Exercise 1:

Introduction to LiDAR Point Cloud Data using the Fusion Software Package

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(Adapted from tutorial by Ian Madin, DOGAMI)

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Goal: The goal of this exercise is to introduce you to the visualization of lidar point cloud data in order to gain a better understanding of what the data looks like, what it depicts, and how visualization of the data can help to evaluate data quality and possible sources of data artifacts.

Fusion is a free lidar viewing software package developed by the Silviculture and Forest Models Team at the U.S. Forest Service's Pacific Northwest Research Station. More information about Fusion and software download are available at: http://www.fs.fed.us/eng/rsac/fusion/

There are many point cloud viewing software packages available, some more powerful and higher performance than Fusion, but we choose to use Fusion for this exercise because it is free and easily accessible to all users. The software also offers numerous ways to interrogate the point cloud and thus is helpful for teaching. We will only scratch the surface of what Fusion is capable of, so please take some time to explore the software on your own. The url above has great links to tutorials on how to perform different types of analysis and visualizations.

Data used in this exercise comes courtesy of Ian Madin at DOGAMI:

"DOGAMI lidar data sample from Carpenterville on Southern Oregon Coast. 8 pulse/m^2 leaf-on points in LAS format, 14,000,000 points in 1.4 km^2 tile"

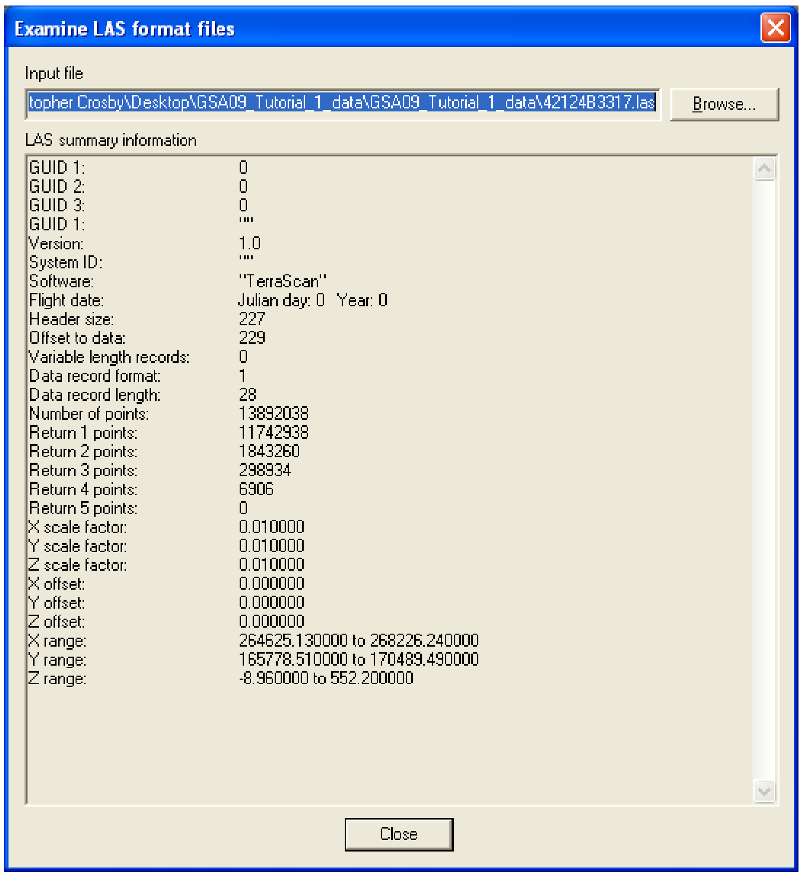
A note on navigating in Fusion: Fusion uses two main windows to view data – a data browser window that has most of the software controls and which displays data in map view. The Lidar Data Viewer (LDV) window provides an interactive 3D perspective on the data. You will be regularly moving back and forth between the two windows throughout this exercise.

Getting Started:

- Launch Fusion
- Load the ortho image file we will use as a base: *42124b3317_ortho.jpg* by clicking the "Image" button in the upper left corner and navigating to and selecting the image.
- Load the point cloud file (in binary LAS format) by clicking the "Raw Data…" button in the upper left and navigating to and selecting the file: *42124B3317.las* Accept the defaults on the menu that appears and click "OK"

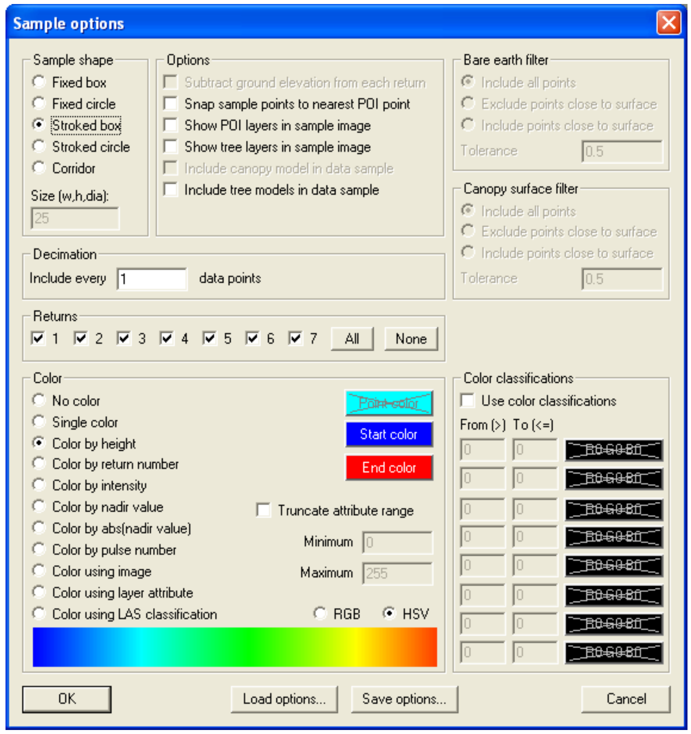
Note that you can't see the point data - Fusion doesn't render the point cloud data by default because there are ~14 million points in the file and doing so is computationally intensive. The base image is for navigation.

- Select *Tools> Miscellaneous Utilities> Examine LAS file headers* to view the header information of the LAS file. One of the advantages of LAS is the header that contains valuable info about the file.

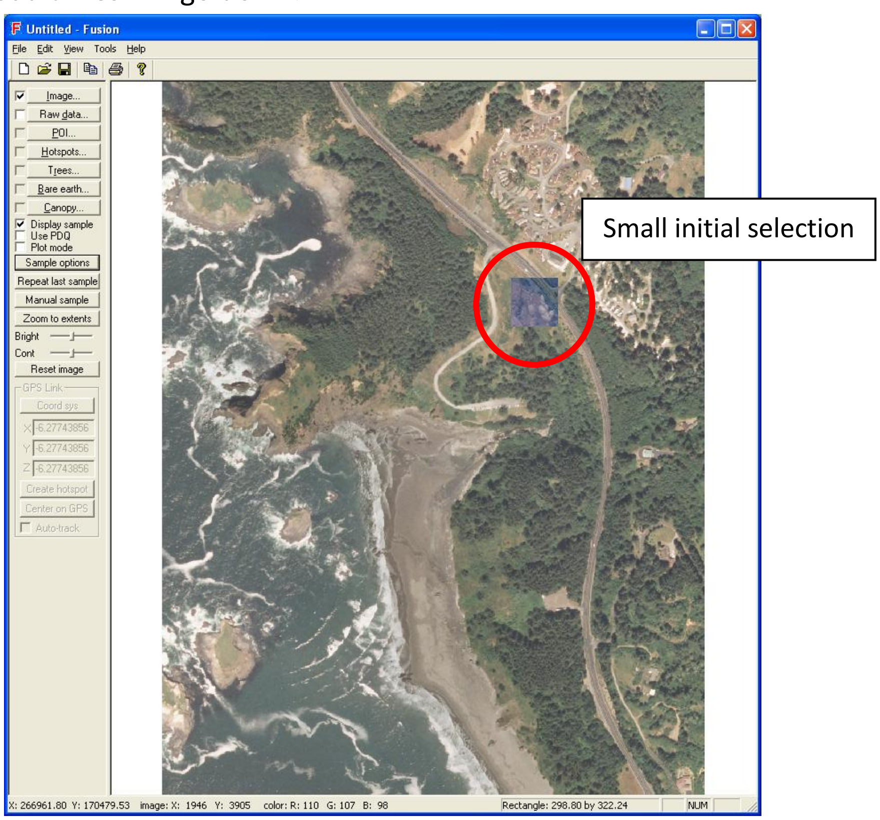


<u>Viewing points colored by elevation:</u>

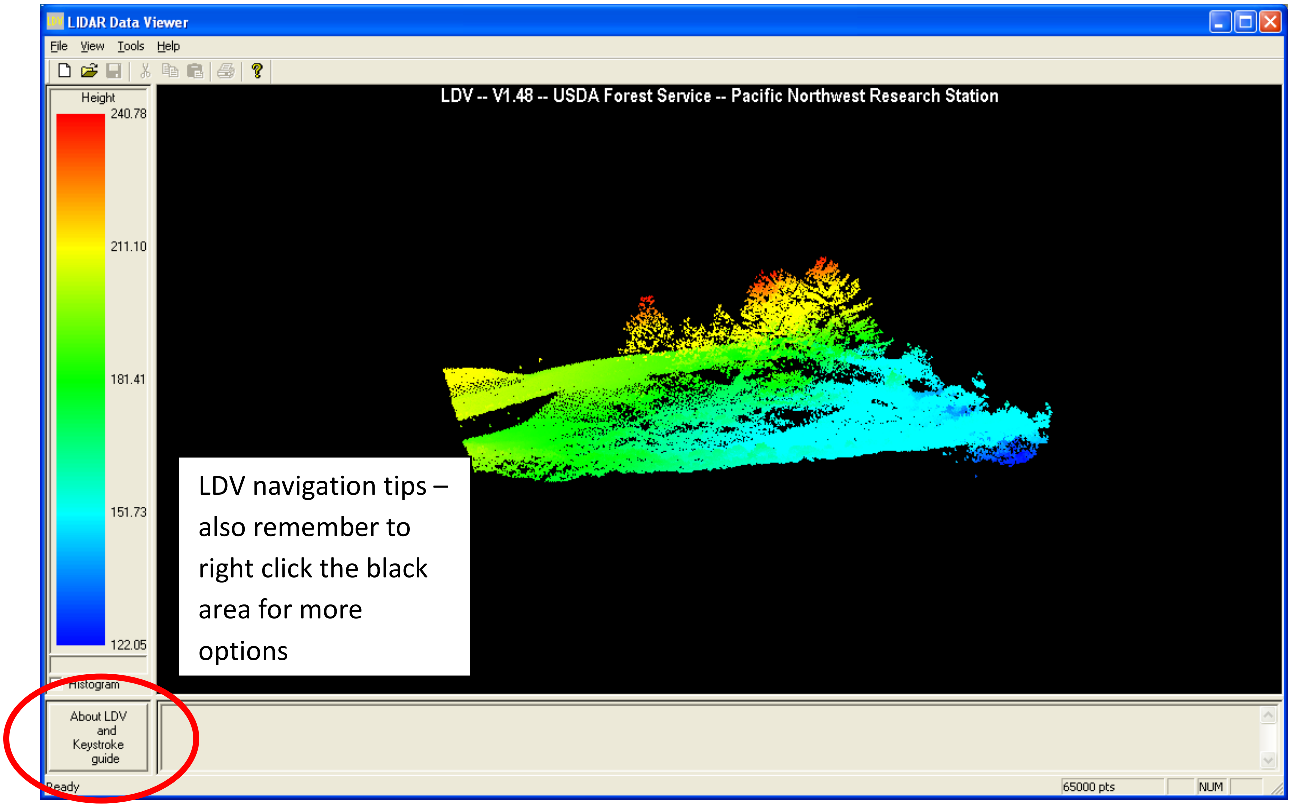
- Click "Sample options" button on left and choose *color by height*, *all returns*, *stroked box.* These should be the default values, but you should confirm.



- Next, draw a SMALL selection box on the aerial photo image. The first time you examine the data Fusion indexes the points and this can be very slow so start small. As you work with the data load times will go down:

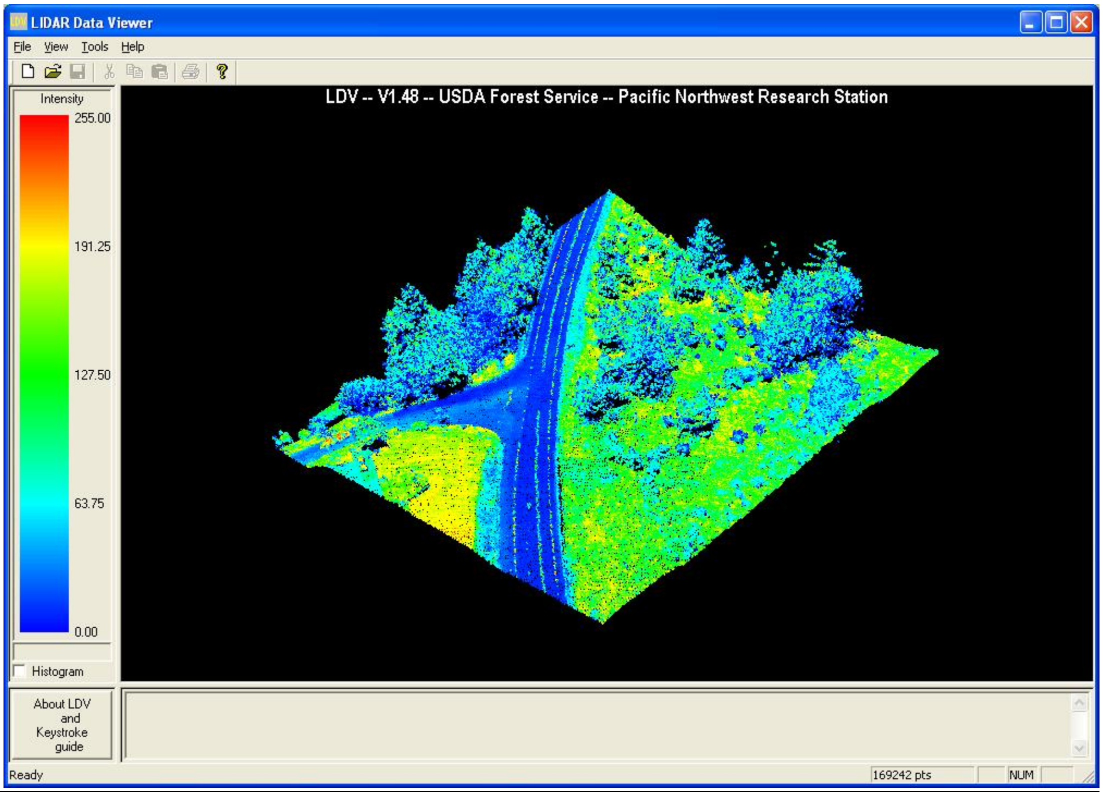


- Fusion will think for a while it initially indexes data (drink coffee, check email…).
- Once indexed the LDV viewer will pop up with image where returns are color coded by elevation. Color ramp and elevation values are shown on the left.
- Experiment with navigation – the "About LDV…" menu in the lower left provides an overview of commands.
- Right click on screen to bring up menu, select *spinning side view* or *wiggle vision*

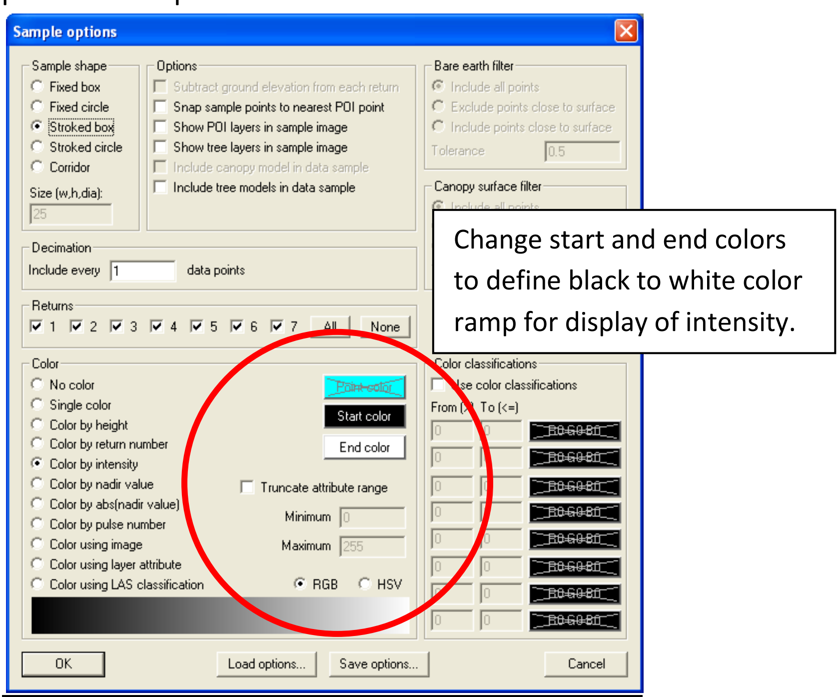


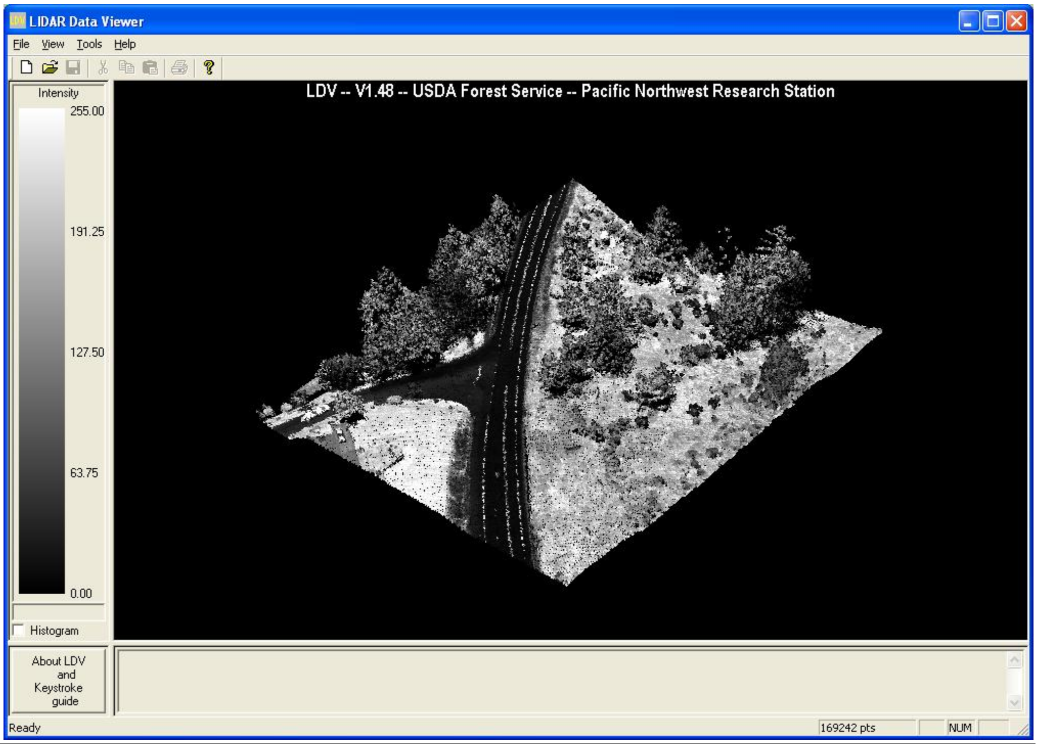
<u>Viewing points colored by intensity:</u>

- Back in the navigation window (not the LDV), select the "Sample options" menu again, except this time choose *color by intensity.*
- Next, either draw a new selection box on the image or click the "Repeat last sample" button to use the area you were previously viewing. Intensity will be initially be displayed as a blue to red color ramp. Think about the distribution of intensity values in the image and what intensities correspond to which materials.



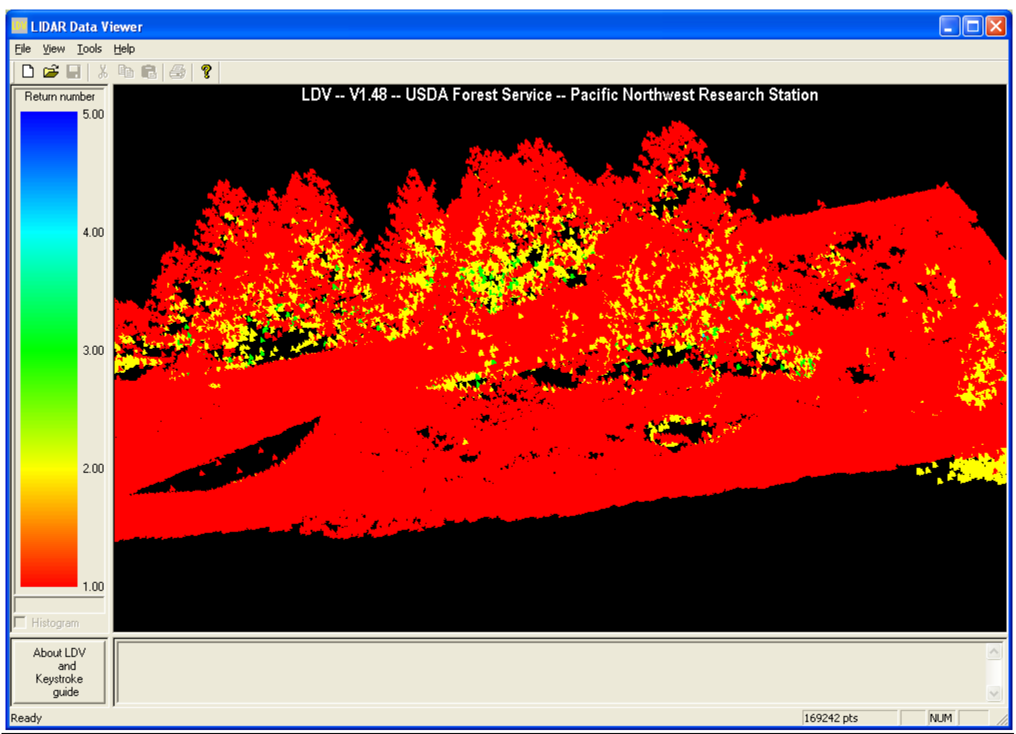
- If you'd rather view the intensity values in a black to white range of colors as is often done, return to the "Sample options" menu and change the *Start color* to black and *End color* to white. Make sure the RGB button is also selected. Click ok to close the menu then hit the "Repeat last sample" button.





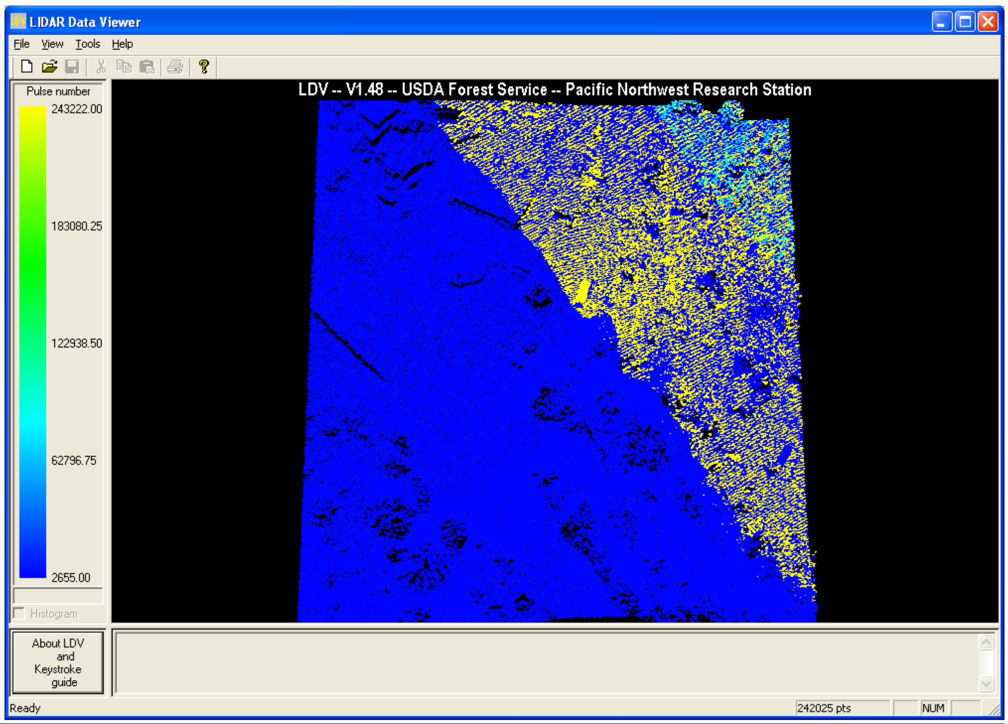
<u>Viewing points colored by return number:</u>

- Return to "Sample options" and switch the display to *color by return number* and click "Repeat last sample". Note the ratio of first to second and third returns. Also note places where there are no returns at all.



Viewing points colored by acquisition sequence (“pulse number”):

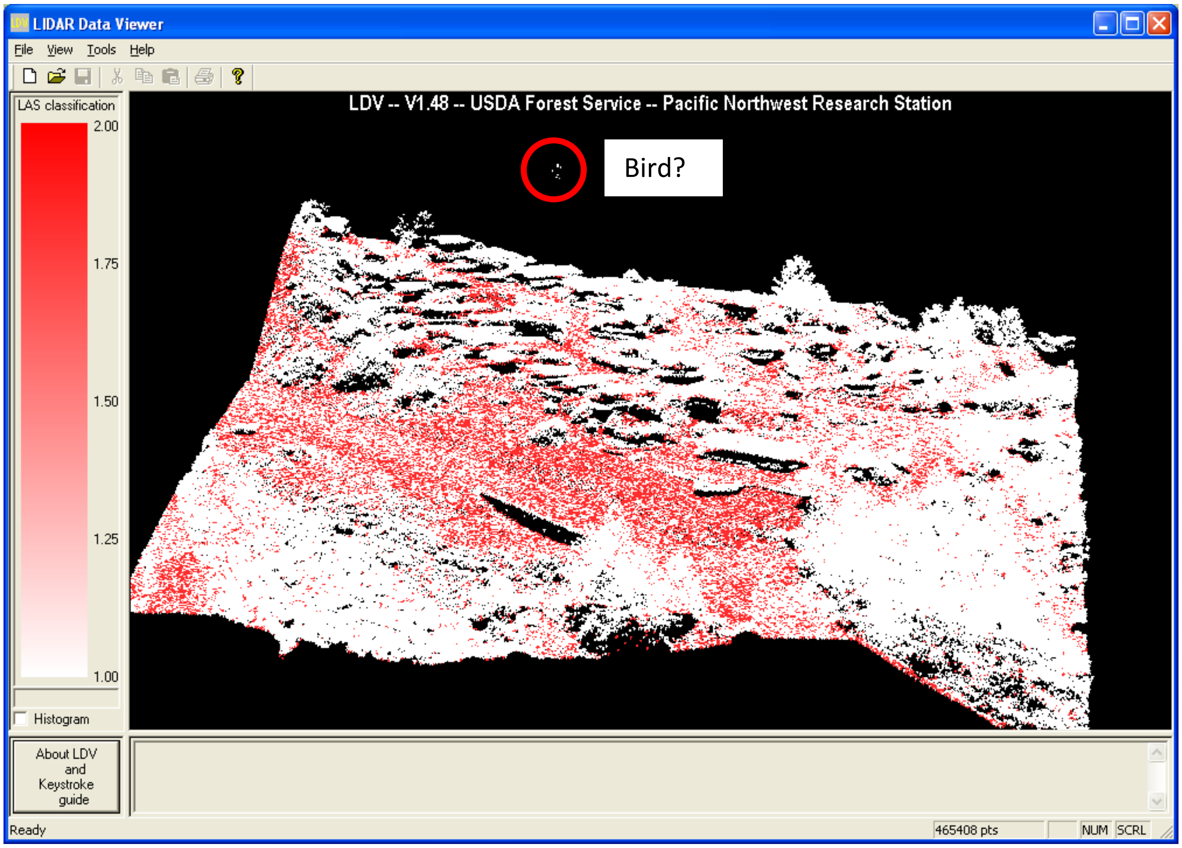
- Return to sample options, switch to *color by pulse number* and update the display. Sorting by pulse number effectively sorts pulses based on GPS time and displays data from adjacent swaths by color. It is handy for identifying the geometry of the acquisition, amount of swath overlap, and places where you may have edge artifacts from swath edges:



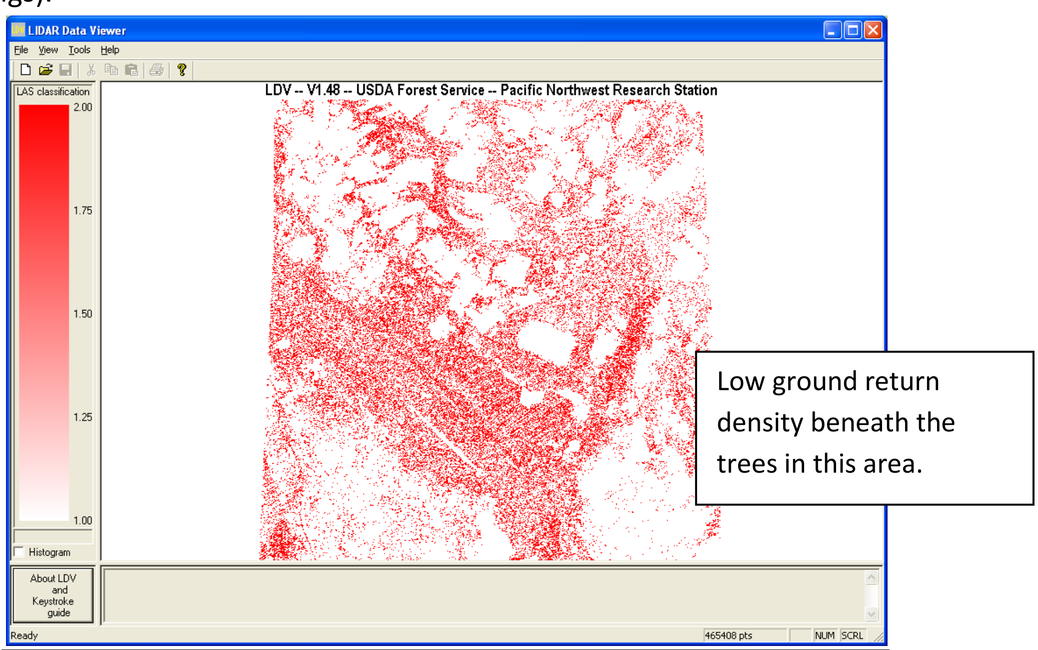
Viewing points colored by classification:

This is a nice way to display only ground returns from within the complete point cloud and can be very instructive for understanding lidar returns density on the ground – something you should be interested in if you are working with bare earth DEMs derived from these data.

- Select “Sample Options”, choose *color using LAS classification*, choose *truncate attribute range*, set minimum = 1, maximum = 2, set *start color* to white



- You can change the background color of the display by right clicking on the screen in LDV, clicking on *colors*, and setting background color to white. This is a nice way to quickly see where these may be a lack of ground returns due to vegetation (or buildings).



Viewing points colored by image:

Fusion allows you to use the colors of the ortho image to colorize the point cloud data.

- In "Sample options", choose *color using image*
- "Repeat last sample" or draw a new selection box on image to load the points. The points are now colored with the RGB values of the pixel within which they are located in the ortho image. You can use ctrl +/- commands on the keyboard to change the size of each individual point.
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