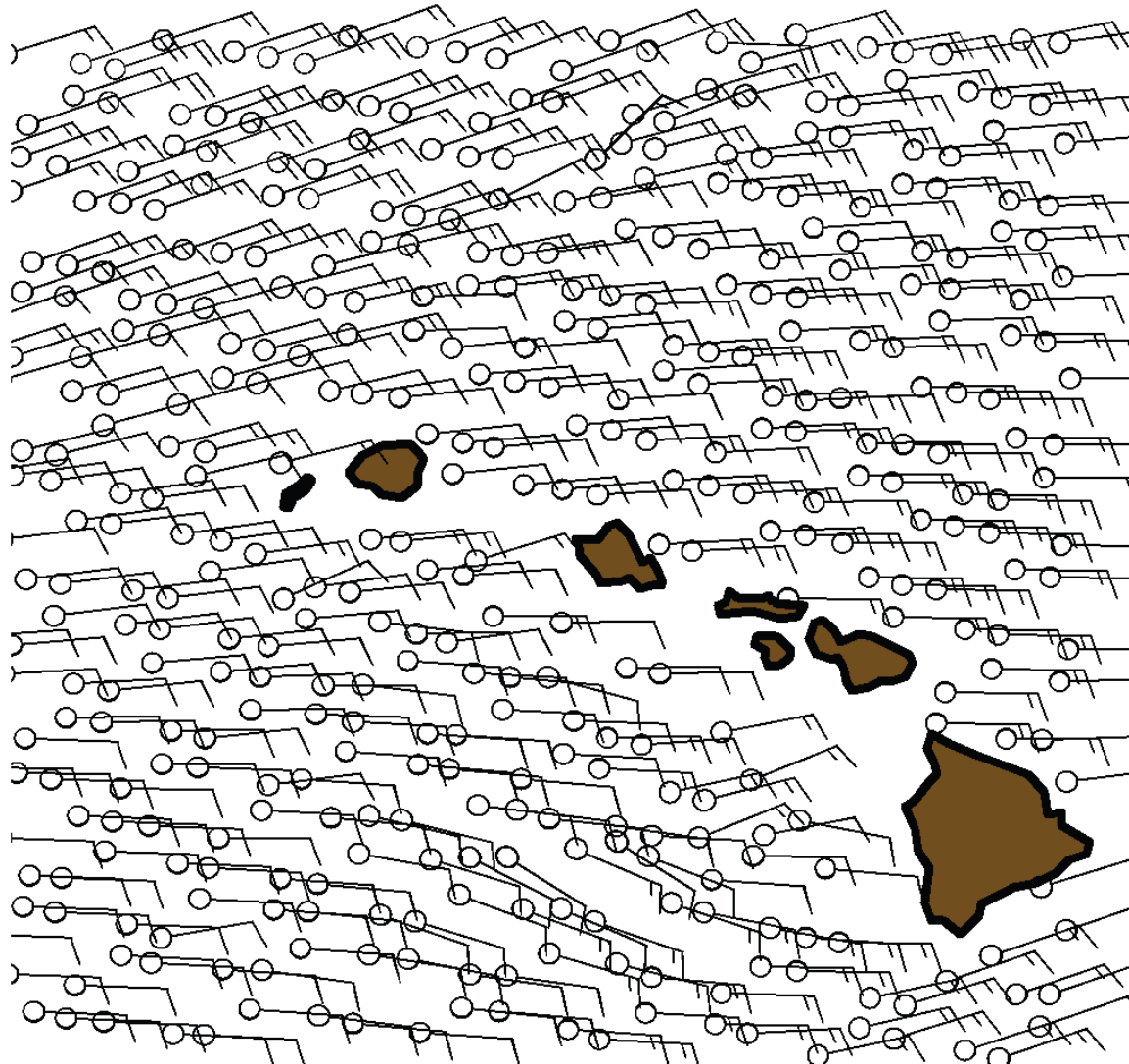
Ocean currents and sea surface temperature



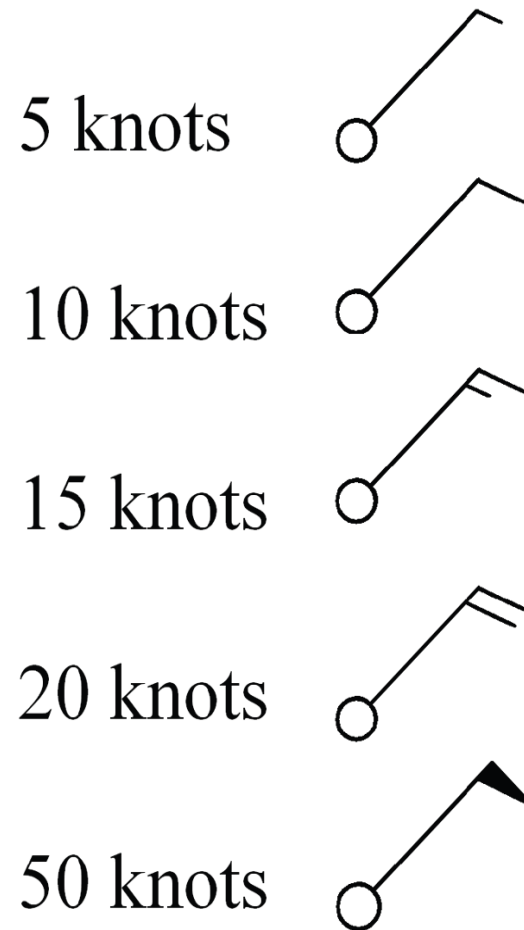
Red hue shows a lot of hot air



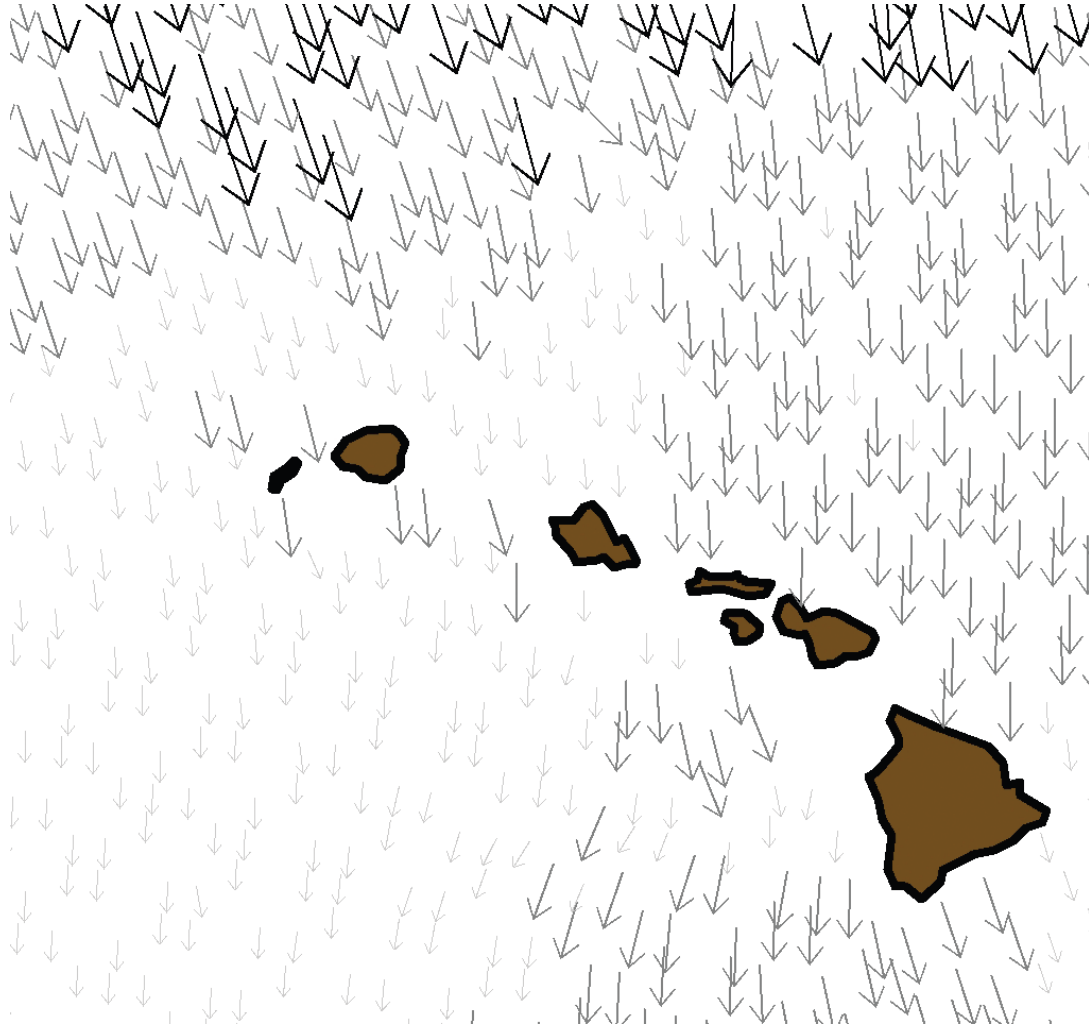
Wind barbs clutter



Direction and speed of the wind

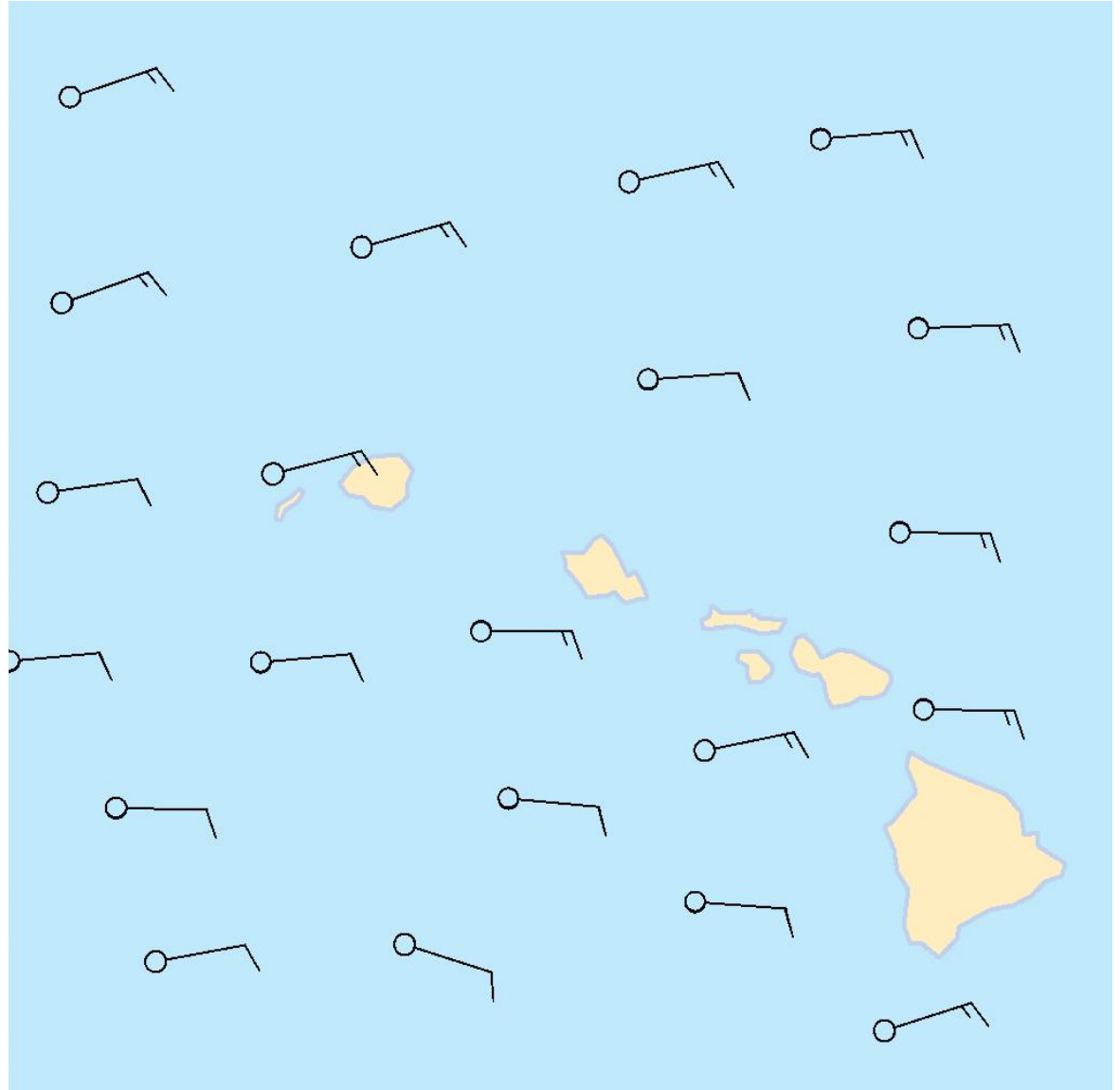


Another way to show wind speed and direction

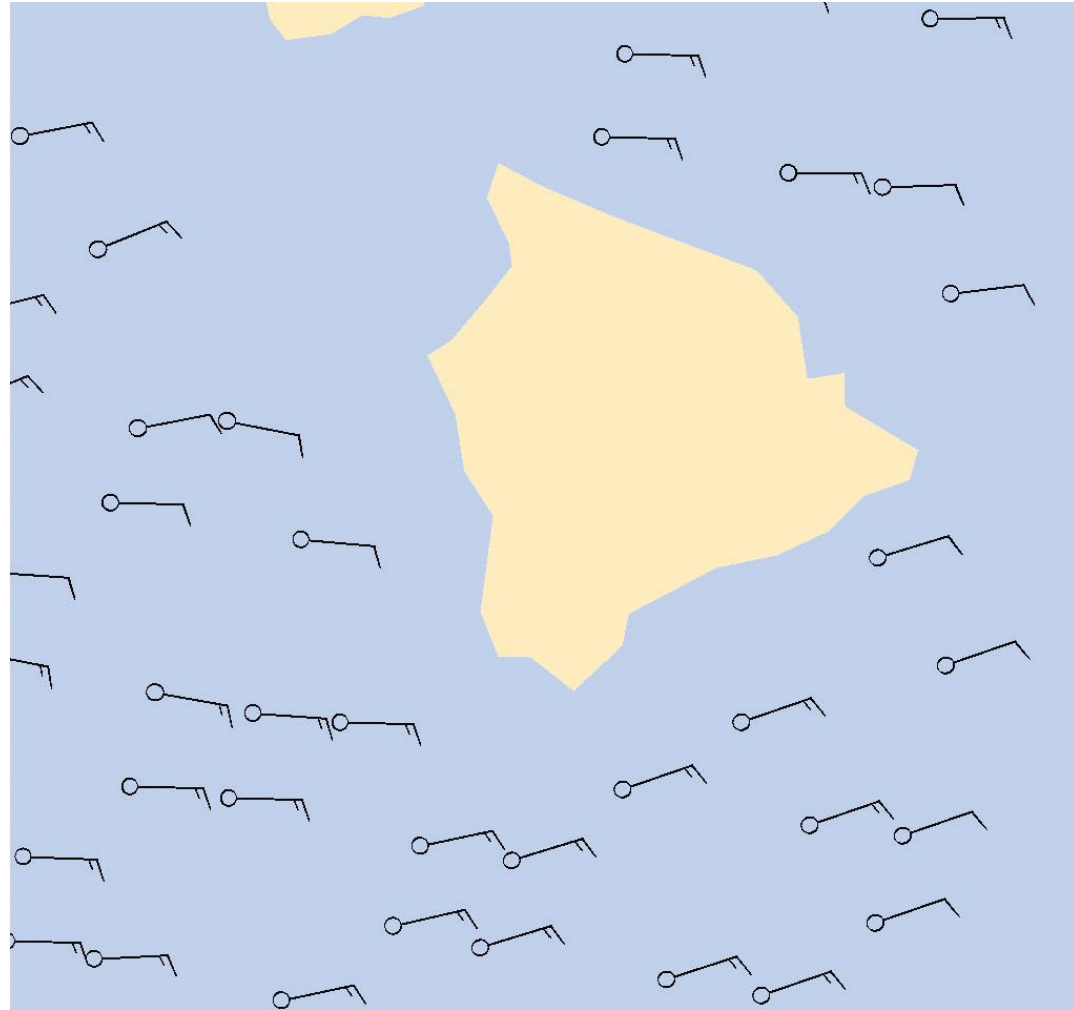


Darker and longer
arrows = a fast
wind

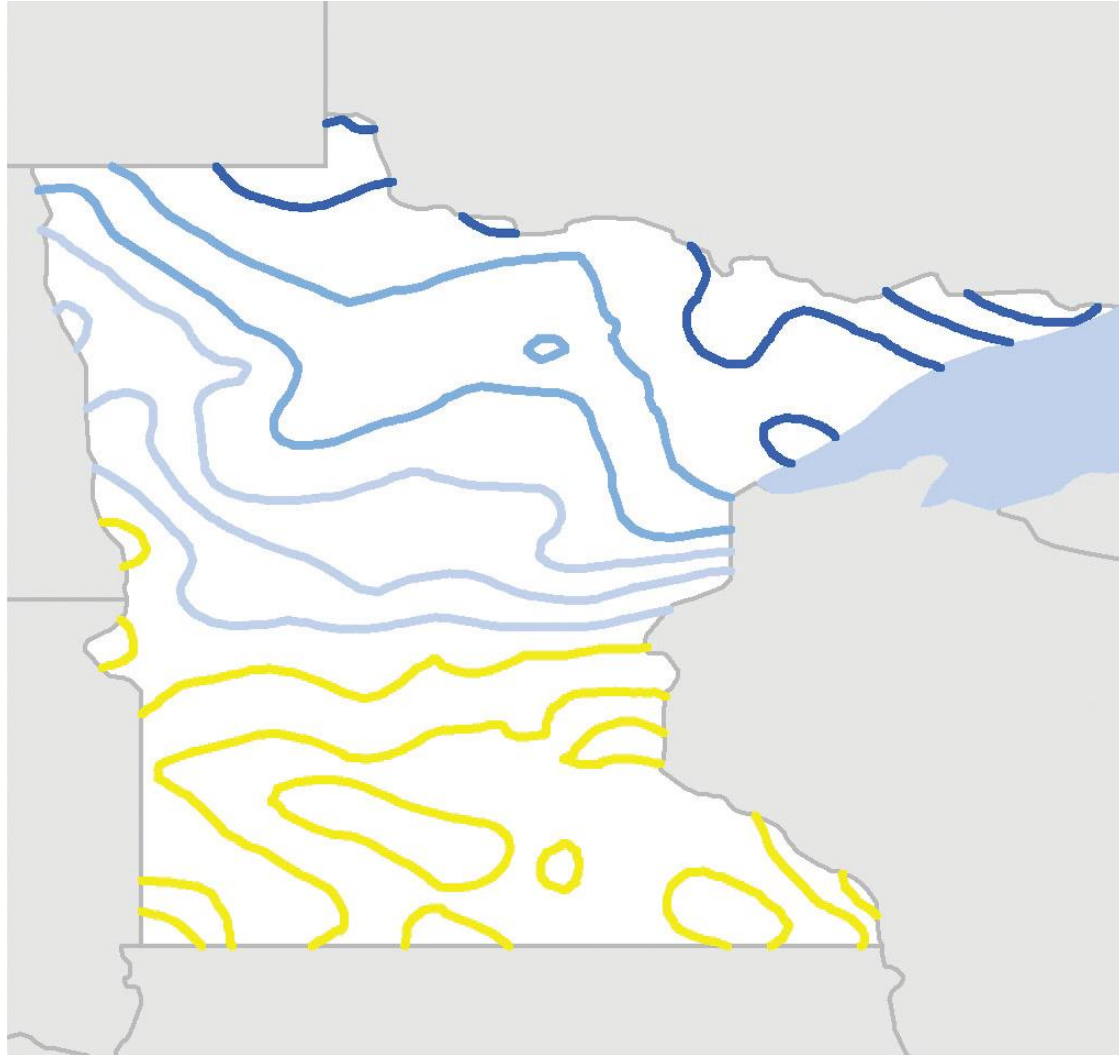
Resampled to decrease visual clutter



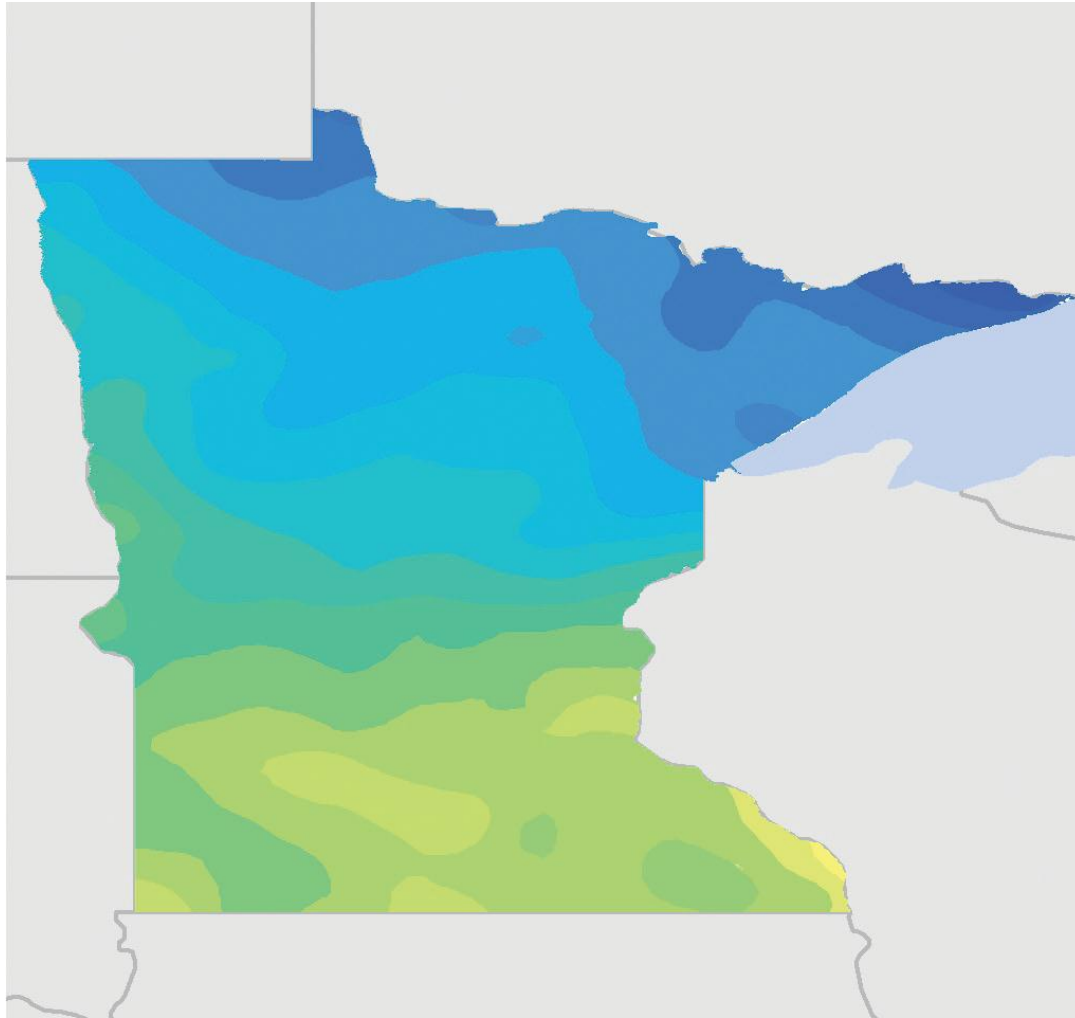
Effect of enlarging the map extent – all barbs visible



Temperature isolines in color

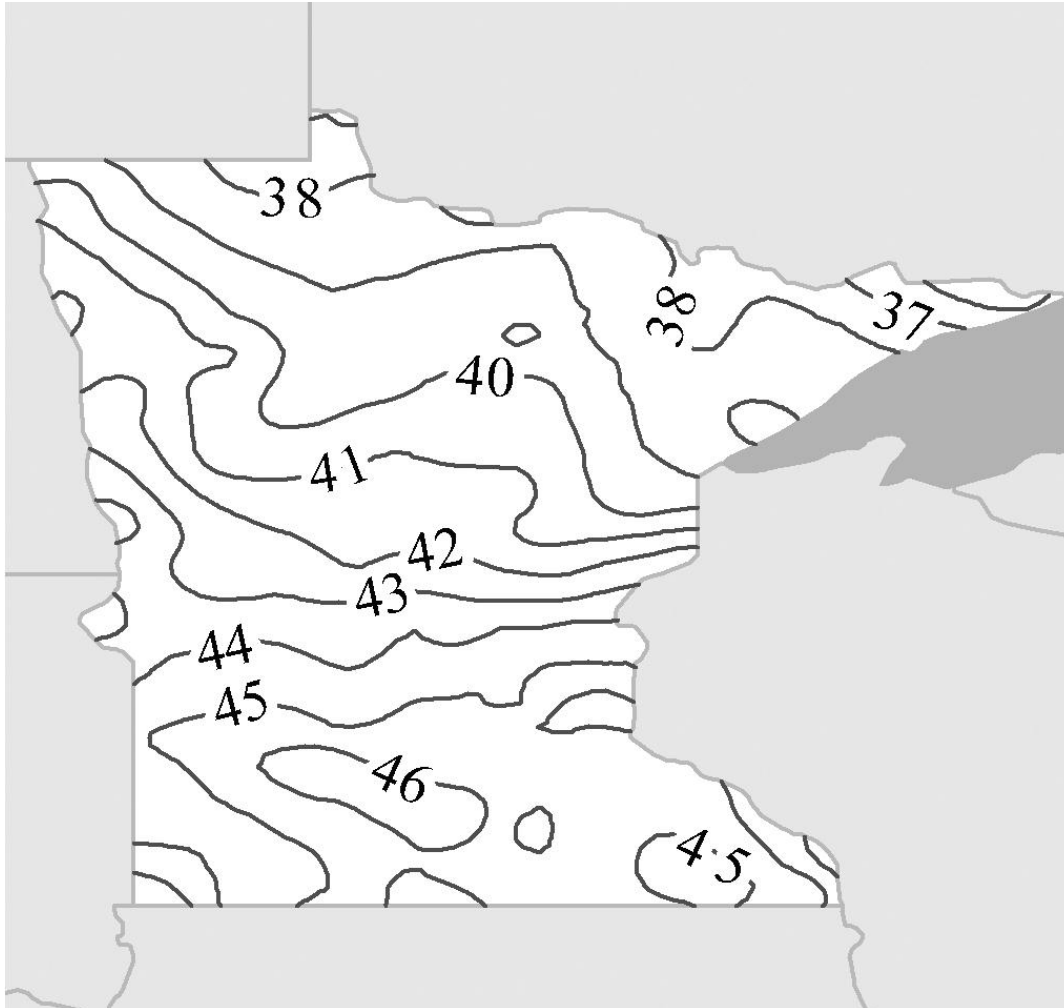


Area between isolines is shaded



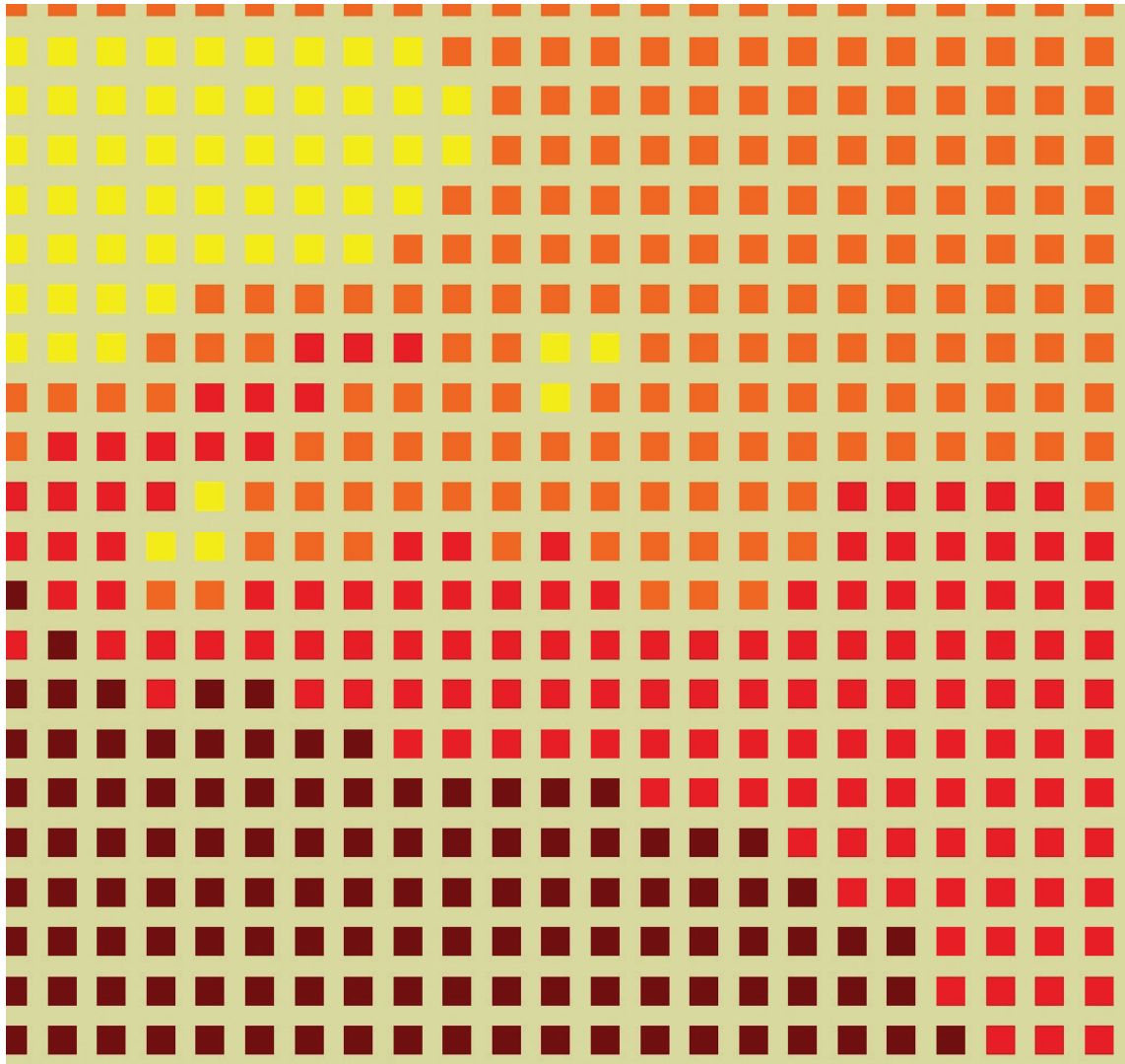
This gives a different view. Consider your audience's needs when deciding which view to use.

Temperature isoline map with degrees shown












May need to
use halo-text
for the labels or
a symbol with
text

Temperature points, cont.
























This design also shows clearly that the data was taken at discrete stations

Level 1 Anderson

| Land Cover Category Name | No. | RGB Color |
|--------------------------|---|-------------|
| Urban or Built-up Land | 1  | 235 109 105 |
| Agricultural Land | 2  | 206 166 138 |
| Rangeland | 3  | 255 224 174 |
| Forest Land | 4  | 166 213 158 |
| Water | 5  | 117 181 220 |
| Wetland | 6  | 188 219 232 |
| Barren | 7  | 200 200 200 |
| Tundra | 8  | 189 221 209 |
| Perennial Snow or Ice | 9  | 255 255 255 |

Original Munsell
model converted
into RGB triplets

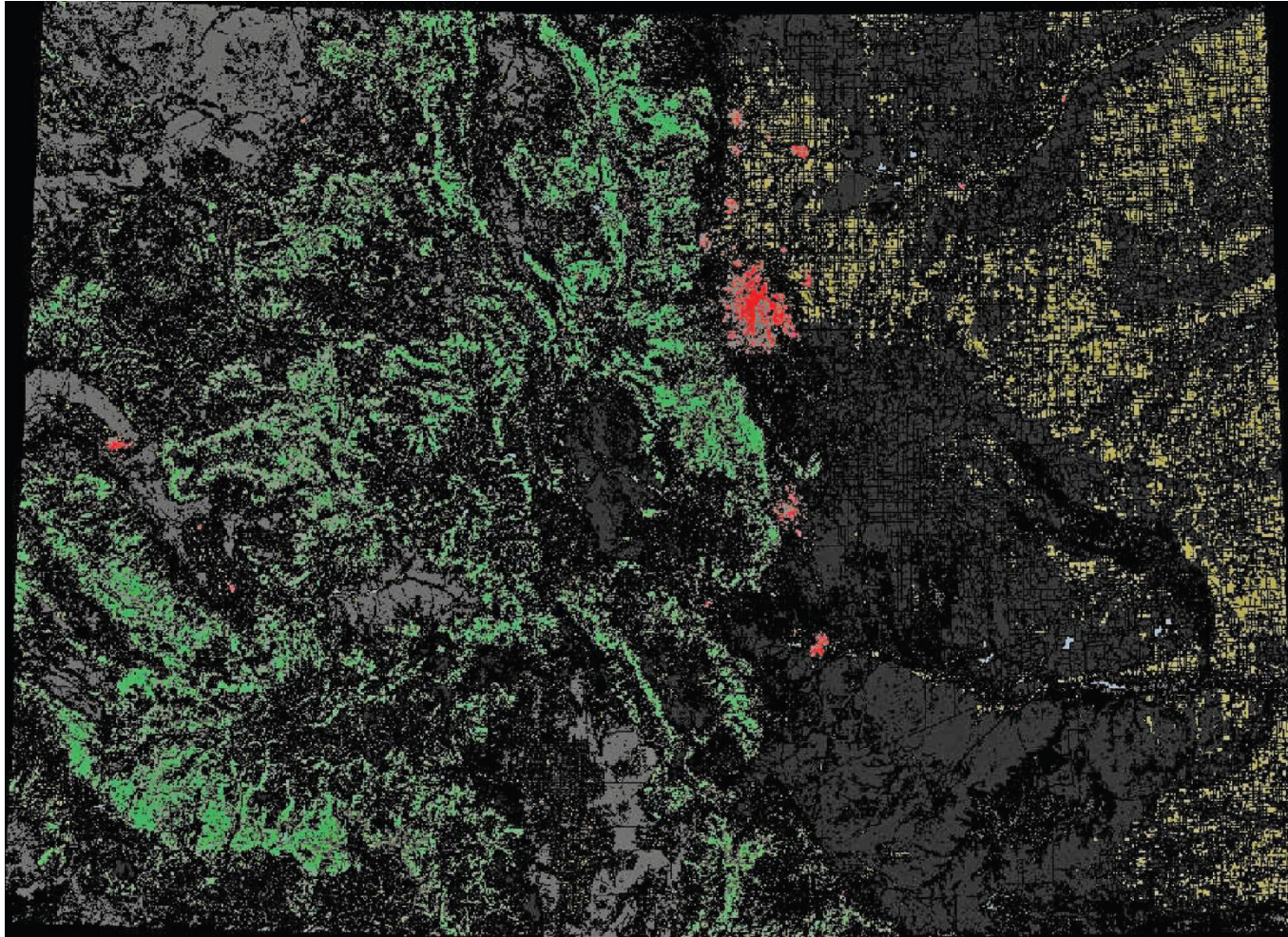
National Land Cover Database (NLCD)

| Land Cover Category Name | No. | RGB Color | Land Cover Category Name | No. | RGB Color |
|--|-----|---|------------------------------|-----|---|
| Water | 11 |  102 140 190 | Shrubland | 51 |  220 202 143 |
| Perennial ice, snow | 12 |  255 255 255 | Orchards, vineyards, other | 61 |  187 174 118 |
| Low intensity residential | 21 |  253 229 228 | Grasslands, herbaceous | 71 |  253 233 170 |
| High intensity residential | 22 |  247 178 159 | Pasture, hay | 81 |  252 246 93 |
| Commercial, industrial, transportation | 23 |  231 86 78 | Row crops | 82 |  202 145 71 |
| Bare rock, sand, clay | 31 |  210 205 192 | Small grains | 83 |  121 108 75 |
| Quarries, strip mines, gravel pits | 32 |  175 175 177 | Fallow | 84 |  244 238 203 |
| Transitional | 33 |  83 62 118 | Urban, recreational grasses | 85 |  240 156 54 |
| Deciduous forest | 41 |  134 200 127 | Woody wetlands | 91 |  201 230 249 |
| Evergreen forest | 42 |  56 129 78 | Emergent herbaceous wetlands | 92 |  144 192 217 |
| Mixed forest | 43 |  212 231 177 | | | |

1992 NLCD for S. Carolina

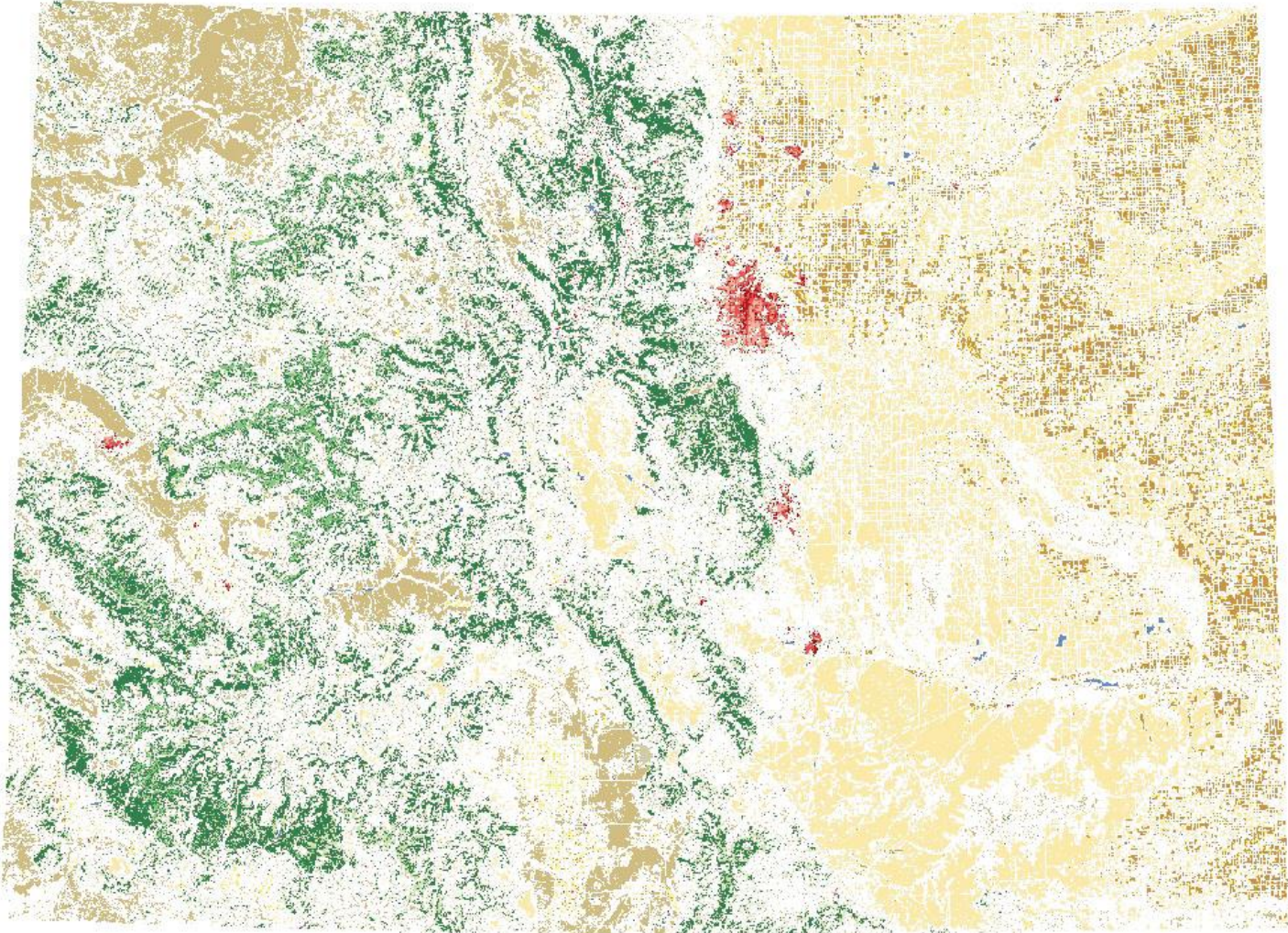


NLCD for Colorado

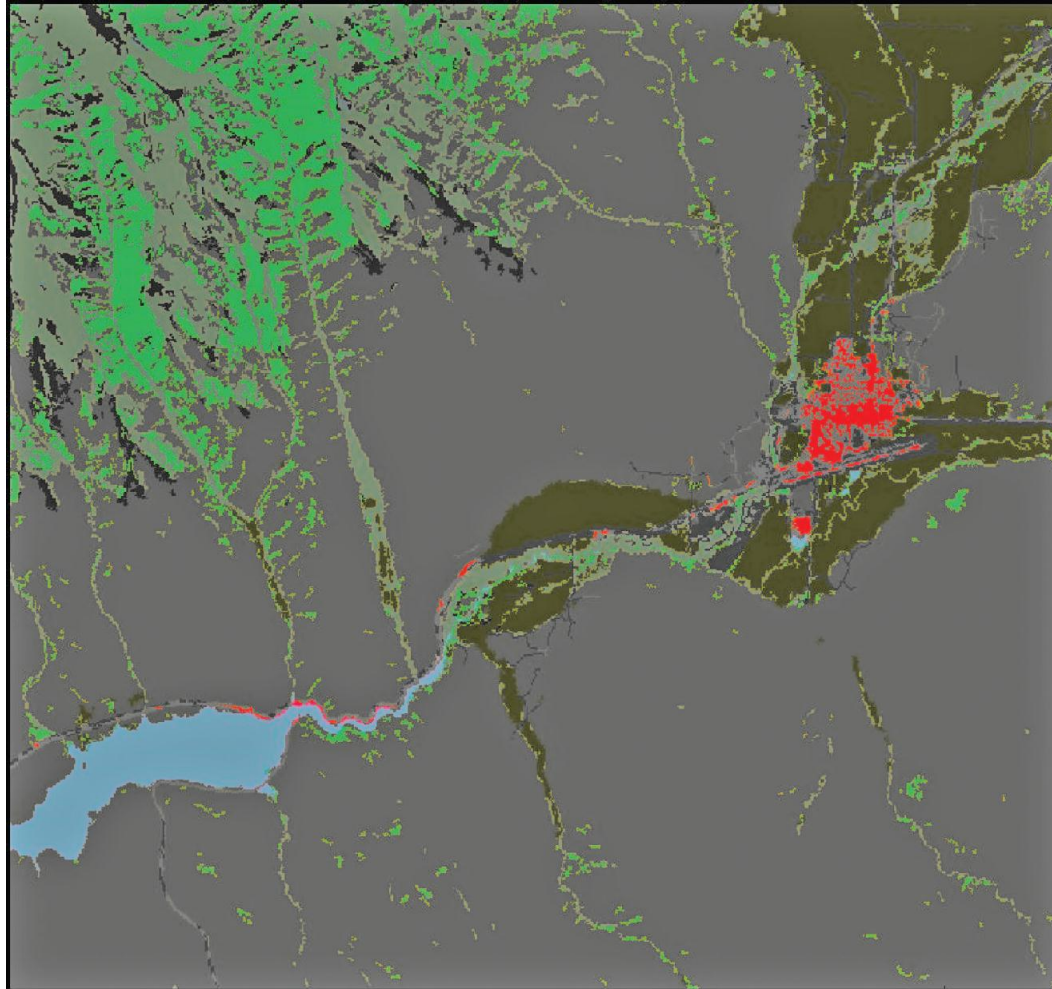


Graphic
color filter
used

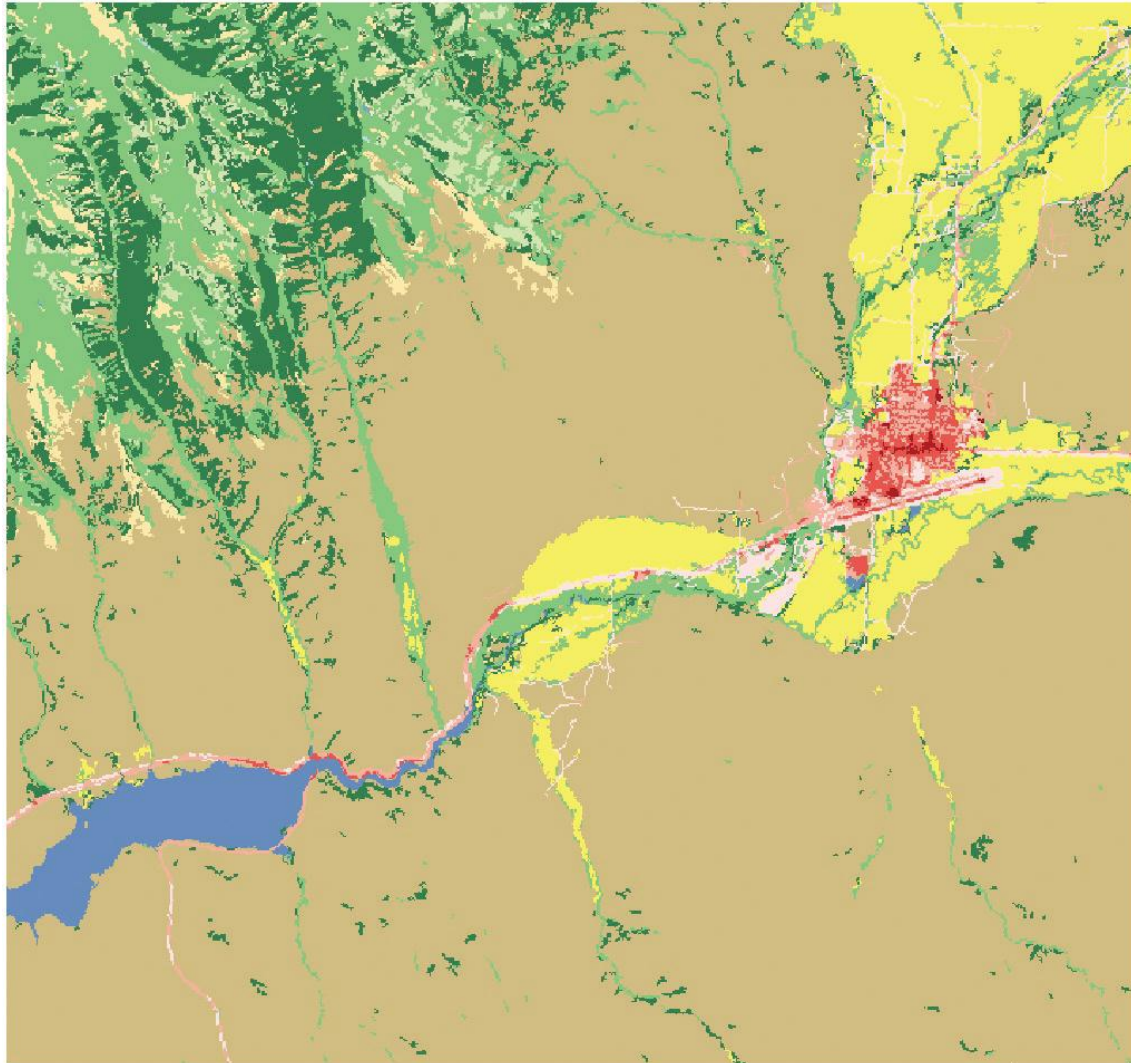
Same map with suggested color scheme



Same map, zoomed in with modified color scheme



Same scale, suggested colors

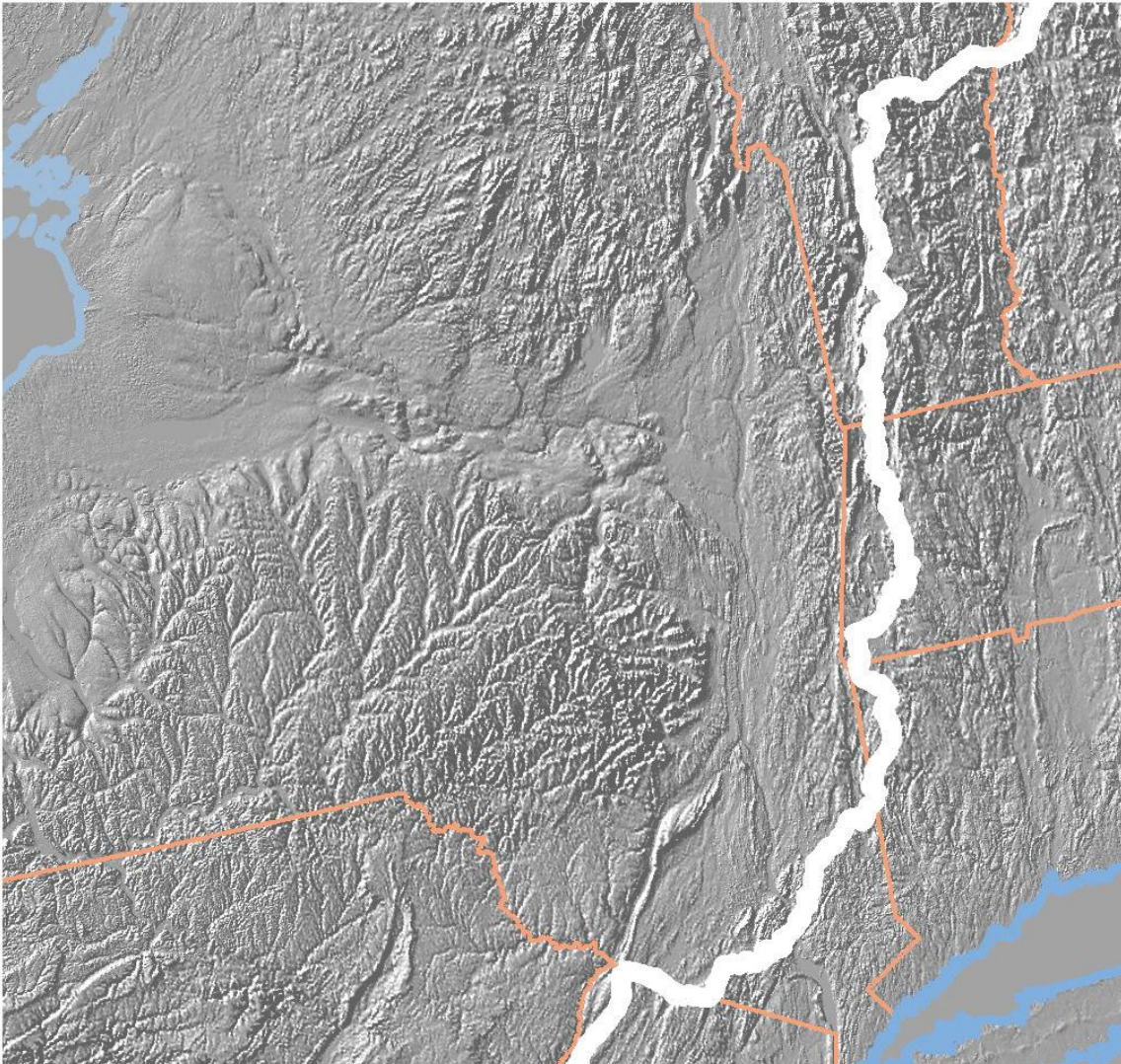


Appalachian Trail



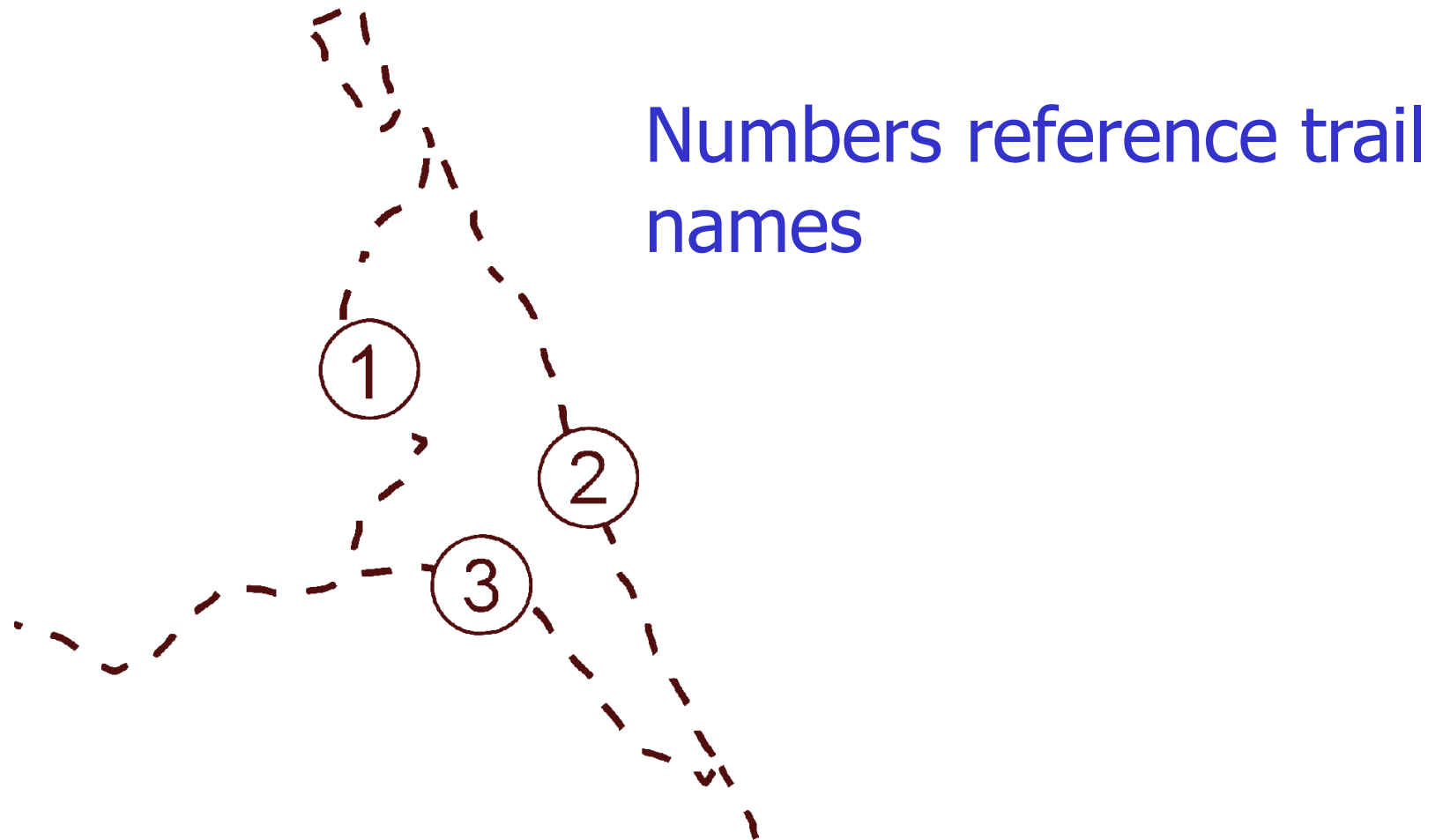
States outlined
in white do not
compete with
the trail line

To show the NY portion of trail

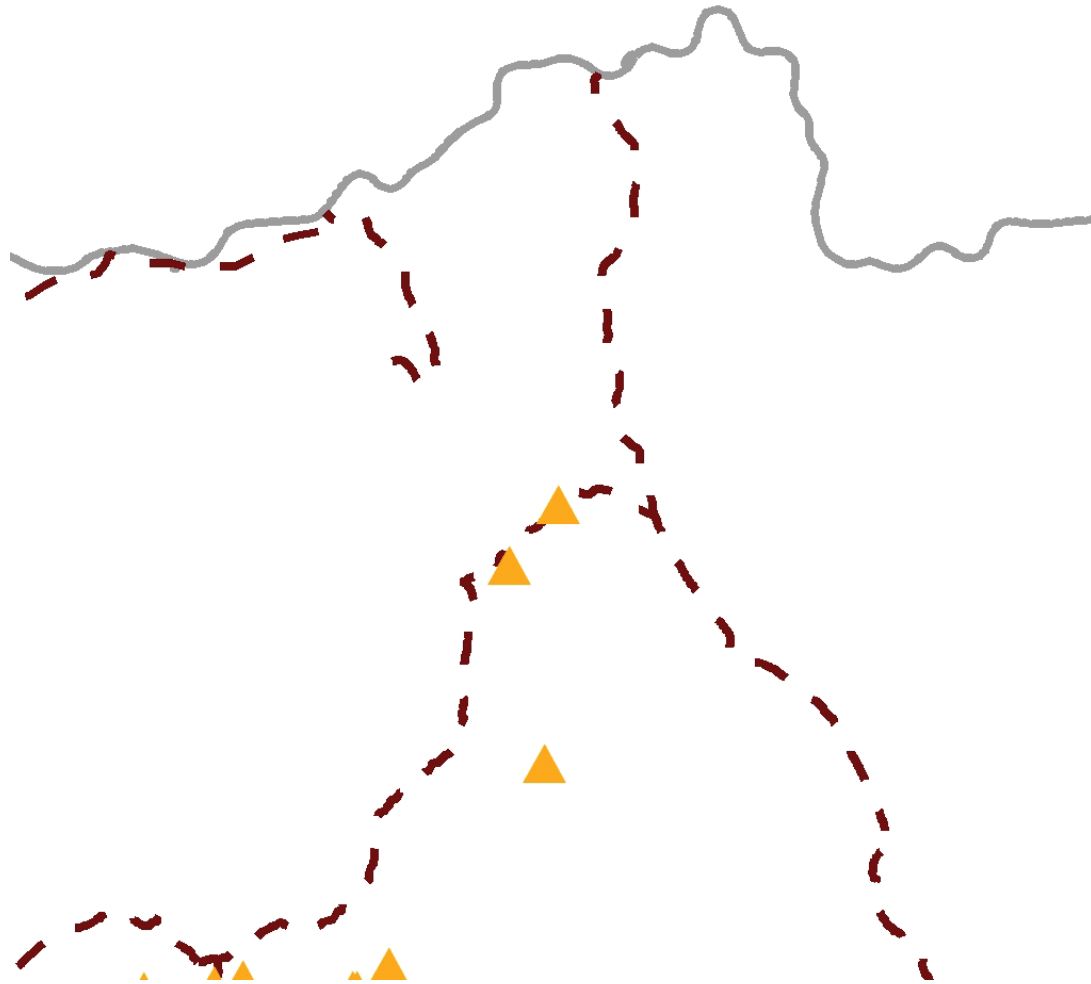


State
boundaries in
light orange
so the trail
line is
prominent

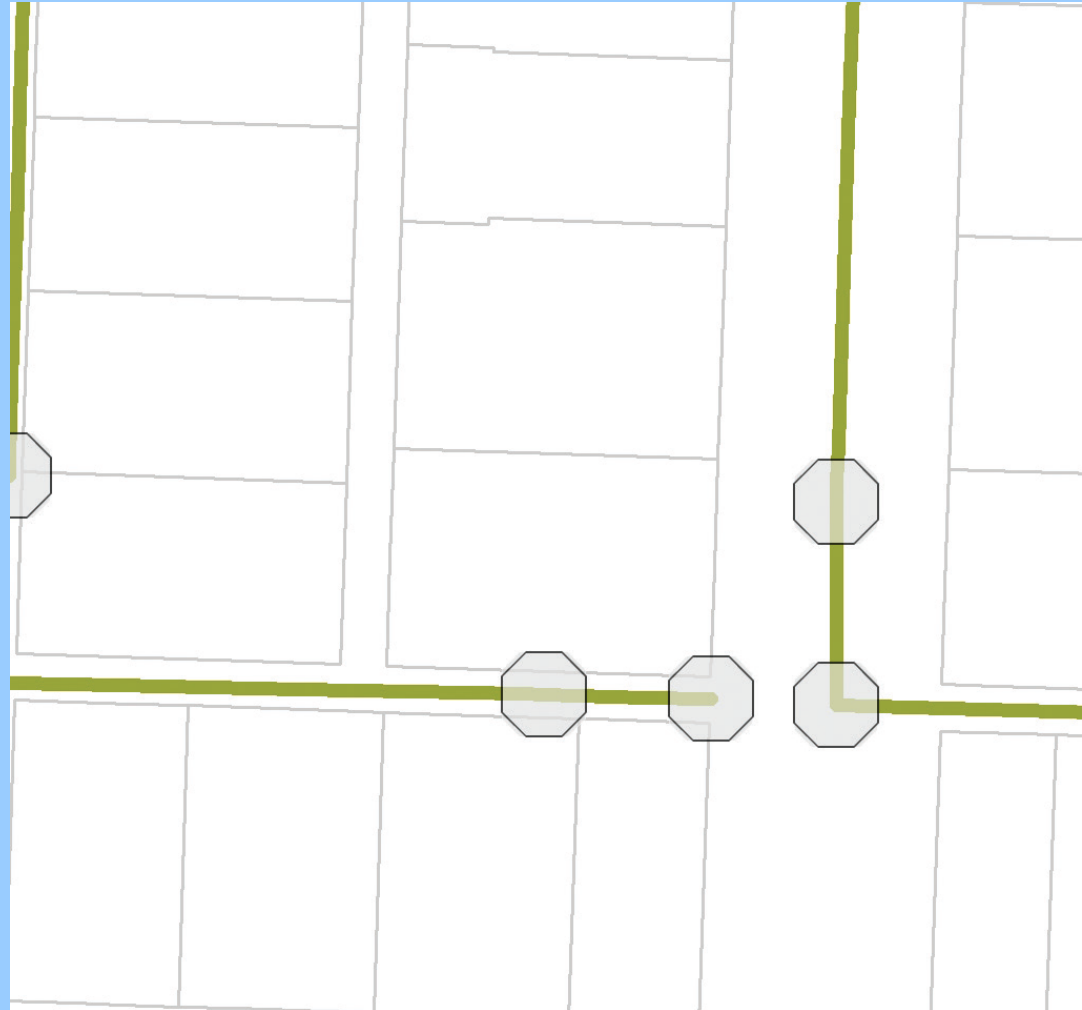
Common way to show a trail system



Example of ordering features



Transparent manhole covers shown on top of sewer lines



Smaller manhole covers

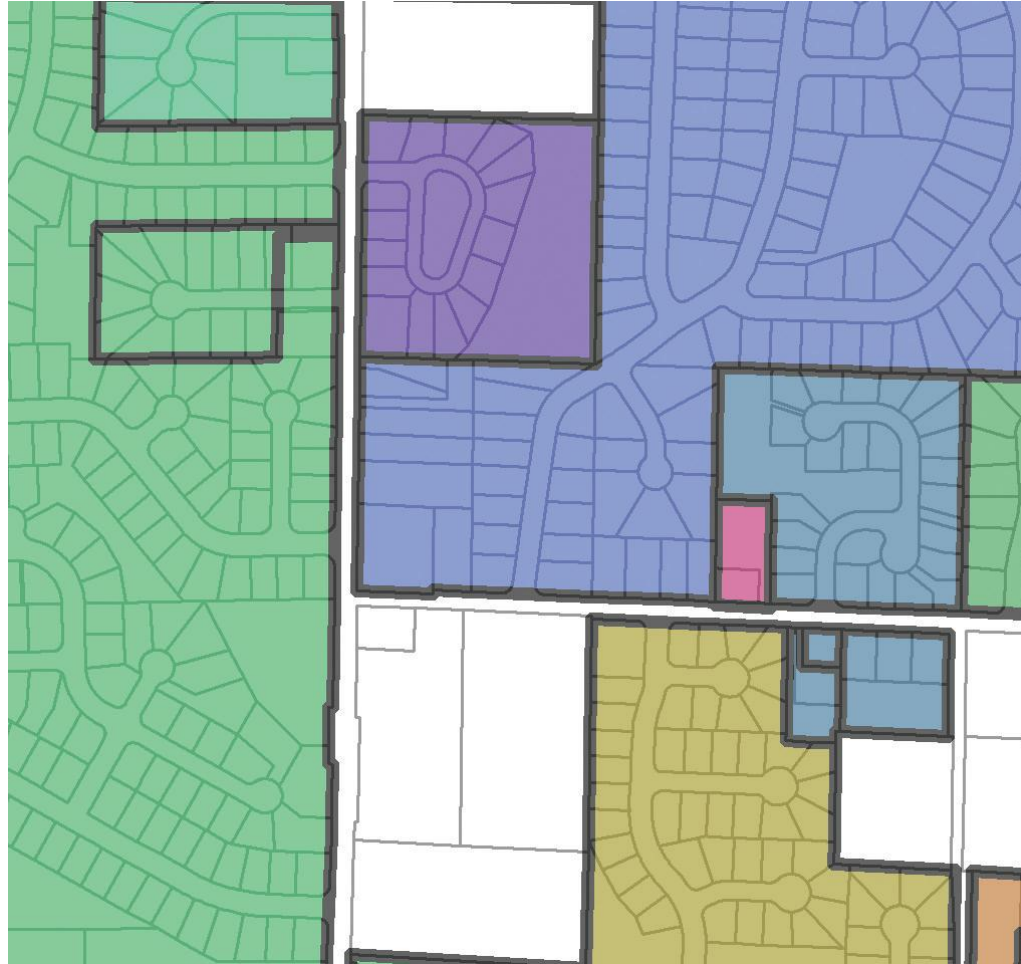


Provides for
equal focus on
storm and
sewer drains

Polyline format



Focus is on the bold color areas with thick black outlines



Think about frames

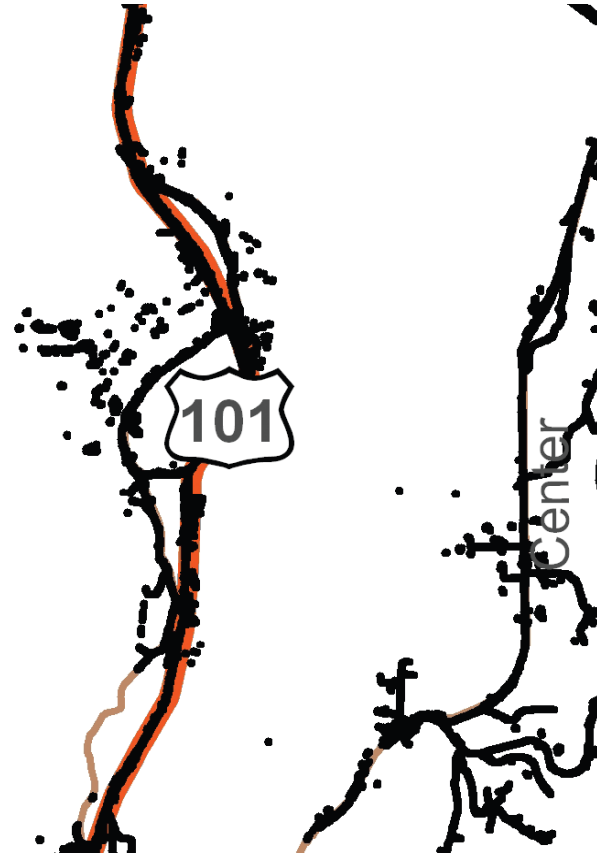


Map Frame Borders are Distracting

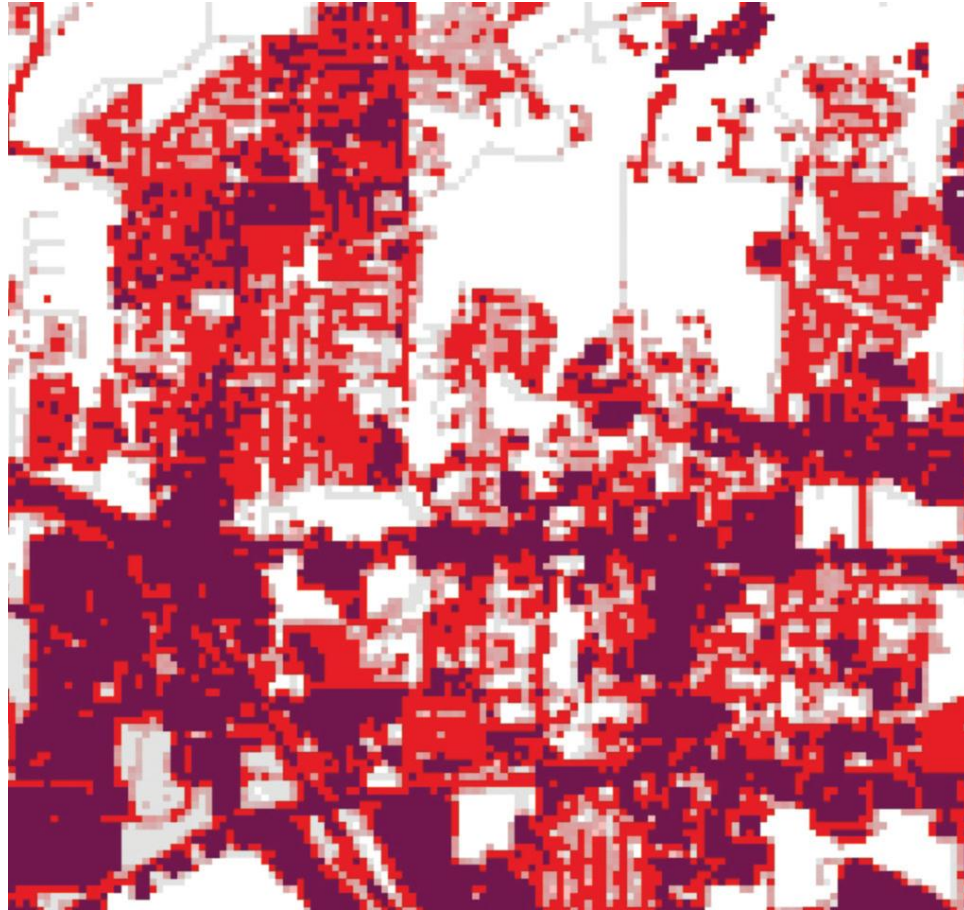


No Map Frames Means Viewer Focuses on the Data

Impervious surfaces data overlaid on highway and road to show correlation



Use of color ramp for data in percentage form

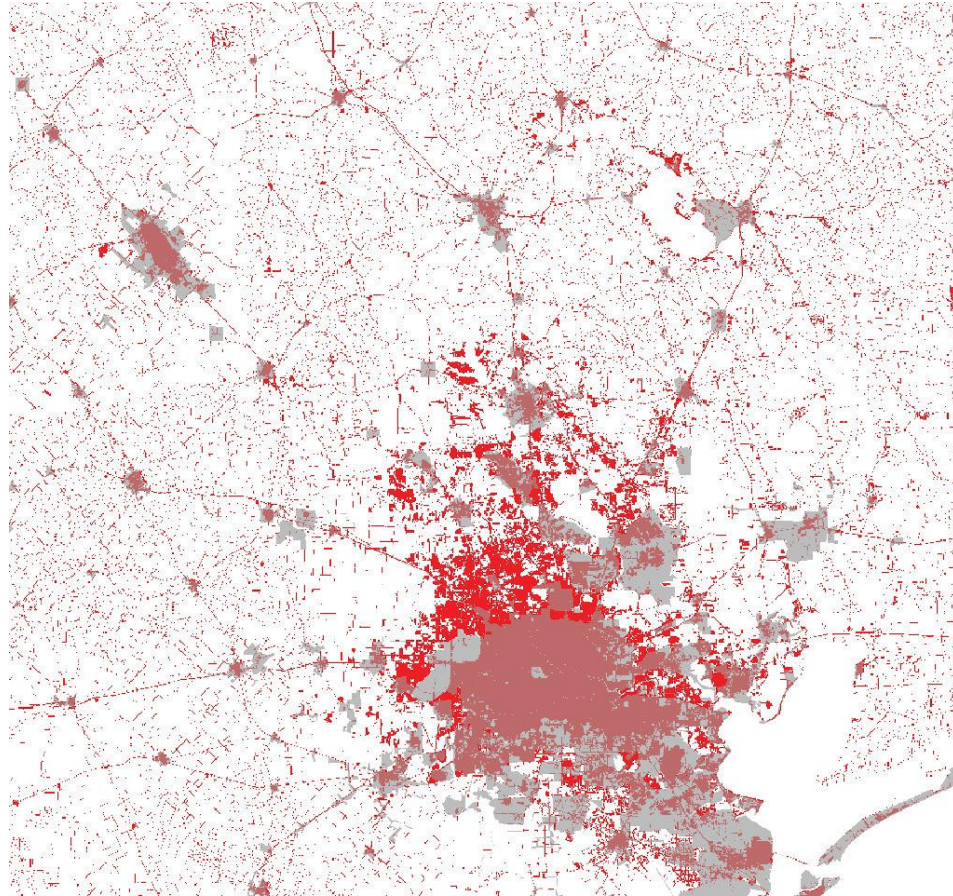


The same map lightened to show another dataset

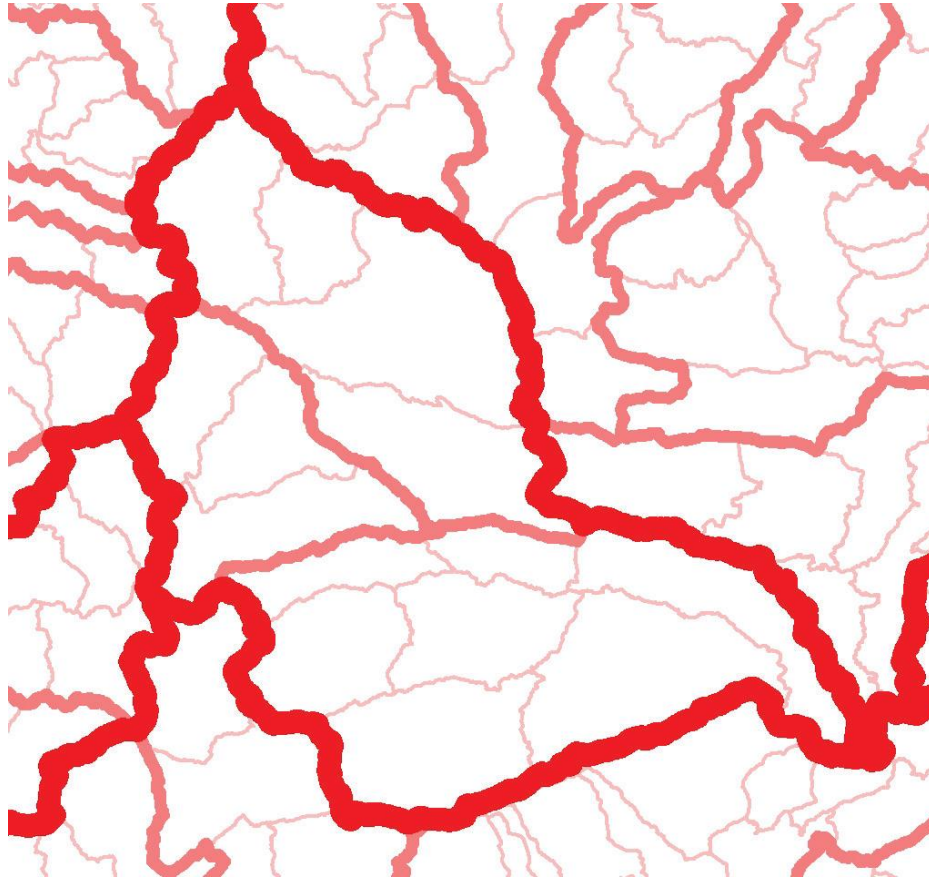


Number of
households per
census block

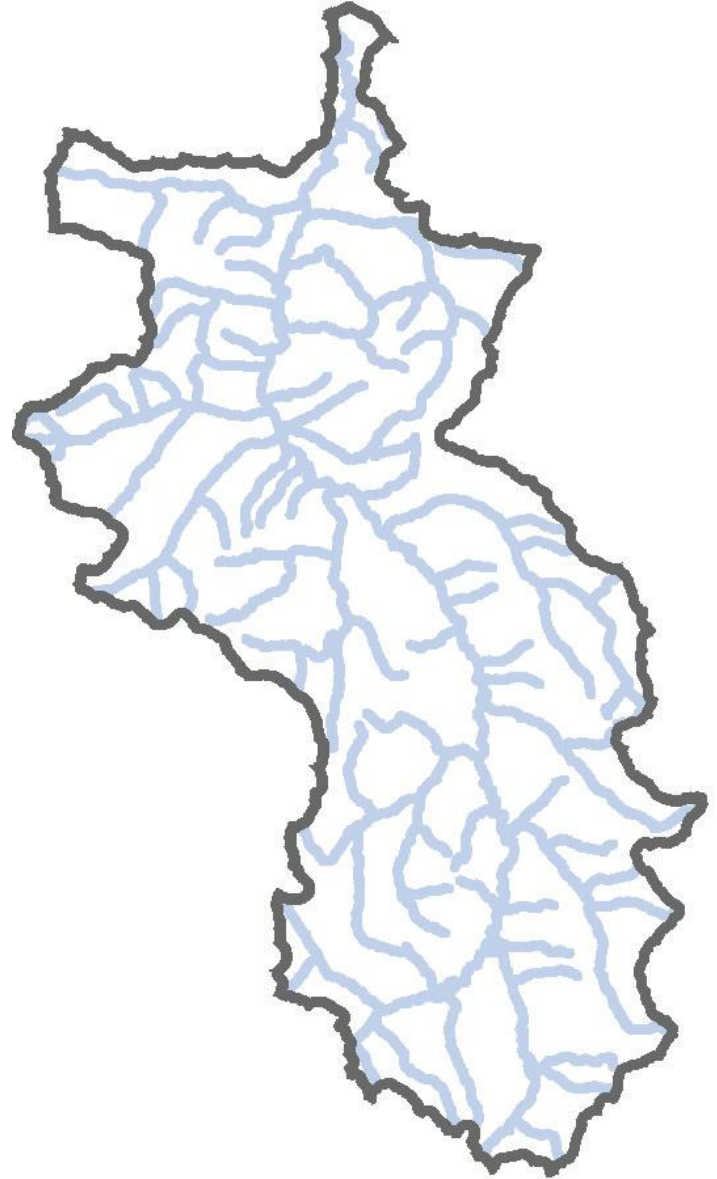
Population in gray, imperviousness in red pixels



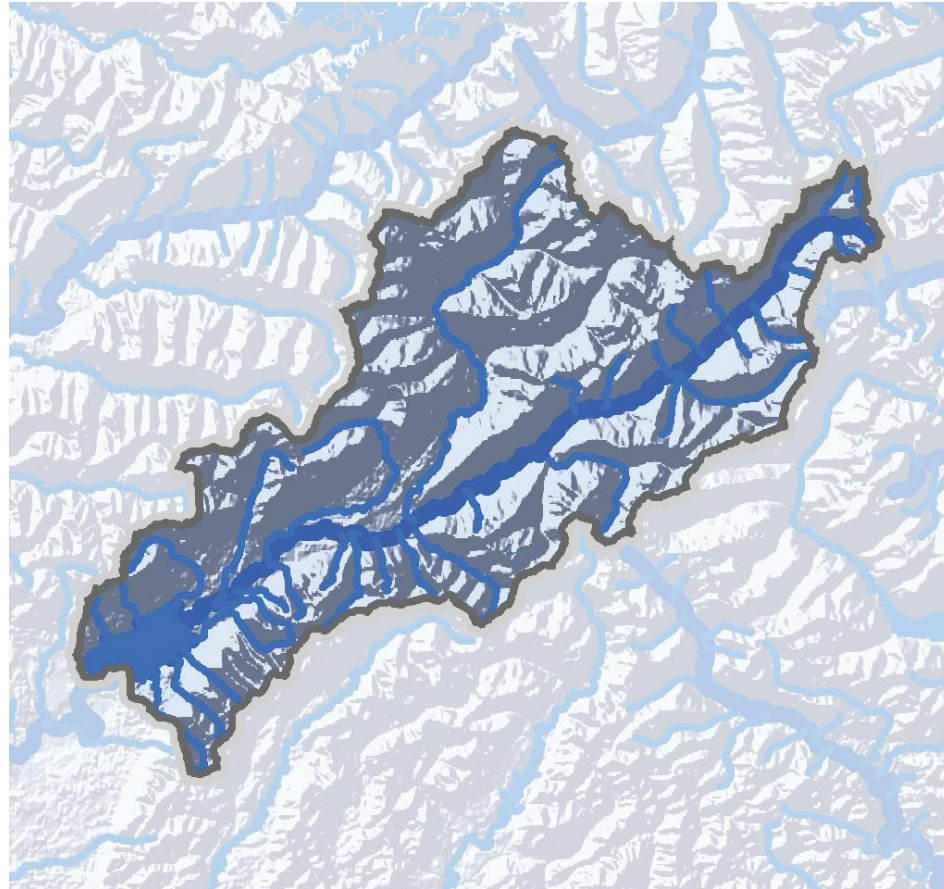
Showing nested basin levels with line thickness and color



Absence of data around the map focuses attention



Achieving a balance between contextual detail and focusing the viewer's attention

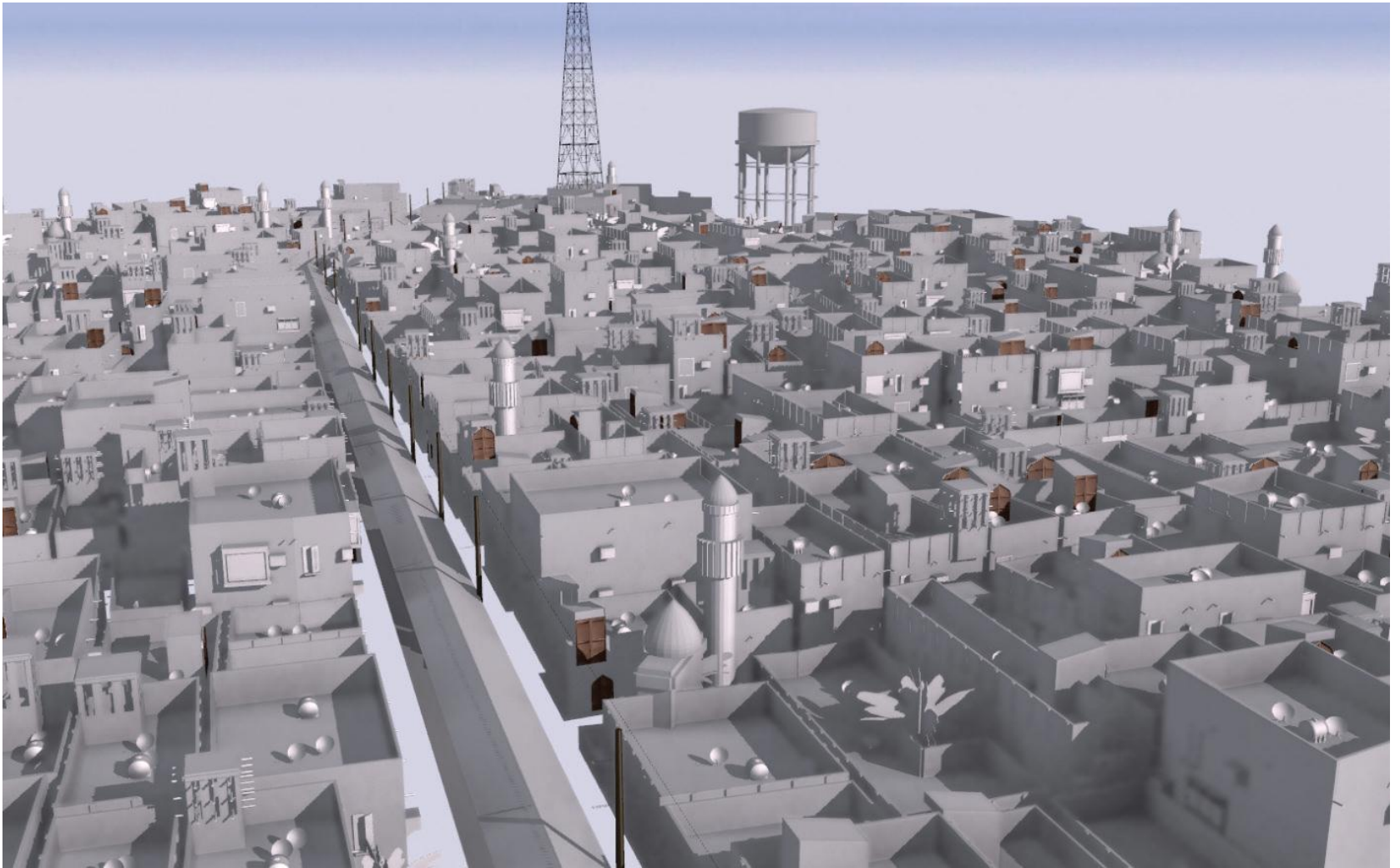


Hillshade map with basins

Hillshade
lightened by \sim
50%



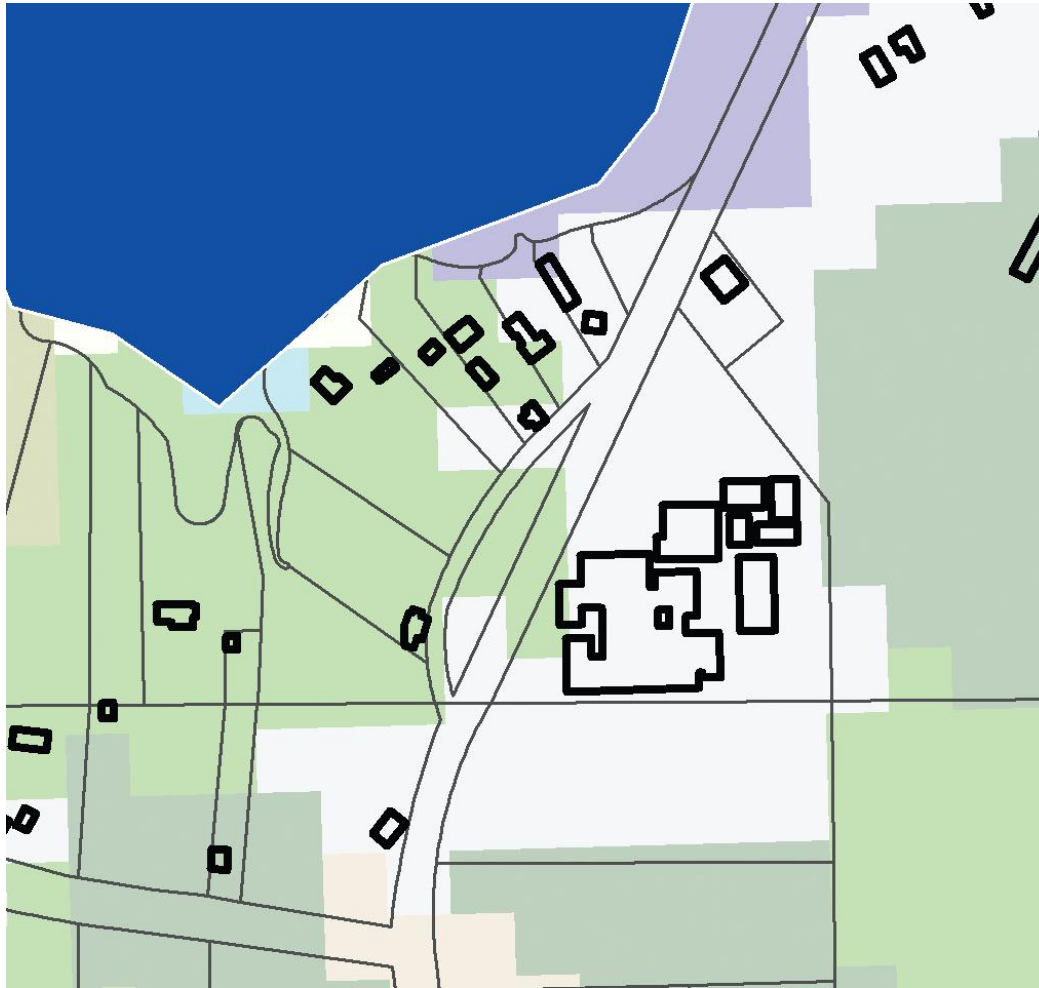
Use of 3D software



Building footprints with parcels in light gray



Scale is critical- be sure the data use the same scales



Building
footprints

Land parcels

Land cover

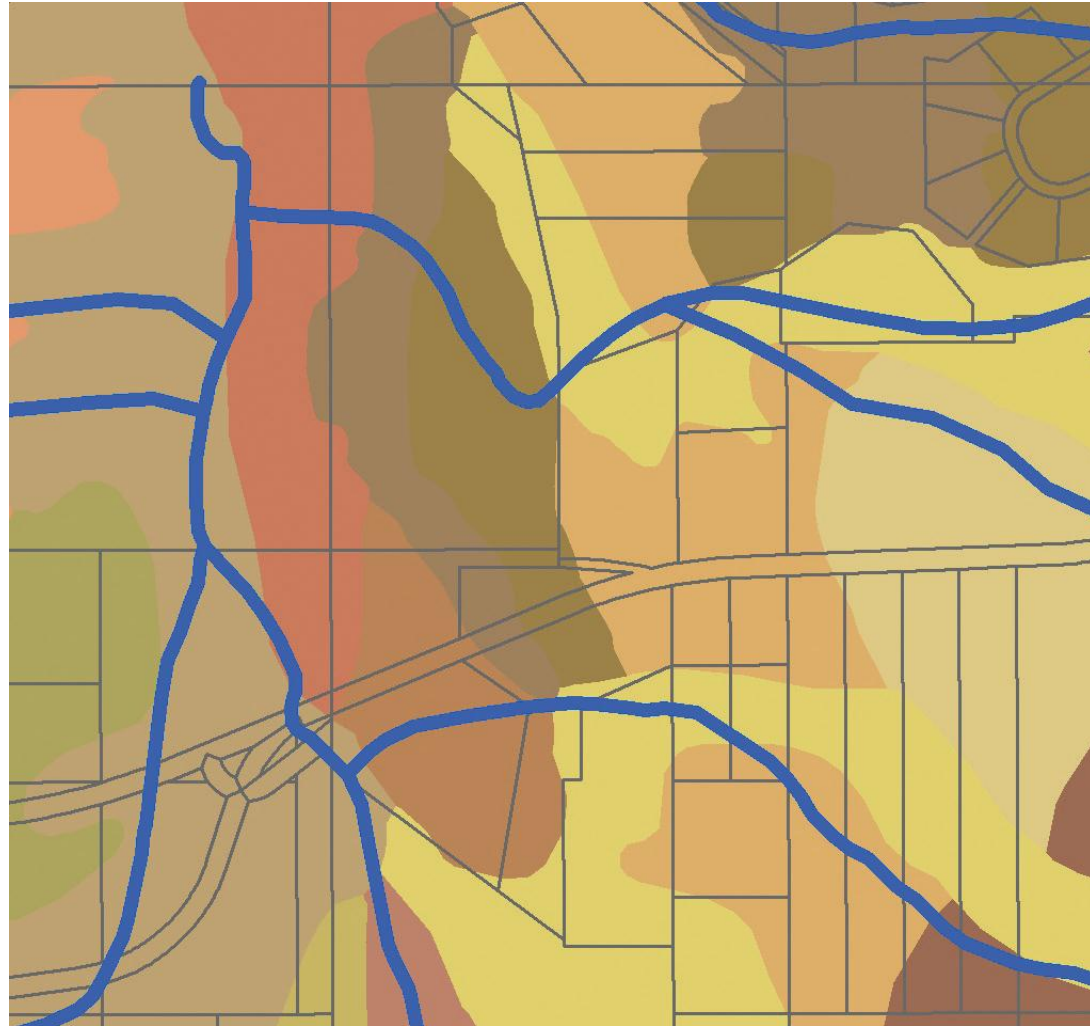
Orthophotograph with outlined footprints



Bold color applied to small features



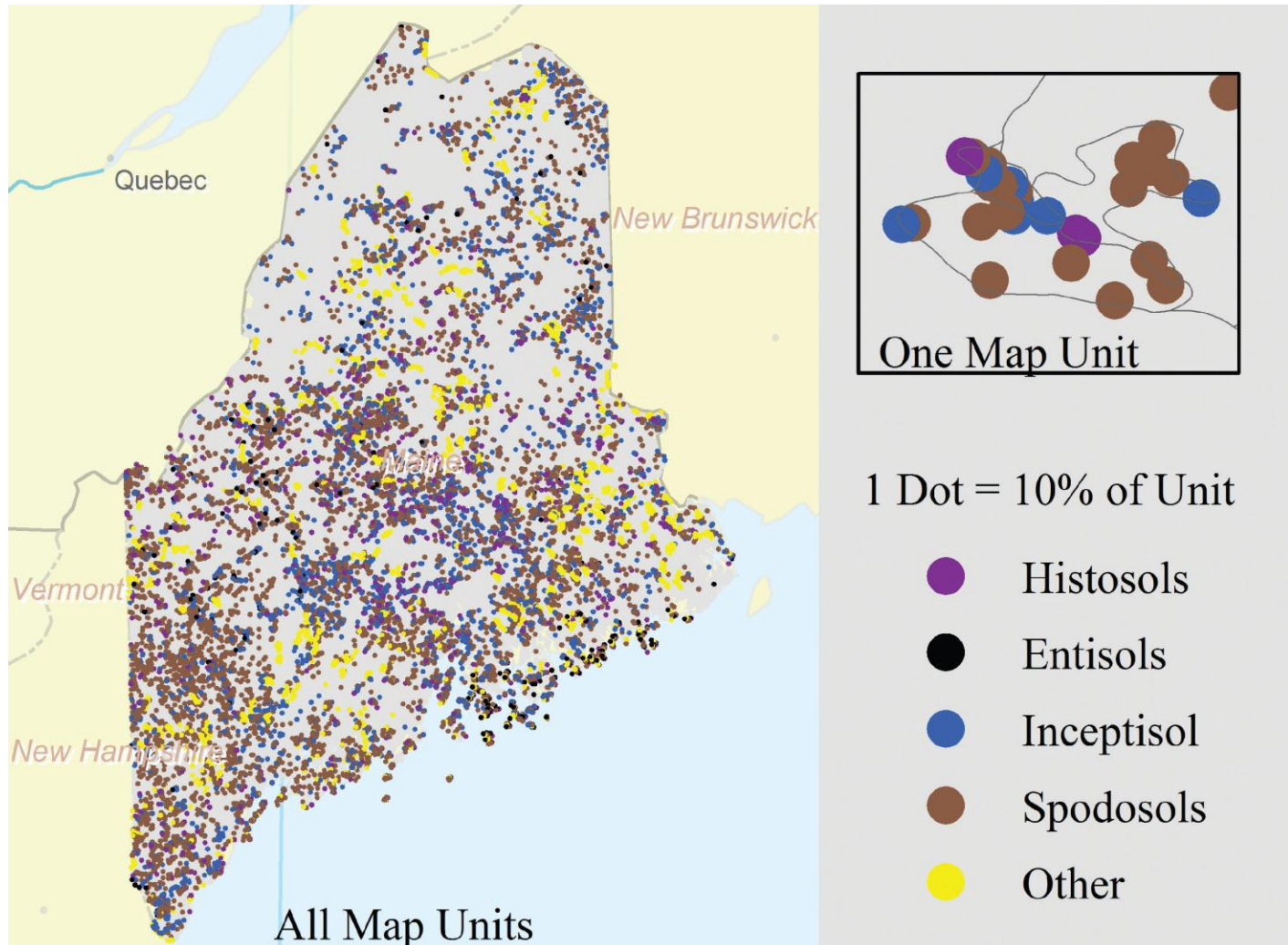
Soil map under hydrology data and parcel boundaries



How to show 2 polygon datasets



Dot-density soil map



Predefined color scheme for some geologic data

Map Unit Age

Colors

Quaternary

Yellow, White



Cenozoic

Brown, Orange, Rust



Mesozoic

Green, Olive



Paleozoic

Blue, Purple



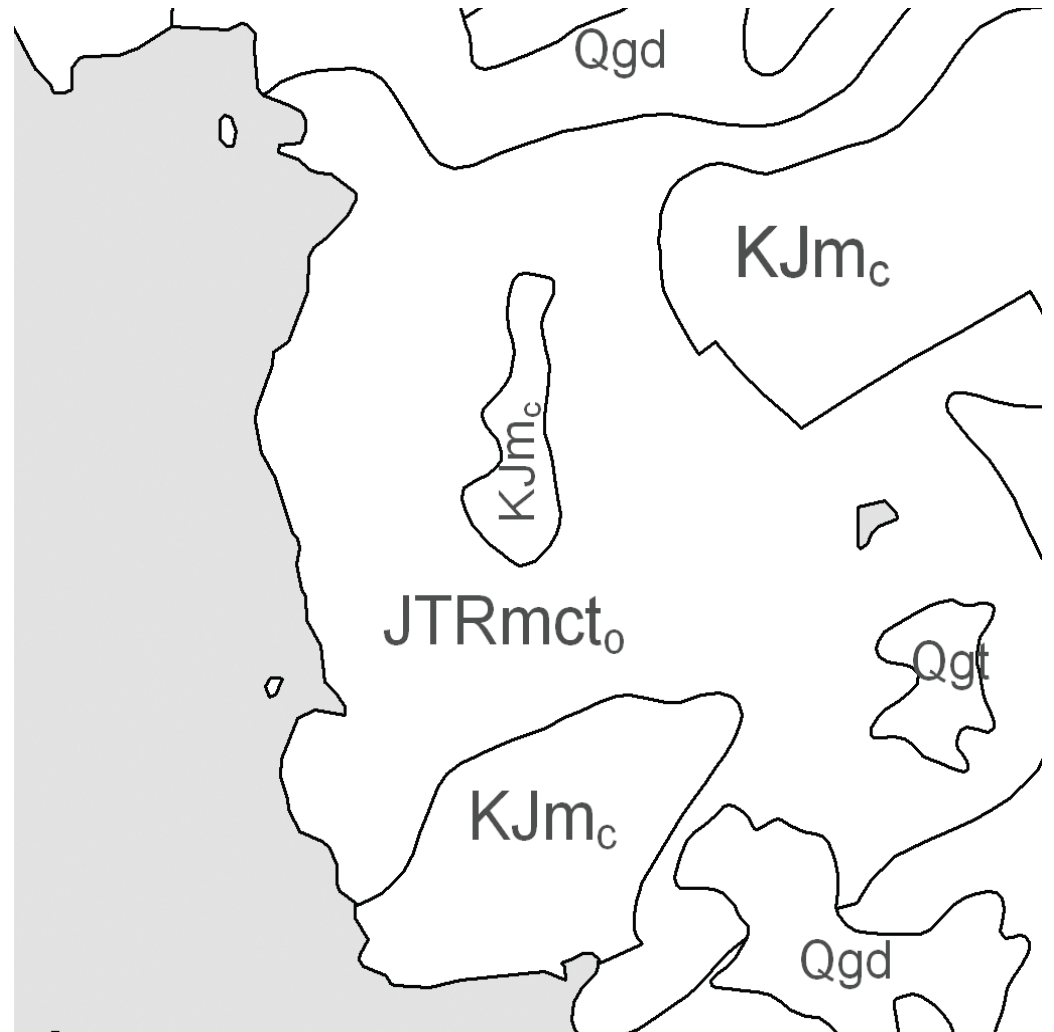
Precambrian

Red, Pink

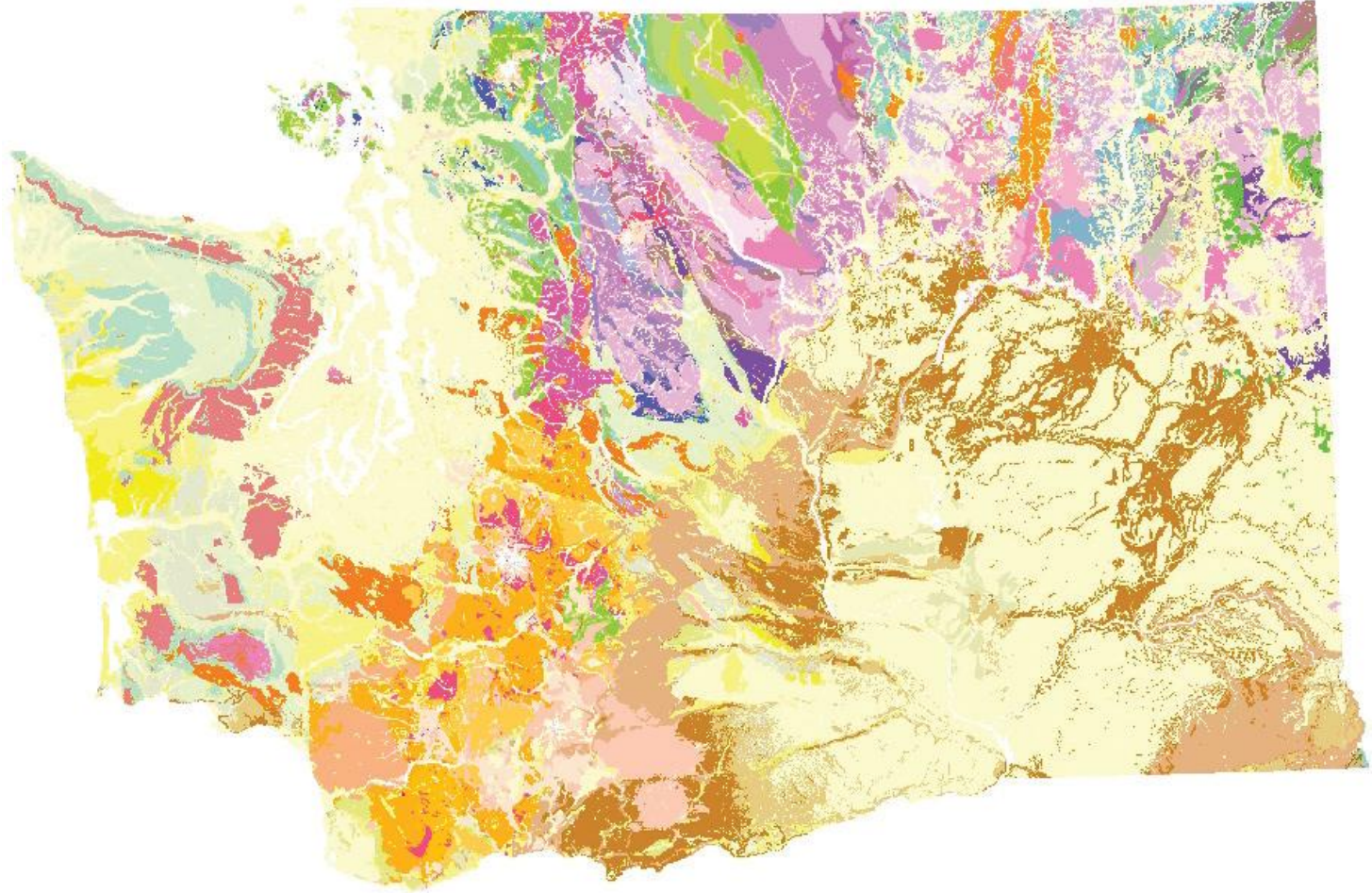


Use of white for land, gray for water

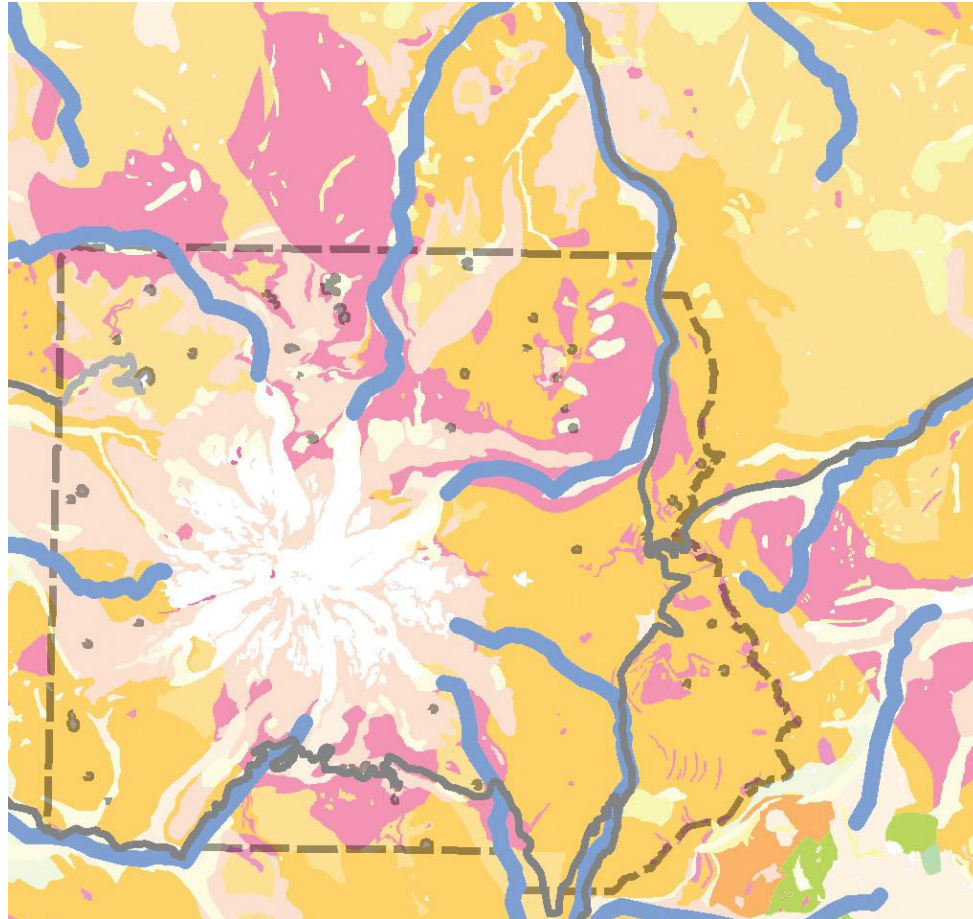
Good contrast
with dark gray
labels



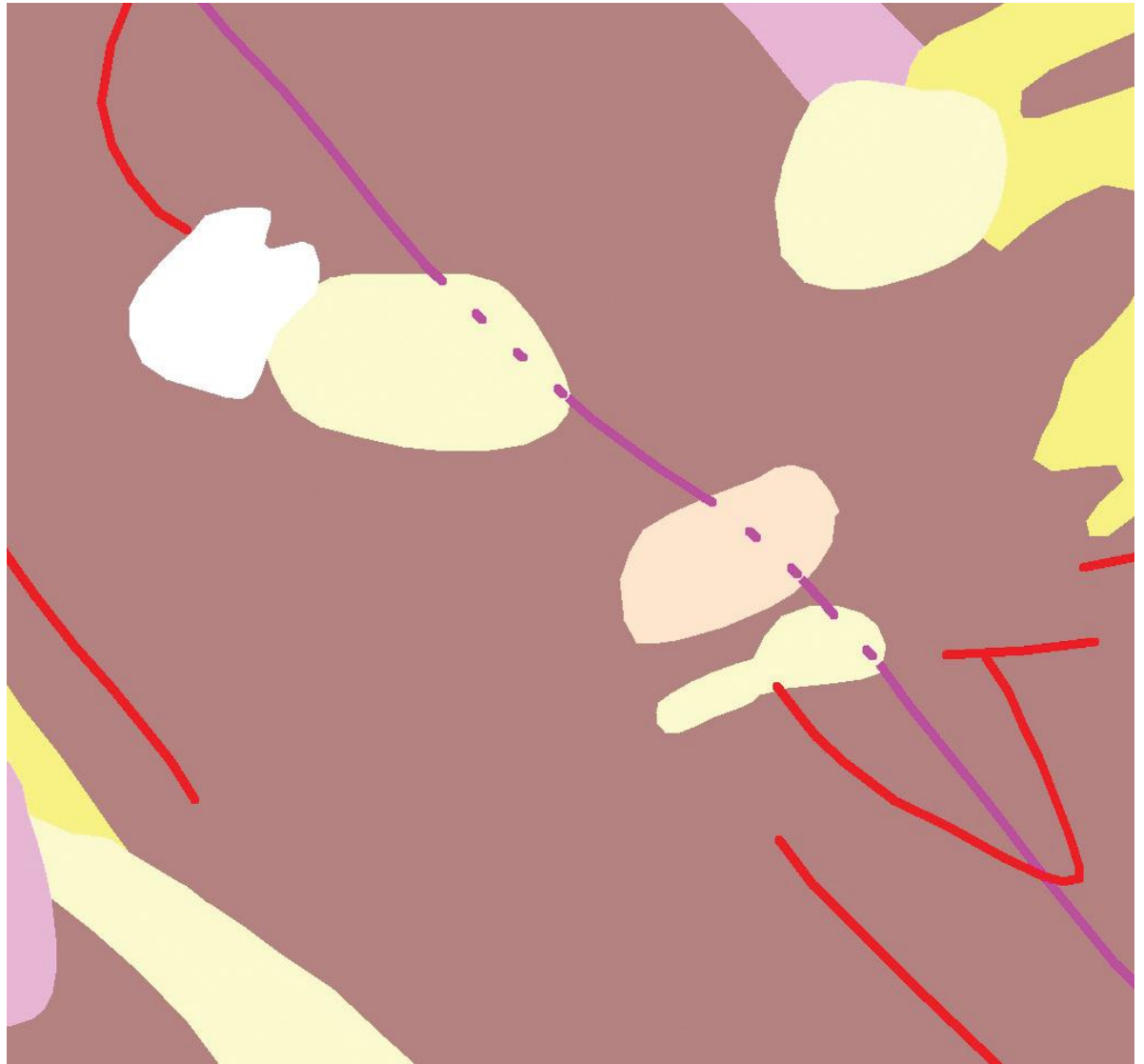
Standard color scheme showing geologic age



Mt. Rainier – using a muted geology background so overlying roads and other boundaries are visible



Use of bright geologic line features

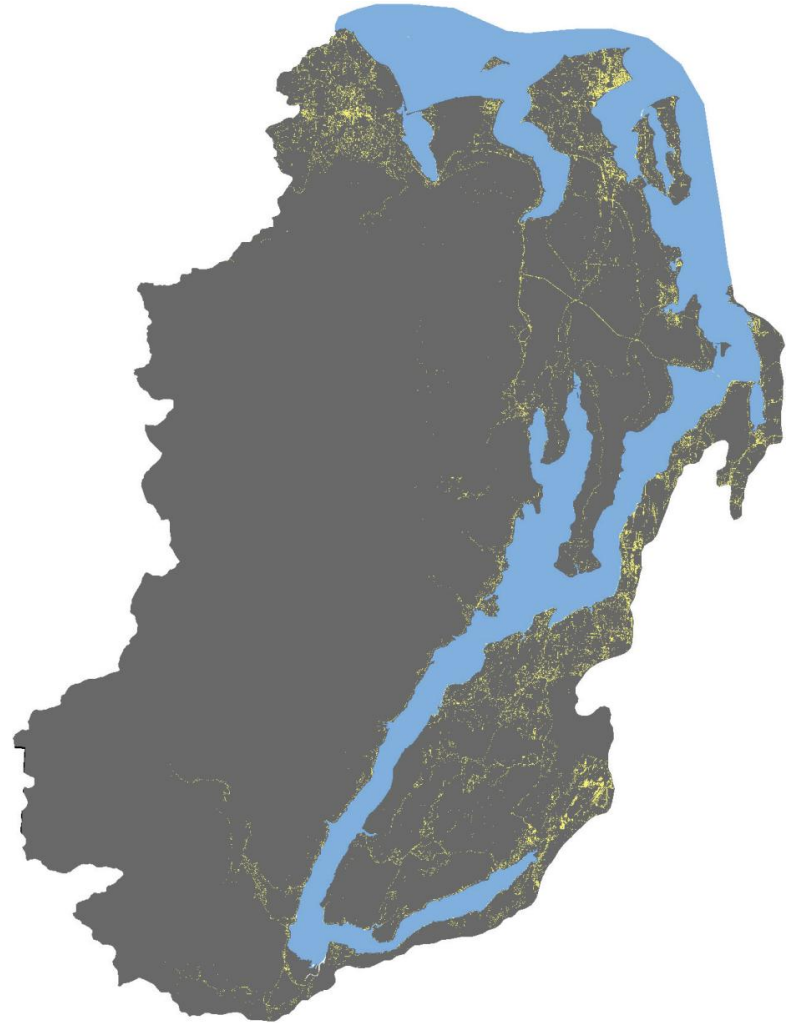


Chapter 7

Static maps Slides

Slide 1 shows a study area and its impervious surfaces

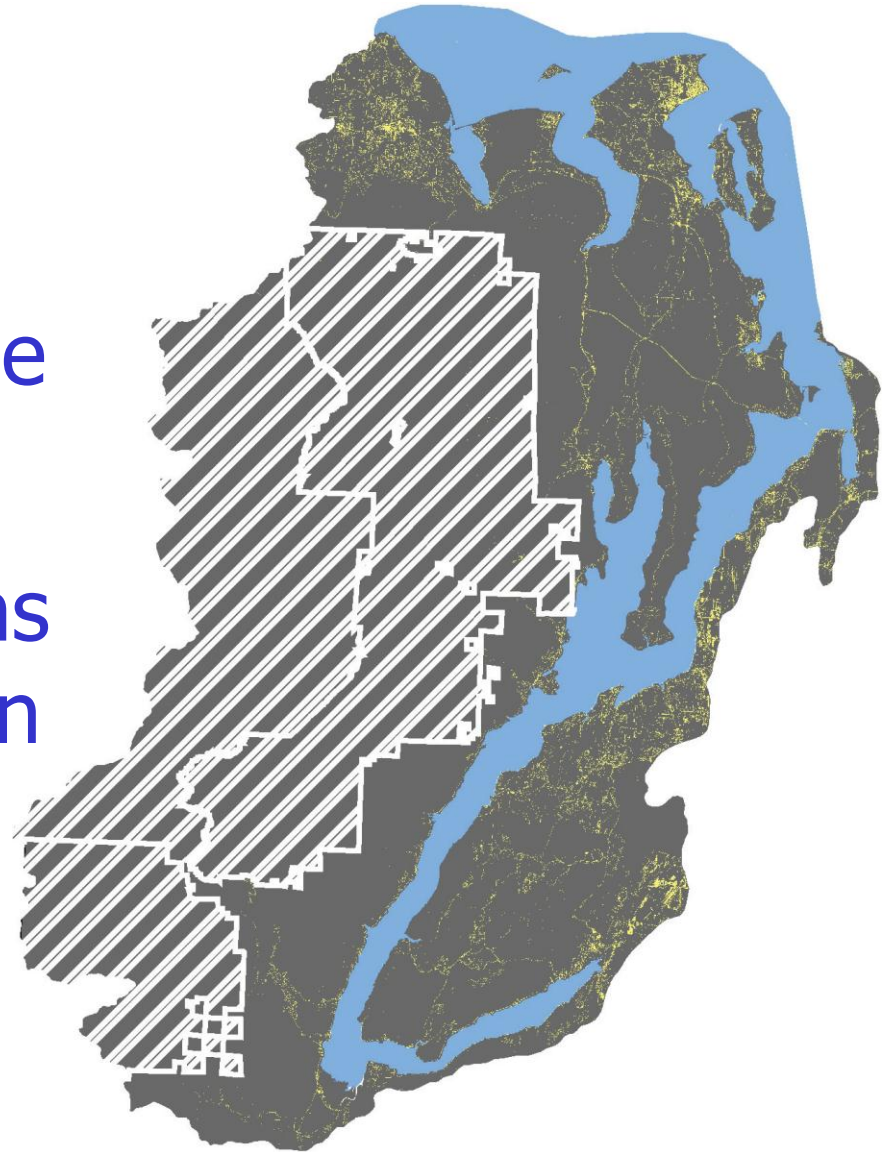
Giving a presentation



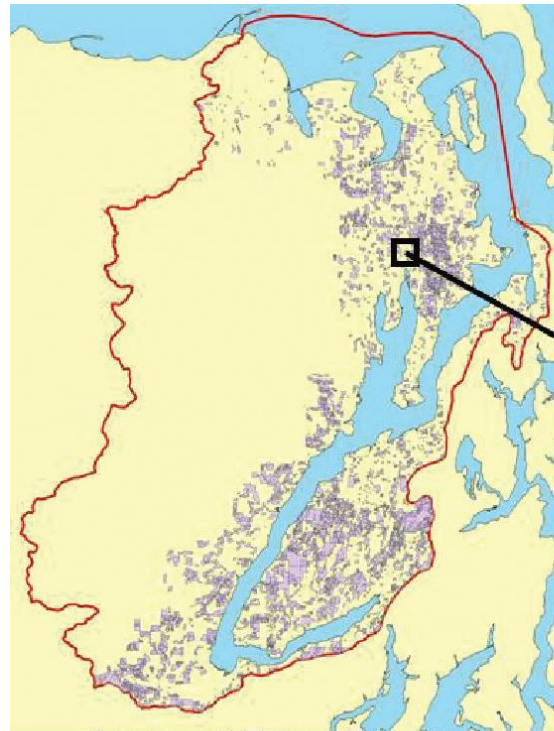
Slide 2 added the national park lands

This layer dominates the map

No text or legend means the audience must listen



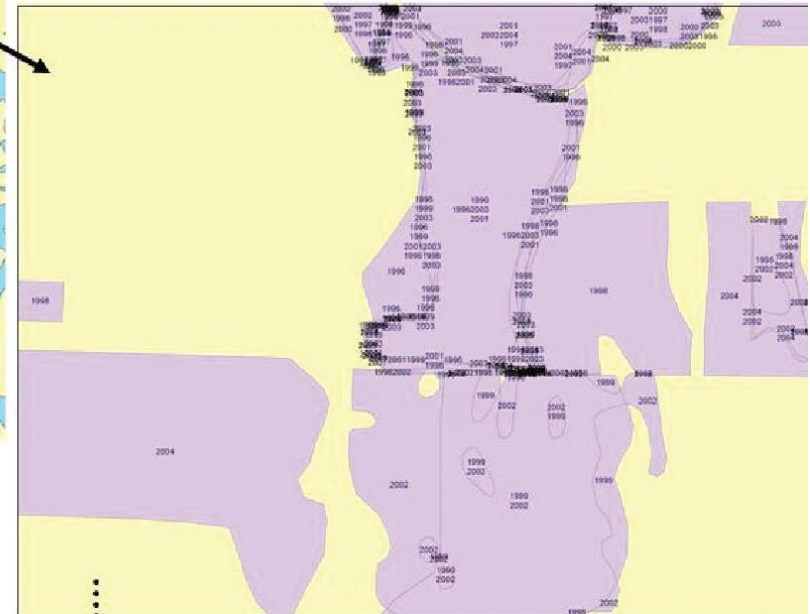
A complex slide can work for a small group



Approved Forest Practices
Applications in ESU

p e t e r s o n
GIS

PRE-PROCESSED FPA DATA 1995-2006

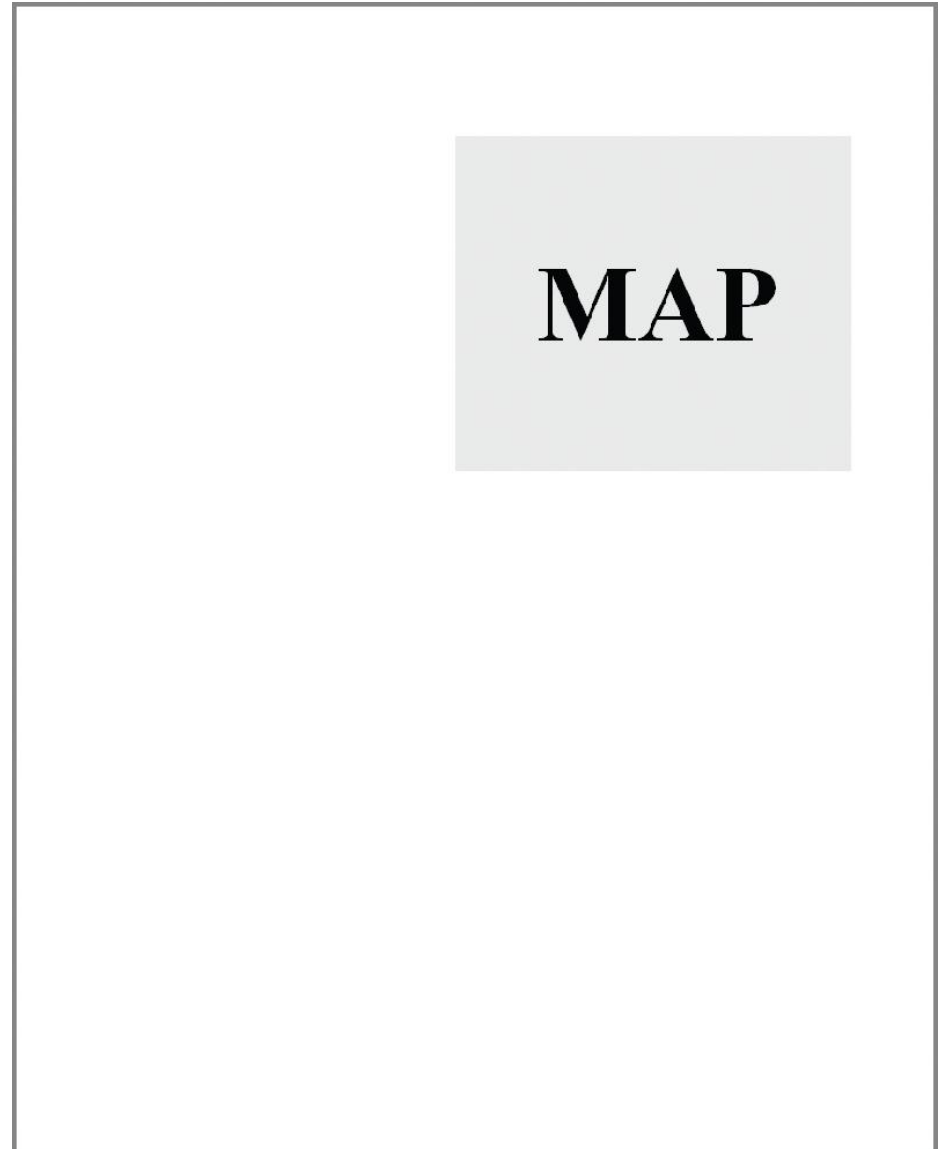


(Continued on
next slide)

Zoom-in FPA: approved applications
Year of application effective date or
renewal date is shown

Guidelines for small, in-line report maps

1/5th to 1/6th of
overall page
area



Chapter 8

Projections

Deciding which projection to use



Mercator



Geoscience Australia Lambert
(Conformal Conic)

Properties of projections

Properties of Projections

area
angle
direction
distance

KEY DISTORTION
CONSIDERATIONS

purpose
scale
directionality
location
familiarity

KEY MAP
CONSIDERATIONS

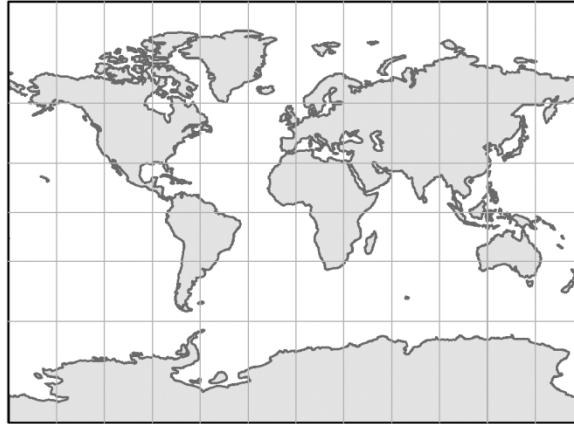
cylindrical
conic
azimuthal

KEY DIRECTIONAL
TYPES

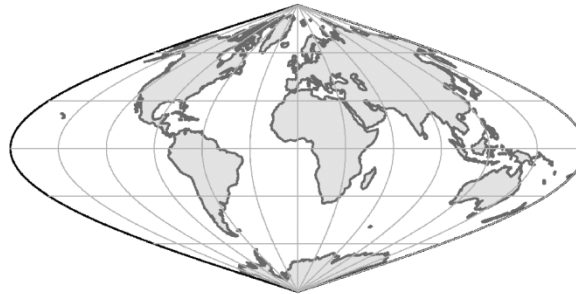
Robinson projection



Projections



Miller
Cylindrical

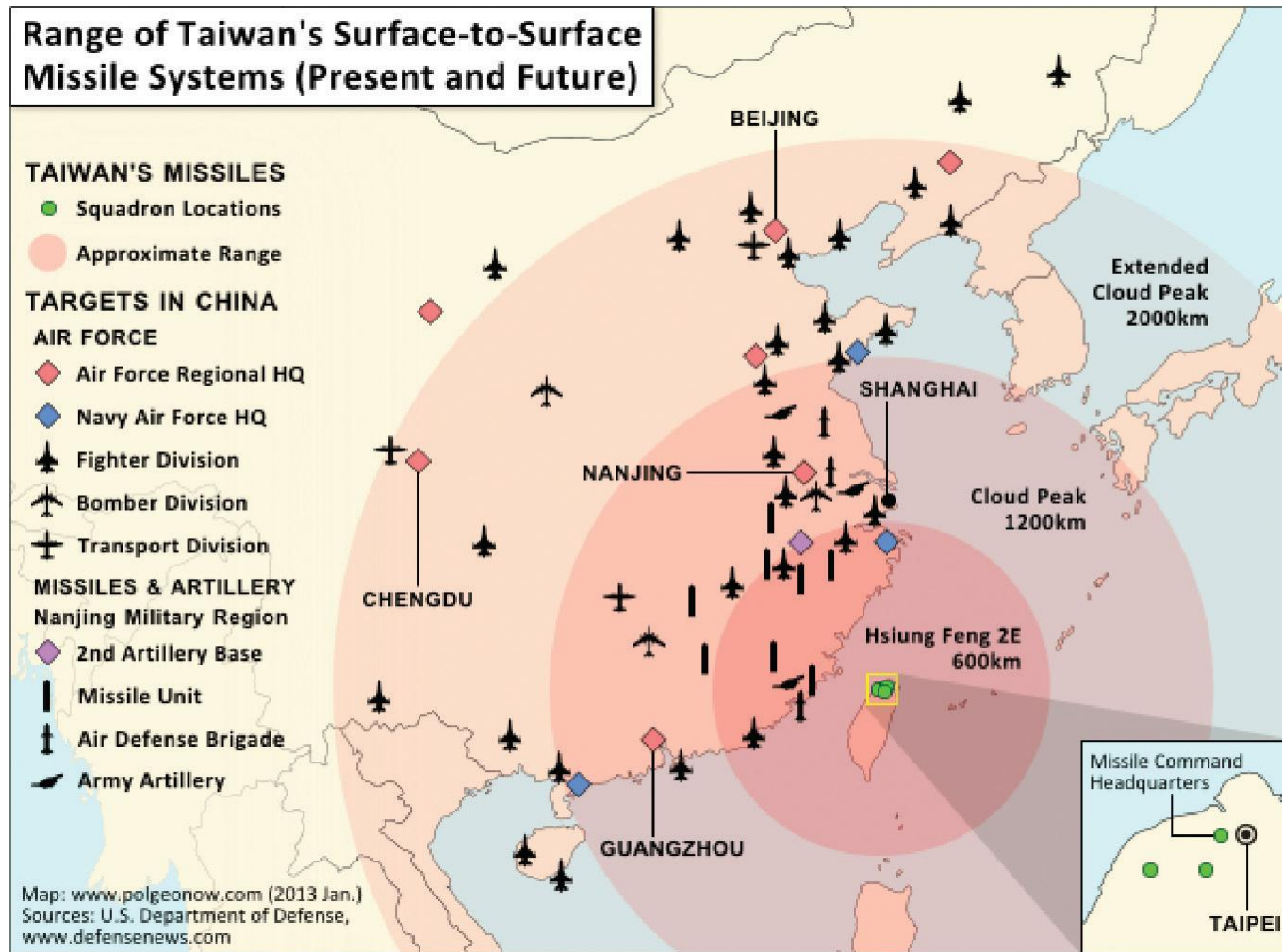


Sinusoidal
Pseudo-cylindrical

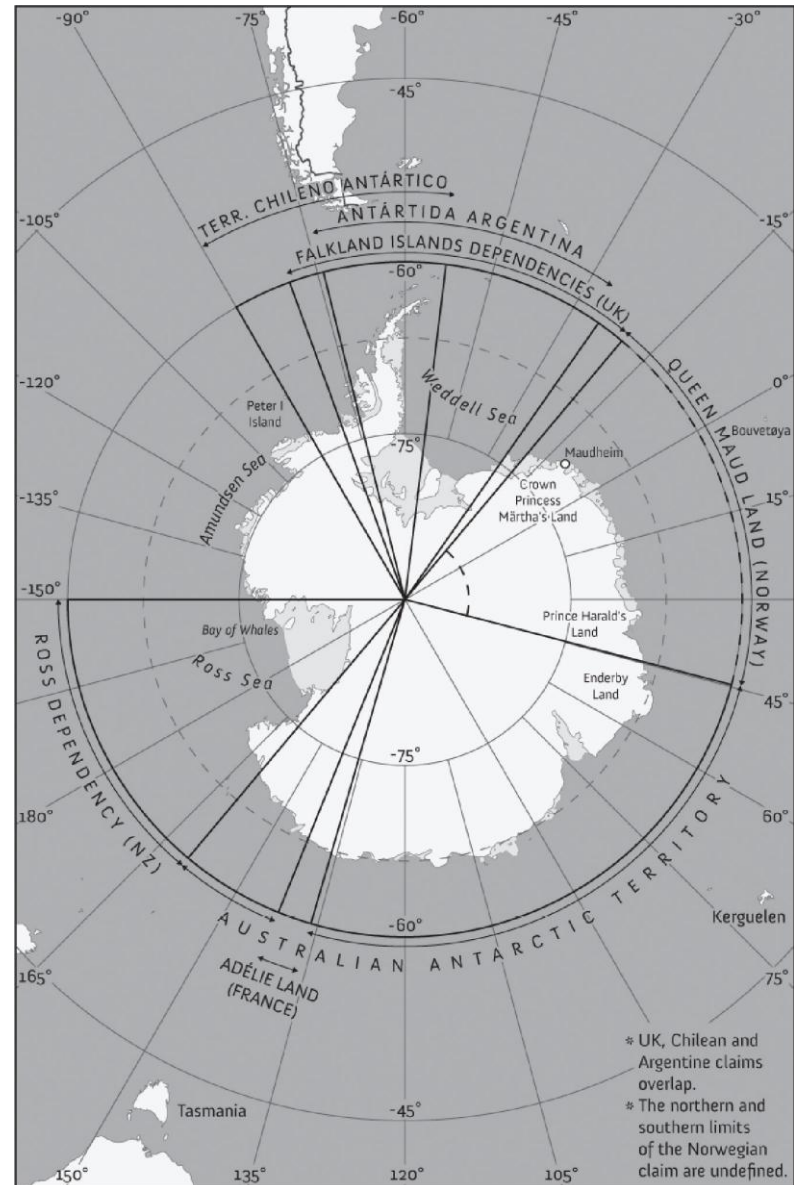


Winkel tripel
Pseudo-cylindrical

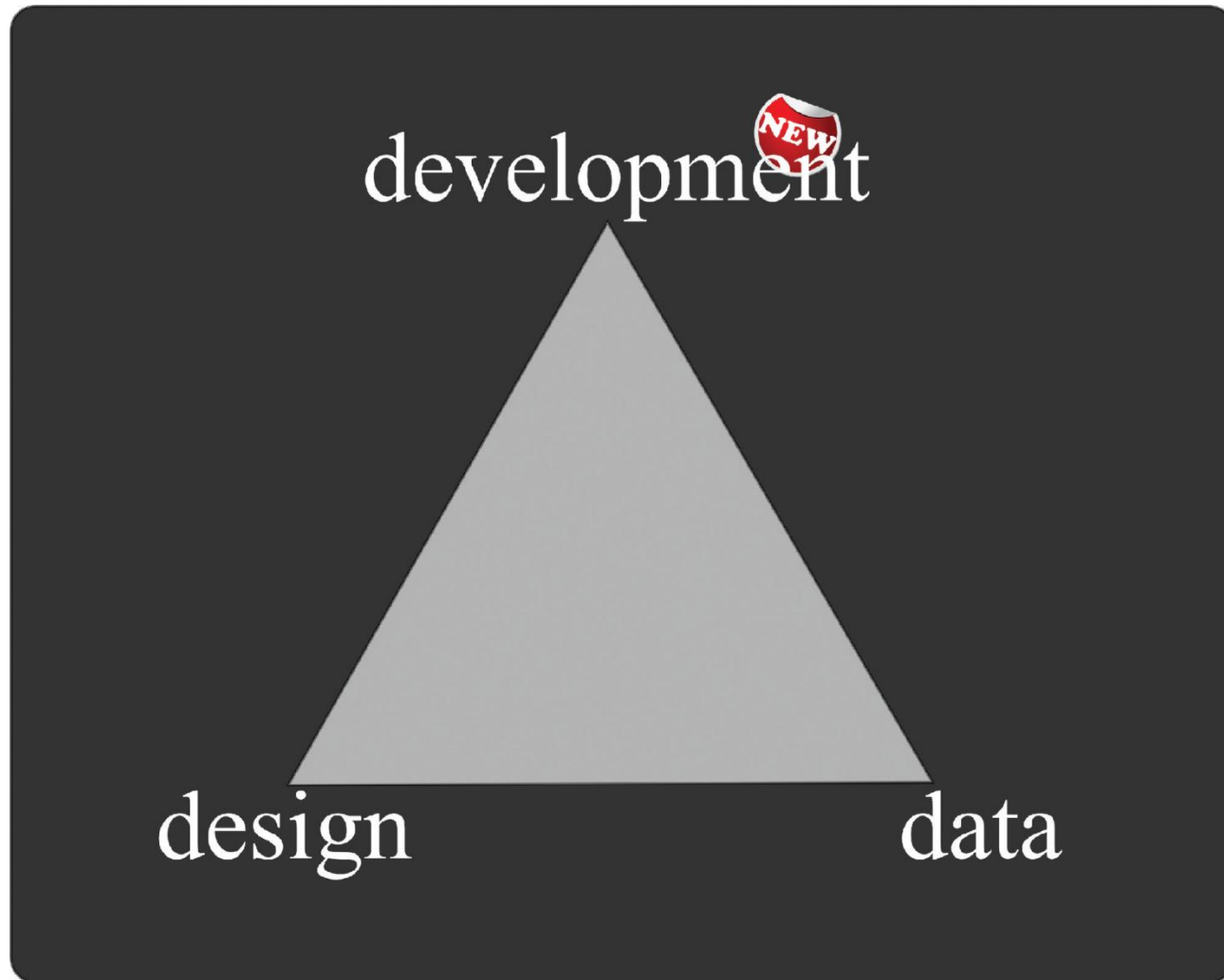
Azimuthal projection - equidistant



Rotated polar stereographic projection



Skills for a cartographer



Chapter 9

Zoom level designs

Digital map at 3 zoom levels

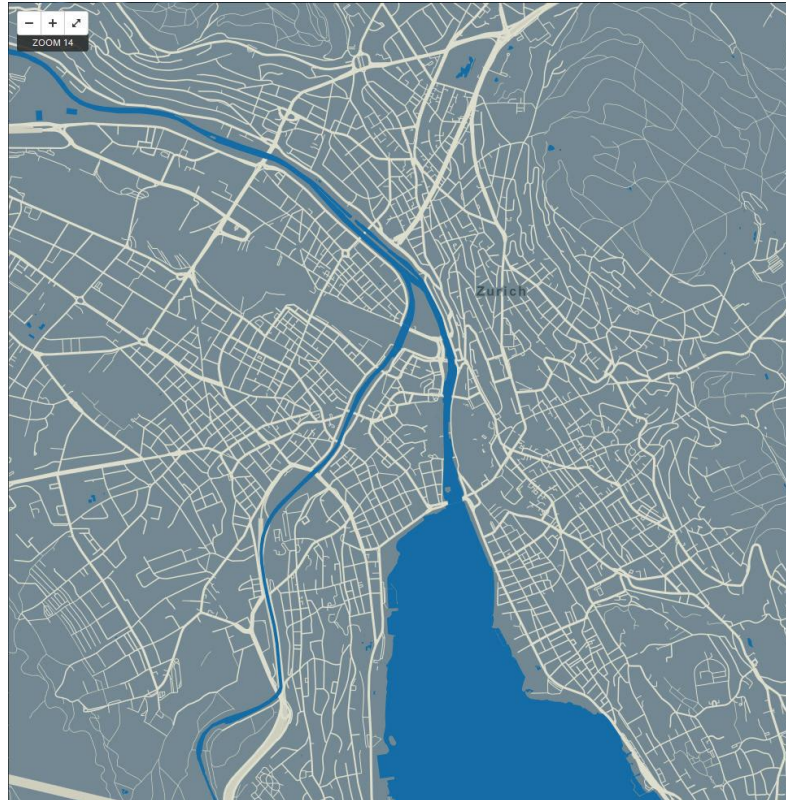
Zoom 2



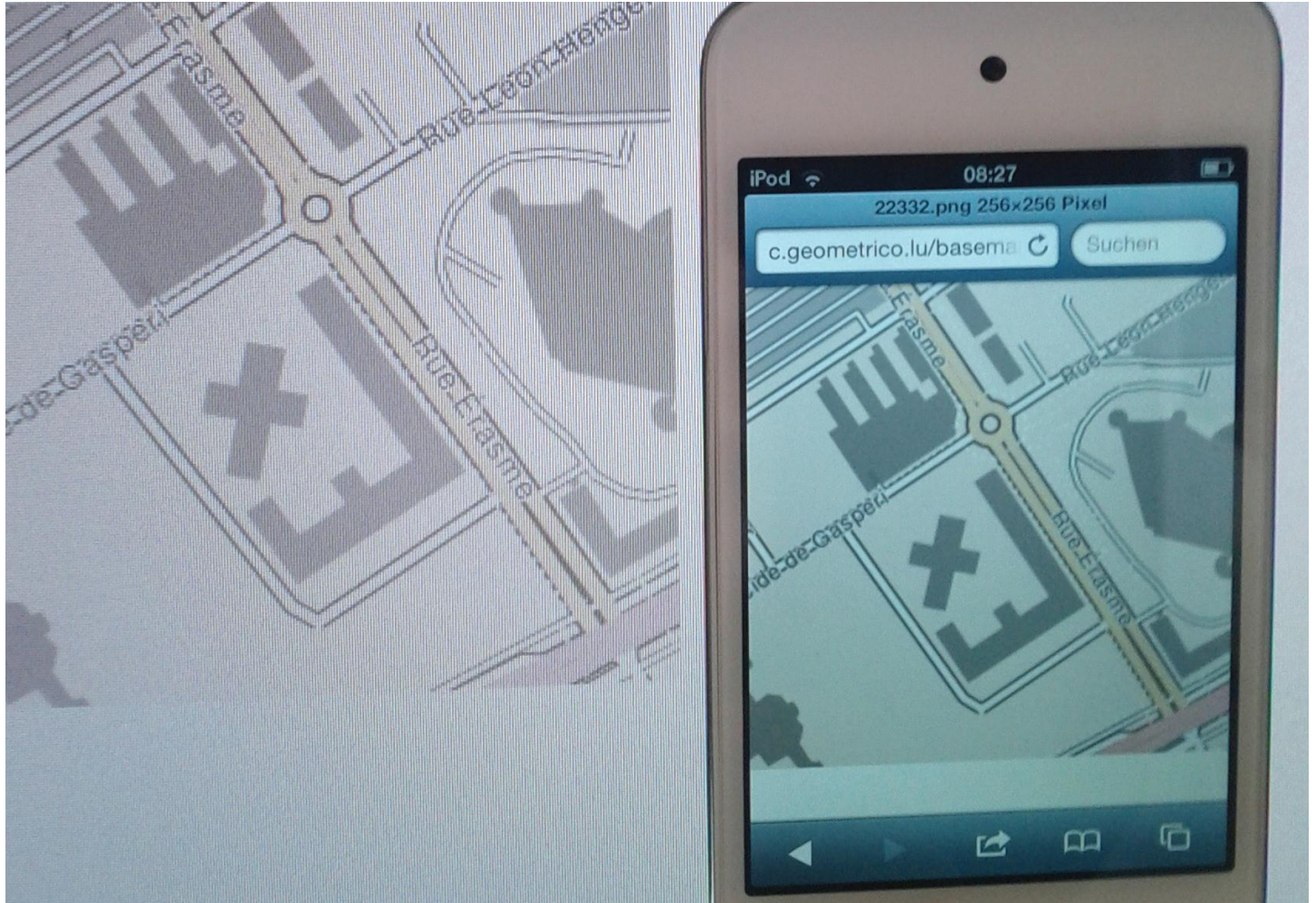
Zoom 7



Zoom 14



Maps may appear differently on different devices



Approximate map scales by zoom levels

| Zoom Level | Approximate Scale |
|------------|-------------------|
| 0 | 1:500m |
| 1 | 1:250m |
| 2 | 1:150m |
| 3 | 1:70m |
| 4 | 1:35m |
| 5 | 1:15m |
| 6 | 1:10m |
| 7 | 1:4m |
| 8 | 1:2m |
| 9 | 1:1m |
| 10 | 1:500,000 |
| 11 | 1:250,000 |
| 12 | 1:150,000 |
| 13 | 1:70,000 |
| 14 | 1:35,000 |
| 15 | 1:15,000 |
| 16 | 1:8,000 |
| 17 | 1:4,000 |
| 18 | 1:2,000 |
| 19 | 1:1,000 |

GIS Cartography

A Guide to Effective Map Design
Second Edition

"This book is an excellent text for the practicing GIS professional and for anyone who wants to know both the theoretical as well as practical underpinnings of cartography."

—*Jack Dangermond, Esri President*

"... Ms. Peterson provides easy-to-understand, detailed guidance on creating effective mapped communications. ... an excellent resource for geo-professionals and early career mapmakers alike. ... significantly contributes to better communications between mapmakers and the decision makers and consumers who need to understand phenomena being mapped. I highly recommend it to readers who want to tell the story of their studies in maps and don't want limitations in design to detract from their important analytical message."

—*J. Edward Pickle, Chief Executive Officer, Boundless*

"... Gretchen Peterson demystifies successful cartographic communication. She reveals that it is not talent or templates that make great maps; it is the insightful coordination of each graphic element. In user-friendly language, Peterson presents insight that cartographers and GIS professionals—at all levels—can use to improve the quality of the work."

—*Dave Imus, Imus Geographics*

See What's New in the Second Edition

- Projection theory
- Hexagonal binning
- Big Data point density maps
- Scale-dependent map design
- 3D building modeling
- Digital cartography and its best practices
- Updated graphics and references
- Study questions and lab exercises at the end of each chapter

In this second edition of a bestseller, author Gretchen Peterson takes a "don't let the technology get in the way" approach to the presentation, focusing on the elements of good design, what makes a good map, and how to get there, rather than specific software tools. She provides a reference that you can thumb through time and again as you create your maps. Copiously illustrated, the second edition explores novel concepts that kick-start your pursuit of map-making excellence.

K22213