Landscape level analysis of QL2 LiDAR data by species for avian nesting habitat in eastern North Carolina

Doug Newcomb USFWS, Vaclav Petras NCSU

FIC 08/25/2016

LiDAR in NC (2001 – 2005)

- 3 Phases
- 5m – 1m point spacing (3m average USGS Quality Level 4)
- 25.5 billion points

LiDAR in NC (2014 – 2017)

- 5 Phases (Phases 1-2 2014, 3 2015)
- Phases 1-3: 2 pts/m spacing (USGS Quality Level 2)
- First 2 phases – 40 counties ~ **240 billion points**
- Phase 4-5 : planned 8 pts/m

Landscape Level Forest Structure Analysis

- Flatten data set
- Pick bin size
- Perform multiple statistical analysis on point clouds of same size bins

Software Tools

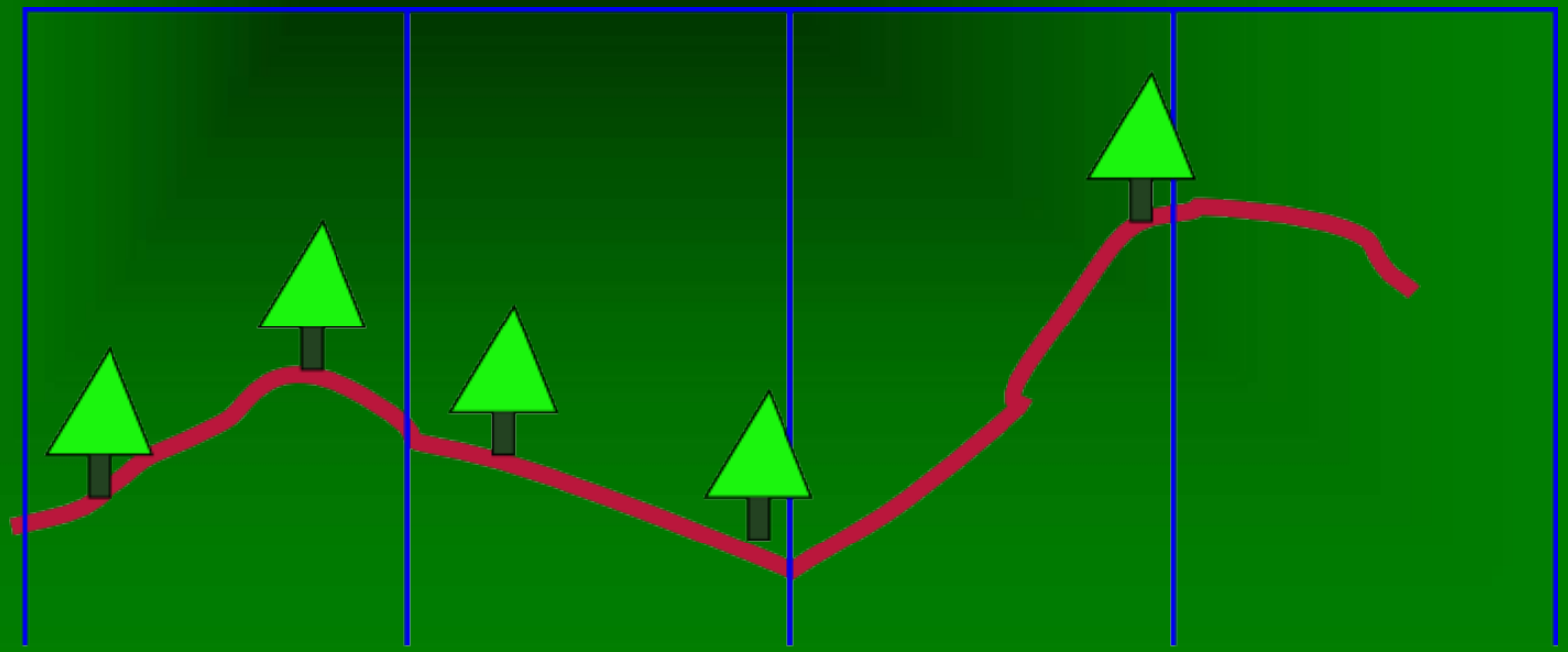
- Lastools (version)
- Gdal (1.11.1)
- GRASS GIS (7.1/7.2svn)
- QGIS (2.14)
- R 3.2.2
- Ubuntu Linux 14.04

Statistical Analysis of point cloud: Computer

- Dell T7600 workstation, 32 GB RAM , USB 3.0 Hub with 2 x 4TB hard drives (one for each phase of the 2014 LAS files) running Ubuntu 14.0.4
- GRASS 7.1 compiled from source.

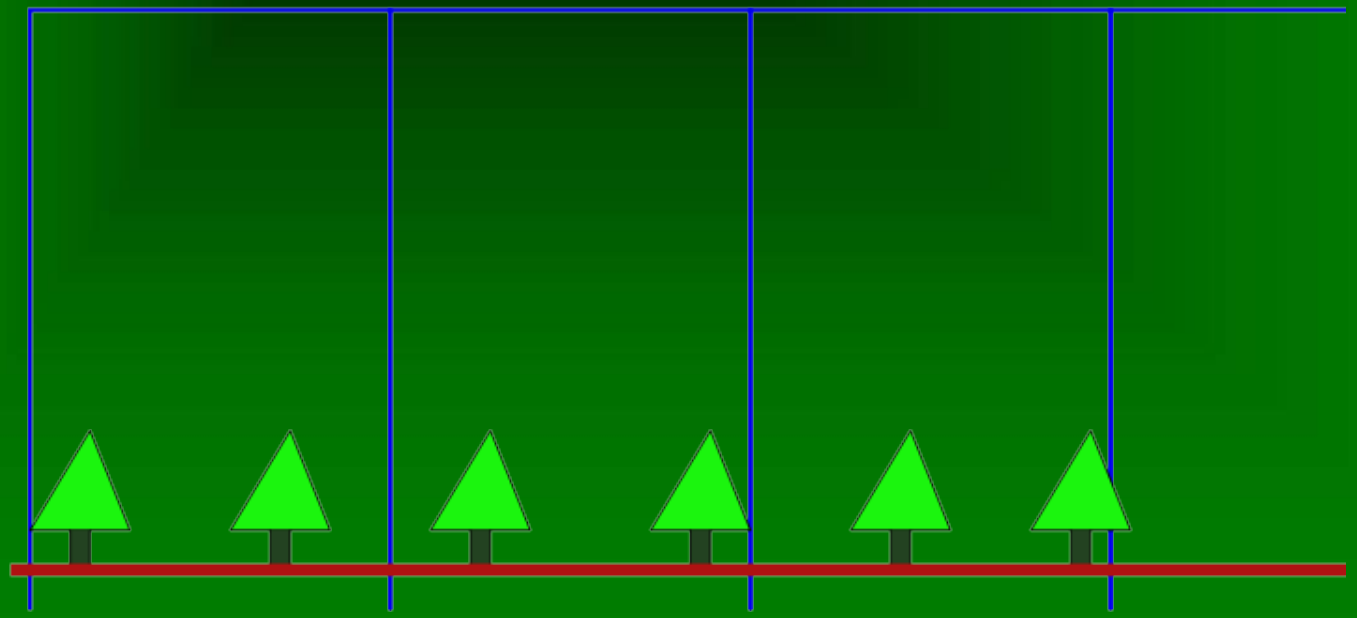
Flatten Data

Elevation changes within the grid cells can make the "canopy height" artificially high and alter other within bin statistical analysis

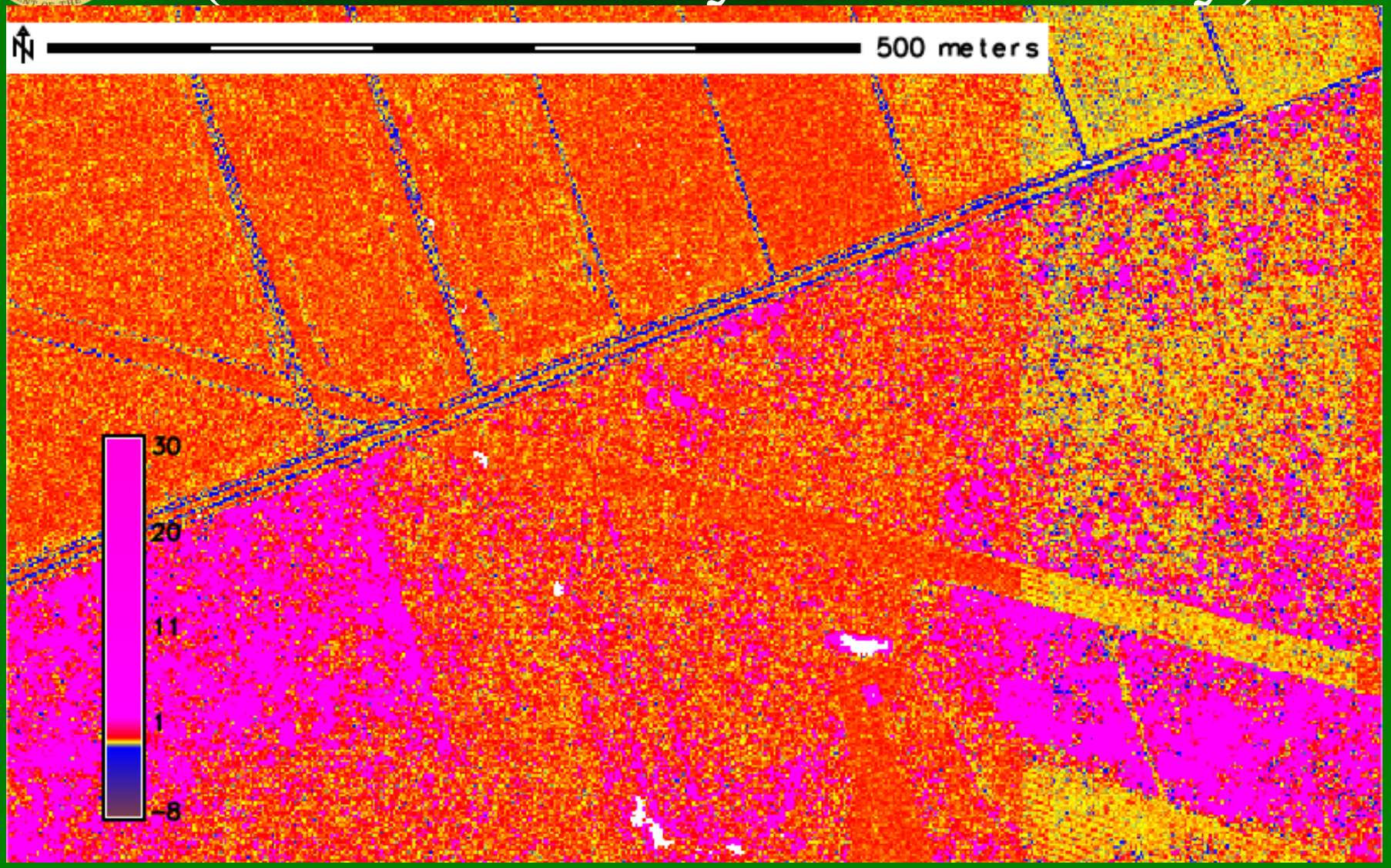


Flatten Data

Converting the individual point Z values to height above ground allows for more consistant analysis – GRASS GIS r.in.lidar



Min 5ft relative to DEM (Bladen county Carolina bay)



Picking bin sizes: 60ft

60ft was used in analysis of 2001 – 2005 data to allow for 20 -25 points in forested areas of minimum lidar density and pick a large enough bin size to cover entire trees.

Cell size was replicated with 2014 data set.

Picking bin sizes: 20ft

20ft was used in analysis of 2014 data to allow for 20 -25 points in forested areas of minimum lidar density and increase chances of getting a ground return. Some dense veg. may not have ground returns

Statistical Analysis of point cloud: Lastools

- Use Lasmerge command to aggregate las tiles in each county into files of 4.1 billion points per file (1-3 files per county)
- Just under the 4.2 billion point limit for LAS 1.2 format (used by liblas)

Statistical Analysis of point cloud: Lastools

- Example:1) Compress the the las files to laz format using lastools ~/lastools/lastools/bin/laszip -i *.las -odir /media/newcomb/Public1/lidar/Craven/las

  2) Aggregate the laz files per county to laz files of 4.1 billion points each using lastools. ~/lastools/lastools/bin/lasmerge -i *.laz -o ../Craven2014_ground1.laz -split 4100000000

  3) A list of the files per county was created as a text file ls /media/newcomb/Public1/lidar/Craven/*laz |cat > lasfiles.txt

Statistical Analysis of point cloud: GDAL

- Gdalbuildvrt command to create virtual seamless 5ft DEM files from tiles in county , then
- Gdal_translate to convert the virtual seamless files to geotiff images with proper projection labeling

Statistical Analysis of point cloud: GDAL

- Example: gdalbuildvrt -allow_projection_difference craven.vrt DEM05/*.img

(allow projection differences required because tiles in same county were labeled differently for projection)

- gdal_translate -a_srs "/home/newcomb/lidar_2014_project/BL_37_20962801_20141231.prj" -co "COMPRESS=DEFLATE" -co "PREDICTOR=3" -co "TILED=YES" craven.vrt /gisdata/grass6/temp2014dems/cravendem05.tif

Statistical Analysis of point cloud: GRASS

- R.external to link to each county 5ft resolution geotiff
- Example: r.external input=/gisdata/temp2014dems/cravendem05.tif output=cravendem05

Statistical Analysis of point cloud: GRASS

- G.region to set the computational region to the extent of the 5 ft DEM for each county set the raster size to either 20 or 60 feet, and set the raster cell footprints to match on overall data set.

Statistical Analysis of point cloud: GRASS

- Example: g.region raster=cravendem05 res=60 align=nc_60ft_blank@PERMANENT

Statistical Analysis of point cloud: GRASS

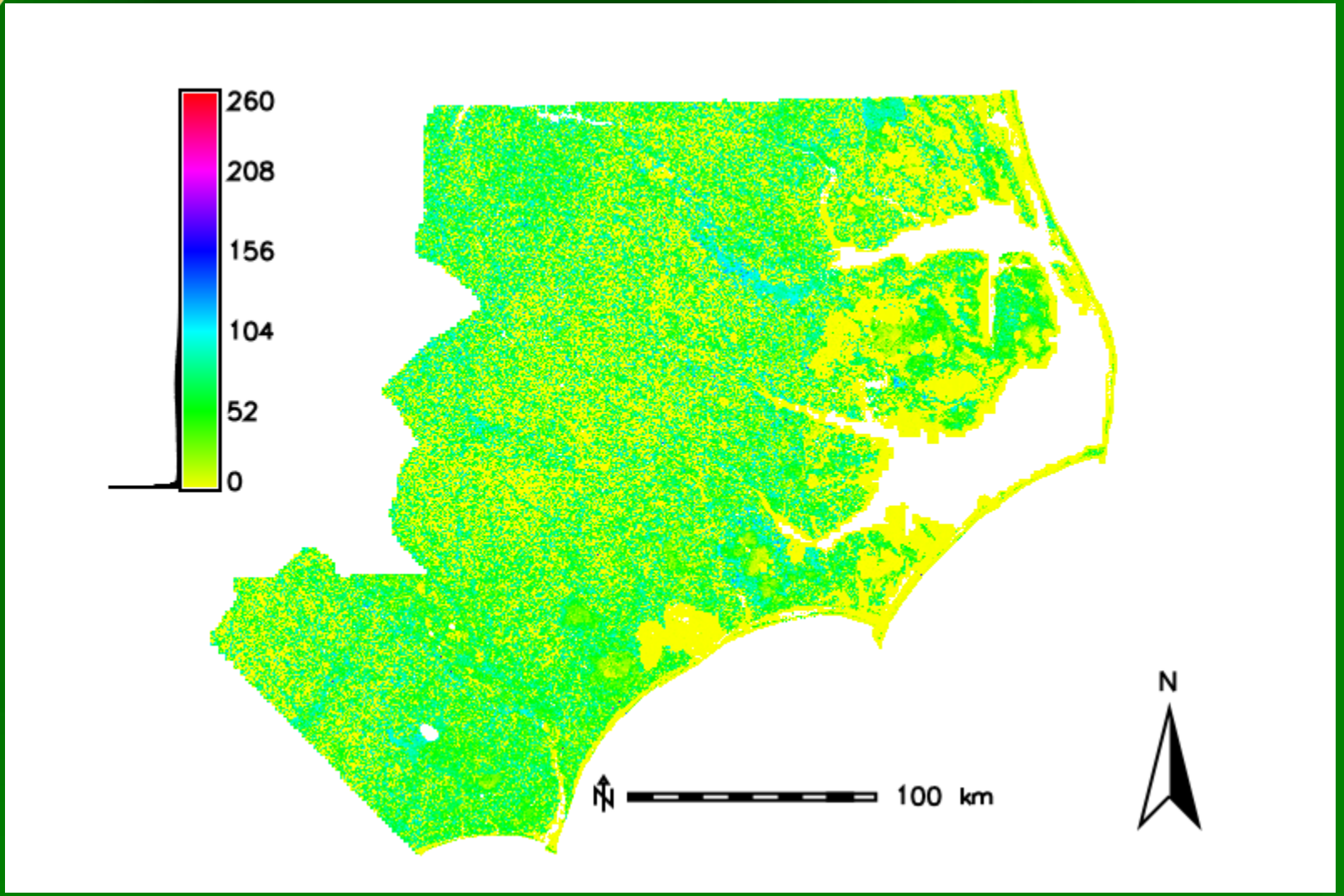
- R.in.lidar – take list of aggregated laz files for each county, set the base raster to the 5ft DEM for the county to normalize to height above ground, perform range (canopy height), variance, skewness, point count within vertical limits

Statistical Analysis of point cloud: GRASS

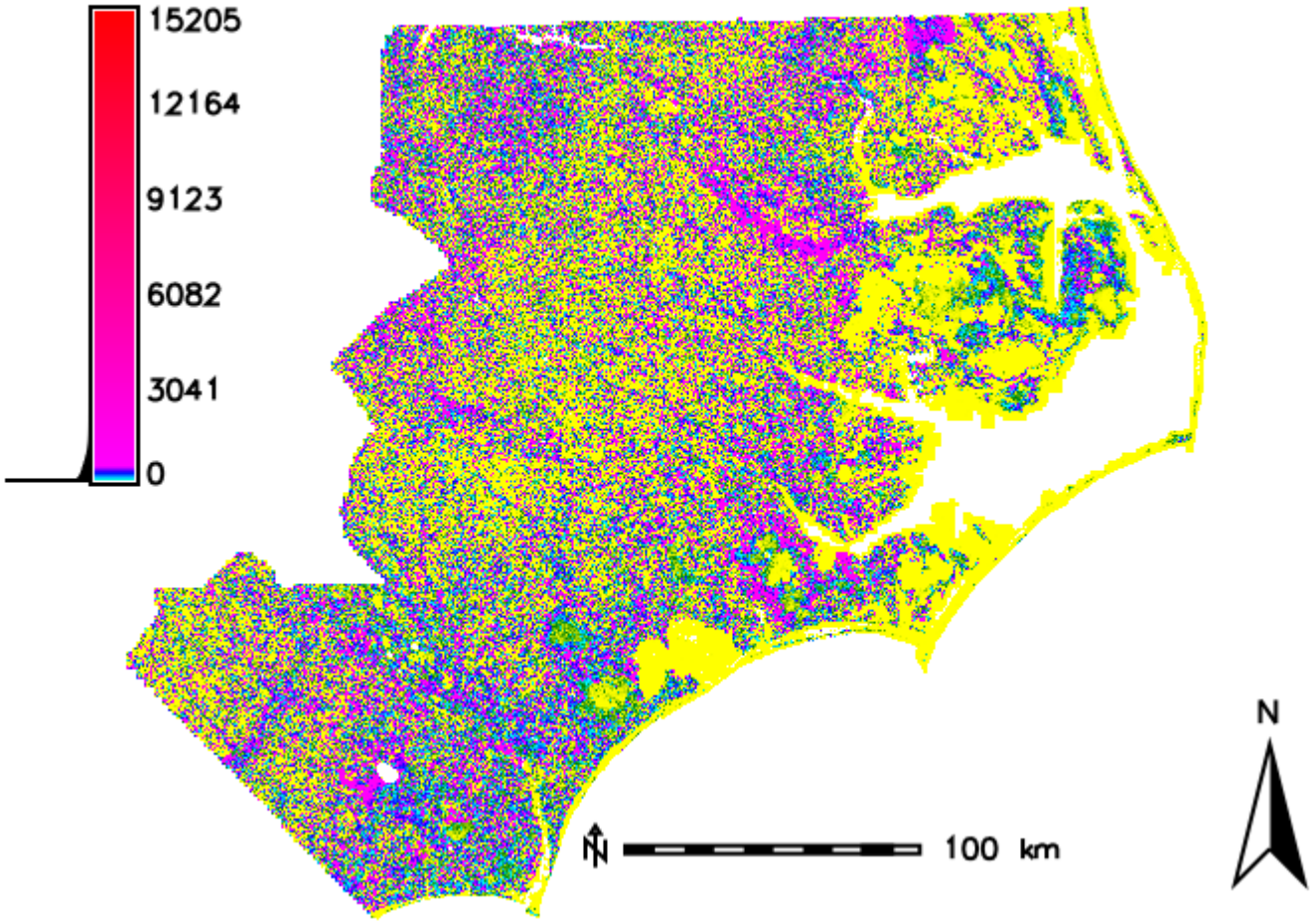
- Example: r.in.lidar --overwrite -o -d output="nc_var_craven" file="/media/user/Public1/lidar/Craven/lasfiles.txt" method="variance" type="FCELL" base_raster="cravendem05" zrange=-10,250 zscale=1.0 percent=100 class_filter=1,2,3,4,5,6,9,10,11,13,17,18,19,20

- (grab all points except points labeled noise, exclude high noise not captured as noise)

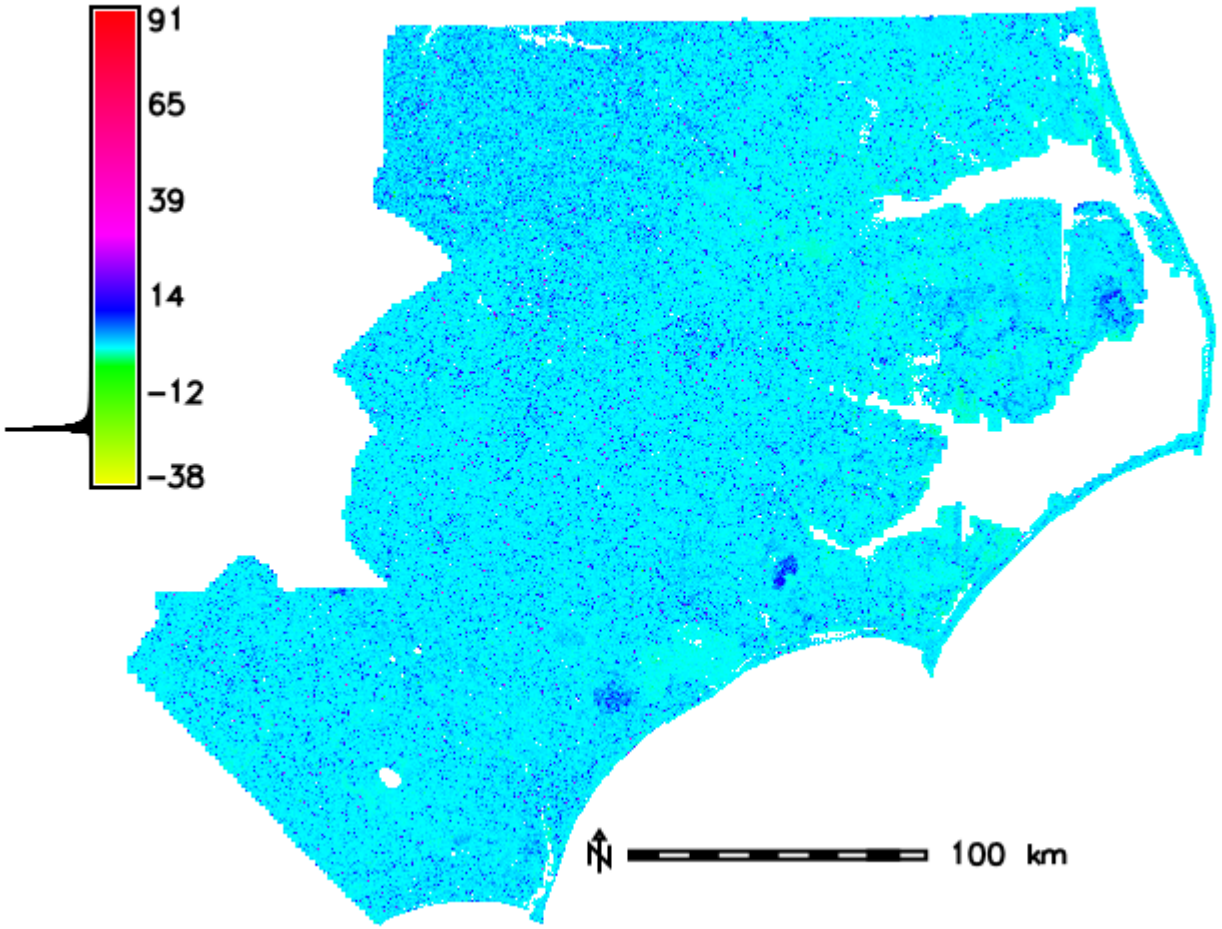
40 County 60ft Canopy Height



40 County 60ft Z Variance



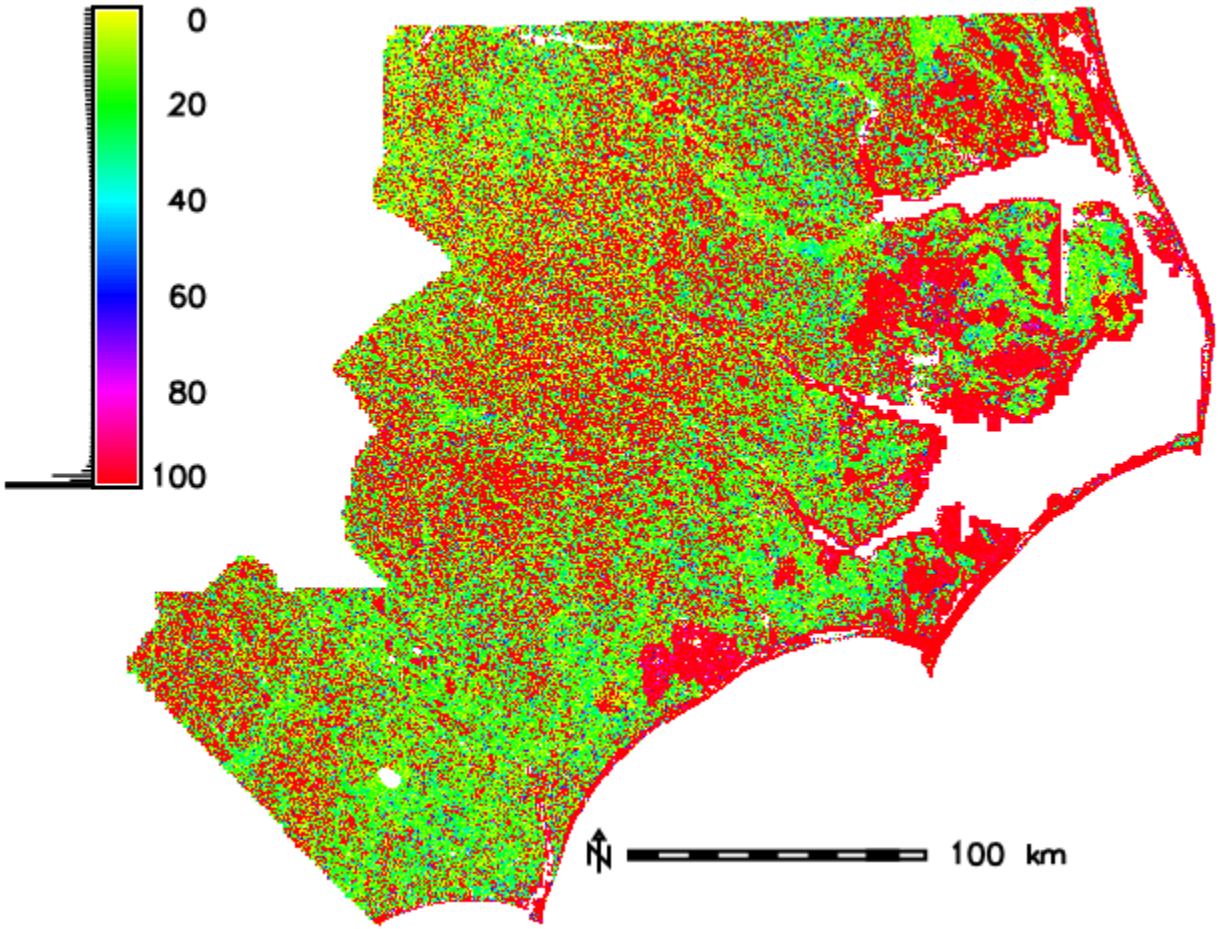
40 County 60ft Z Skewness



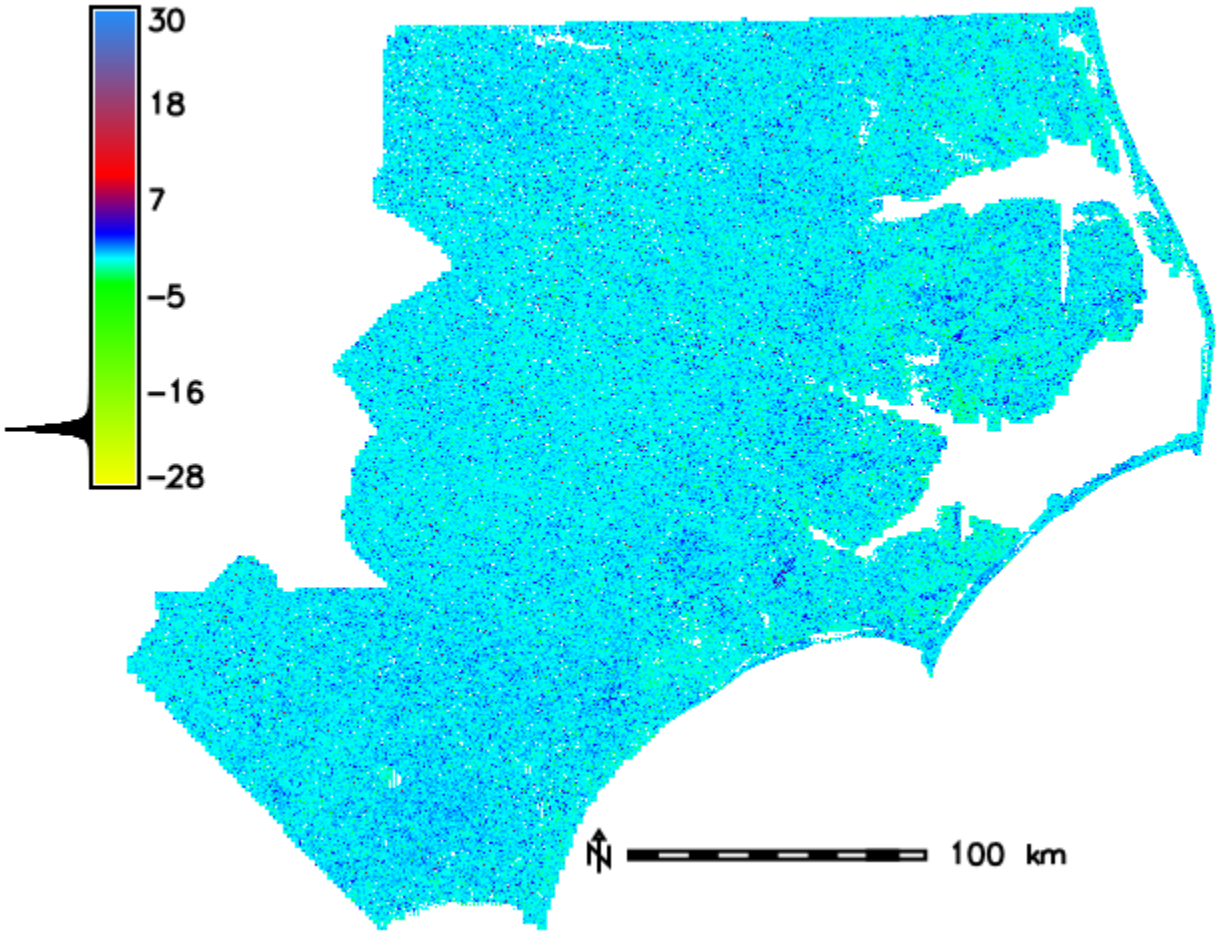
Looking top down:

- Use r.in lidar to create 20ft resolution DSM from point cloud (method = max)
- Use resulting DSM as base raster layer for r.in.lidar to look at point counts and skewness within 10 ft of the top of canopy

40 County 20ft top ten ft of canopy point count percentage



40 County 20ft top ten ft of canopyZ Skewness



Statistical Analysis of point cloud: QGIS

- Buffer point nesting data from NC Natural Heritage Program and to 25m (based on earlier work, Newcomb, 2013)

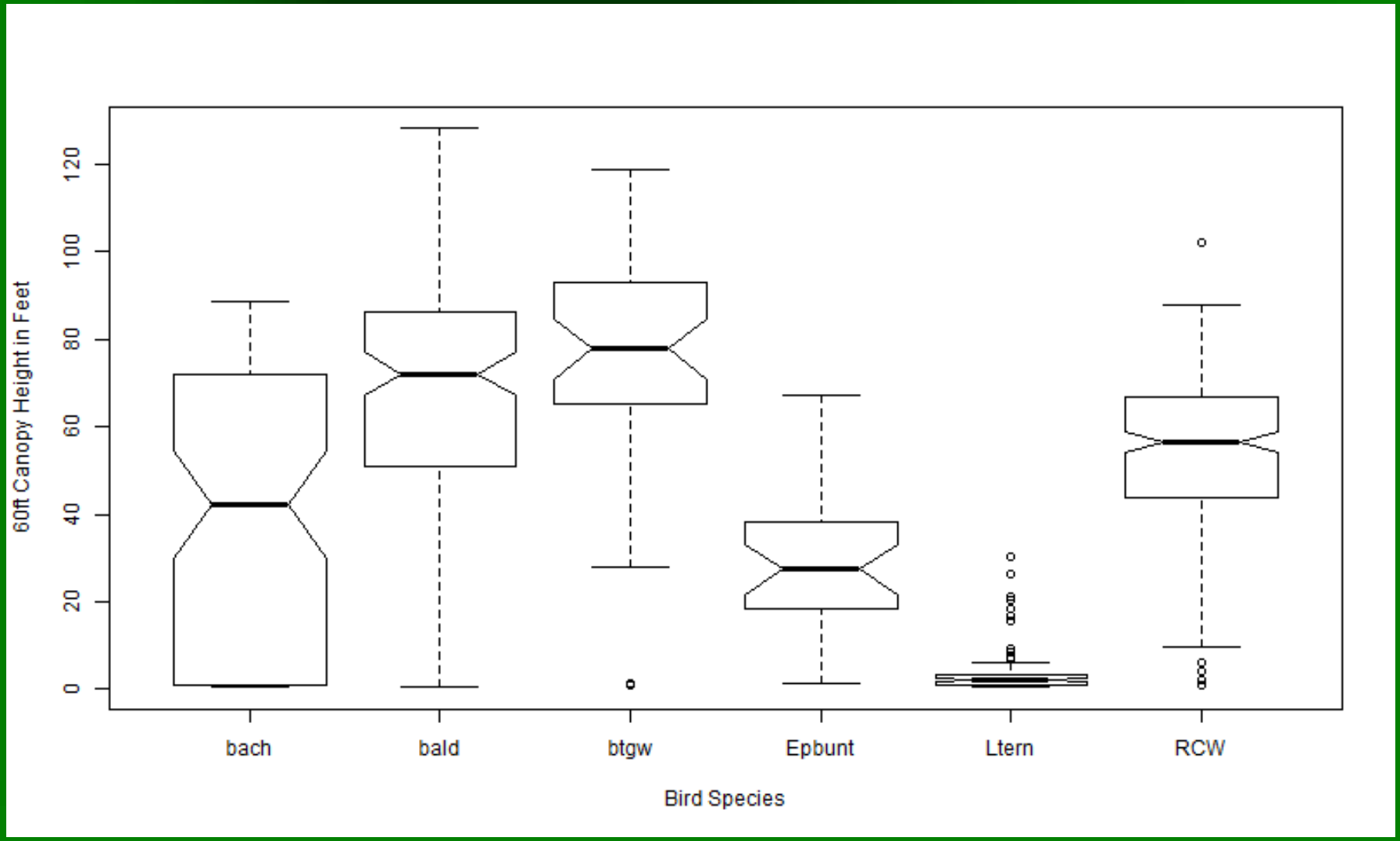
Statistical Analysis of point cloud: GRASS

- V.in.ogr - Import Buffered point nesting data. https://grass.osgeo.org/grass71/manuals/v.in.ogr.html
- V.rast.stats – perform mean and standard deviation analysis of raster values in 25m buffer, https://grass.osgeo.org/grass71/manuals/v.rast.stats.html
- V.db.select – select and export results to text file, https://grass.osgeo.org/grass71/manuals/v.db.select.html

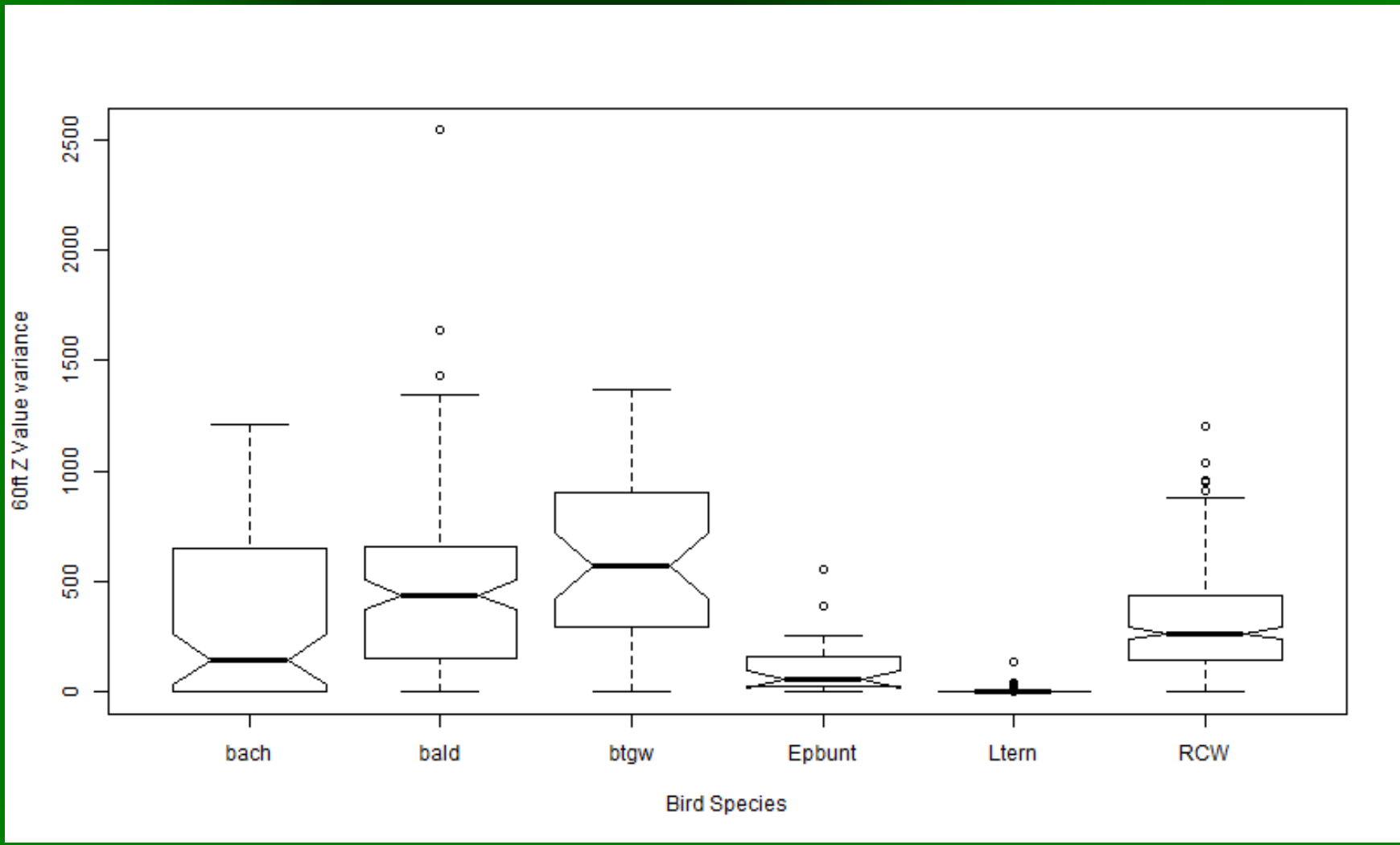
Intersect nest locations of avian species with different habitat preferences

- Avian Species:
- Bachman's Sparrow (*Peucaea aestivalis*) - bach
- Bald Eagle (*Haliaeetus leucocephalus*) – bald
- Black-throated Green Warbler - Coastal Plain population (*Setophaga virens waynei*) - btgw
- Least Tern (*Sternula antillarum*) - Ltern
- Eastern Painted Bunting (Passerina ciris ciris) - Epbunt
- Red-cockaded Woodpecker (Picoides borealis) - rcw

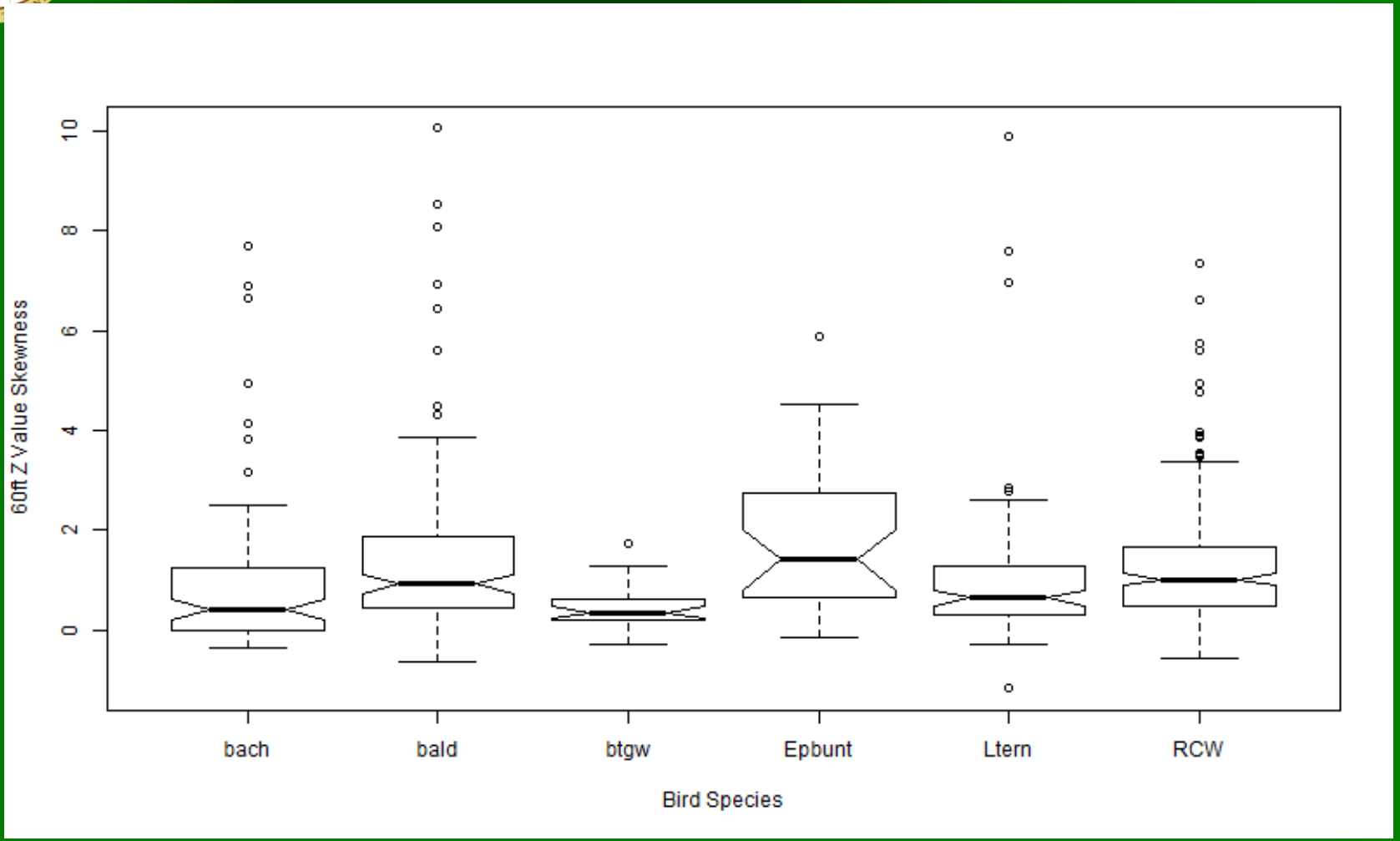
40 County 60ft Canopy Height



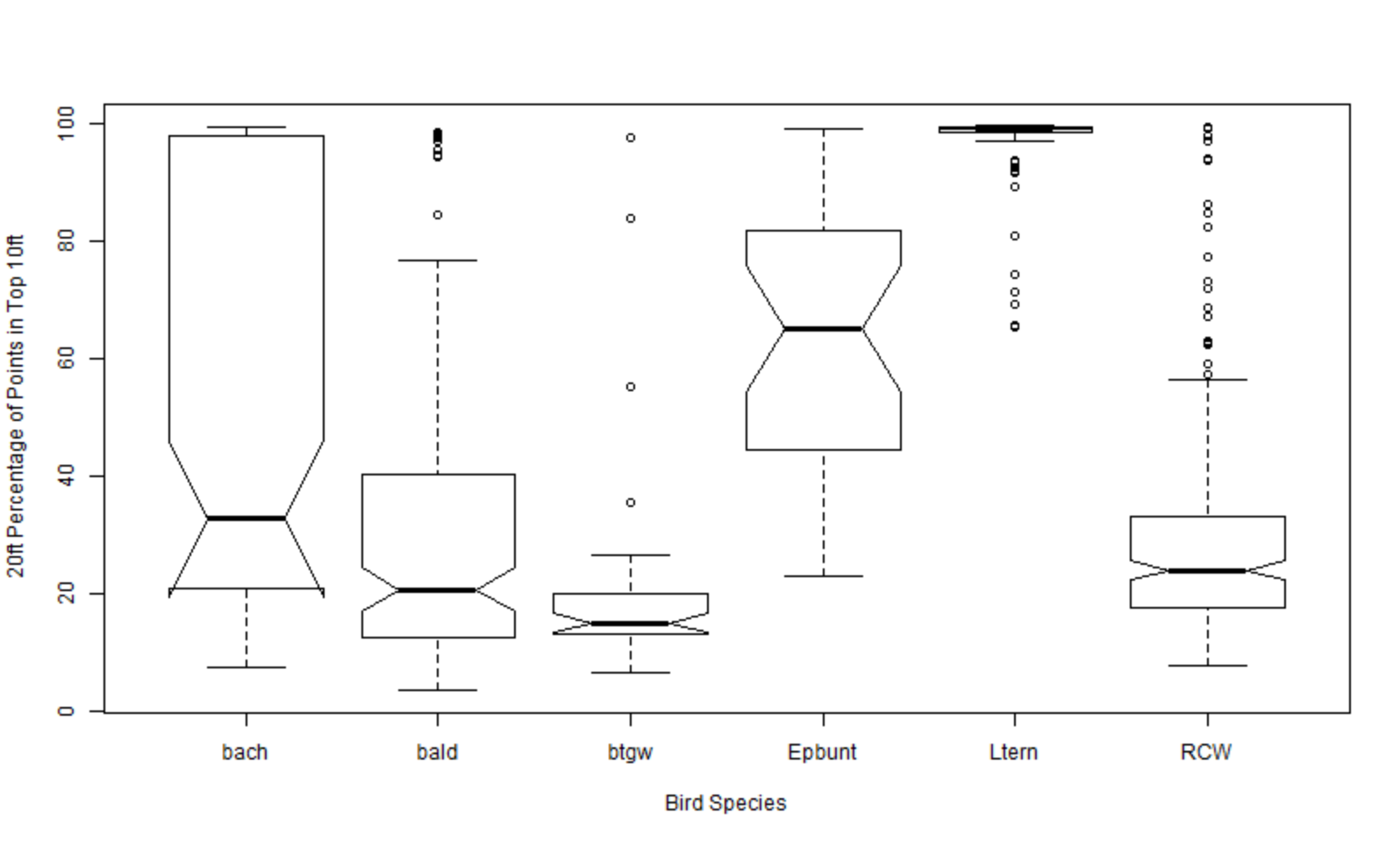
40 County 60ft Z Variance



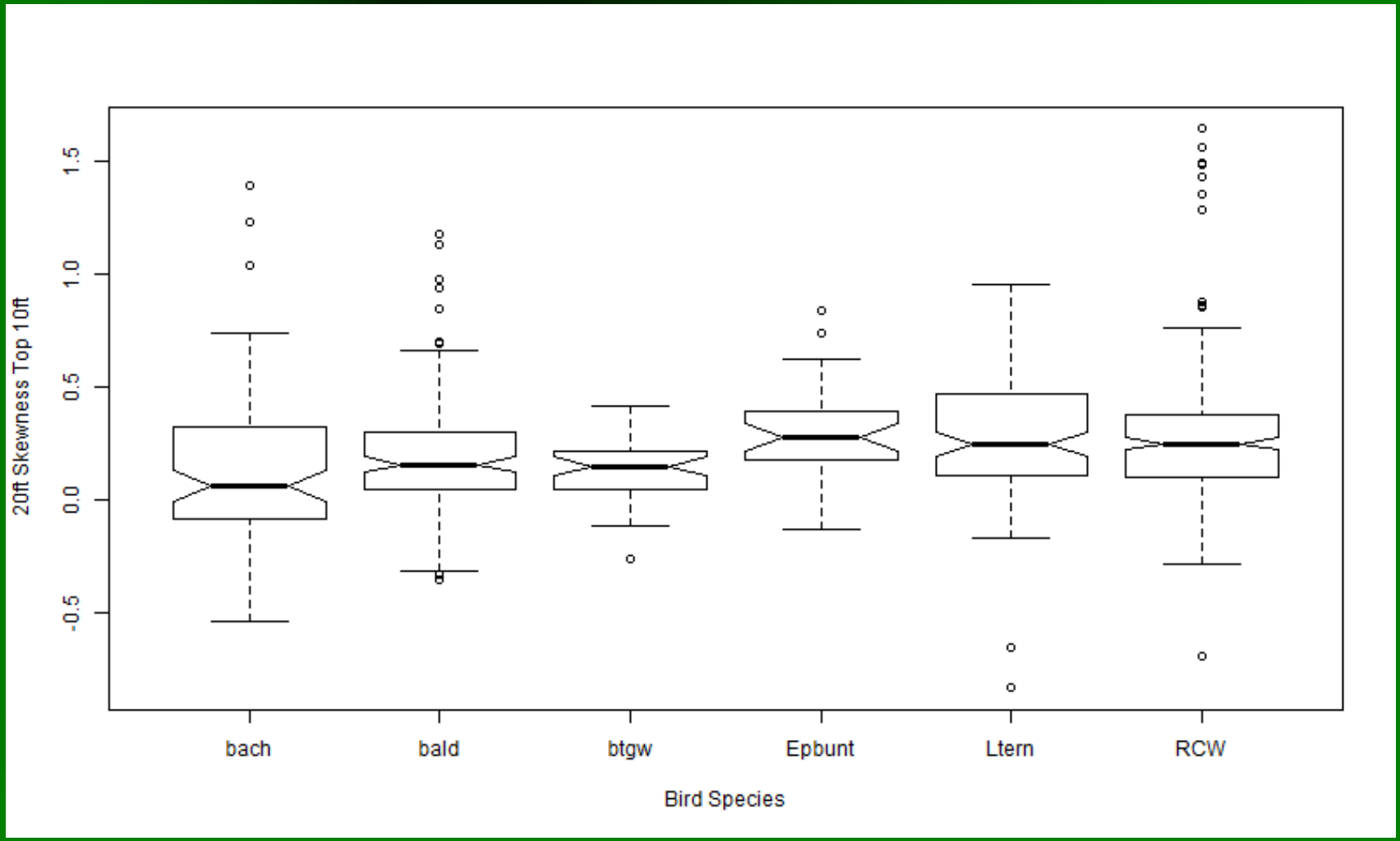
40 County 60ft Z Skewness



40 County 20ft top ten ft of canopy point count percentage



40 County 20ft resolution top ten ft of canopy Z Skewness



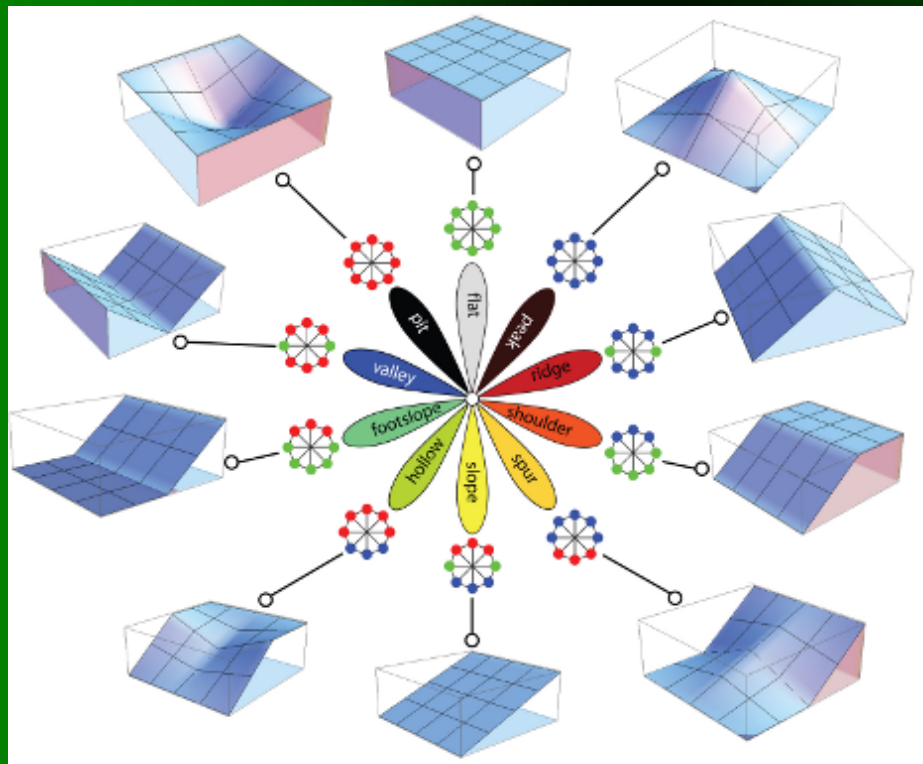
Top of Canopy – treat it as a terrain surface?

- Use r.in.lidar to create a 5ft top of canopy layer (method=max)
- R.geomorphon – GRASS plugin for line of sight terrain analysis.

Top of Canopy – treat it as a terrain surface?

- R.geomorphon – http://grass.osgeo.org/grass70/manuals/addons/r.geomorphon.html
- 10 common terrain classes or more complex classification (498 classes).

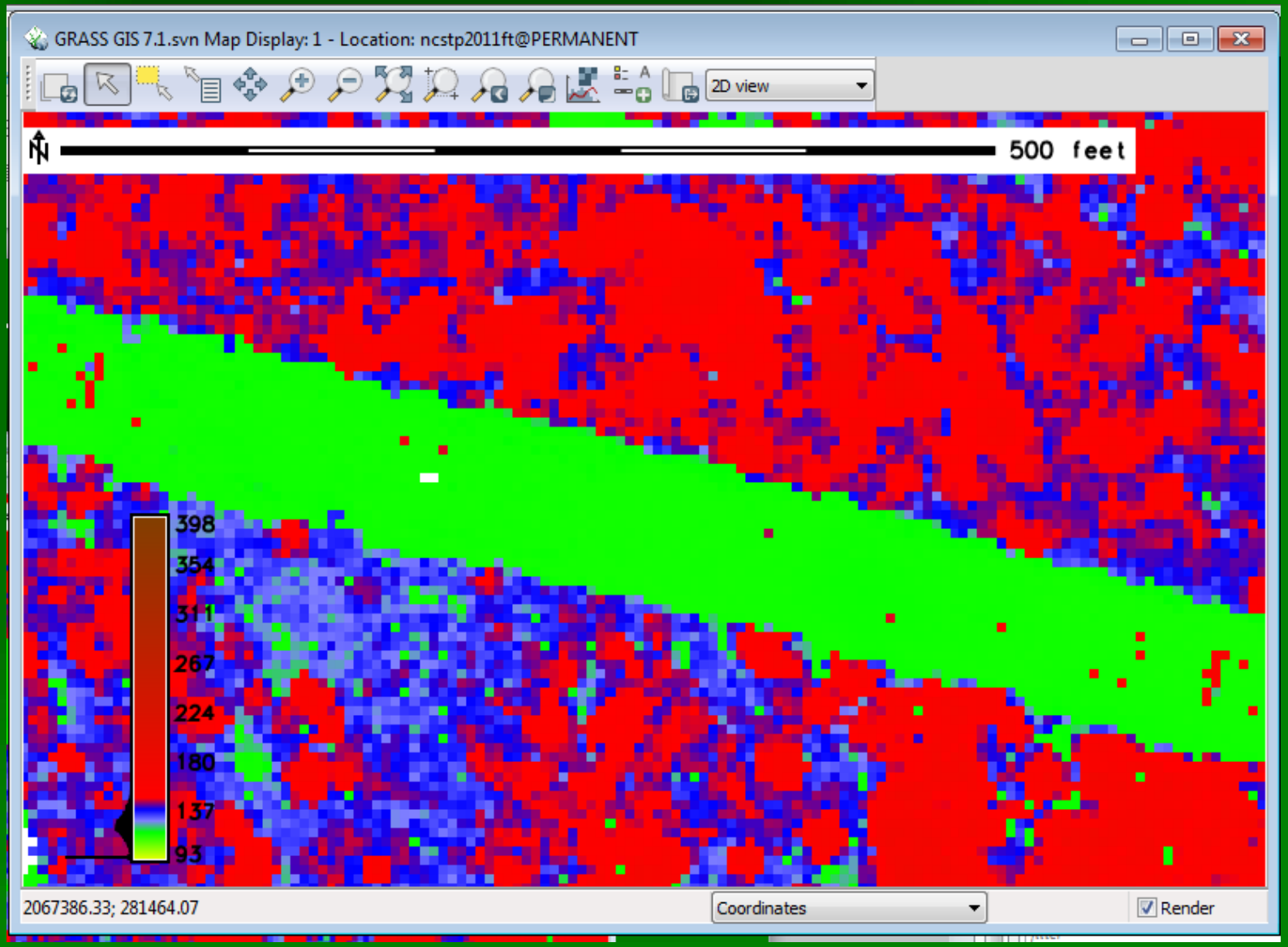
Top of Canopy – treat it as a terrain surface?



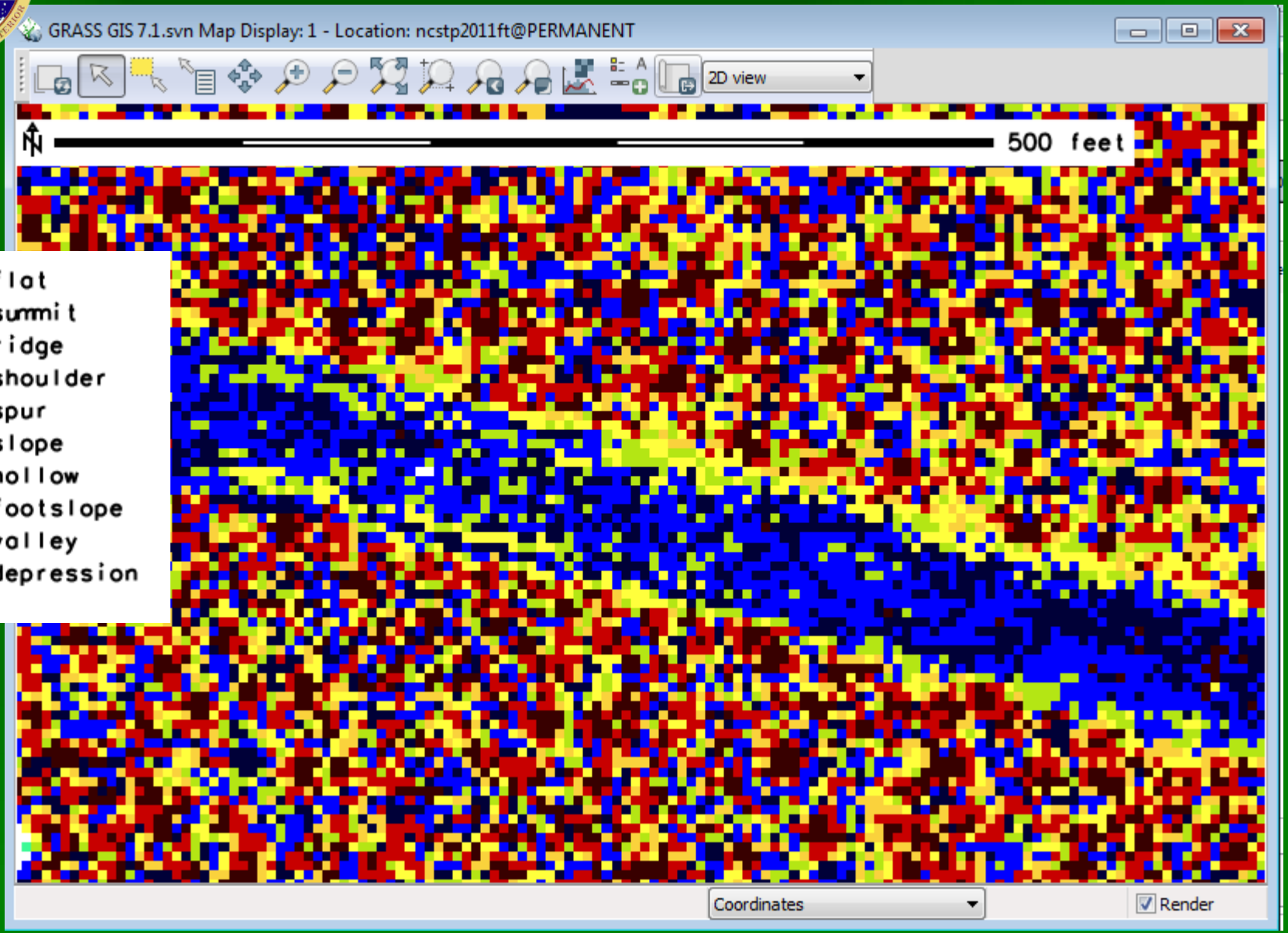
_+	0	1	2	3	4	5	6	7	8
0	FL	FL	FL	FS	FS	VL	VL	VL	PT
1	FL	FL	FS	FS	FS	VL	VL	VL	—
2	FL	SH	SL	SL	HL	HL	VL	—	—
3	SH	SH	SL	SL	SL	HL	—	—	—
4	SH	SH	SP	SL	SL	—	—	—	—
5	RI	RI	SP	SP	—	—	—	—	—
6	RI	RI	RI	—	—	—	—	—	—
7	RI	RI	—	—	—	—	—	—	—
8	PK	—	—	—	—	—	—	—	—

5ft resolution top of canopy

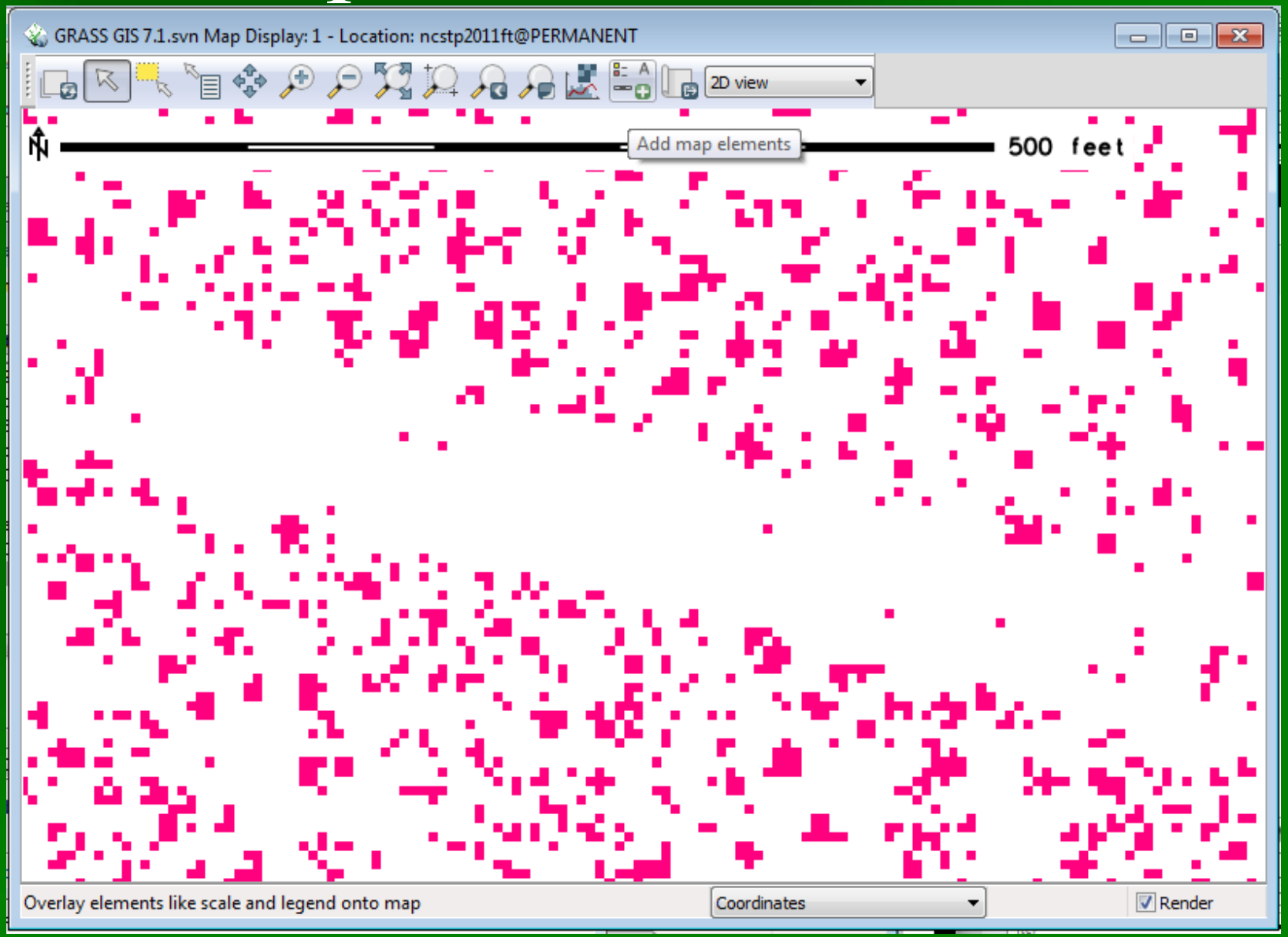
(Datum height, not canopy height)



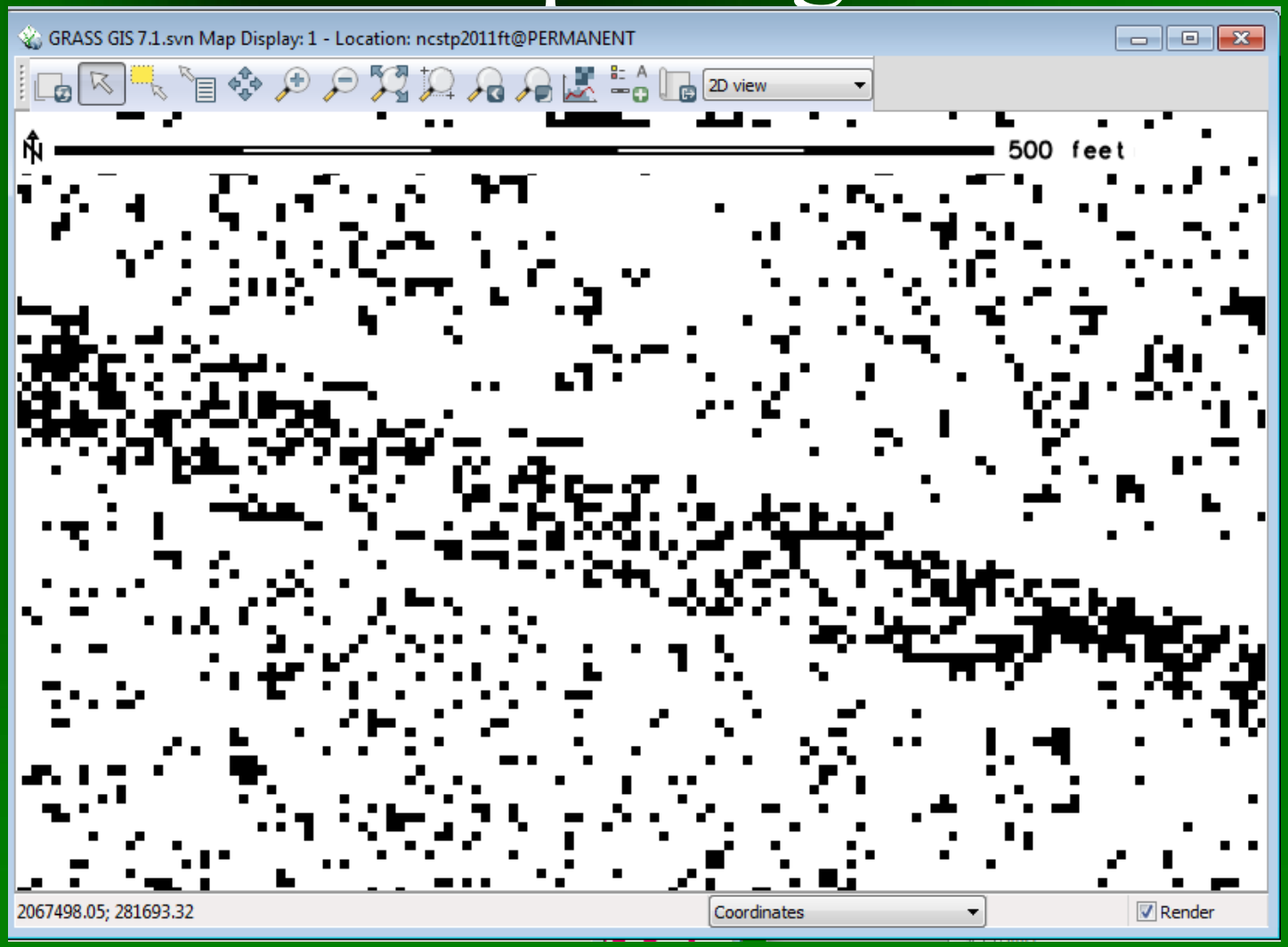
Top of canopy geomorphon



Treetops = summit class?



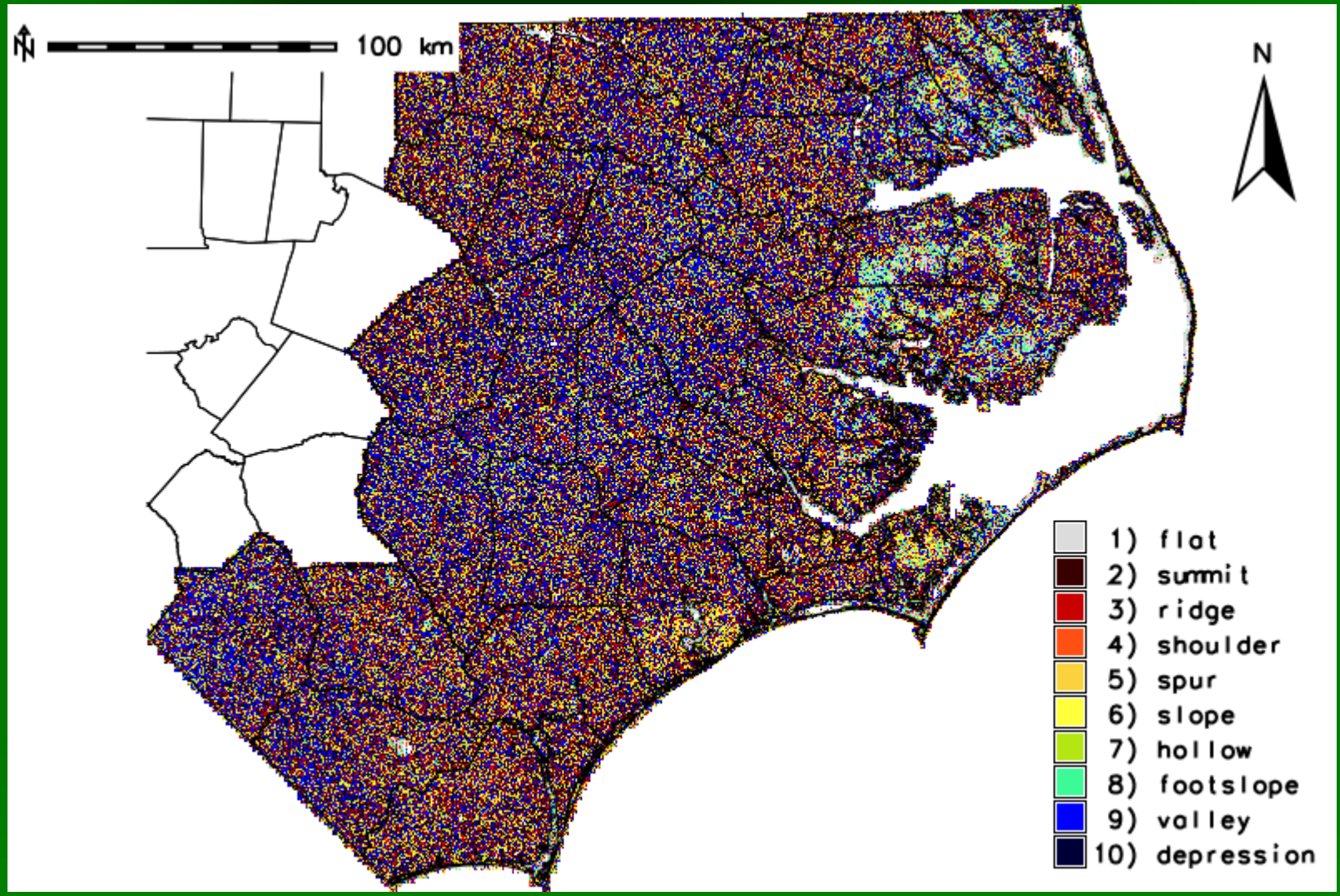
Top of canopy – depressions = openings?



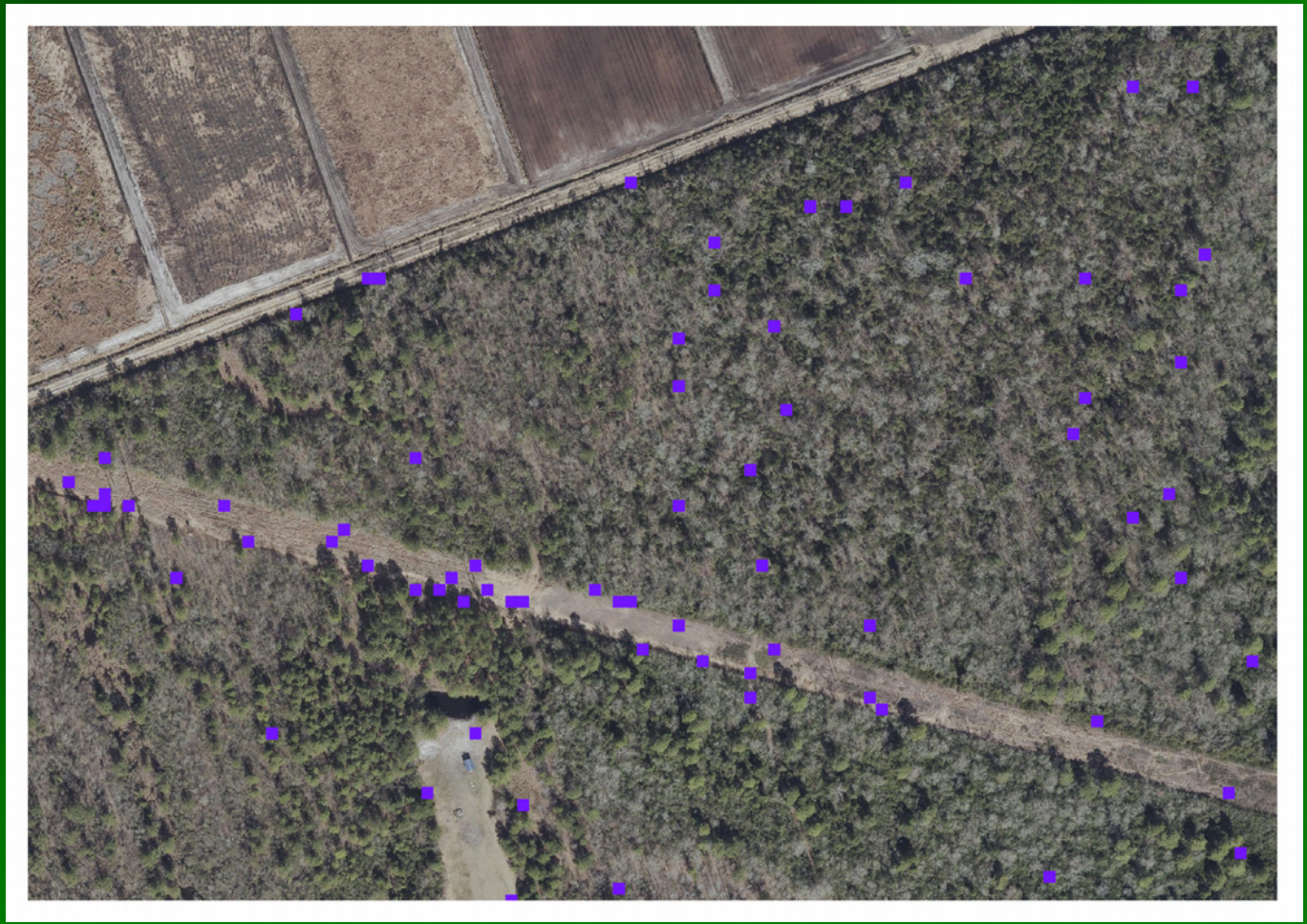
Top of canopy

Some filtering by canopy heights will be necessary, but terrain analysis could be a quick and easy way to help characterize vegetation structure with canopy peaks nad openings.

Top of canopy 20ft geomorphons for 40 county area.



Top 10ft of canopy has single point (blue) at 20ft resolution.



Possible standing dead tree locations? Need field work.

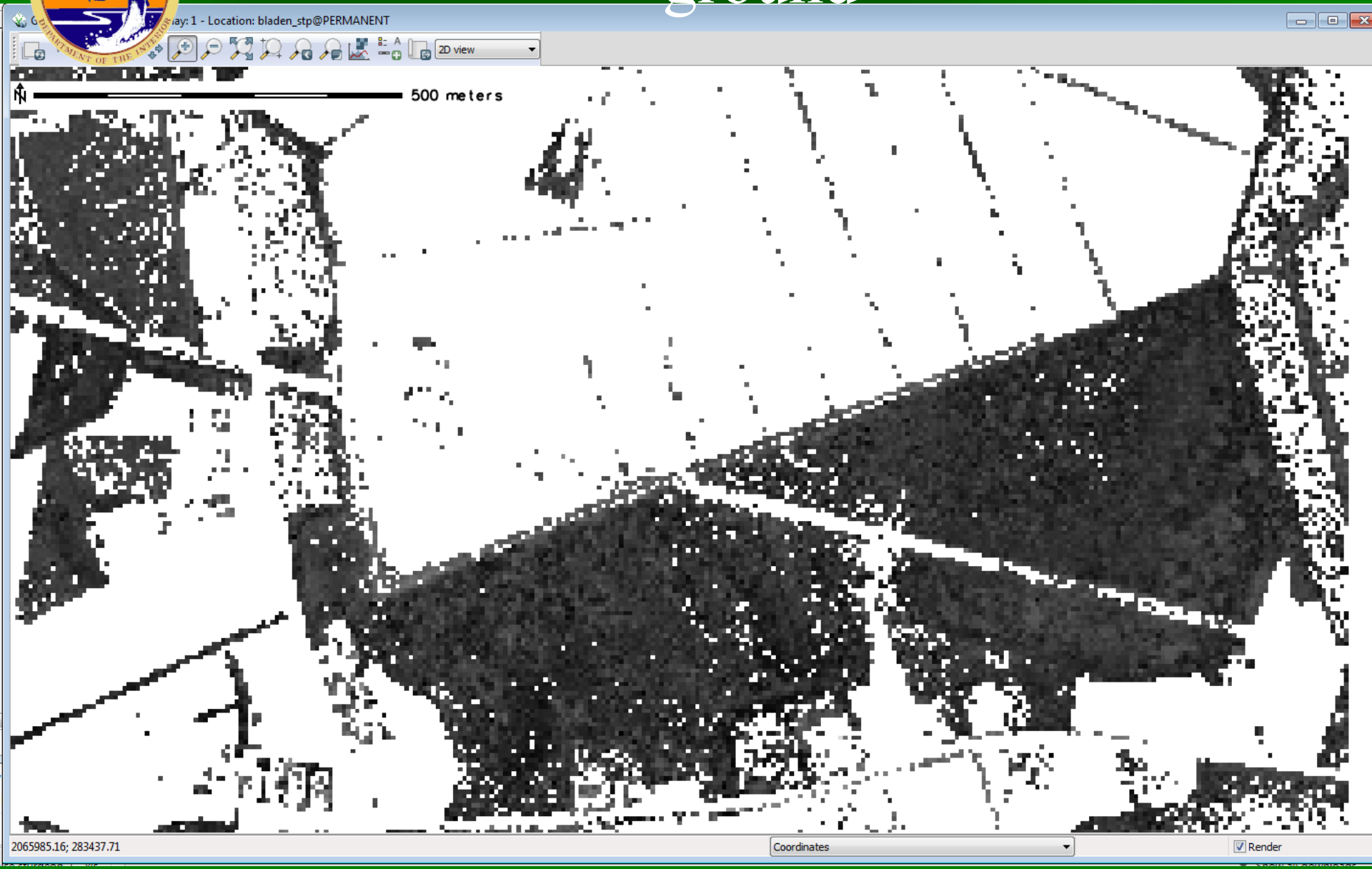
NEW Feature for upcoming GRASS 7.2

Statistical analysis of Lidar Intensities by height above ground with upper and lower bounds.

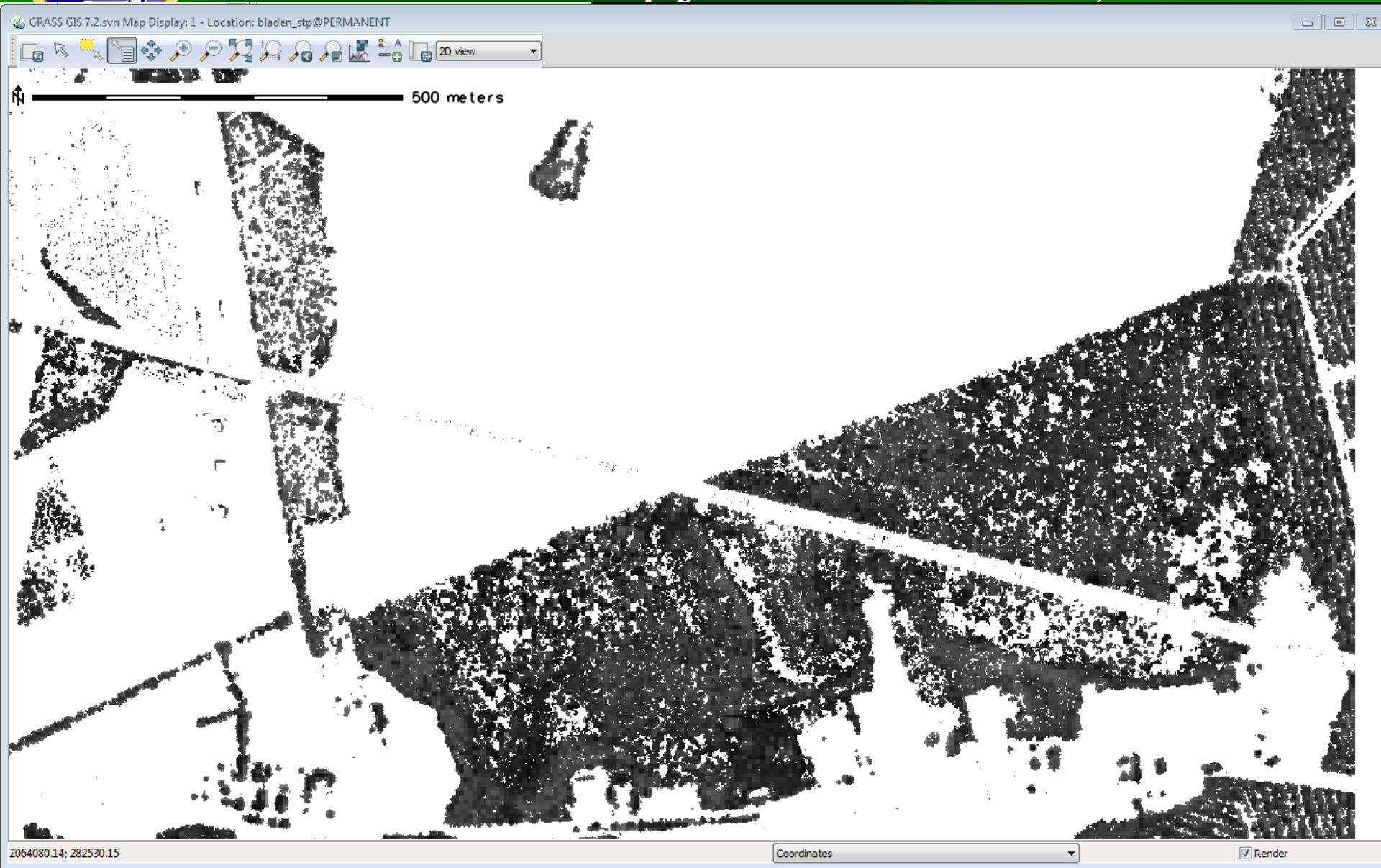
2013 6 inch ortho of Sample Area

Mean intensity 0 to 1 ft above ground

Mean intensity 3 to 5 ft above ground



Mean intensity top 10 ft of canopy (masked to canopy ht above 20ft)



Ongoing adjustments

- Performed LiDAR min point analysis relative to exiting 5ft DEM for 40 county area.
- Created new DEM data set where new value if min LiDAR value less than existing DEM, but keep old value if min LiDAR value is greater than existing DEM.

Phase 3 (Eastern Piedmont) Lidar processing underway.

Acknowledgements:

- North Carolina Natural Heritage Program
- GRASS GIS team

Questions?