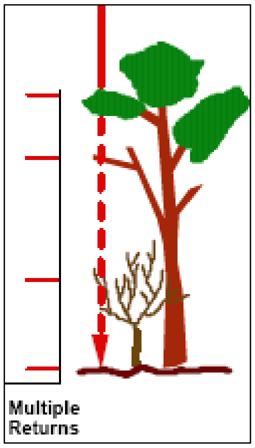
LIDAR REMOTE SENSING

LIDAR stands for Light Detection And Ranging and is also called laser altimetry. A laser pulse is generated in an airplane targeted towards the ground and the elevation is estimated based on the return time of the laser pulse. Laser transmitters are used that fire thousands of pulses per second. The laser detector then can record the time (and knowing the speed of light, distance) for first return, second return, third return, and last return for each sample location below the plane.

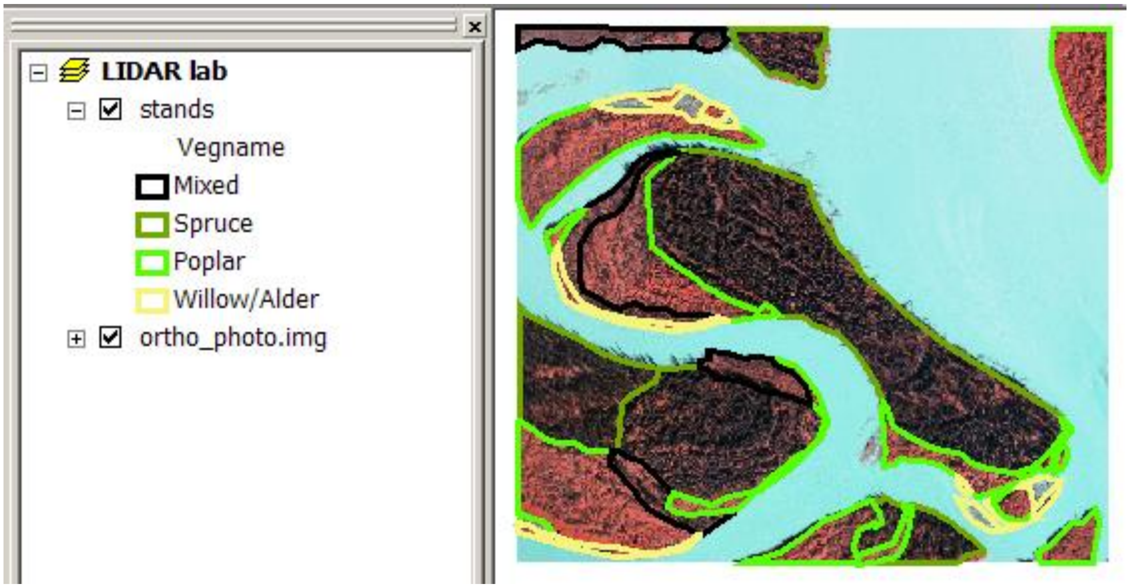


The distance measurements are converted to map coordinates and elevations for each laser pulse by combining the distance data with information on the position of the airplane at the time the laser pulse was fired. The airplane position along its entire flight path is determined using differential GPS. By filtering the last return, a raster theme representing “bare earth” elevations is produced.

What are the estimated heights of the following stands or polygons?

What are the estimates of percent canopy closure for each stand?

Where are all the old growth white spruce trees taller than 33m in height?

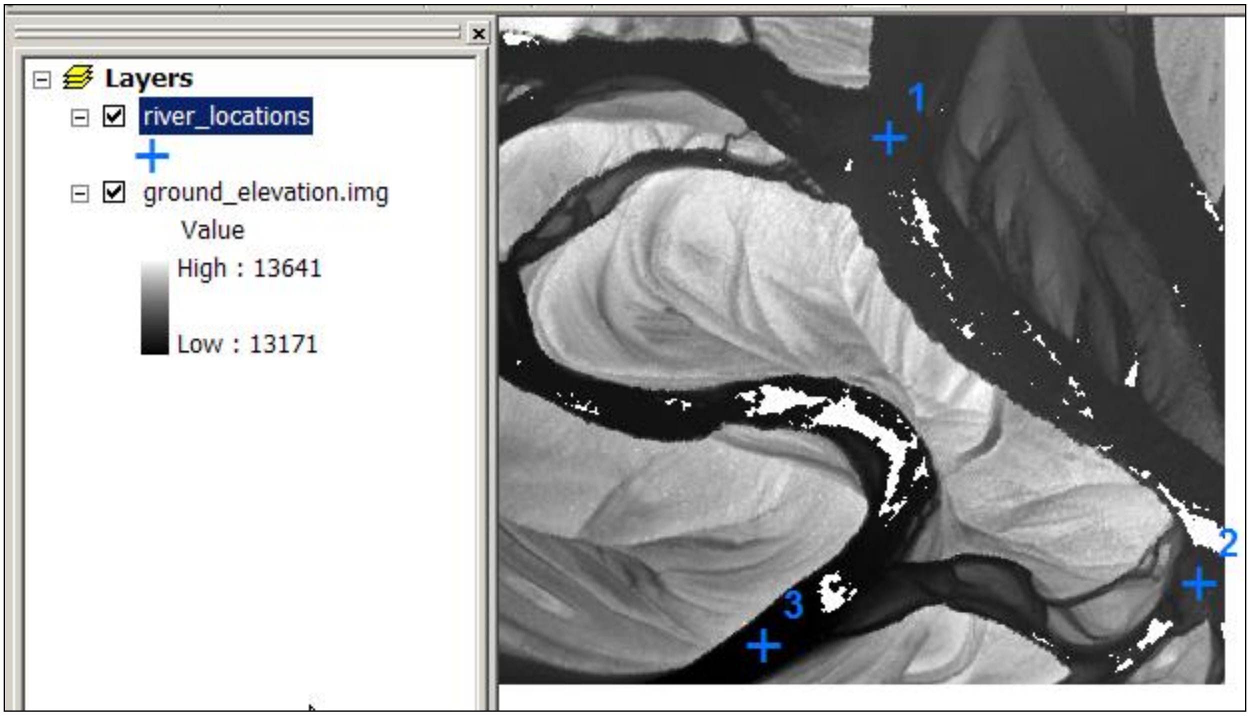


Download and unzip the file ***LIDAR.zip*** from :

http://dverbyla.net/nrm435/data/

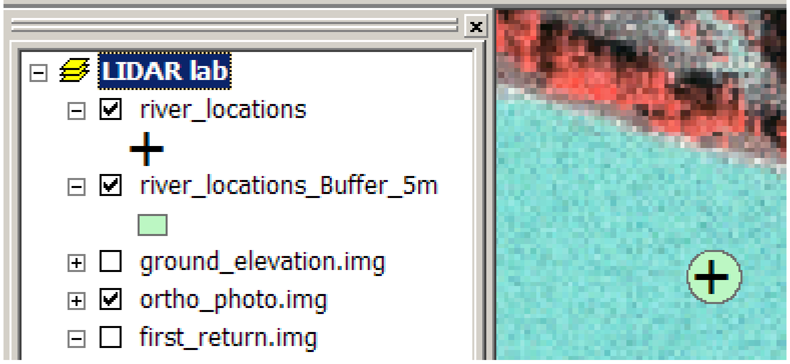
LIDAR Elevation Estimates

Use ArcMap to view three point locations from the Tanana River and the “ground elevation” estimates derived from LIDAR. The ***elevation estimates are in cm.***

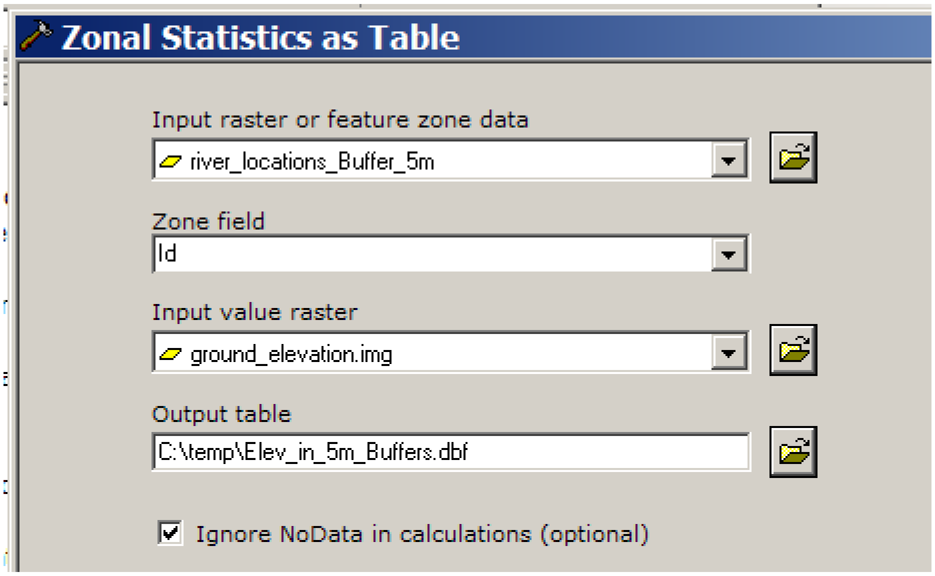


How good are the LIDAR elevation estimates? One way to assess the accuracy is to sample from the river locations to check that the elevation estimates are consistently decreasing as you go downstream. Another precision check is to see how variable the elevation estimates are in areas of nearly constant elevations.

Buffer your river locations by 5 meters.



Then determine the mean and standard deviation within each buffer:



Zonal Statistics as Table

Input raster or feature zone data: river_locations_Buffer_5m

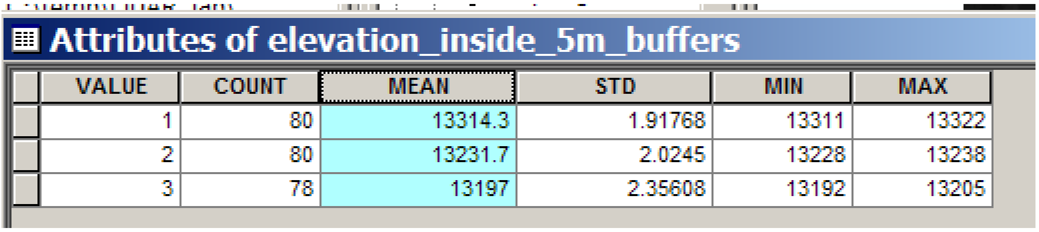
Zone field: Id

Input value raster: ground_elevation.img

Output table: C:\temp\Elev_in_5m_Buffers.dbf

☑ Ignore NoData in calculations (optional)

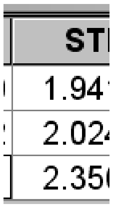
Is the river elevation consistently decreasing from samples going downstream from plot 1 to 2 to 3? **YES**



Attributes of elevation_inside_5m_buffers

VALUE	COUNT	MEAN	STD	MIN	MAX
1	80	13314.3	1.91768	13311	13322
2	80	13231.7	2.0245	13228	13238
3	78	13197	2.35608	13192	13205

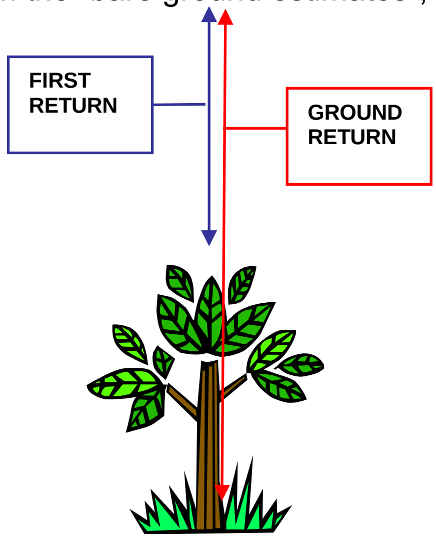
What is the standard deviation of elevation estimates within 5 meters of each sample point?
about 2 cm



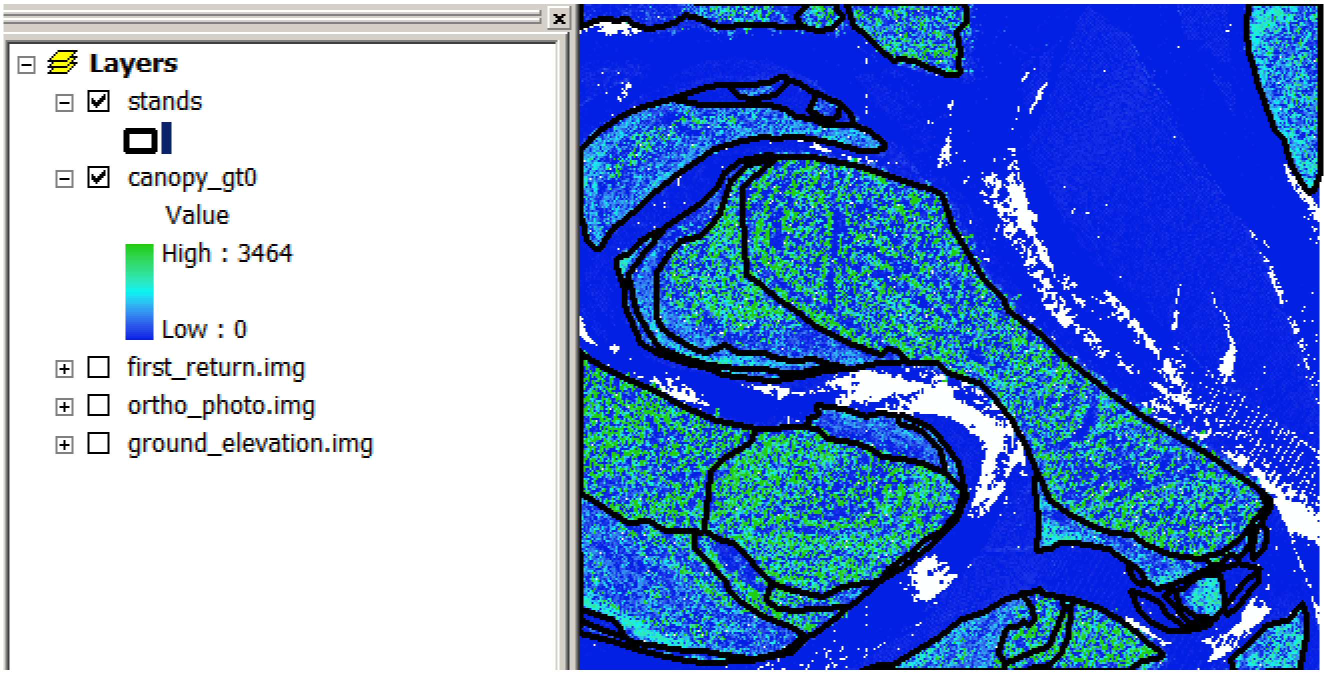
ST
1.94
2.02
2.35

Developing a Canopy Height Raster

The first return from LIDAR represents the top of the canopy elevation estimates. If you subtract these estimates from the "bare ground estimates", then you have estimates of canopy heights.

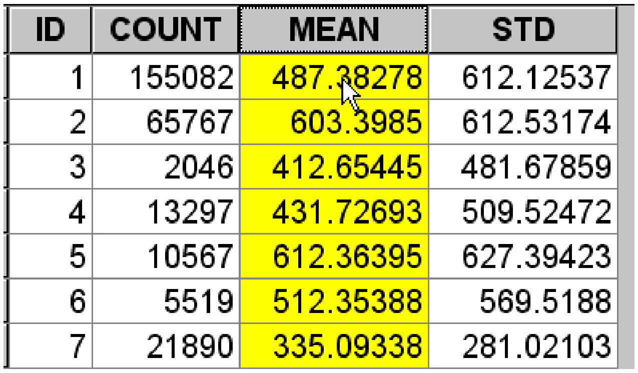


Use the ***Raster Calculator*** or ***Minus*** geoprocessing tool to create a raster of canopy height estimates. Any negative canopy height estimates are due to error in the system…perhaps the slight change in position between the time of first return relative to the time of last return. Use the ***Set Null*** tool to turn these negative elevation estimates to NoData….



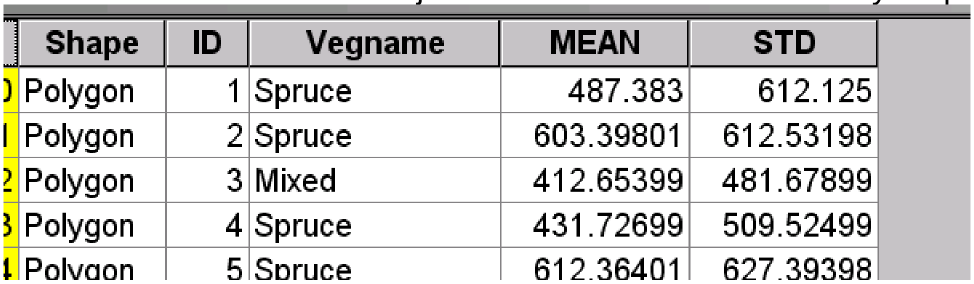
Estimating Stand Canopy Heights

Use the ***Zonal Statistics As Table*** tool to determine the mean canopy height within each stand polygon.



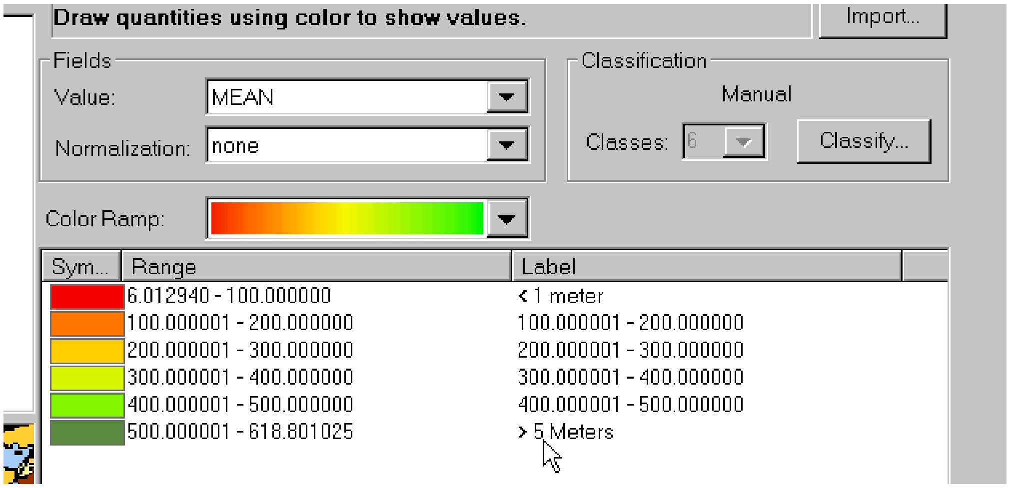
ID	COUNT	MEAN	STD
1	155082	487.38278	612.12537
2	65767	603.3985	612.53174
3	2046	412.65445	481.67859
4	13297	431.72693	509.52472
5	10567	612.36395	627.39423
6	5519	512.35388	569.5188
7	21890	335.09338	281.02103

Use the ***Join Field*** tool to join the Mean and STD fields to your polygon attribute table.



Shape	ID	Vegname	MEAN	STD
Polygon	1	Spruce	487.383	612.125
Polygon	2	Spruce	603.39801	612.53198
Polygon	3	Mixed	412.65399	481.67899
Polygon	4	Spruce	431.72699	509.52499
Polygon	5	Spruce	612.36401	627.39398

Adjust your layer symbology showing the estimates as 1-m height classes of each stand polygon…



Value: MEAN

Normalization: none

Classification: Manual

Classes: 6

Sym...	Range	Label
🟥	6.012940 - 100.000000	< 1 meter
🟧	100.000001 - 200.000000	100.000001 - 200.000000
🟨	200.000001 - 300.000000	200.000001 - 300.000000
🟨	300.000001 - 400.000000	300.000001 - 400.000000
🟩	400.000001 - 500.000000	400.000001 - 500.000000
🟩	500.000001 - 618.801025	> 5 Meters

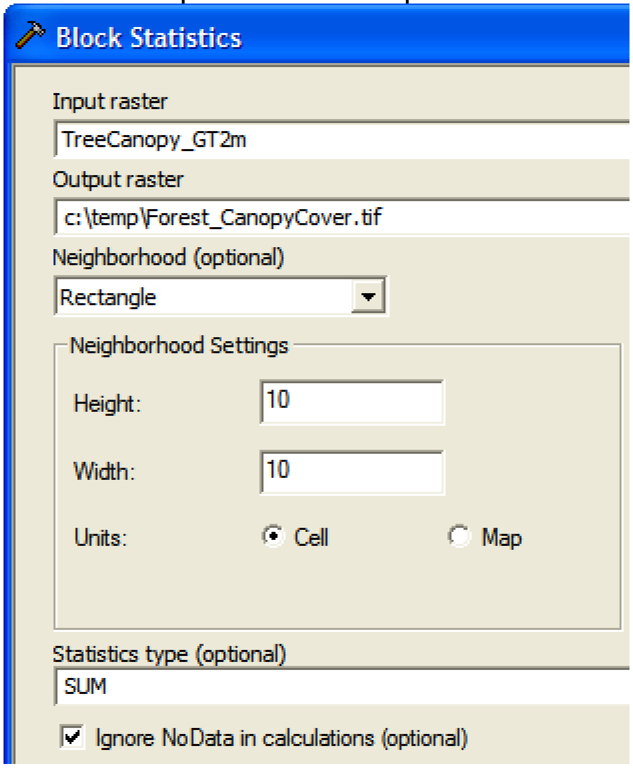
Canopy Cover Estimates

Forest Canopy Cover is expressed as a percentage tree canopy within an area. So we will estimate tree canopy cover within 100 meter pixels. We will consider each pixel as covered with canopy if the canopy height exceeds 2 meters.

First, use the ***Con tool or Raster Calculator*** to create a raster of pixels with canopy heights above 2 meters: 1 representing pixels with canopy height above 200 cm (2 meters), 0 representing pixel with canopy height <= 200 cm (2 meters)

Symbolize your output raster, so pixels with canopy height less than 2m are not colored, while pixels above 2m in canopy height are colored green.

The next step is to estimate percent forest canopy cover within 100-meter areas called blocks.



Block Statistics

Input raster: TreeCanopy_GT2m

Output raster: c:\temp\Forest_CanopyCover.tif

Neighborhood (optional): Rectangle

Neighborhood Settings

Height: 10

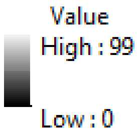
Width: 10

Units: ● Cell ○ Map

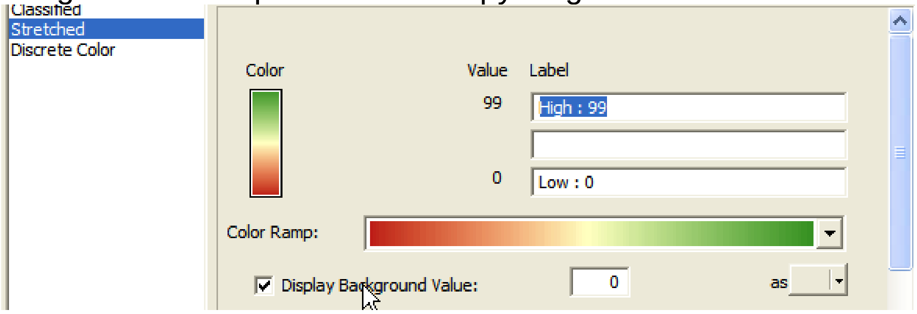
Statistics type (optional): SUM

☑ Ignore NoData in calculations (optional)

There are a total of 10X10=100 pixels in each block, so the output has a limit between 0 and 100.



Since our input raster has 1 meter pixels, our neighborhood will be 10 by 10 or 100 m2 area. The sum represents the total number of forest canopy pixels within each neighborhood, since we assigned zero for pixels with canopy height less than 2m.

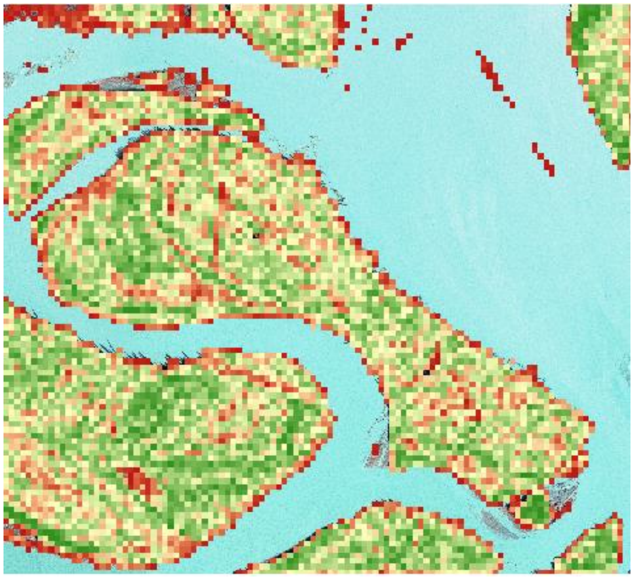


99 High : 99

0 Low : 0

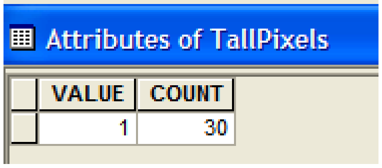
Color Ramp:

☑ Display Background Value: 0 as



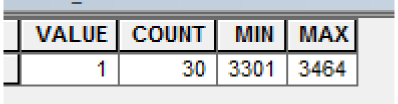
Mapping Tall Trees

We are interested in tall white spruce trees that may be old and therefore valuable for tree-ring collections. We want to locate all trees that are taller than 33 meters as point features.
First, select all the pixels with canopy height about 33 meters (3300 cm), making all other pixels NoData.


Attributes of TallPixels

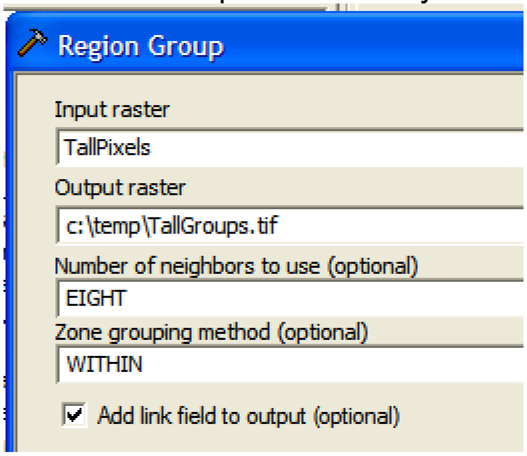
VALUE	COUNT
1	30

Double check using the ***Zonal Statistics As Table*** tool…..

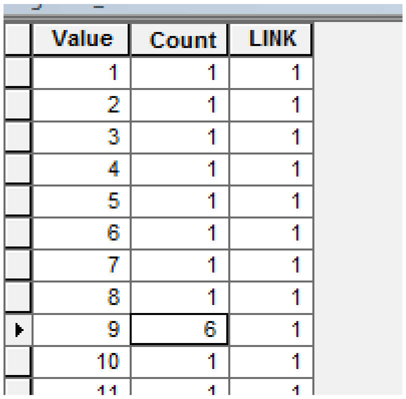


VALUE	COUNT	MIN	MAX
1	30	3301	3464

Some of these pixels are likely from the same tree, so if the pixels touch group them together…


Region Group

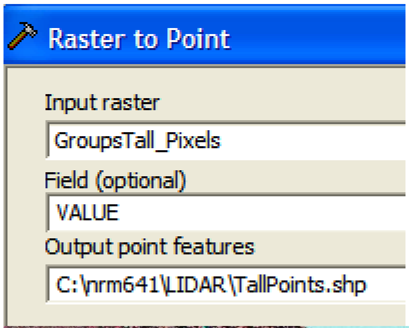
Input raster
TallPixels
Output raster
c:\temp\TallGroups.tif
Number of neighbors to use (optional)
EIGHT
Zone grouping method (optional)
WITHIN
☑ Add link field to output (optional)



Value	Count	LINK
1	1	1
2	1	1
3	1	1
4	1	1
5	1	1
6	1	1
7	1	1
8	1	1
9	6	1
10	1	1
11	1	1

Notice that group 9 consisted of six pixels.

Next, convert your tall pixels groups to points.

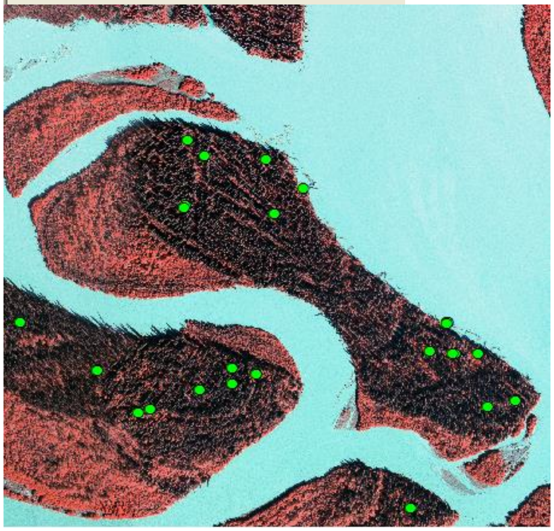


Raster to Point

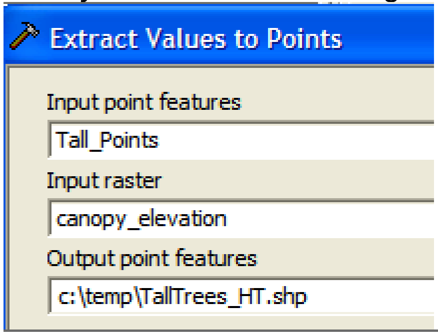
Input raster
GroupsTall_Pixels

Field (optional)
VALUE

Output point features
C:\nrm641\LIDAR\TallPoints.shp



Finally transfer the tree height value to each point:

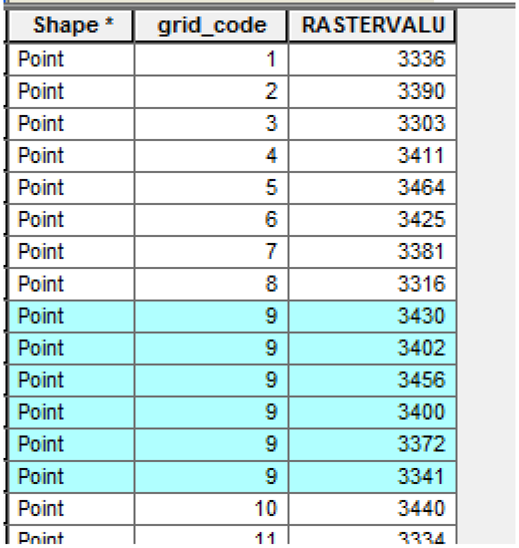


Extract Values to Points

Input point features
Tall_Points

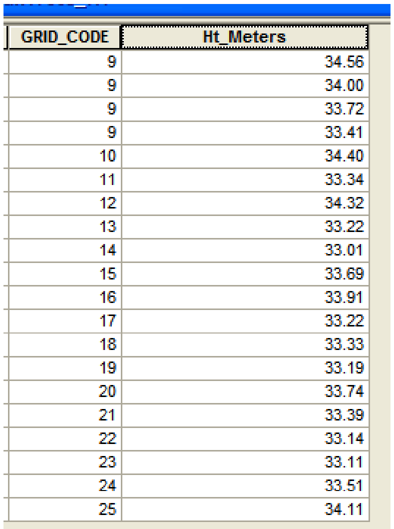
Input raster
canopy_elevation

Output point features
c:\temp\TallTrees_HT.shp

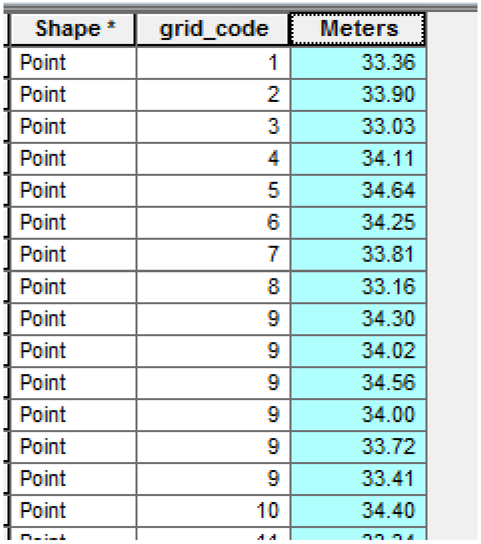


Shape *	grid_code	RASTERVALU
Point	1	3336
Point	2	3390
Point	3	3303
Point	4	3411
Point	5	3464
Point	6	3425
Point	7	3381
Point	8	3316
Point	9	3430
Point	9	3402
Point	9	3456
Point	9	3400
Point	9	3372
Point	9	3341
Point	10	3440
Point	11	3334

And convert your heights from cm to meters.

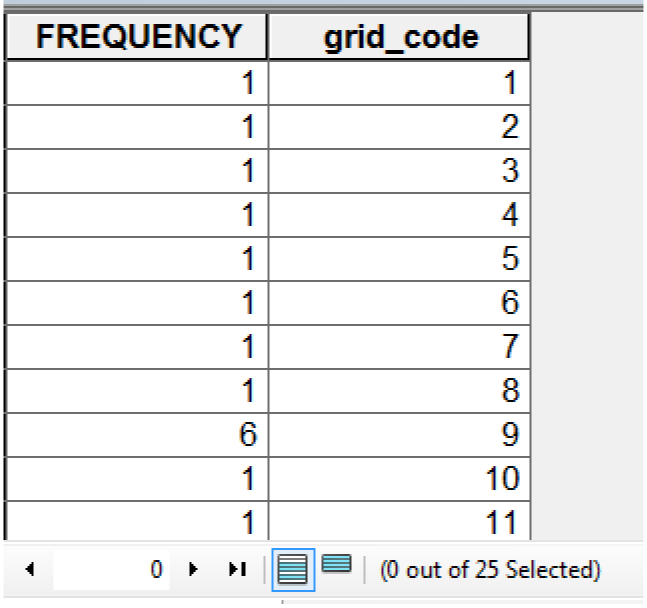


GRID_CODE	Ht_Meters
9	34.56
9	34.00
9	33.72
9	33.41
10	34.40
11	33.34
12	34.32
13	33.22
14	33.01
15	33.69
16	33.91
17	33.22
18	33.33
19	33.19
20	33.74
21	33.39
22	33.14
23	33.11
24	33.51
25	34.11



Shape *	grid_code	Meters
Point	1	33.36
Point	2	33.90
Point	3	33.03
Point	4	34.11
Point	5	34.64
Point	6	34.25
Point	7	33.81
Point	8	33.16
Point	9	34.30
Point	9	34.02
Point	9	34.56
Point	9	34.00
Point	9	33.72
Point	9	33.41
Point	10	34.40

Points with the same grid code came from pixels that were connected to each other…run the ***Frequency*** tool to determine the count of separate areas of tall trees.



FREQUENCY	grid_code
1	1
1	2
1	3
1	4
1	5
1	6
1	7
1	8
6	9
1	10
1	11

so there were 25 groups of tall pixels, most as single pixel groups.