Lecture 16

Spatial Data and Cartography (Part 2)

10/31/2018

Plotting

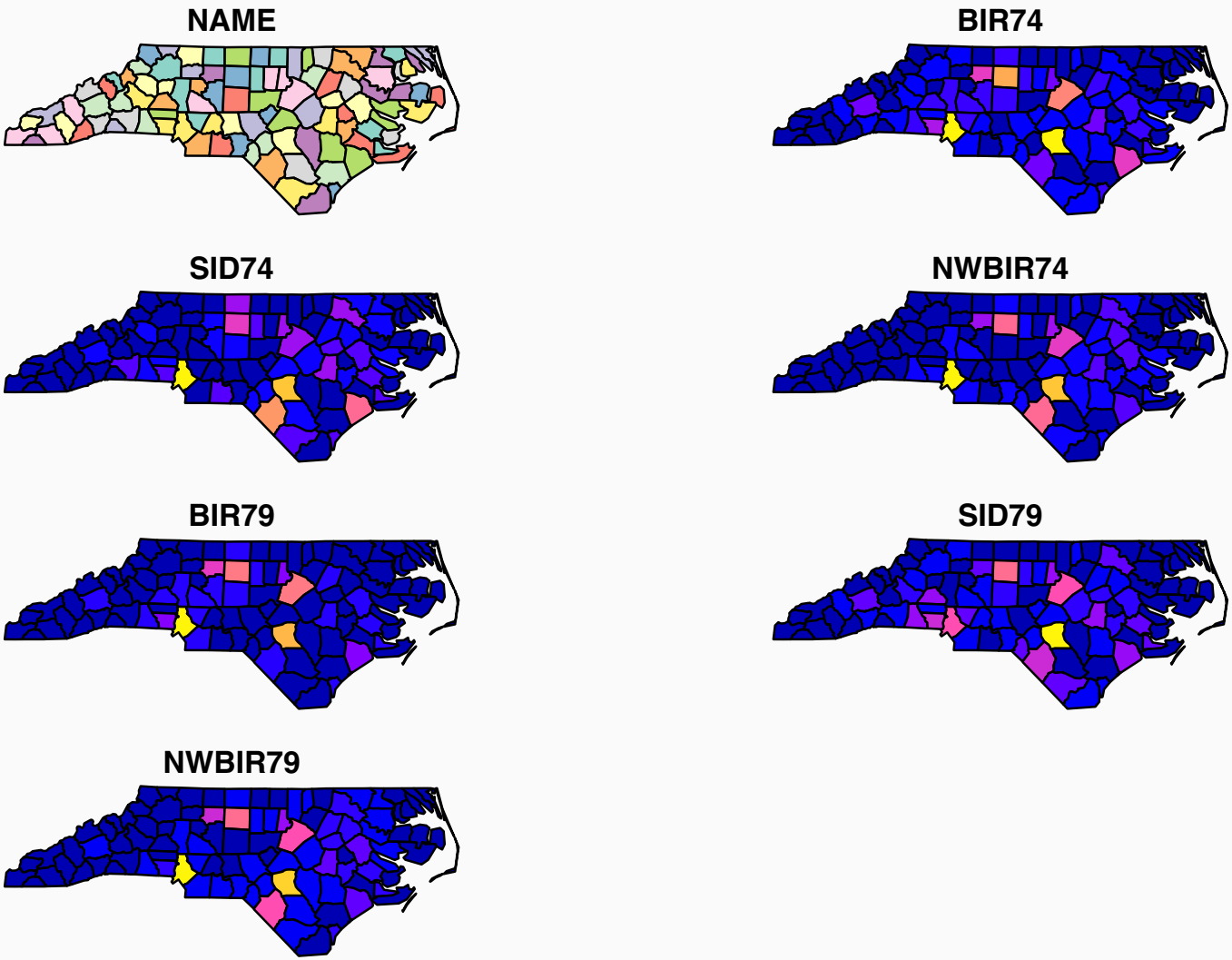
Example Data - NC SIDS

```
nc = st_read(system.file("shape/nc.shp", package="sf"), quiet = TRUE) %>%
  select(-(AREA:CNTY_ID), -(FIPS:CRESS_ID))

tbl_df(nc)
## # A tibble: 100 x 8
##    NAME  BIR74 SID74 NWBIR74 BIR79 SID79 NWBIR79                  geometry
##    <fct> <dbl> <dbl>   <dbl> <dbl> <dbl>   <dbl>         <MULTIPOLYGON [°]>
##  1 Ashe   1091     1      10  1364     0      19 (((-81.47276 36.23436, -~
##  2 Alle~   487     0      10   542     3      12 (((-81.23989 36.36536, -~
##  3 Surry  3188     5     208  3616     6     260 (((-80.45634 36.24256, -~
##  4 Curr~   508     1     123   830     2     145 (((-76.00897 36.3196, -7~
##  5 Nort~  1421     9    1066  1606     3    1197 (((-77.21767 36.24098, -~
##  6 Hert~  1452     7     954  1838     5    1237 (((-76.74506 36.23392, -~
##  7 Camd~   286     0     115   350     2     139 (((-76.00897 36.3196, -7~
##  8 Gates   420     0     254   594     2     371 (((-76.56251 36.34057, -~
##  9 Warr~   968     4     748  1190     2     844 (((-78.30876 36.26004, -~
## 10 Stok~  1612     1     160  2038     5     176 (((-80.02567 36.25023, -~
## # ... with 90 more rows
```

Base Plots

```
plot(nc)
```

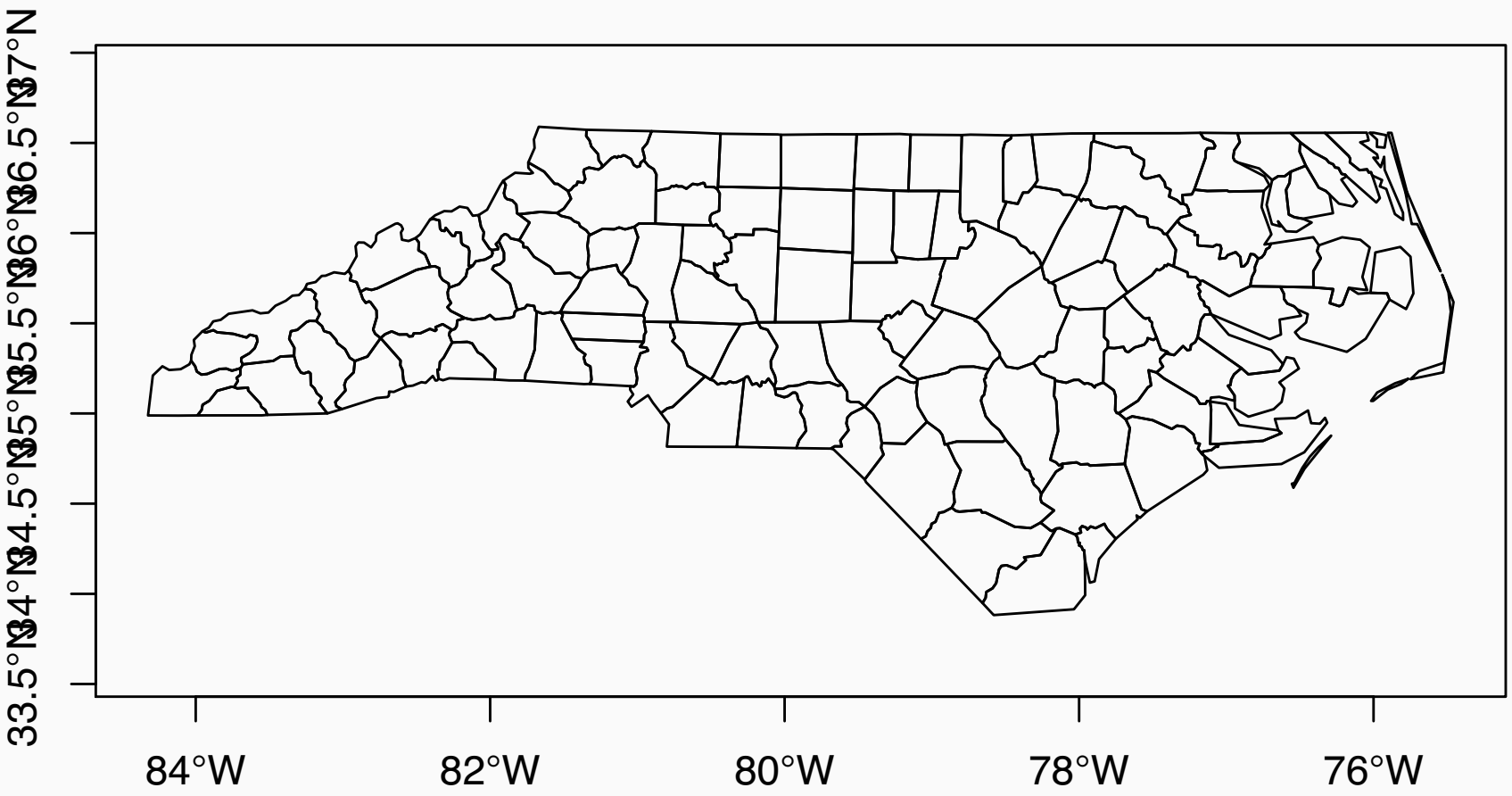
sf



Geometry Plot

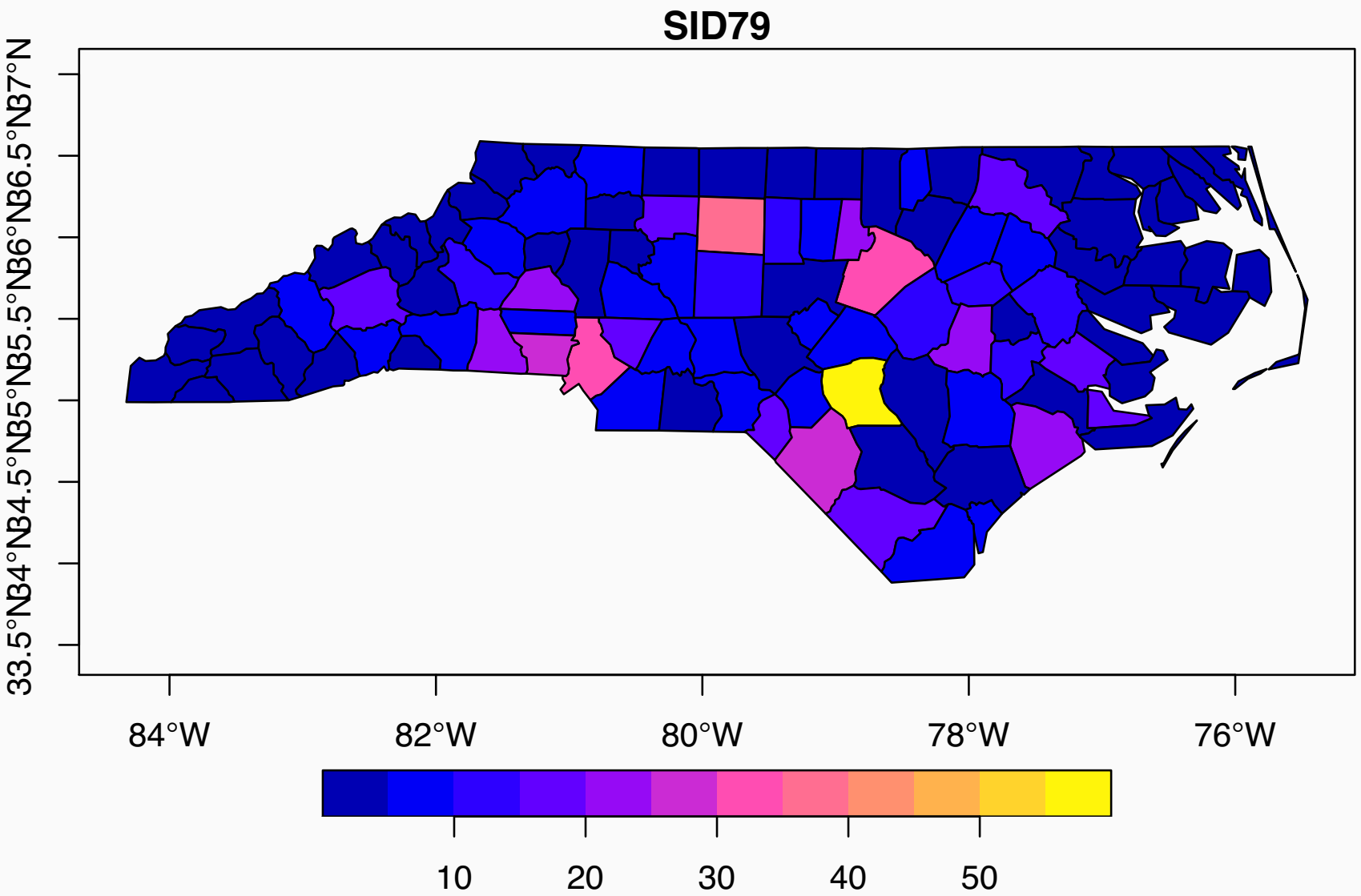
```
plot(st_geometry(nc), axes=TRUE)
```

sfc



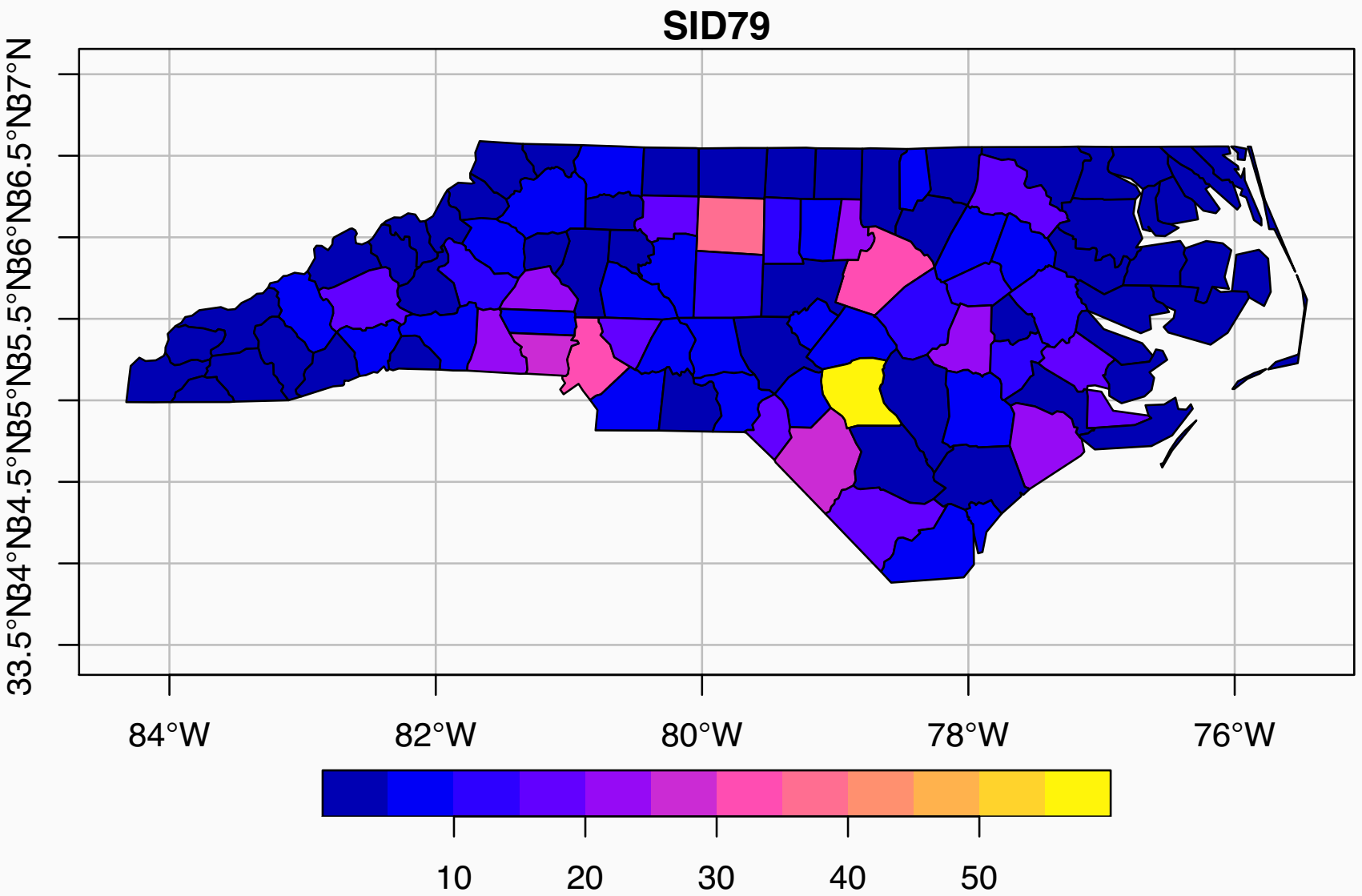
Graticules

```
plot(nc[,"SID79"], axes=TRUE)
```



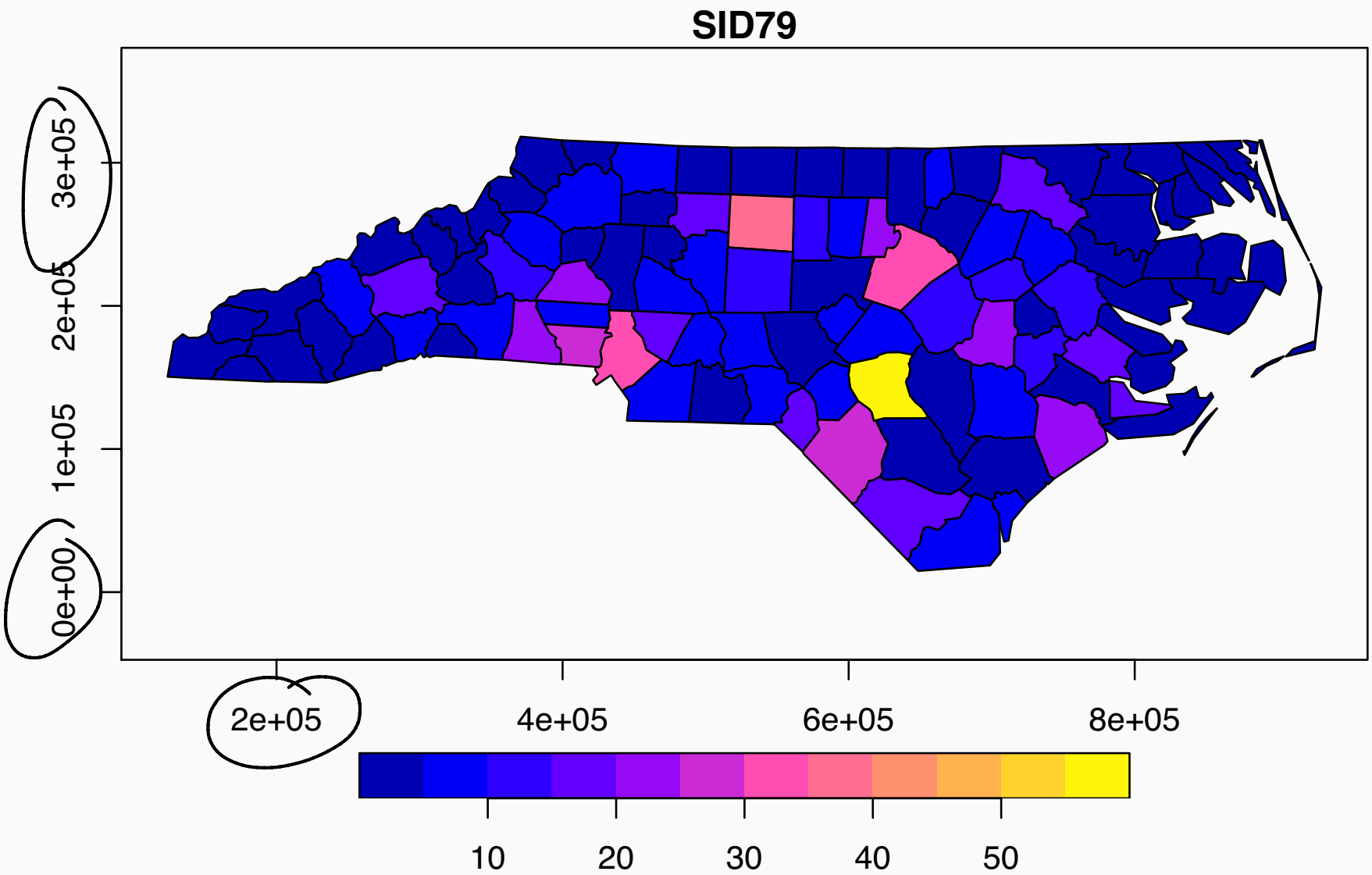
Graticules

```
plot(nc[,"SID79"], graticule=st_crs(nc), axes=TRUE)
```



Graticules (EPSG:3631)

```
plot(st_transform(nc[,"SID79"], 3631), axes=TRUE)
```

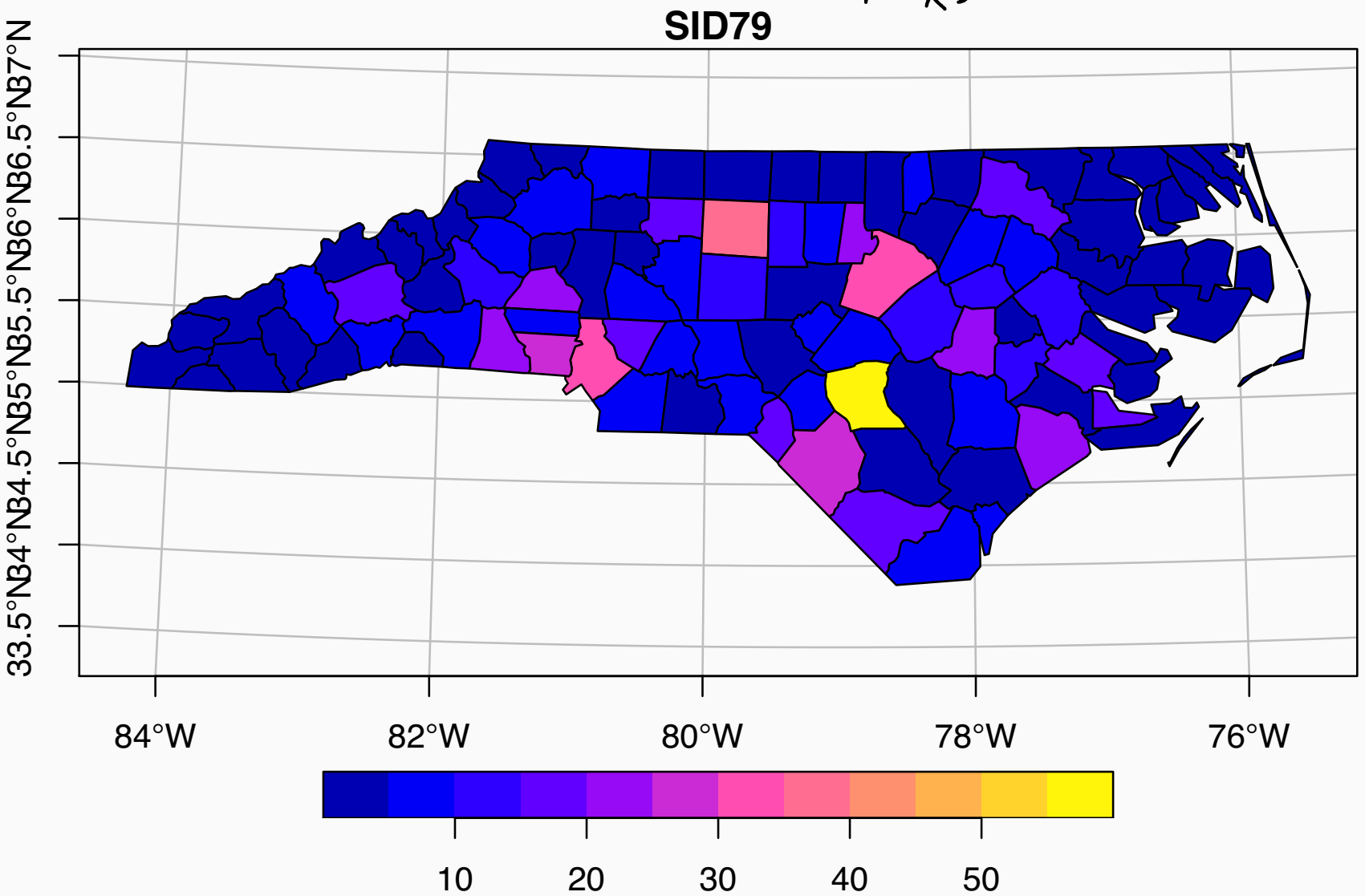


Graticules (EPSG:3631)

```
plot(st_transform(nc,"SID79"], 3631), graticule=st_crs(nc), axes=TRUE)
```

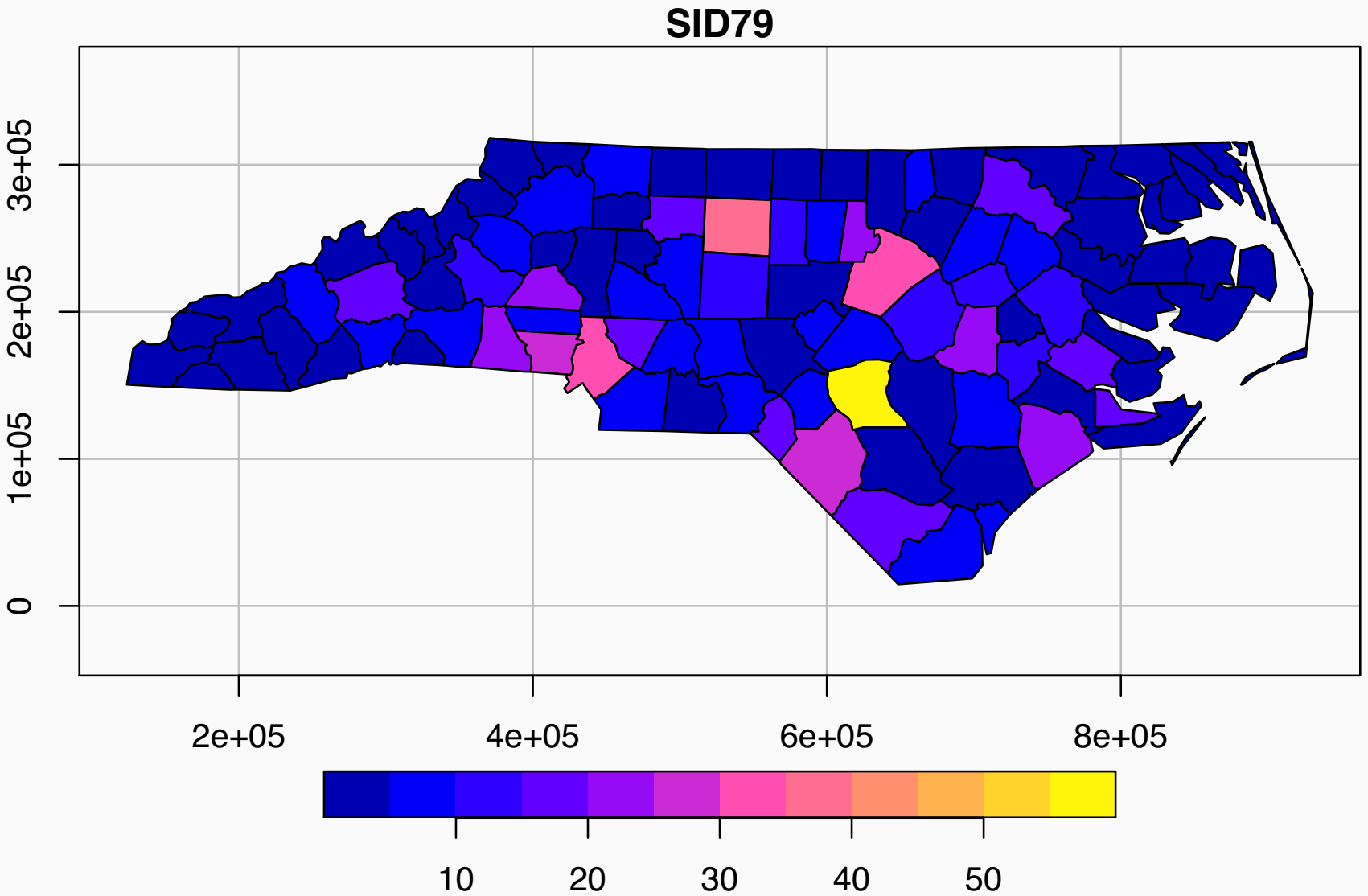
proj

trk/axes



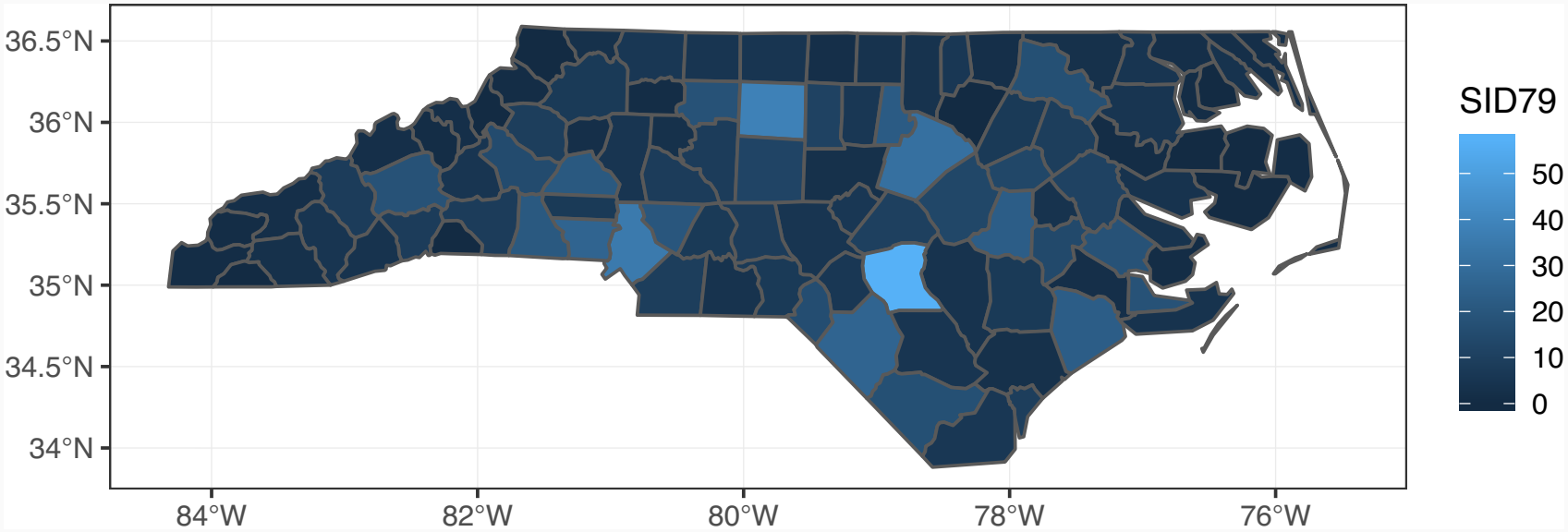
Graticules (EPSG:3631)

```
plot(st_transform(nc,"SID79"], 3631), graticule=st_crs(3631), axes=TRUE)
```



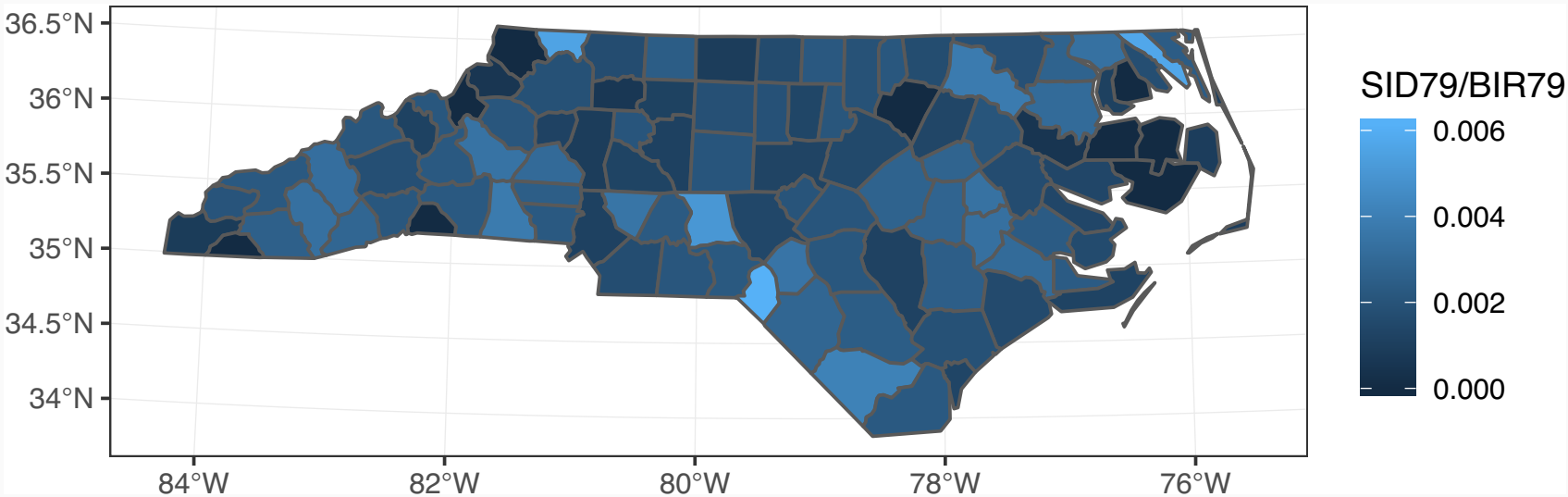
ggplot2

```
ggplot(nc) +
  geom_sf(aes(fill=SID79))
```



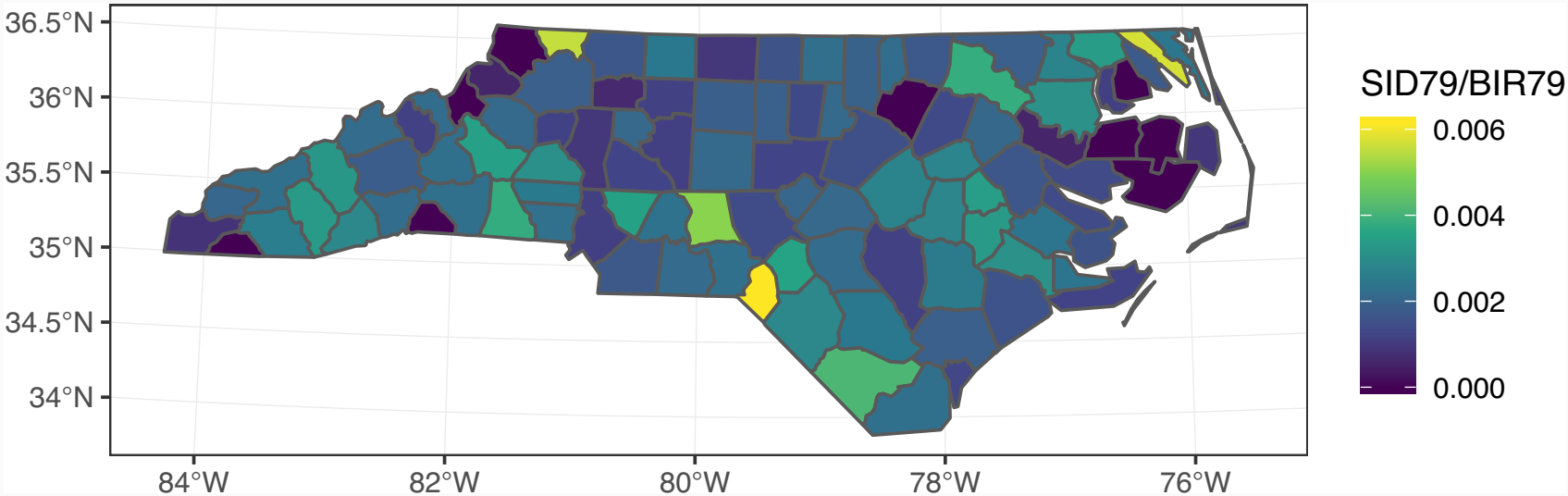
ggplot2 + projections

```
ggplot(st_transform(nc, 3631)) +
  geom_sf(aes(fill=SID79 / BIR79))
```



ggplot2 + viridis

```
ggplot(st_transform(nc, 3631)) +
  geom_sf(aes(fill=SID79 / BIR79)) +
  scale_fill_viridis_c()
```

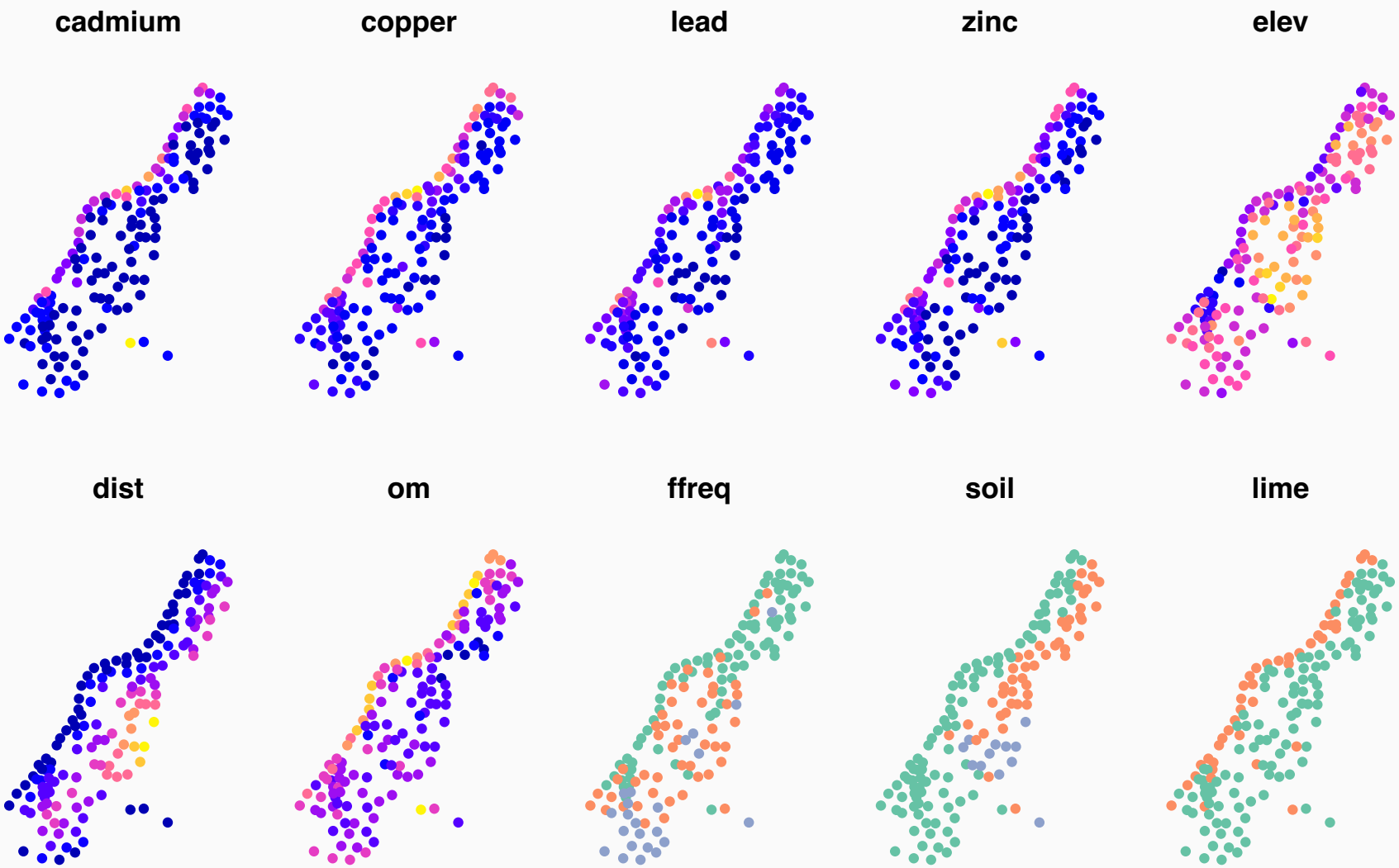


Example Data - Meuse

```
data(meuse, meuse.riv, package="sp")

meuse = st_as_sf(meuse, coords=c("x", "y"), crs=28992)
meuse_riv = st_polygon(list(meuse.riv)) %>% st_sfc() %>% st_set_crs(28992)

tbl_df(meuse)
## # A tibble: 155 x 13
##    cadmium copper  lead  zinc  elev    dist    om ffreq soil  lime  landuse
##  *   <dbl>  <dbl> <dbl> <dbl> <dbl>   <dbl> <dbl> <fct> <fct> <fct> <fct>
##  1    11.7     85   299  1022  7.91 0.00136  13.6 1     1     1     Ah
##  2     8.6     81   277  1141  6.98 0.0122   14   1     1     1     Ah
##  3     6.5     68   199   640  7.8  0.103    13   1     1     1     Ah
##  4     2.6     81   116   257  7.66 0.190     8   1     2     0     Ga
##  5     2.8     48   117   269  7.48 0.277     8.7 1     2     0     Ah
##  6     3       61   137   281  7.79 0.364     7.8 1     2     0     Ga
##  7     3.2     31   132   346  8.22 0.190     9.2 1     2     0     Ah
##  8     2.8     29   150   406  8.49 0.0922    9.5 1     1     0     Ab
##  9     2.4     37   133   347  8.67 0.185    10.6 1     1     0     Ab
## 10     1.6     24    80   183  9.05 0.310     6.3 1     2     0     W
## # ... with 145 more rows, and 2 more variables: dist.m <dbl>,
## #   geometry <POINT [m]>
```

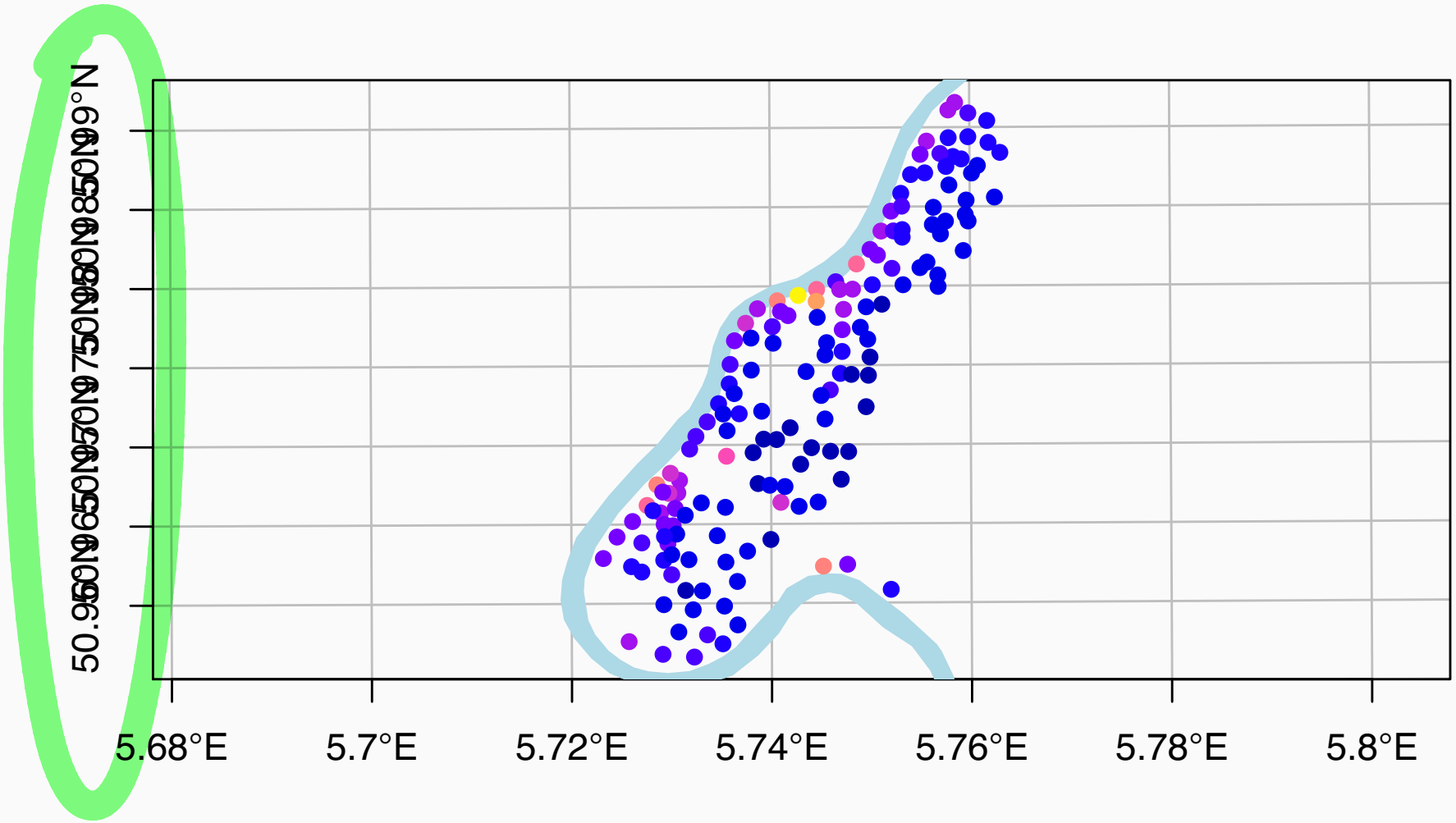
Meuse

```
plot(meuse, pch=16)
```



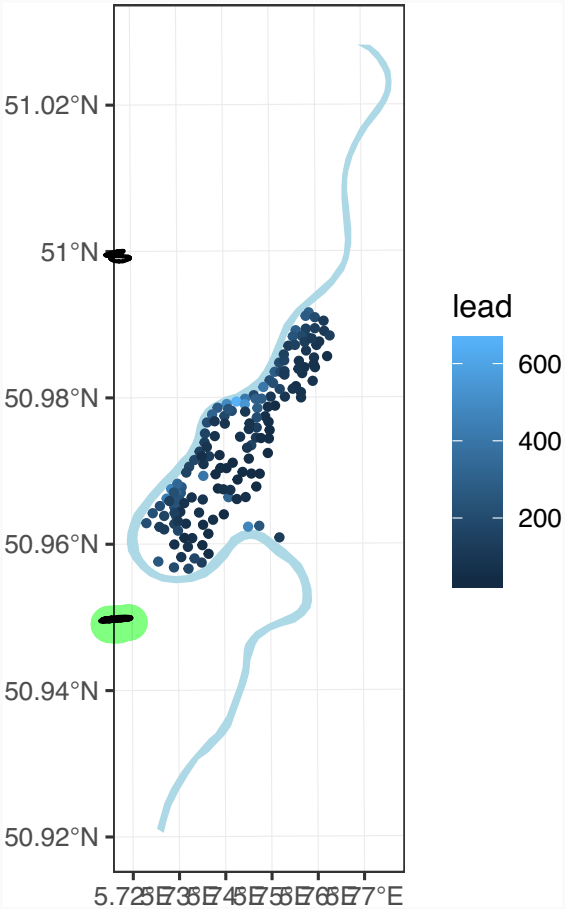
Layering plots

```
plot(meuse_riv, col=adjustcolor("lightblue", alpha.f=1), border = NA,
     axes=TRUE, graticule=st_crs(4326), xlim=st_bbox(meuse)[c(1,3)], ylim=st_bbox(meus
plot(meuse[,"lead"], pch=16, add=TRUE)
```



ggplot2

```
ggplot() +
  geom_sf(data=st_sf(meuse_riv), fill="lightblue", color=NA) +
  geom_sf(data=meuse, aes(color=lead), size=1)
```

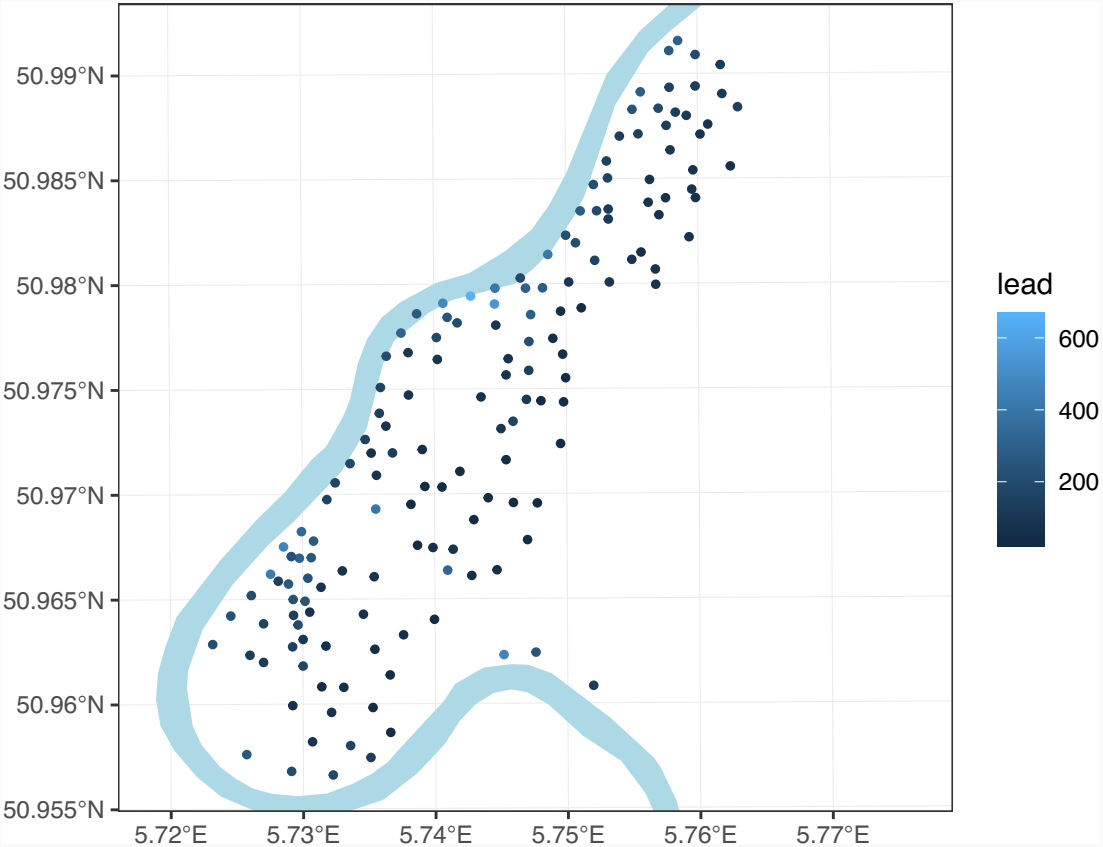


ggplot2 - axis limits

```
ggplot() +
  geom_sf(data=st_sf(meuse_riv), fill="lightblue", color=NA) +
  geom_sf(data=meuse, aes(color=lead), size=1) +
  ylim(50.95, 50.99)
```

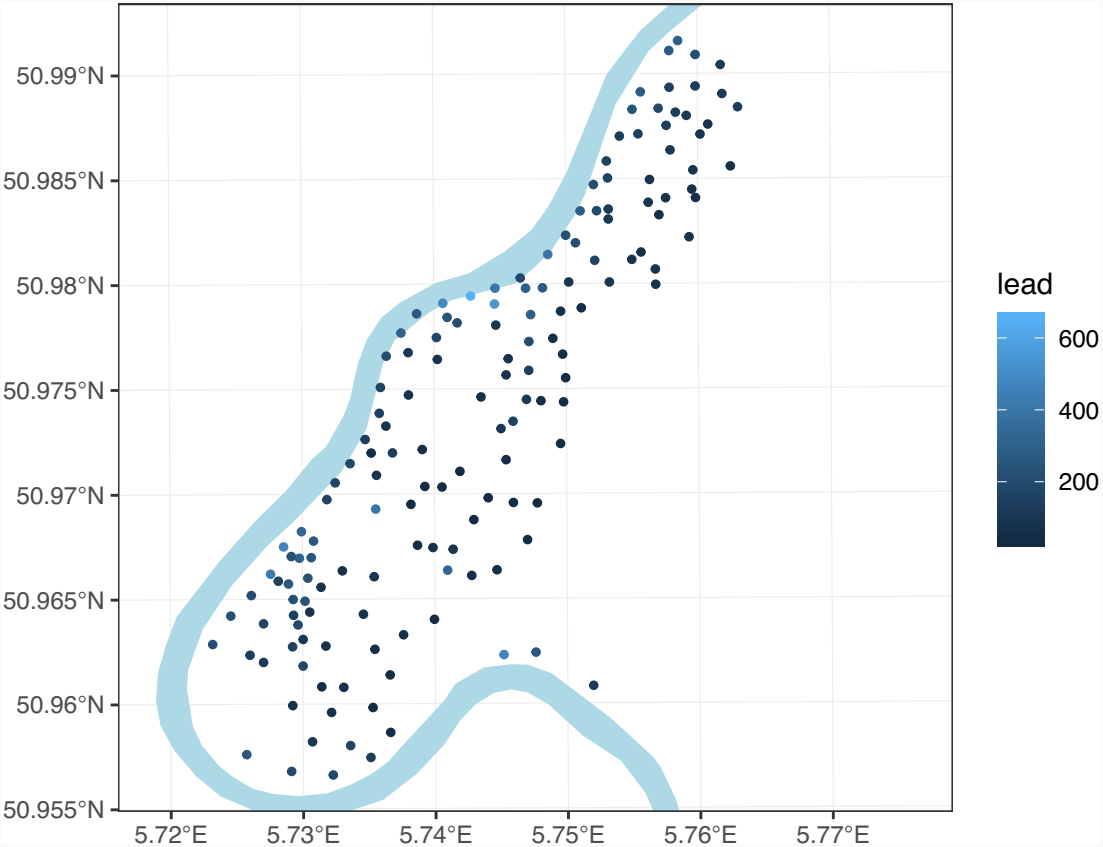
ggplot2 - axis limits

```
ggplot() +
  geom_sf(data=st_sf(meuse_riv), fill="lightblue", color=NA) +
  geom_sf(data=meuse, aes(color=lead), size=1) +
  ylim(329714, 333611)
```



ggplot2 - bounding box

```
ggplot() +
  geom_sf(data=st_sf(meuse_riv), fill="lightblue", color=NA) +
  geom_sf(data=meuse, aes(color=lead), size=1) +
  ylim(st_bbox(meuse)["ymin"], st_bbox(meuse)["ymax"])
```

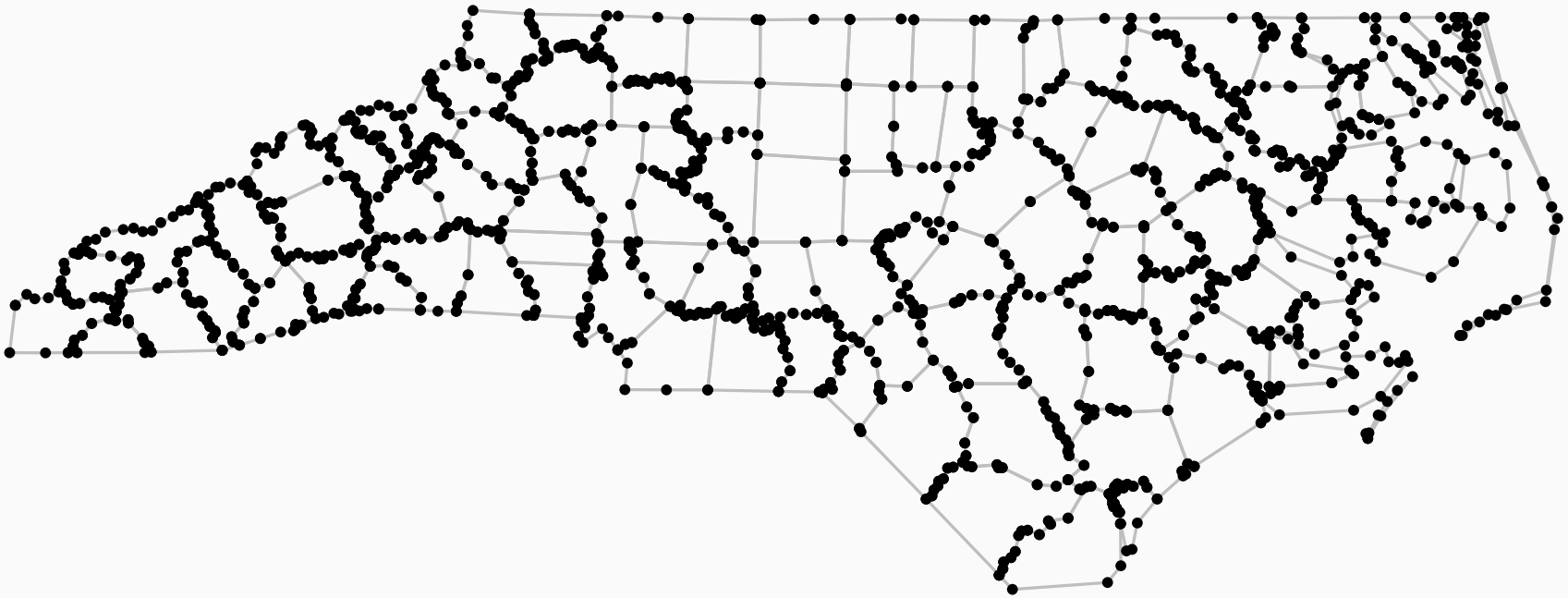


Geometry Manipulation

Casting

```
nc_pts = st_cast(nc, "MULTIPOINT")

tbl_df(nc_pts)
## # A tibble: 100 x 8
##    NAME  BIR74 SID74 NWBIR74 BIR79 SID79 NWBIR79                  geometry
##  * <fct> <dbl> <dbl>   <dbl> <dbl> <dbl>   <dbl>           <MULTIPOINT [°]>
##  1 Ashe   1091     1      10  1364     0      19 (-81.47276 36.23436, -81~
##  2 Alle~   487     0      10   542     3      12 (-81.23989 36.36536, -81~
##  3 Surry  3188     5     208  3616     6     260 (-80.45634 36.24256, -80~
##  4 Curr~   508     1     123   830     2     145 (-76.00897 36.3196, -76.~
##  5 Nort~  1421     9    1066  1606     3    1197 (-77.21767 36.24098, -77~
##  6 Hert~  1452     7     954  1838     5    1237 (-76.74506 36.23392, -76~
##  7 Camd~   286     0     115   350     2     139 (-76.00897 36.3196, -75.~
##  8 Gates   420     0     254   594     2     371 (-76.56251 36.34057, -76~
##  9 Warr~   968     4     748  1190     2     844 (-78.30876 36.26004, -78~
## 10 Stok~  1612     1     160  2038     5     176 (-80.02567 36.25023, -80~
## # ... with 90 more rows
```

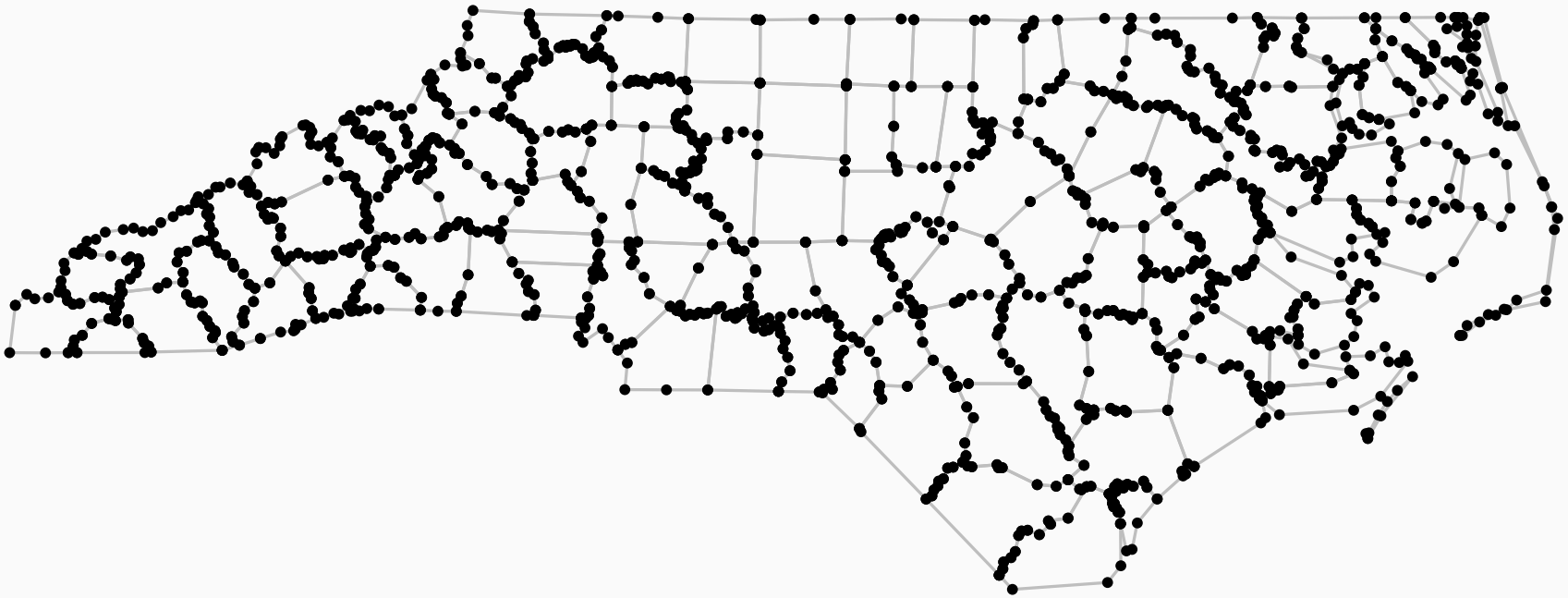
```r
plot(st_geometry(nc), border='grey')
plot(st_geometry(nc_pts), pch=16, cex=0.5, add=TRUE)
```



Casting - POINT

```
st_cast(nc, "POINT")
## Simple feature collection with 2529 features and 7 fields
## geometry type:  POINT
## dimension:      XY
## bbox:           xmin: -84.32385 ymin: 33.88199 xmax: -75.45698 ymax: 36.58965
## epsg (SRID):    4267
## proj4string:    +proj=longlat +datum=NAD27 +no_defs
## First 10 features:
##     NAME BIR74 SID74 NWBIR74 BIR79 SID79 NWBIR79
## 1   Ashe  1091     1      10  1364     0      19
## 1.1 Ashe  1091     1      10  1364     0      19
## 1.2 Ashe  1091     1      10  1364     0      19
## 1.3 Ashe  1091     1      10  1364     0      19
## 1.4 Ashe  1091     1      10  1364     0      19
## 1.5 Ashe  1091     1      10  1364     0      19
## 1.6 Ashe  1091     1      10  1364     0      19
## 1.7 Ashe  1091     1      10  1364     0      19
## 1.8 Ashe  1091     1      10  1364     0      19
## 1.9 Ashe  1091     1      10  1364     0      19
##                       geometry
## 1   POINT (-81.47276 36.23436)
## 1.1 POINT (-81.54084 36.27251)
## 1.2 POINT (-81.56198 36.27359)
## 1.3 POINT (-81.63306 36.34069)
## 1.4 POINT (-81.74107 36.39178)
## 1.5 POINT (-81.69828 36.47178)
## 1.6  POINT (-81.7028 36.51934)
## 1.7    POINT (-81.67 36.58965)
```

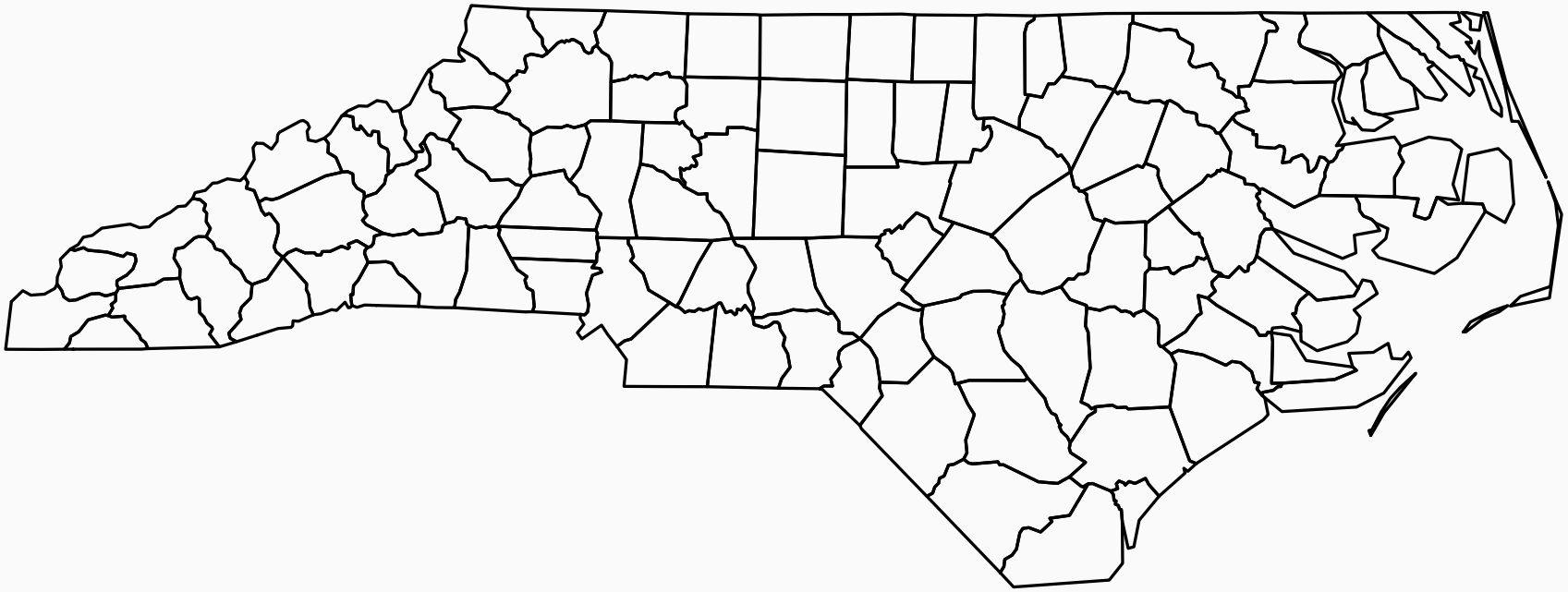
```
plot(st_geometry(nc), border='grey')
plot(st_geometry(st_cast(nc, "POINT")), pch=16, cex=0.5, add=TRUE)
```



Casting - LINESTRING

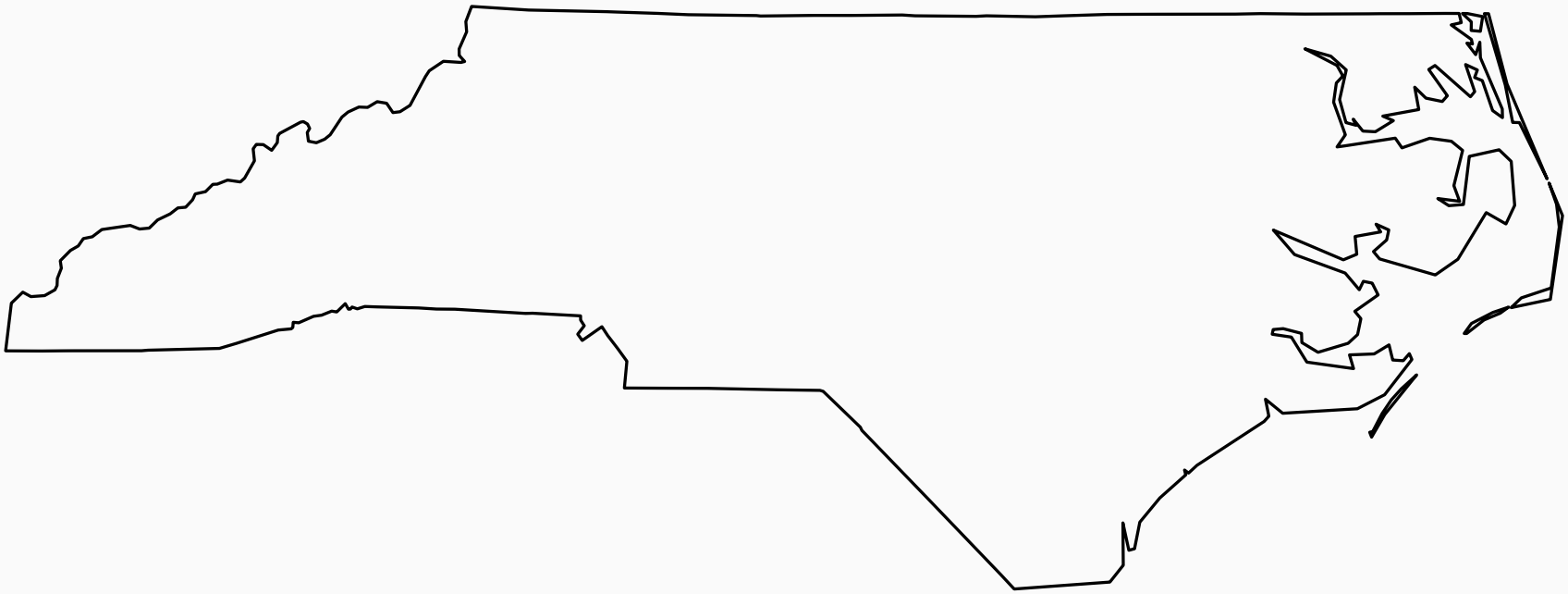
```
st_cast(nc, "MULTILINESTRING") %>% as_tibble()
## # A tibble: 100 x 8
##    NAME  BIR74 SID74 NWBIR74 BIR79 SID79 NWBIR79                  geometry
##  * <fct> <dbl> <dbl>   <dbl> <dbl> <dbl>   <dbl>     <MULTILINESTRING [°]>
##  1 Ashe   1091     1      10  1364     0      19 ((-81.47276 36.23436, -8~
##  2 Alle~   487     0      10   542     3      12 ((-81.23989 36.36536, -8~
##  3 Surry  3188     5     208  3616     6     260 ((-80.45634 36.24256, -8~
##  4 Curr~   508     1     123   830     2     145 ((-76.00897 36.3196, -76~
##  5 Nort~  1421     9    1066  1606     3    1197 ((-77.21767 36.24098, -7~
##  6 Hert~  1452     7     954  1838     5    1237 ((-76.74506 36.23392, -7~
##  7 Camd~   286     0     115   350     2     139 ((-76.00897 36.3196, -75~
##  8 Gates   420     0     254   594     2     371 ((-76.56251 36.34057, -7~
##  9 Warr~   968     4     748  1190     2     844 ((-78.30876 36.26004, -7~
## 10 Stok~  1612     1     160  2038     5     176 ((-80.02567 36.25023, -8~
## # ... with 90 more rows
```

```
st_cast(nc, "MULTILINESTRING") %>% st_geometry() %>% plot()
```



Grouping Features

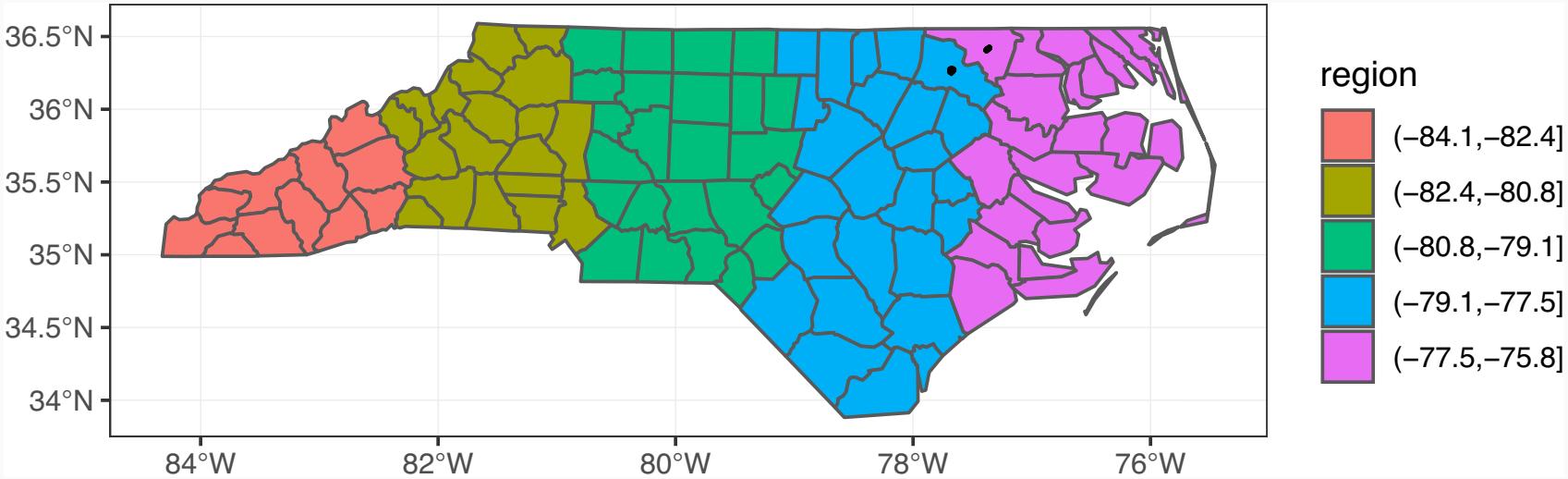
```
nc_state = st_union(nc)
tbl_df(nc_state)
## # A tibble: 1 x 1
##                                                                 geometry
## *                                                          <MULTIPOLYGON [°]>
## 1 (((-76.54427 34.58783, -76.55515 34.61066, -76.53775 34.61392, -76.48448~
plot(nc_state)
```



More Grouping

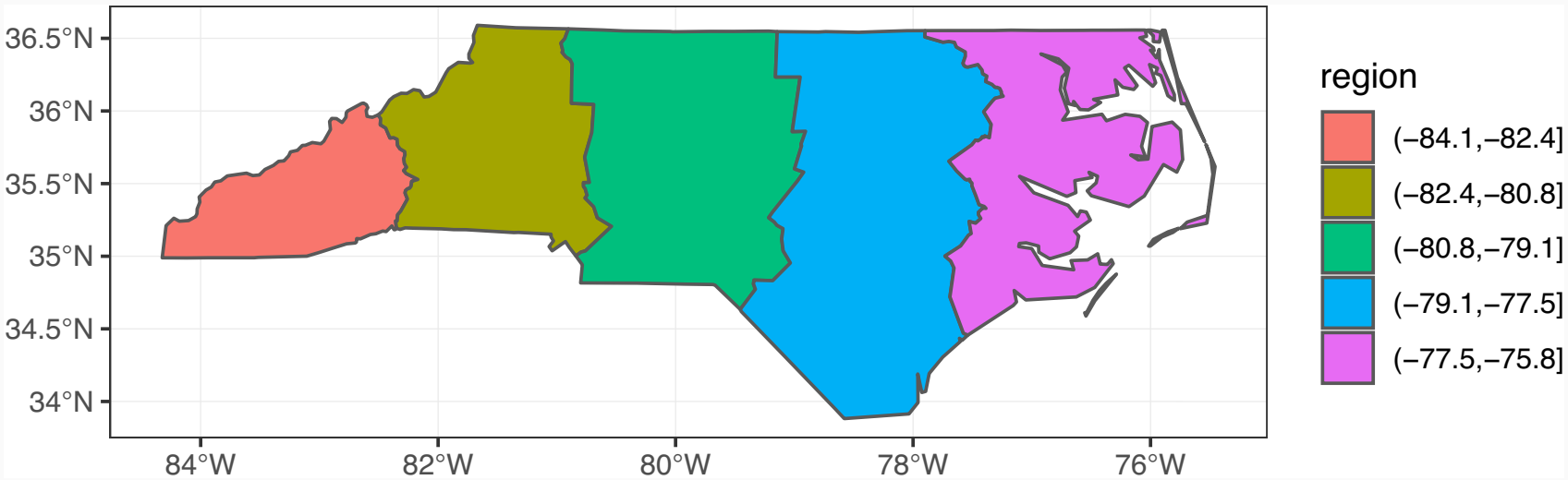
```
nc_cut = nc %>%
  mutate(X = st_centroid(nc) %>% st_coordinates() %>% .[,1]) %>%
  mutate(region = cut(X, breaks = 5))

tbl_df(nc_cut)
## # A tibble: 100 x 10
##    NAME  BIR74 SID74 NWBIR74 BIR79 SID79 NWBIR79     X region
##    <fct> <dbl> <dbl>   <dbl> <dbl> <dbl>   <dbl> <dbl> <fct>
##  1 Ashe   1091     1      10  1364     0      19 -81.5 (-82.~
##  2 Alle~   487     0      10   542     3      12 -81.1 (-82.~
##  3 Surry  3188     5     208  3616     6     260 -80.7 (-80.~
##  4 Curr~   508     1     123   830     2     145 -76.0 (-77.~
##  5 Nort~  1421     9    1066  1606     3    1197 -77.4 (-77.~
##  6 Hert~  1452     7     954  1838     5    1237 -77.0 (-77.~
##  7 Camd~   286     0     115   350     2     139 -76.2 (-77.~
##  8 Gates   420     0     254   594     2     371 -76.7 (-77.~
##  9 Warr~   968     4     748  1190     2     844 -78.1 (-79.~
## 10 Stok~  1612     1     160  2038     5     176 -80.2 (-80.~
## # ... with 90 more rows, and 1 more variable: geometry <MULTIPOLYGON [°]>
```

```
ggplot(nc_cut) +
  geom_sf(aes(fill=region))
```



dplyr and sf

```
nc_cut %>%
  group_by(region) %>%
  summarize() %>%
  ggplot() +
    geom_sf(aes(fill=region))
```

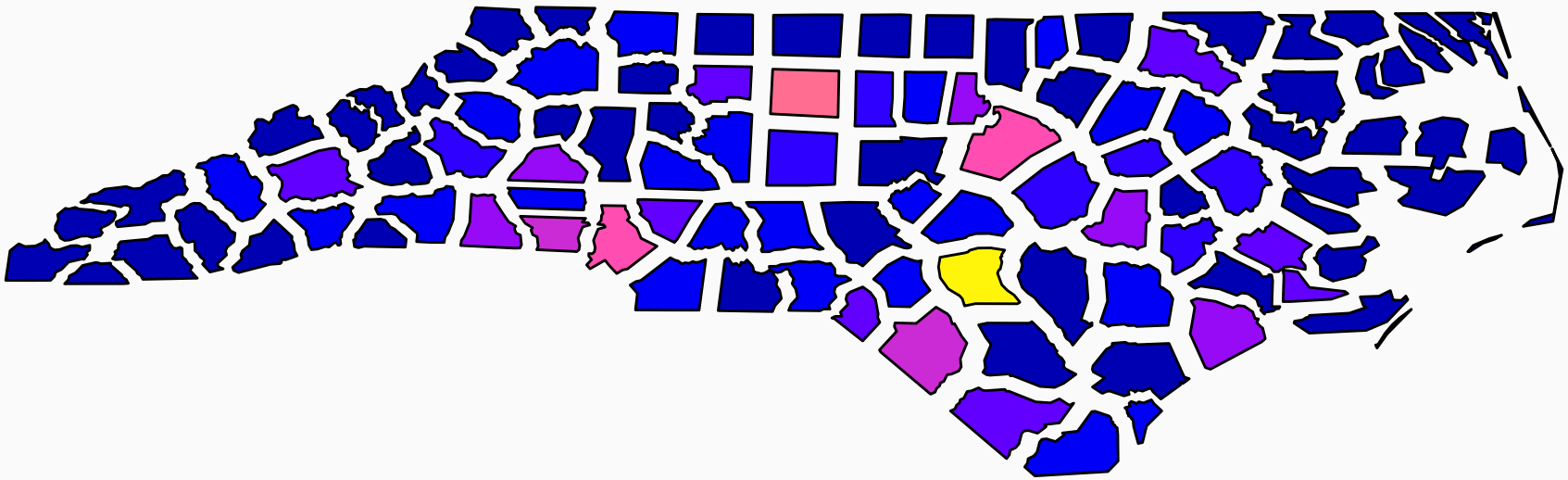


Affine Transfomations

```
rotate = function(a) matrix(c(cos(a), sin(a), -sin(a), cos(a)), 2, 2)

ctrd = st_centroid(nc_state)
state_rotate = lwgeom::st_make_valid( (nc_state) * rotate(-pi/4) )
plot(state_rotate, axes=TRUE)
```

Scaling Size

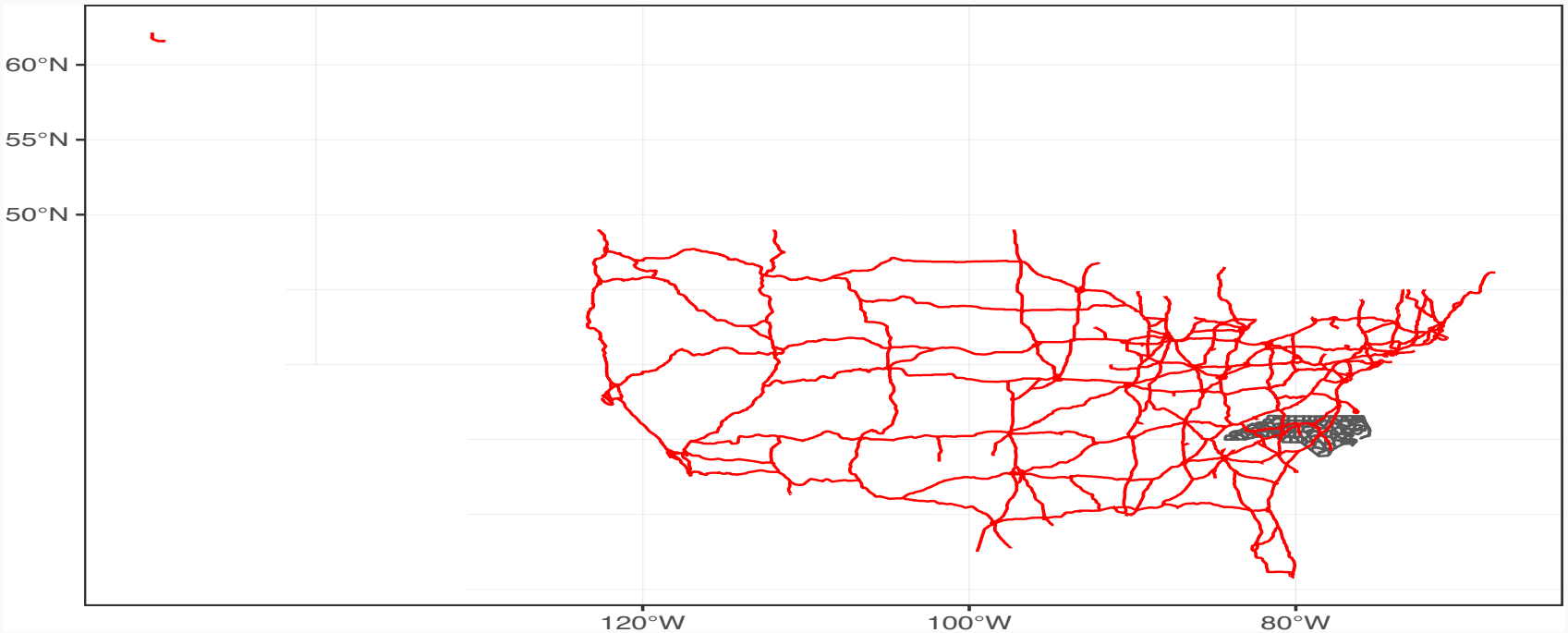
```
ctrd = st_centroid(st_geometry(nc))
area = st_area(nc) %>% strip_attrs()

nc_rot = nc
st_geometry(nc_rot) = (st_geometry(nc) - ctrd) * 0.75 + ctrd

plot(nc_rot[,"SID79"])
```



Highway Example

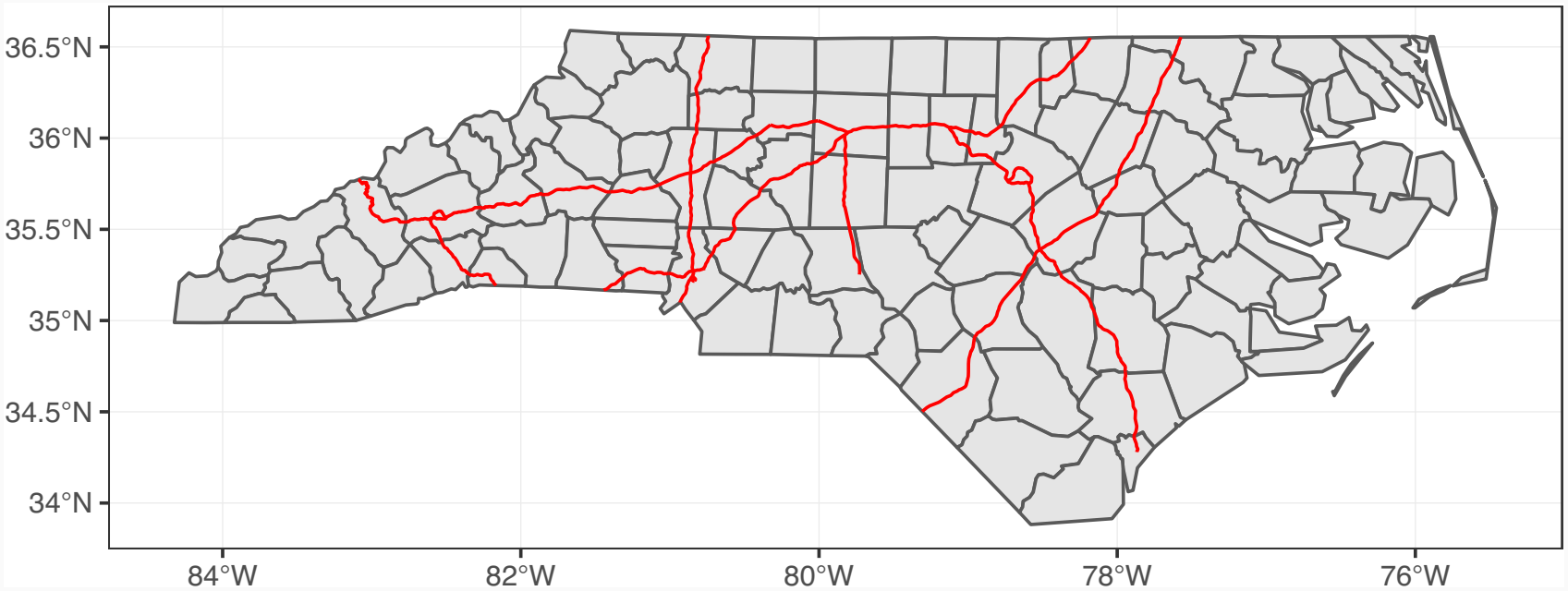
Highways

```
hwy = st_read("https://www2.stat.duke.edu/~cr173/Sta444_Fa18/slides/data/us_interstate
              quiet=TRUE, stringsAsFactors=FALSE) %>% st_transform(st_crs(nc))
ggplot() +
  geom_sf(data=nc) +
  geom_sf(data=hwy, col='red')
```



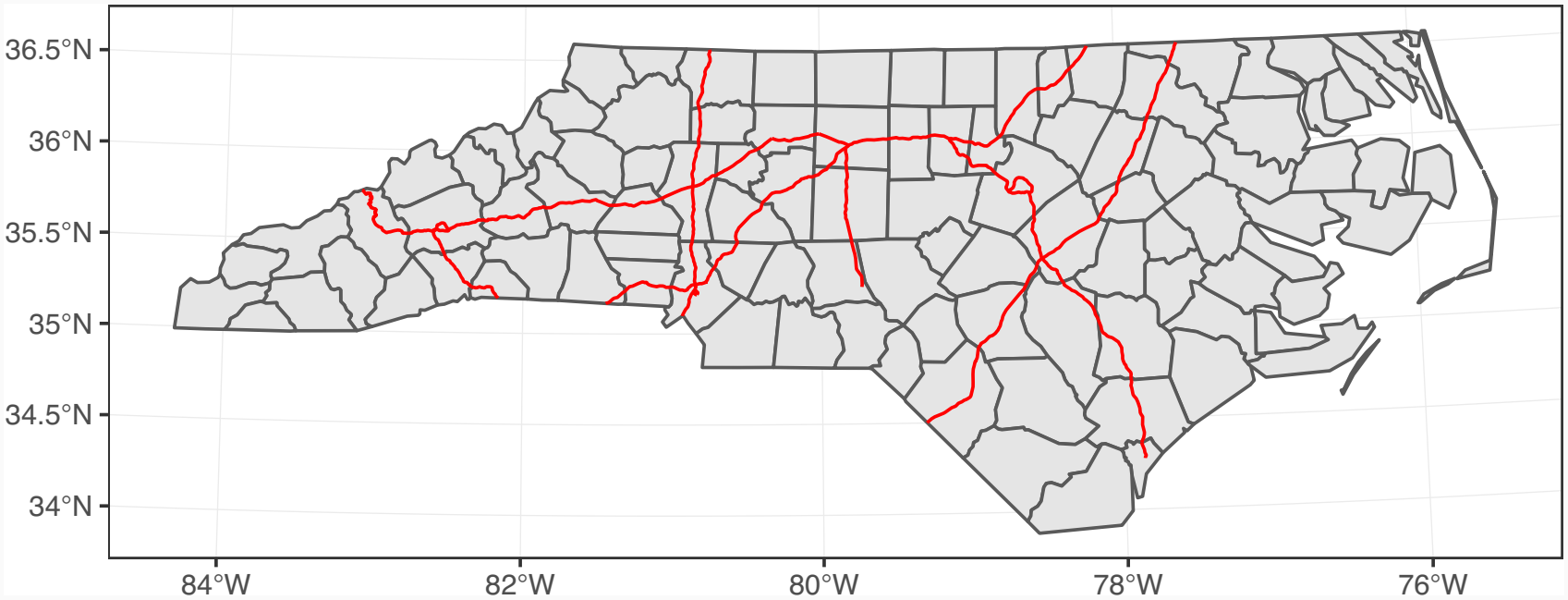
NC Interstate Highways

```
hwy_nc = st_intersection(hwy, nc)
## although coordinates are longitude/latitude, st_intersection assumes that they are

ggplot() +
  geom_sf(data=nc) +
  geom_sf(data=hwy_nc, col='red')
```



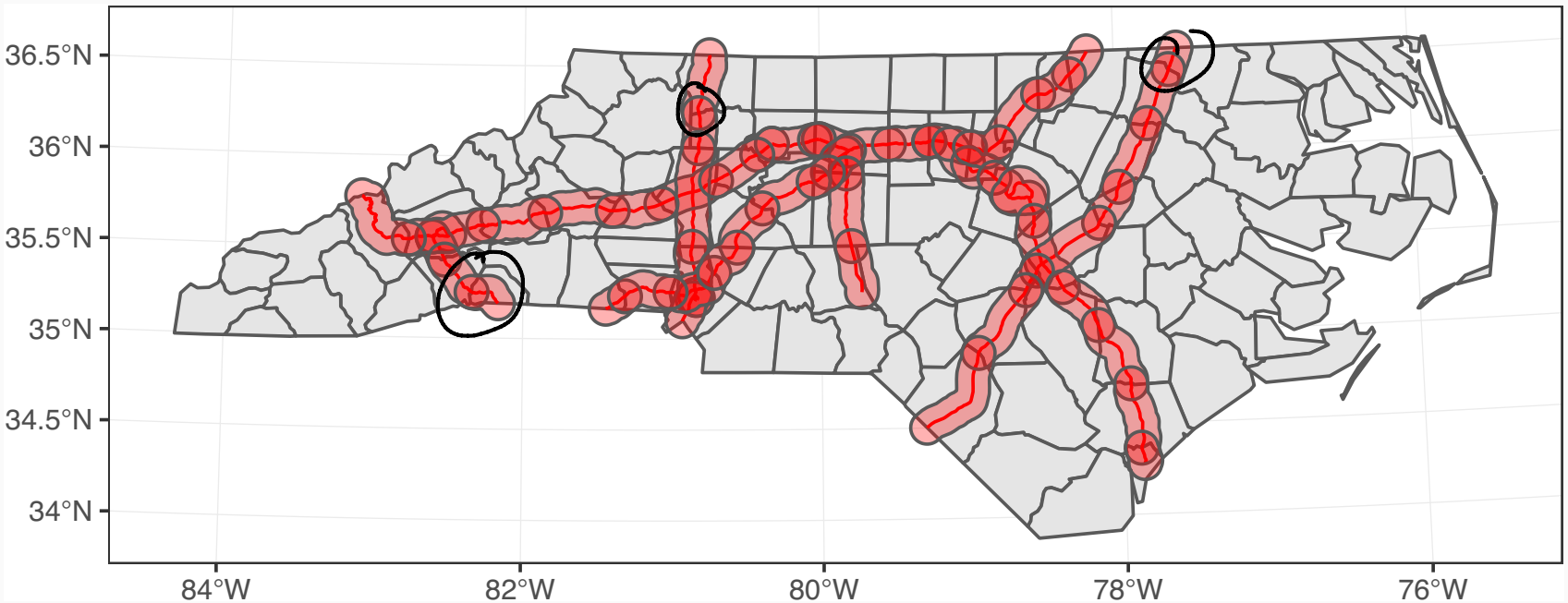
Counties near the interstate (Projection)

```
nc_utm  = st_transform(nc, "+proj=utm +zone=17 +datum=NAD83 +units=m +no_defs")

ggplot() +
  geom_sf(data=nc_utm) +
  geom_sf(data=hwy_nc, col='red')
```



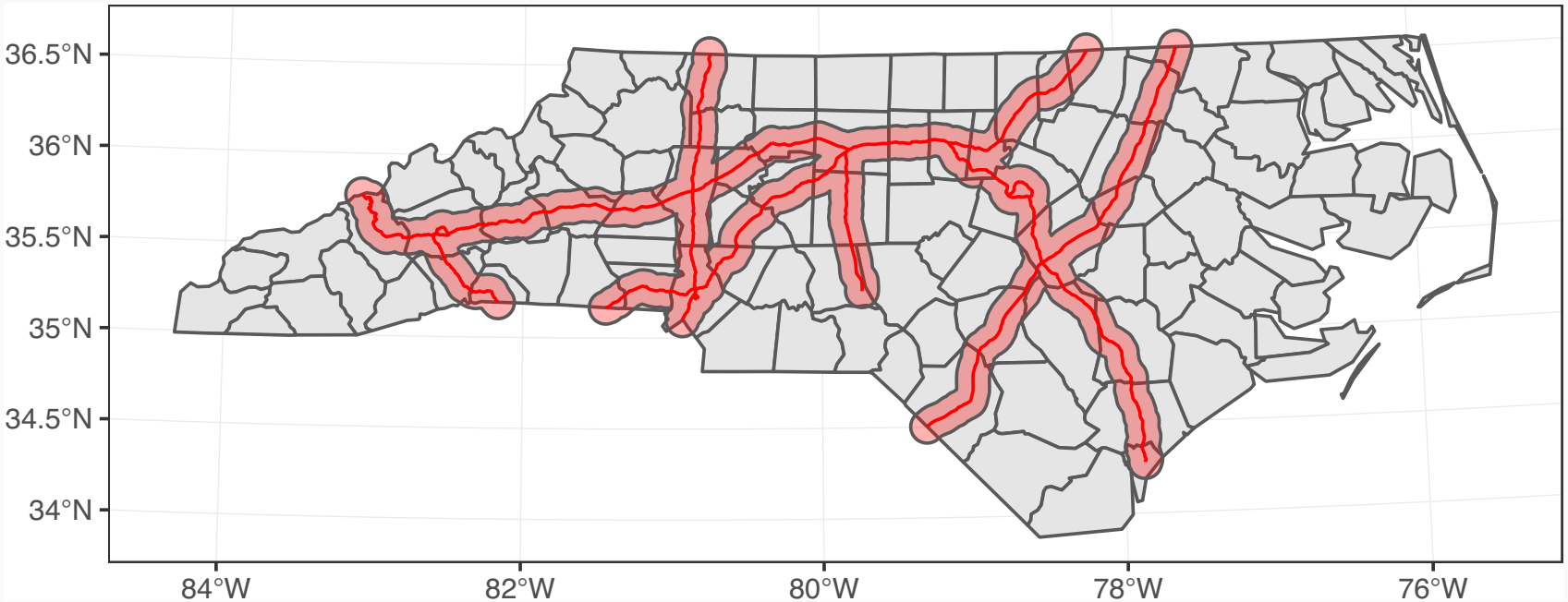
Counties near the interstate (Buffering)

```
hwy_nc_buffer = hwy_nc %>%
  st_transform("+proj=utm +zone=17 +datum=NAD83 +units=m +no_defs") %>%
  st_buffer(10000)

ggplot() +
  geom_sf(data=nc_utm) +
  geom_sf(data=hwy_nc, color='red') +
  geom_sf(data=hwy_nc_buffer, fill='red', alpha=0.3)
```



Counties near the interstate (Buffering + Union)

```
hwy_nc_buffer = hwy_nc %>%
  st_transform("+proj=utm +zone=17 +datum=NAD83 +units=m +no_defs") %>%
  st_buffer(10000) %>%
  st_union() %>%
  st_sf()

ggplot() +
  geom_sf(data=nc_utm) +
  geom_sf(data=hwy_nc, color='red') +
  geom_sf(data=hwy_nc_buffer, fill='red', alpha=0.3)
```



Example

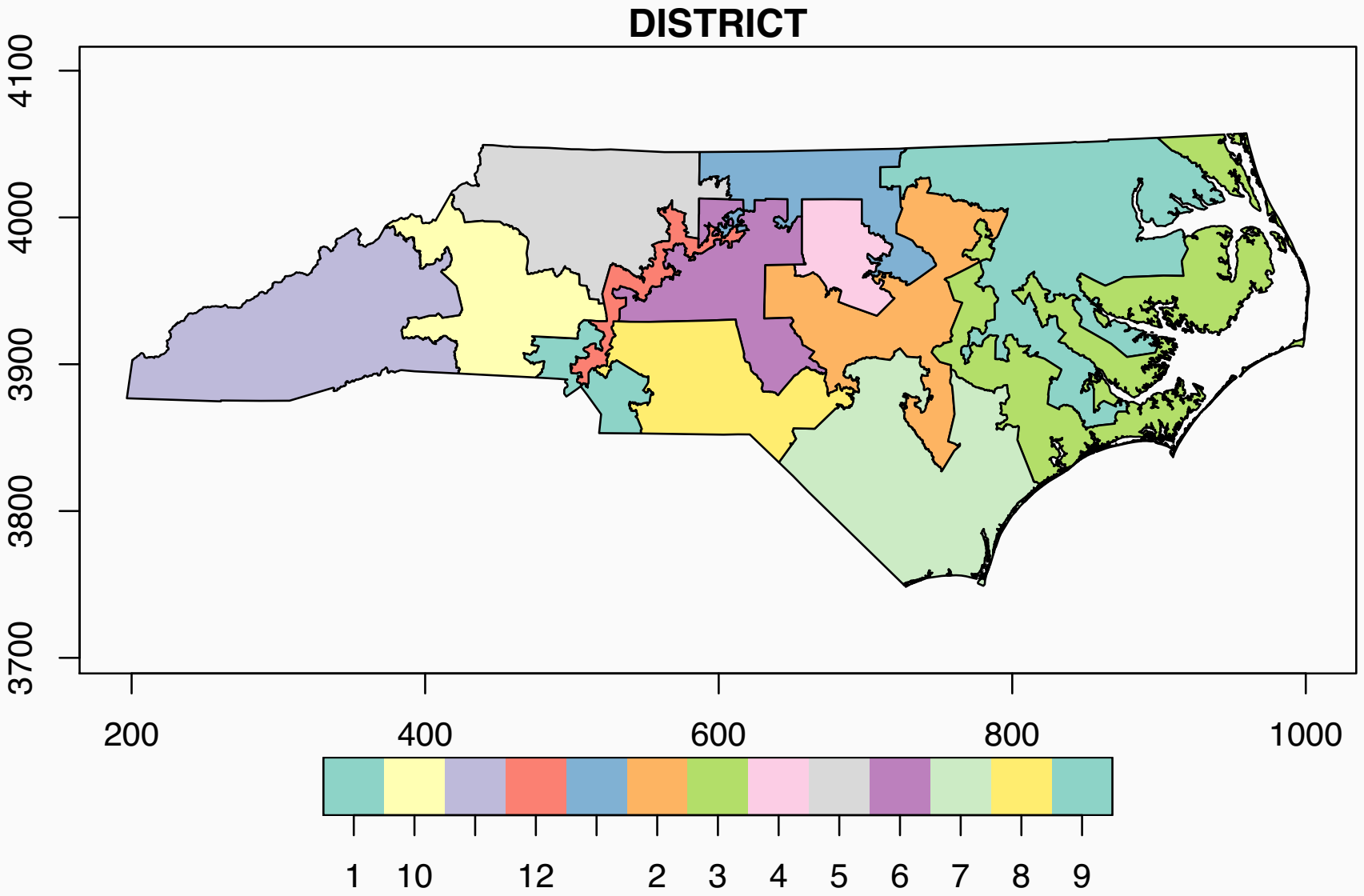
How many counties in North Carolina are within 5, 10, 20, or 50 km of an interstate highway?

Gerrymandering Example

NC House Districts - 112th Congress

```
nc_house = st_read(
  "https://www2.stat.duke.edu/~cr173/Sta444_Fa18/slides/data/nc_districts112
  stringsAsFactors = FALSE, quiet = TRUE) %>%
  select(ID, DISTRICT)

tbl_df(nc_house)
## # A tibble: 13 x 3
##    ID         DISTRICT                                                  geo
##    <chr>      <chr>                                          <MULTIPOLYGON [°]
##  1 037108112~ 1        (((-77.32845 35.35031, -77.35398 35.32799, -77.336
##  2 037108112~ 2        (((-78.89928 35.12619, -78.89763 35.12859, -78.892
##  3 037108112~ 3        (((-75.68266 35.23291, -75.68113 35.23237, -75.682
##  4 037108112~ 4        (((-78.77926 35.78568, -78.77947 35.77568, -78.794
##  5 037108112~ 5        (((-79.8968 36.38075, -79.89213 36.37108, -79.8928
##  6 037108112~ 6        (((-80.4201 35.68953, -80.41483 35.68918, -80.4111
##  7 037108112~ 7        (((-77.59169 34.40907, -77.58699 34.40611, -77.585
##  8 037108112~ 8        (((-78.93373 34.95909, -78.94074 34.95789, -78.943
##  9 037108112~ 9        (((-80.93058 35.18181, -80.9244 35.16754, -80.9210
## 10 037108112~ 10       (((-81.04032 35.40447, -81.30021 35.41461, -81.287
## 11 037108112~ 11       (((-84.00768 35.37262, -84.00831 35.37888, -84.011
## 12 037108112~ 12       (((-80.4996 35.6493, -80.51926 35.63314, -80.52016
## 13 037108112~ 13       (((-79.90775 36.3818, -79.90694 36.38382, -79.9016
```

```
nc_house = nc_house %>%
  st_transform("+proj=utm +zone=17 +datum=NAD83 +units=km +no_defs")
plot(nc_house["DISTRICT"], axes=TRUE)
```

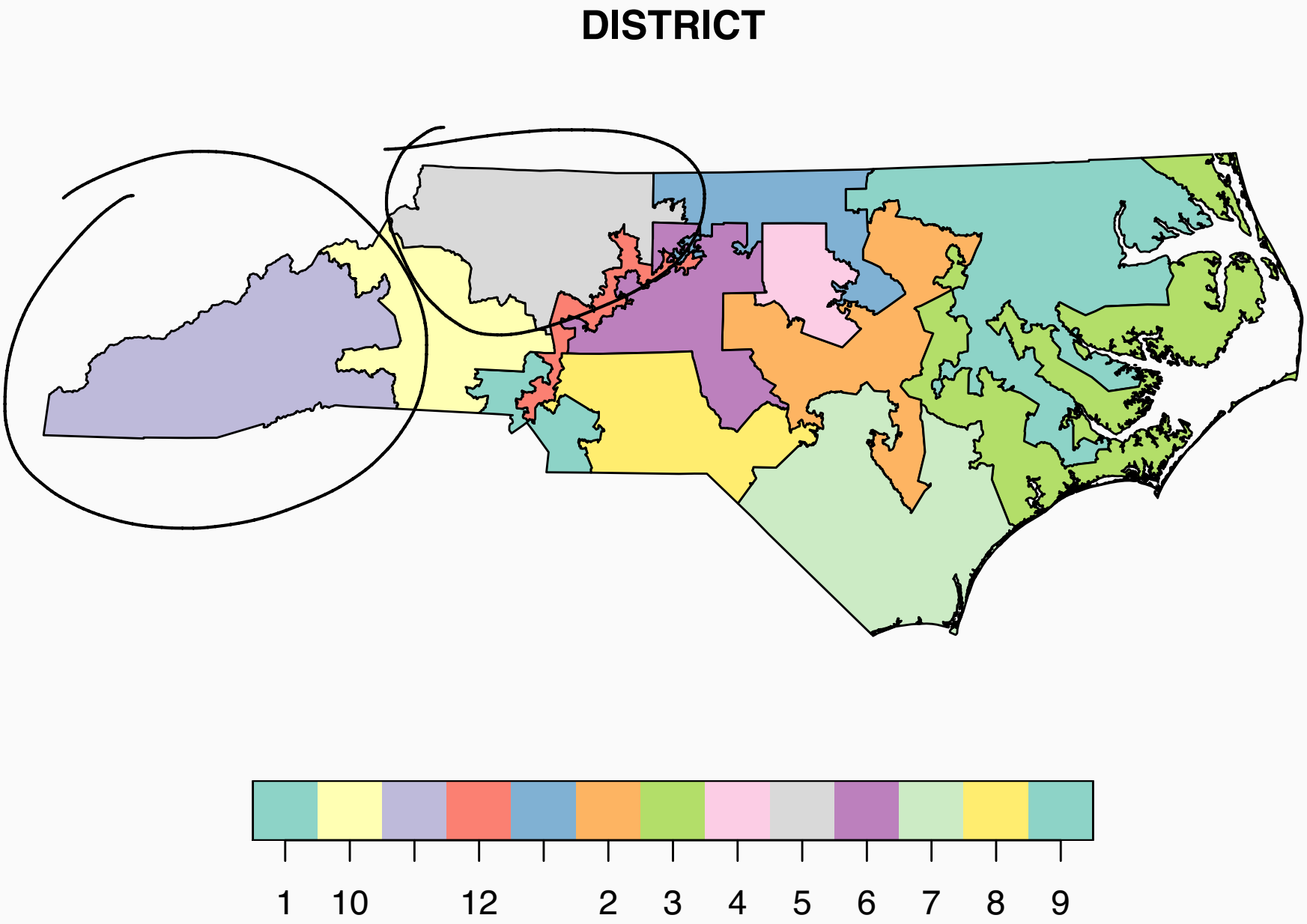


Measuring Compactness - Reock Score

The Reock score the a measure of compactness that is calculated as the the ratio area of a shape to the area of its minimum bounding circle.

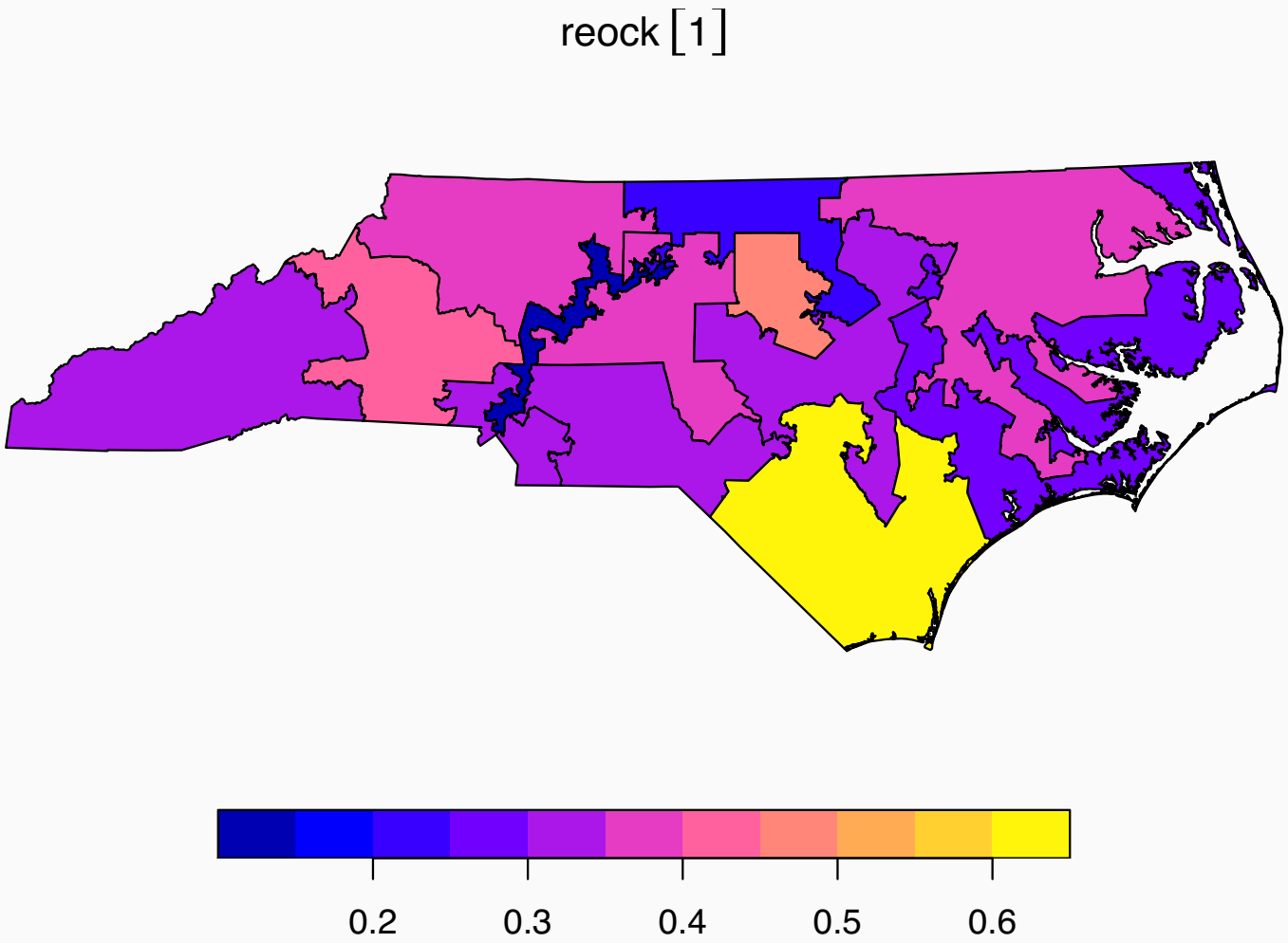
```
circs = nc_house %>% st_geometry() %>% lwgeom::st_minimum_bounding_circle()

sub = nc_house$DISTRICT == 1
plot(circs[sub])
plot(nc_house[sub,"DISTRICT"], add=TRUE)
```

```
plot(nc_house[,"DISTRICT"])
plot(circs,add=TRUE)
```



Calculating Reock

```
nc_house = nc_house %>%
  mutate(reock = st_area(nc_house) / st_area(circs))
plot(nc_house[,"reock"])
```



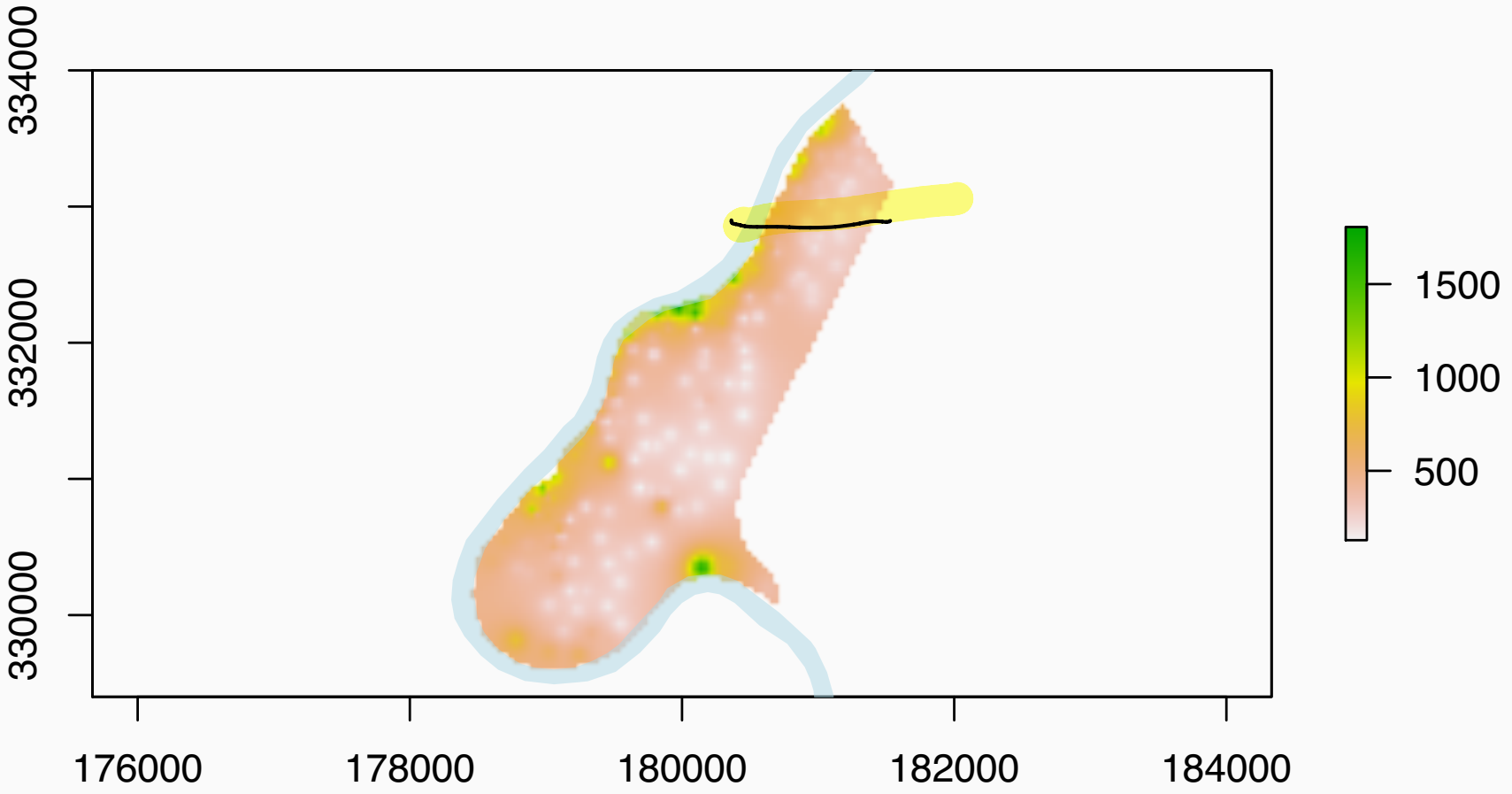
```
tbl_df(nc_house) %>%
  arrange(reock) %>%
  print(n=13)
## # A tibble: 13 x 4
##    ID       DISTRICT reock                                                geo
##    <chr>    <chr>    <S3: uni>                                <MULTIPOLYGON [km]
##  1 0371081~ 12       0.115548~ (((545.2989 3945.167, 543.5279 3943.366, 5
##  2 0371081~ 13       0.237185~ (((597.9666 4026.851, 598.0375 4027.076, 5
##  3 0371081~ 3        0.266378~ (((984.071 3911.853, 984.2139 3911.8, 984.
##  4 0371081~ 2        0.303422~ (((691.4142 3889.056, 691.5584 3889.327, 6
##  5 0371081~ 9        0.338722~ (((506.3209 3893.208, 506.885 3891.626, 50
##  6 0371081~ 8        0.341645~ (((688.6585 3870.456, 688.021 3870.31, 687
##  7 0371081~ 11       0.343731~ (((226.7524 3918.52, 226.7167 3919.217, 22
##  8 0371081~ 6        0.377542~ (((552.4693 3949.669, 552.9463 3949.632, 5
##  9 0371081~ 1        0.377659~ (((833.6772 3918.082, 831.4469 3915.52, 83
## 10 0371081~ 5        0.398978~ (((598.9506 4026.745, 599.3817 4025.677, 5
## 11 0371081~ 10       0.410830~ (((496.3392 3917.9, 472.7445 3919.064, 473
## 12 0371081~ 4        0.480027~ (((700.7066 3962.453, 700.712 3961.343, 69
## 13 0371081~ 7        0.623895~ (((813.3007 3812.784, 813.7436 3812.471, 8
```

Raster Data

Example data - Meuse

```
meuse_rast = raster(system.file("external/test.grd", package="raster"))

meuse_rast
## class       : RasterLayer
## dimensions  : 115, 80, 9200  (nrow, ncol, ncell)
## resolution  : 40, 40  (x, y)
## extent      : 178400, 181600, 329400, 334000  (xmin, xmax, ymin, ymax)
## coord. ref. : +init=epsg:28992 +towgs84=565.237,50.0087,465.658,-0.406857,0.350733,
## data source : /usr/local/lib/R/3.5/site-library/raster/external/test.grd
## names       : test
## values      : 128.434, 1805.78  (min, max)
```

```r
plot(meuse_rast)
plot(meuse_riv, add=TRUE, col=adjustcolor("lightblue",alpha.f = 0.5), border=NA)
```



raster class

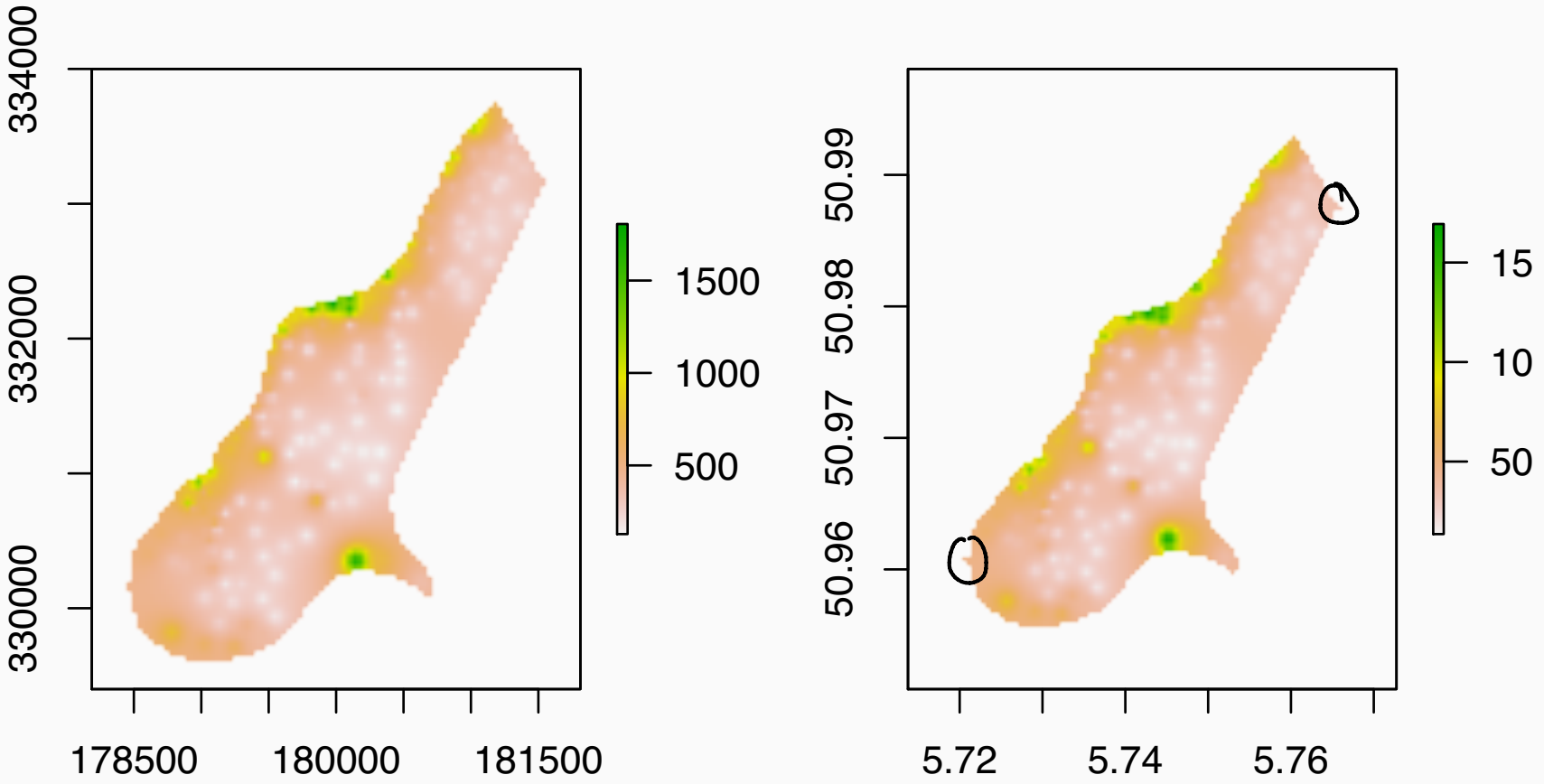
```
str(meuse_rast)
## Formal class 'RasterLayer' [package "raster"] with 12 slots
##   ..@ file    :Formal class '.RasterFile' [package "raster"] with 13 slots
##   .. .. ..@ name        : chr "/usr/local/lib/R/3.5/site-library/raster/external/te
##   .. .. ..@ datanotation: chr "FLT4S"
##   .. .. ..@ byteorder   : Named chr "little"
##   .. .. .. ..- attr(*, "names")= chr "value"
##   .. .. ..@ nodatavalue : num -3.4e+38
##   .. .. ..@ NAchanged   : logi FALSE
##   .. .. ..@ nbands      : int 1
##   .. .. ..@ bandorder   : Named chr "BIL"
##   .. .. .. ..- attr(*, "names")= chr "value"
##   .. .. ..@ offset      : int 0
##   .. .. ..@ toptobottom : logi TRUE
##   .. .. ..@ blockrows   : int 0
##   .. .. ..@ blockcols   : int 0
##   .. .. ..@ driver      : chr "raster"
##   .. .. ..@ open        : logi FALSE
##   ..@ data    :Formal class '.SingleLayerData' [package "raster"] with 13 slots
##   .. .. ..@ values    : logi(0)
##   .. .. ..@ offset    : num 0
##   .. .. ..@ gain      : num 1
##   .. .. ..@ inmemory  : logi FALSE
##   .. .. ..@ fromdisk  : logi TRUE
##   .. .. ..@ isfactor  : logi FALSE
##   .. .. ..@ attributes: list()
##   .. .. ..@ haveminmax: logi TRUE
##   .. .. ..@ min       : num 128
```

raster features

```
extent(meuse_rast)
## class       : Extent
## xmin        : 178400
## xmax        : 181600
## ymin        : 329400
## ymax        : 334000

dim(meuse_rast)
## [1] 115  80   1

res(meuse_rast)
## [1] 40 40

projection(meuse_rast)
## [1] "+init=epsg:28992 +towgs84=565.237,50.0087,465.658,-0.406857,0.350733,-1.87035,

meuse_rast[20,]
##  [1]      NA      NA      NA      NA      NA      NA      NA      NA
##  [9]      NA      NA      NA      NA      NA      NA      NA      NA
## [17]      NA      NA      NA      NA      NA      NA      NA      NA
## [25]      NA      NA      NA      NA      NA      NA      NA      NA
## [33]      NA      NA      NA      NA      NA      NA      NA      NA
## [41]      NA      NA      NA      NA      NA      NA      NA      NA
## [49]      NA      NA      NA      NA      NA      NA      NA      NA
## [57]      NA      NA      NA 749.536 895.292 791.145 607.186 511.044
## [65] 468.404 399.325 350.362 306.180 300.483 310.082 283.940 285.771
## [73] 304.709 309.690 301.799 308.753 328.357 345.611      NA      NA
```

Rasters and Projections

```
library(rgdal)
meuse_rast_ll = projectRaster(meuse_rast, crs="+proj=longlat +datum=NAD27 +no_defs")

par(mfrow=c(1,2))
plot(meuse_rast)
plot(meuse_rast_ll)
```

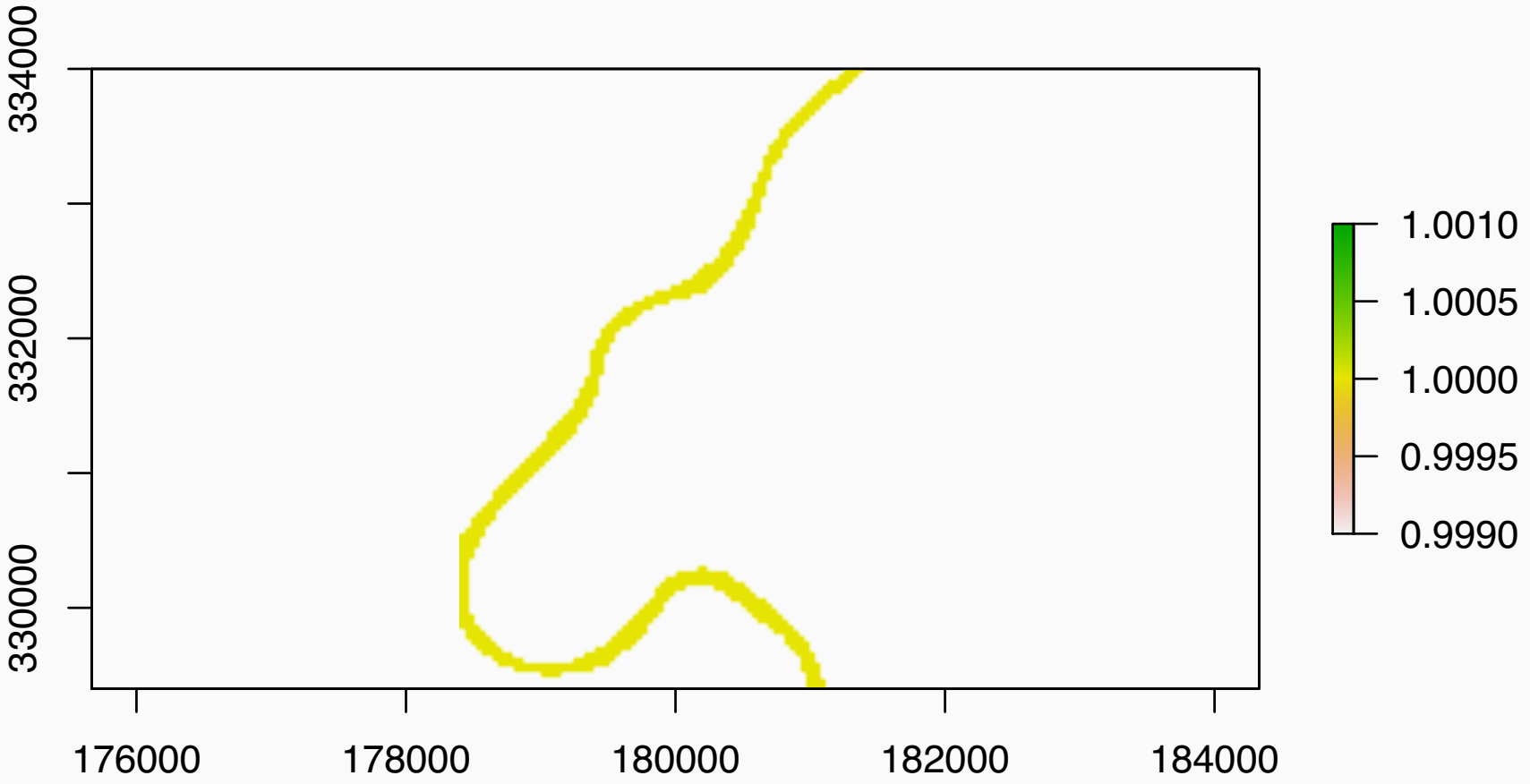


```
meuse_rast
## class       : RasterLayer
## dimensions  : 115, 80, 9200  (nrow, ncol, ncell)
## resolution  : 40, 40  (x, y)
## extent      : 178400, 181600, 329400, 334000  (xmin, xmax, ymin, ymax)
## coord. ref. : +init=epsg:28992 +towgs84=565.237,50.0087,465.658,-0.406857
## data source : /usr/local/lib/R/3.5/site-library/raster/external/test.grd
## names       : test
## values      : 128.434, 1805.78  (min, max)

meuse_rast_ll
## class       : RasterLayer
## dimensions  : 131, 91, 11921  (nrow, ncol, ncell)
## resolution  : 0.000569, 0.00036  (x, y)
## extent      : 5.717362, 5.769141, 50.95089, 50.99805  (xmin, xmax, ymin,
## coord. ref. : +proj=longlat +datum=NAD27 +no_defs +ellps=clrk66 +nadgrids
## data source : in memory
## names       : test
## values      : 135.647, 1693.578  (min, max)
```

Simple Features ⟷ Rasters

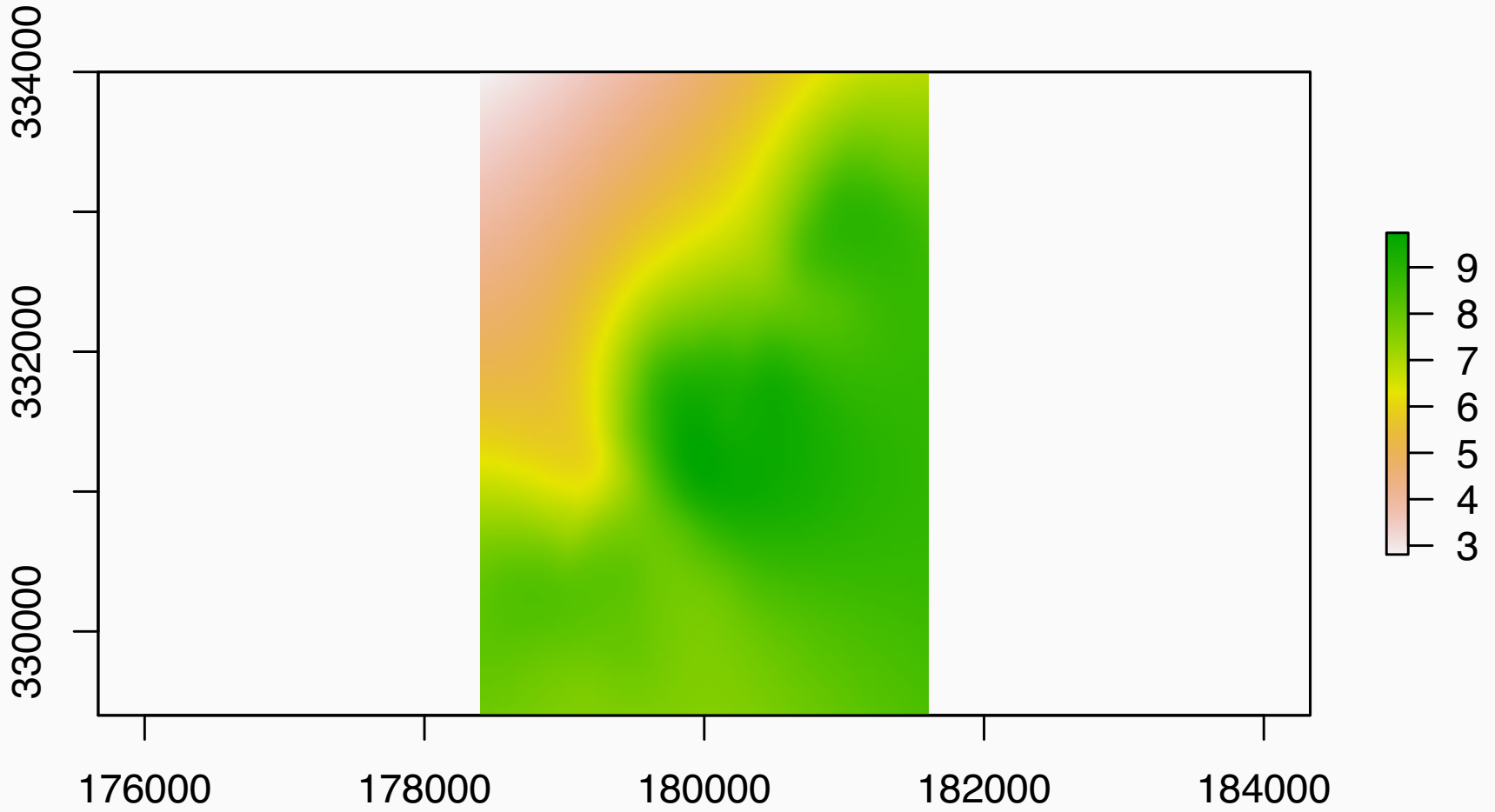
```
meuse_riv_rast = rasterize(meuse_riv, meuse_rast)
## Error in (function (classes, fdef, mtable) : unable to find an inherited method for

meuse_riv_rast = rasterize(as(meuse_riv, "Spatial"), meuse_rast)
plot(meuse_riv_rast)
```

sf → sp



```
head(meuse)
## Simple feature collection with 6 features and 12 fields
## geometry type:  POINT
## dimension:      XY
## bbox:           xmin: 181025 ymin: 333260 xmax: 181390 ymax: 333611
## epsg (SRID):    28992
## proj4string:    +proj=sterea +lat_0=52.15616055555555 +lon_0=5.38763888888889 +k=0.
##   cadmium copper lead zinc  elev       dist   om ffreq soil lime landuse
## 1    11.7     85  299 1022 7.909 0.00135803 13.6     1    1    1      Ah
## 2     8.6     81  277 1141 6.983 0.01222430 14.0     1    1    1      Ah
## 3     6.5     68  199  640 7.800 0.10302900 13.0     1    1    1      Ah
## 4     2.6     81  116  257 7.655 0.19009400  8.0     1    2    0      Ga
## 5     2.8     48  117  269 7.480 0.27709000  8.7     1    2    0      Ah
## 6     3.0     61  137  281 7.791 0.36406700  7.8     1    2    0      Ga
##   dist.m              geometry
## 1     50 POINT (181072 333611)
## 2     30 POINT (181025 333558)
## 3    150 POINT (181165 333537)
## 4    270 POINT (181298 333484)
## 5    380 POINT (181307 333330)
## 6    470 POINT (181390 333260)

head(st_coordinates(meuse))
##        X      Y
## 1 181072 333611
## 2 181025 333558
## 3 181165 333537
## 4 181298 333484
```

```r
library(fields)

tps = Tps(x = st_coordinates(meuse), Y=meuse$elev)
pred_grid = xyFromCell(meuse_rast, seq_along(meuse_rast))

meuse_elev_pred = meuse_rast
meuse_elev_pred[] = predict(tps, pred_grid)

plot(meuse_elev_pred)
```



ggplot and rasters

```
p = rasterToPolygons(meuse_elev_pred) %>% st_as_sf()

(ggplot() + geom_sf(data=meuse, aes(color=elev), size=1)) +
(ggplot() + geom_sf(data=p, aes(fill=test), color=NA))
```