

Forest mapping from the sky and on land

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Spaceborne



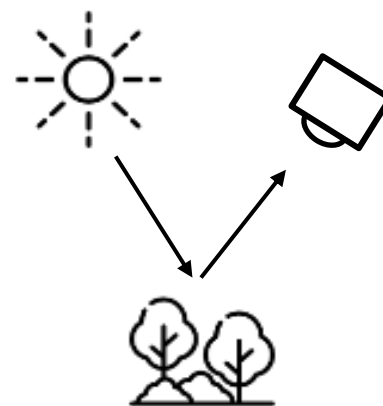
Airborne



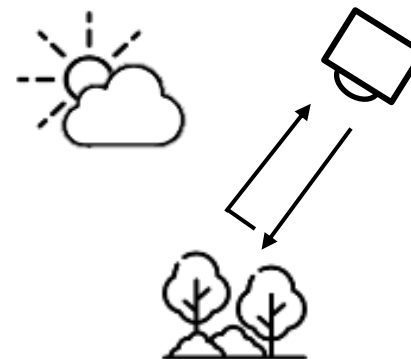
Ground-based



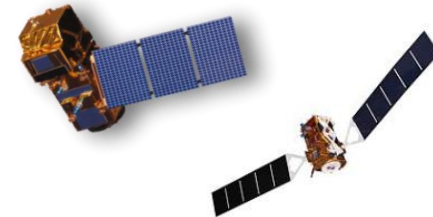
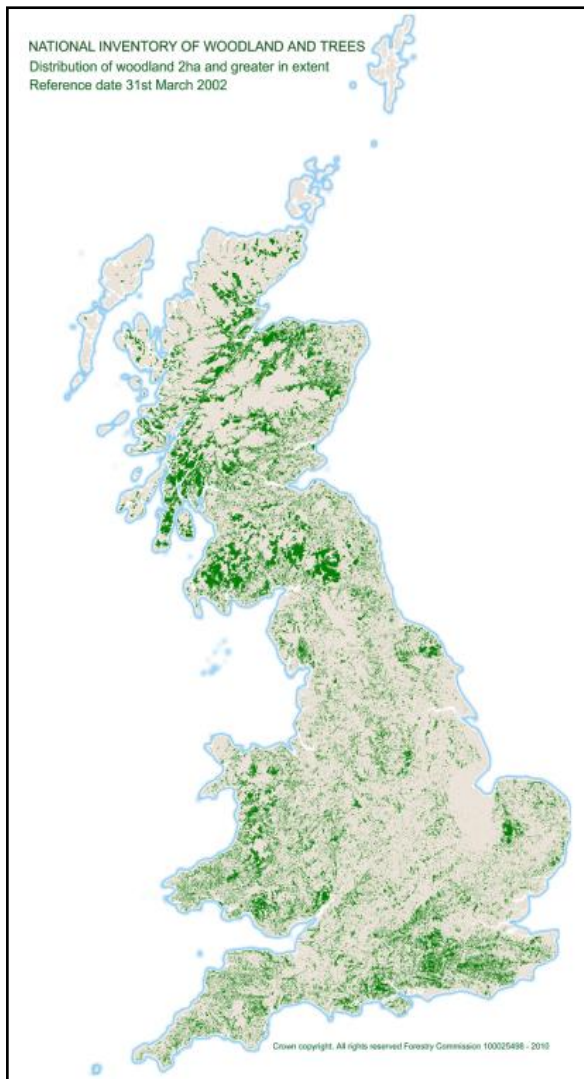
Passive



Active



FLATICON (<https://www.flaticon.com/>)



Sentinel Satellites



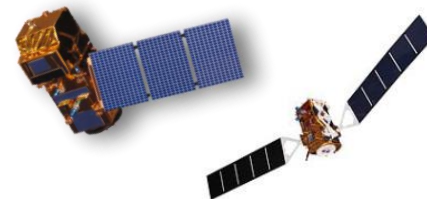
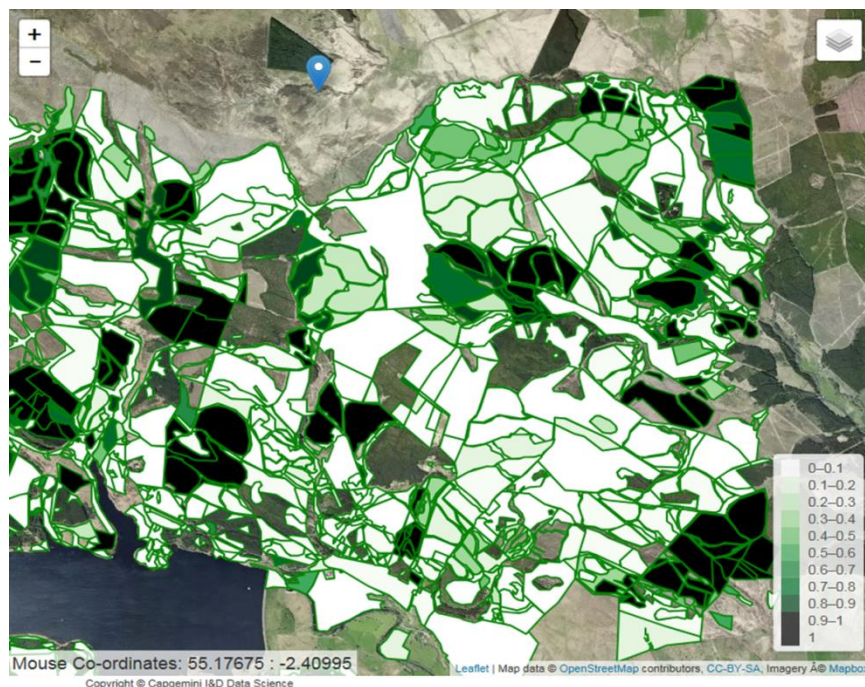
Approach



Verification



Frequency



Sentinel Satellites



Approach



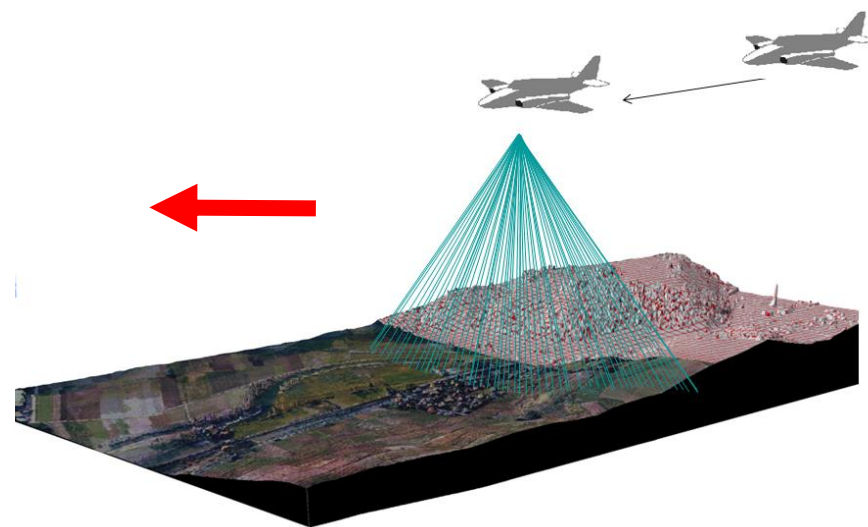
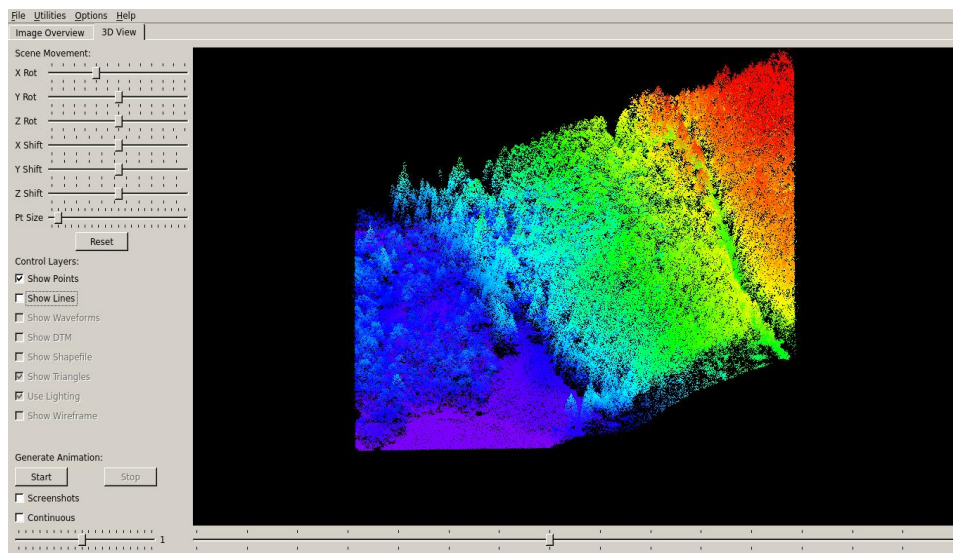
Modelling



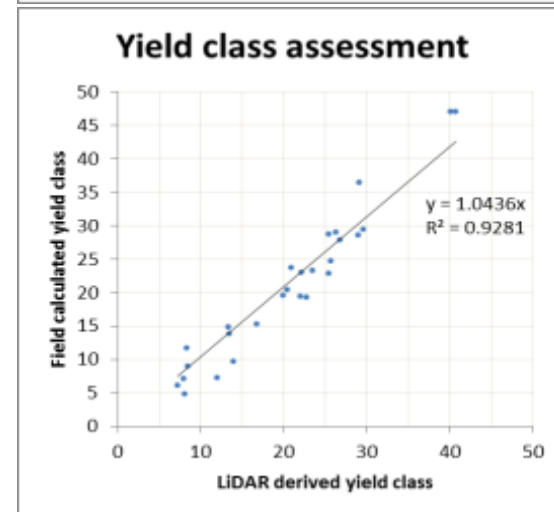
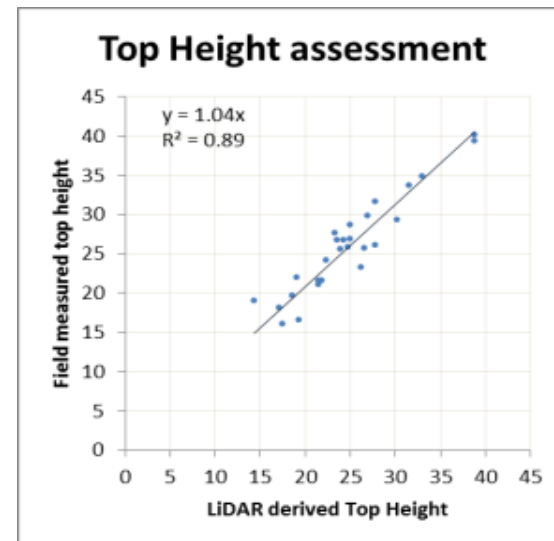
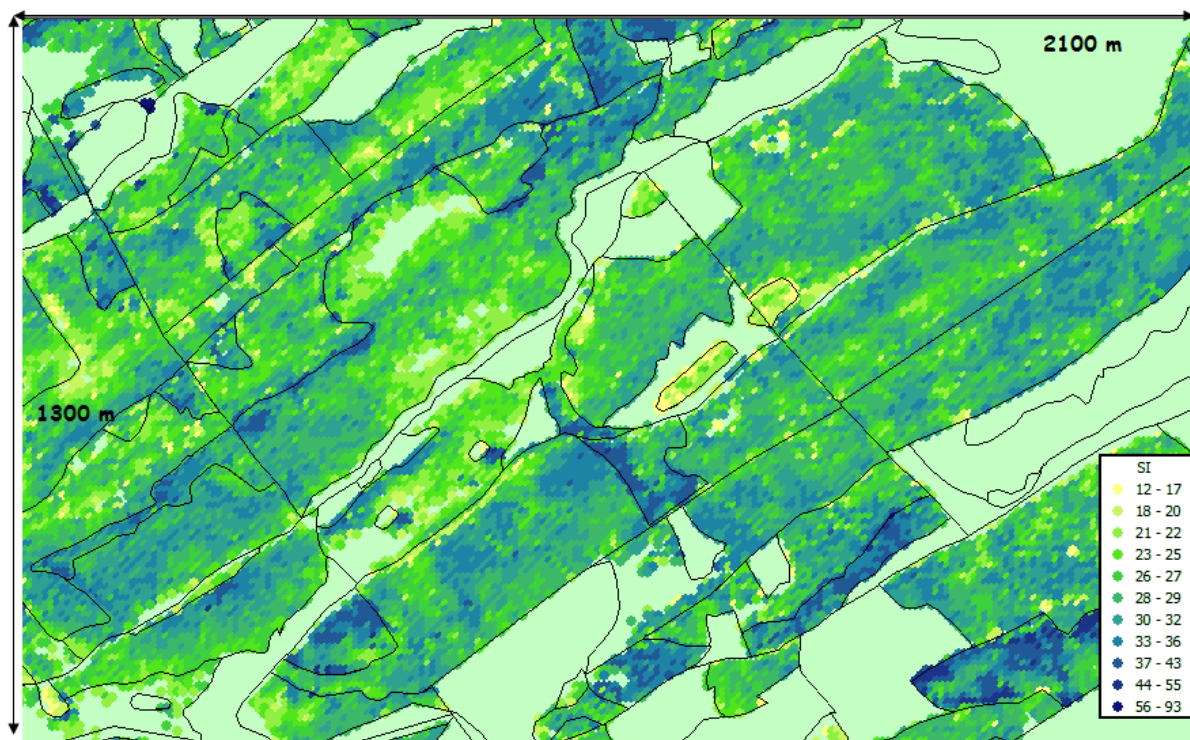
Frequency

Airborne Laser Scanning (LiDAR)

- **LIDAR** is an active sensor that emits millions of laser pulses
- Based on a sequential range of point measurements from the airborne sensor to the surface. It measures the return time for a pulse of laser to travel between the sensor and a target using ultra-accurate clocks
- It allows the creation of high accuracy 3-D Digital Surface Models (0.5 to 1 m resolution)
- (Relatively) Independent of lighting conditions
- Little ground control is required.
- Fully automated analysis of data by means of FR's own software

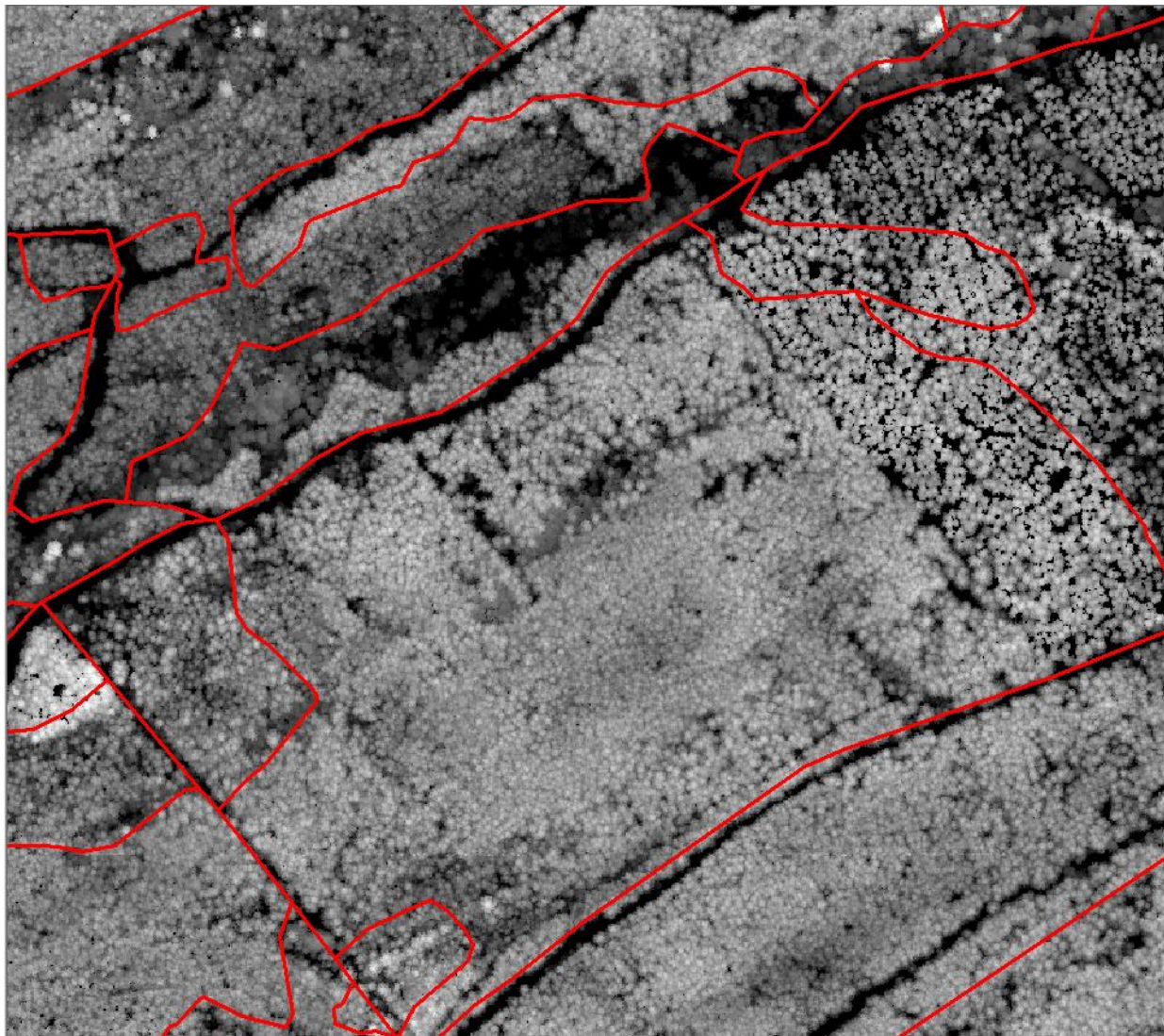


Top Height and Yield Class estimates from LiDAR Area-Based analysis

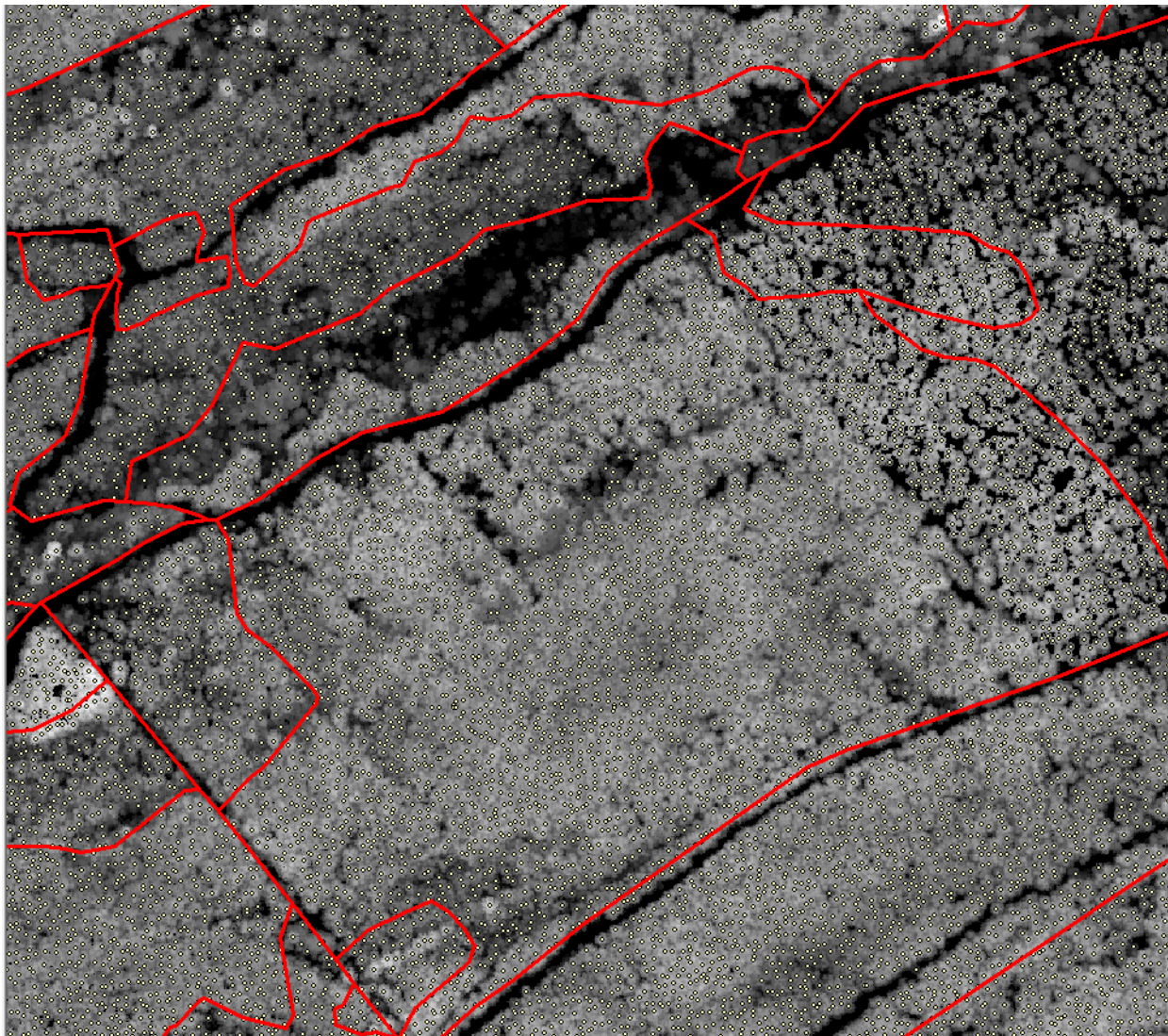


Suarez et al., 2014

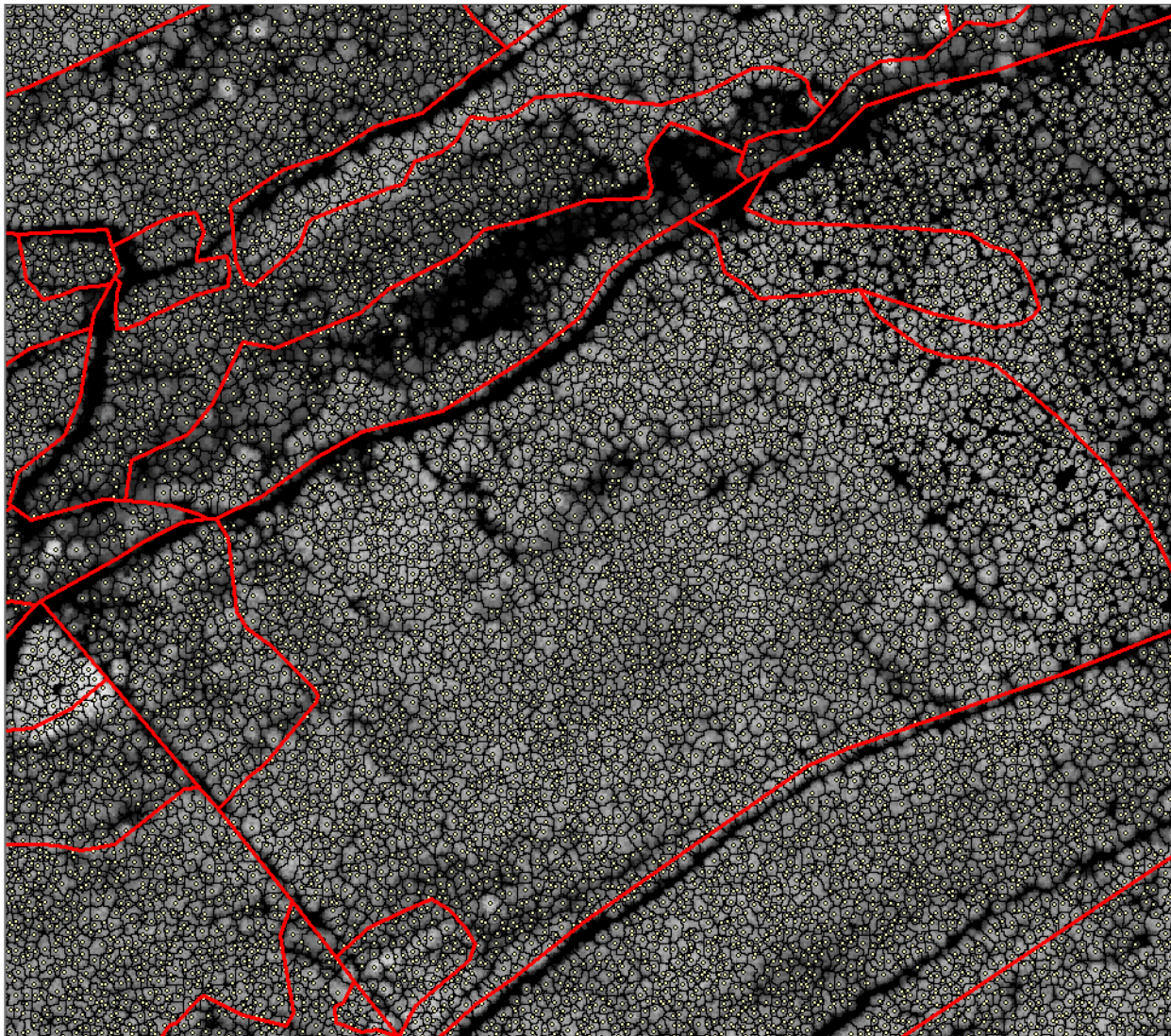
LiDAR survey 2002



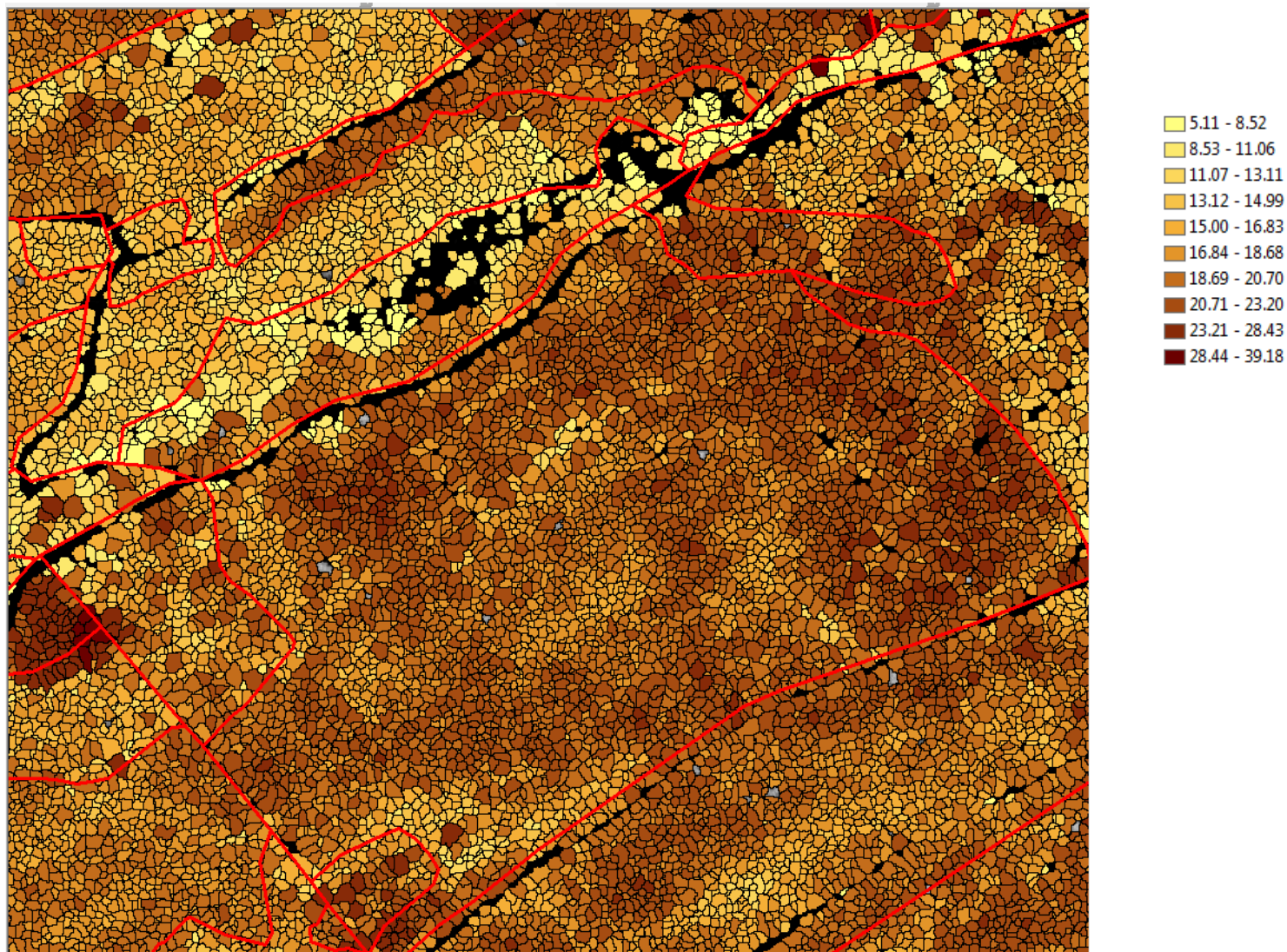
LiDAR survey 2002 - Tree tops detection



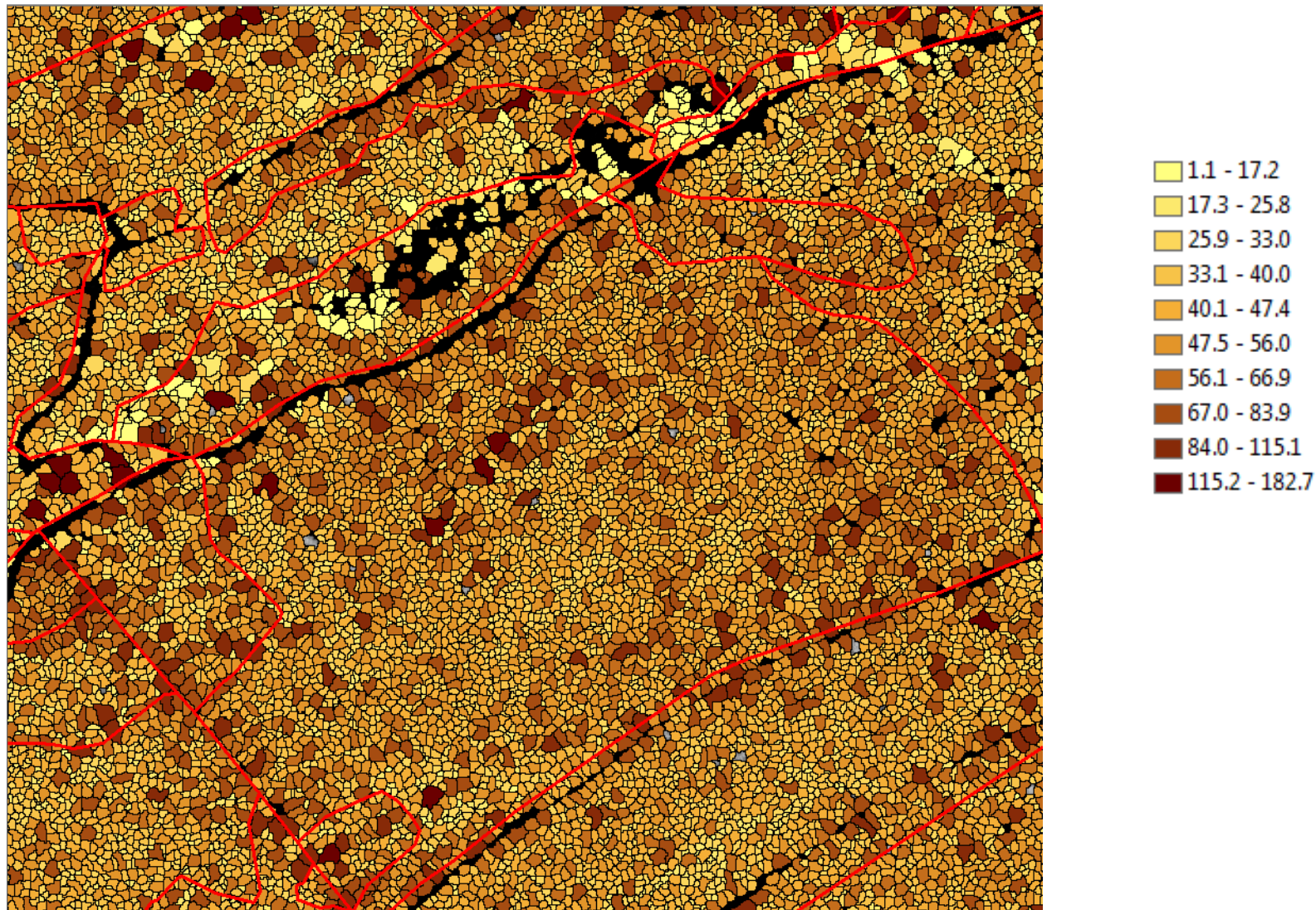
LiDAR survey 2002 - Individual tree canopies delineation



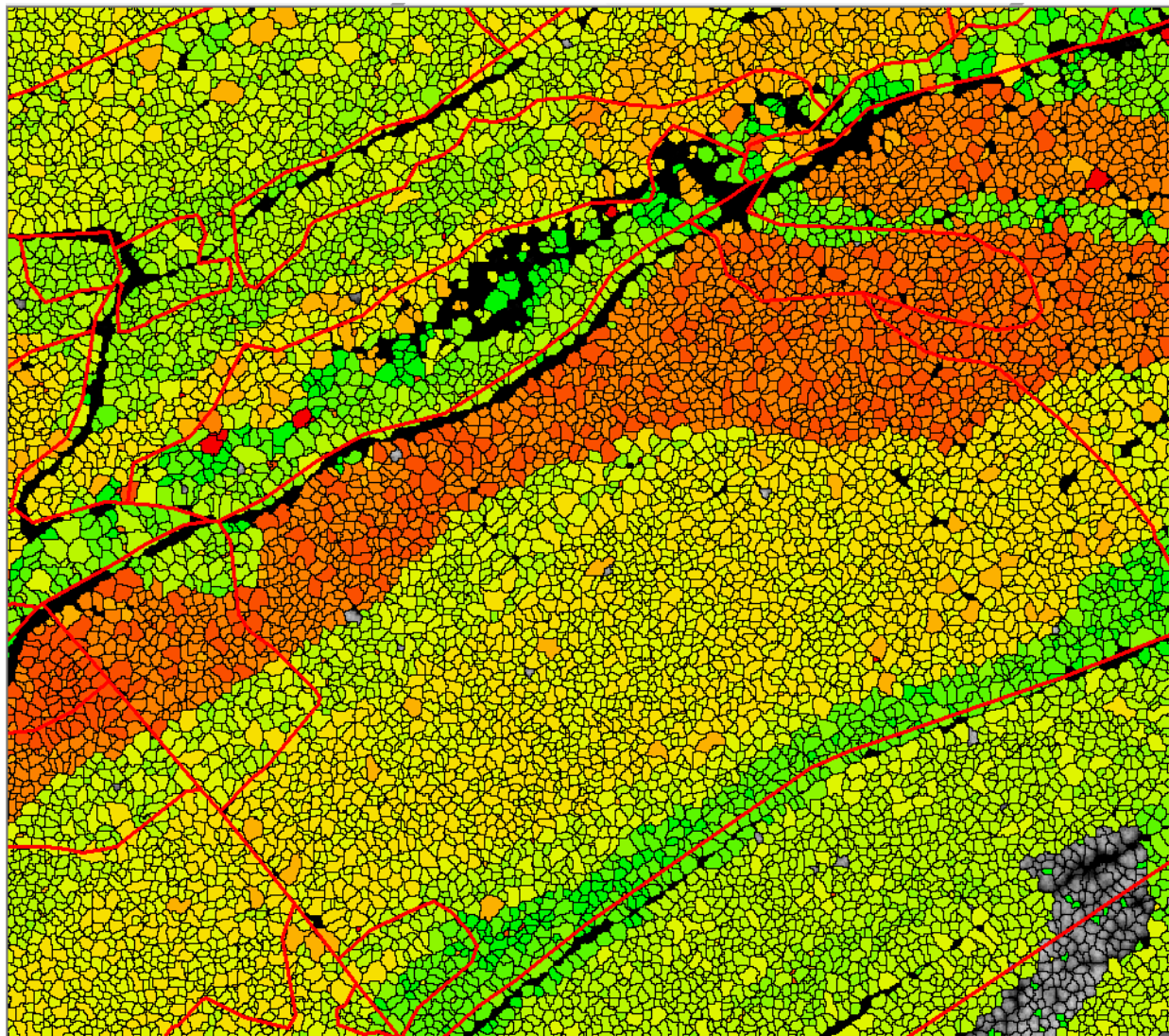
LiDAR survey 2002 - Individual tree tops in metres



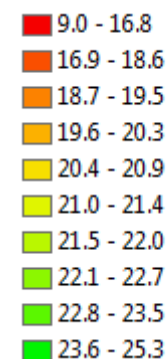
LiDAR survey 2002 - Individual tree dbh in cm



LiDAR survey 2002 – Running ForestGALES wind risk model

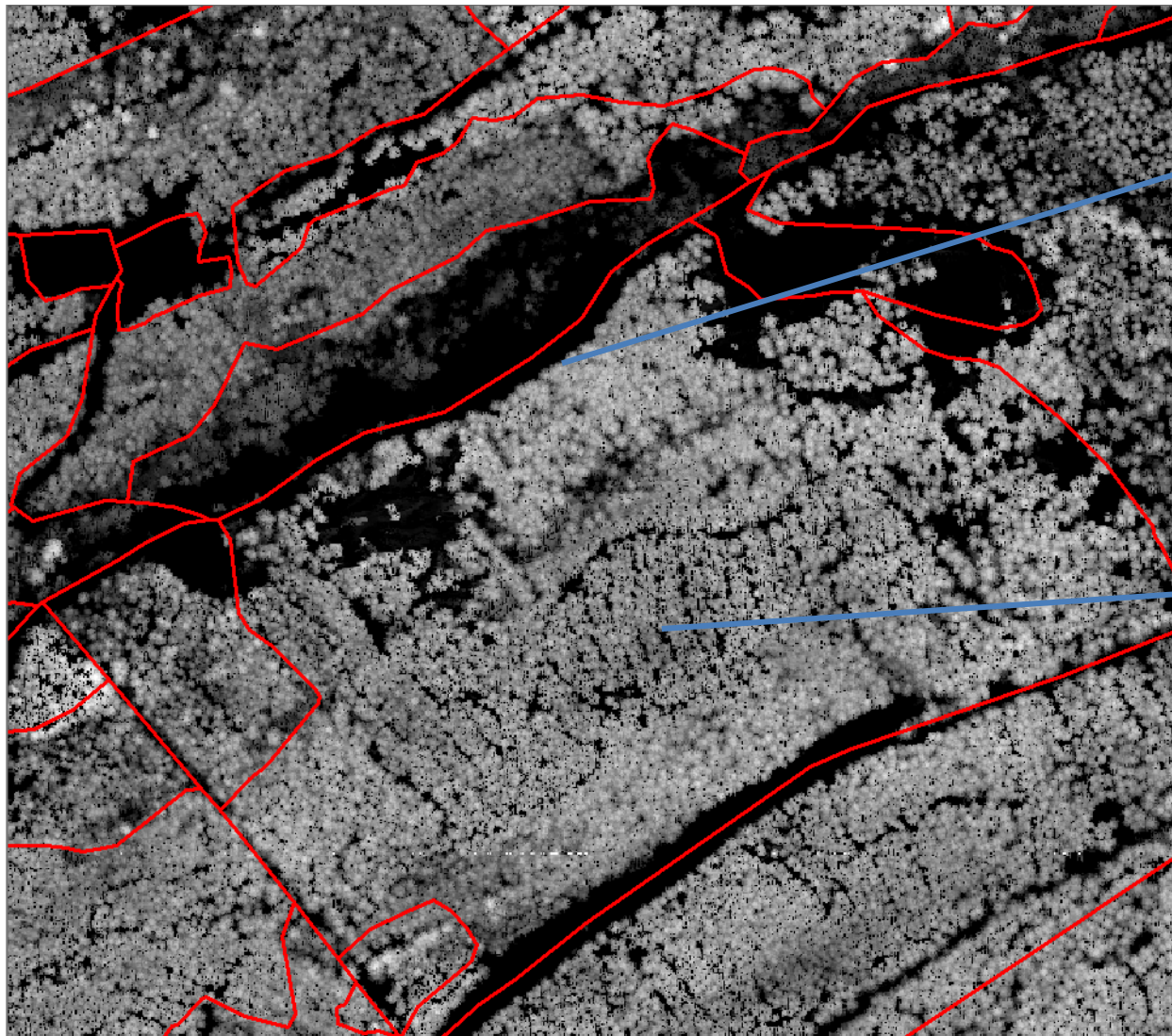


Critical wind speed
required to create
windthrow, in m/s



Note: this simulation will
show the vulnerability of
parts of the stands for
wind damage. The red
areas are the most
vulnerable

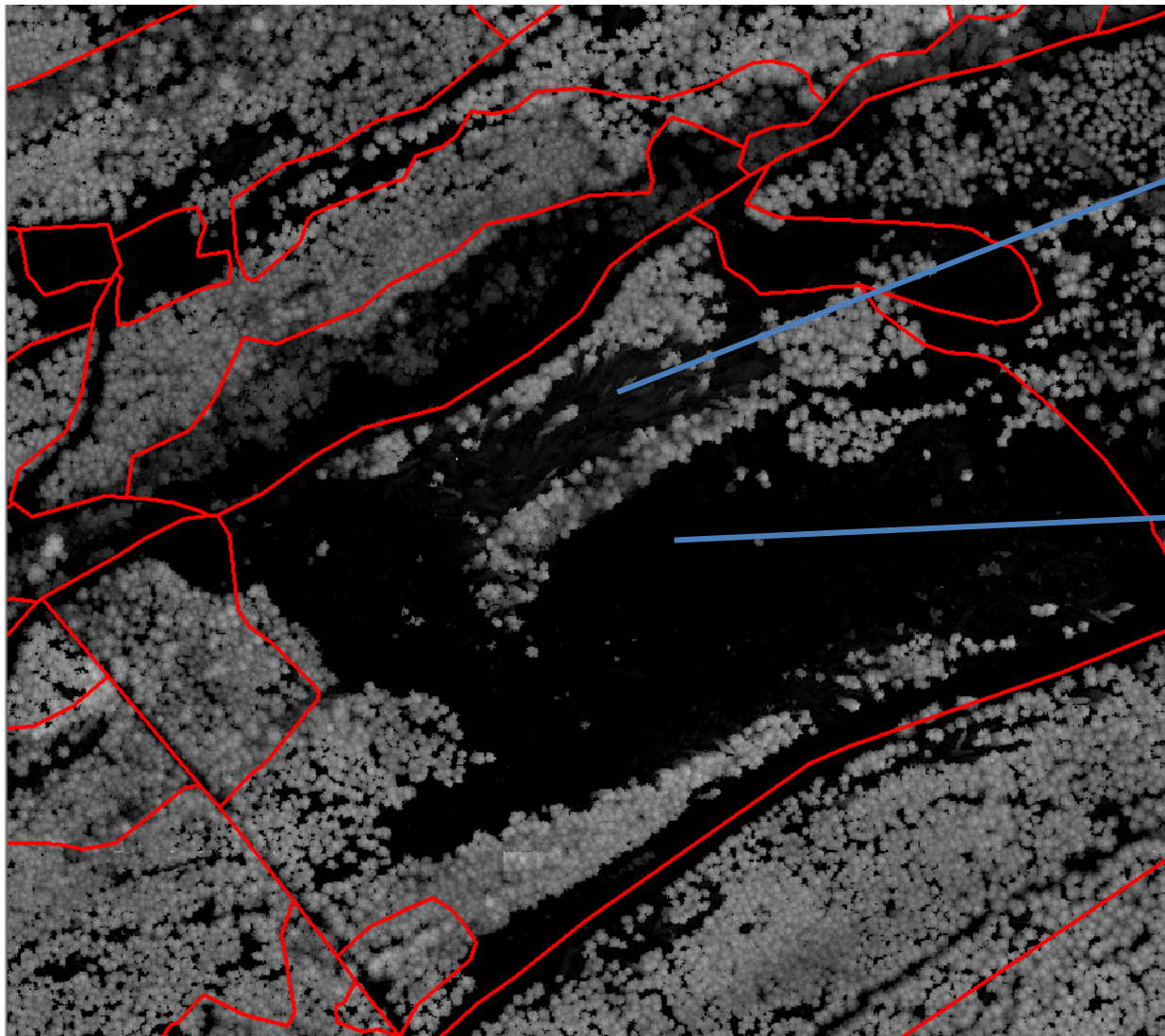
LiDAR survey 2008



Note: Stand in transition to Continuous Cover Forestry was partially felled. This created a new edge in the neighbouring stands that exposed trees to additional wind loading

Note: Line thinning altered spacing, which increased vulnerability to the now more exposed trees

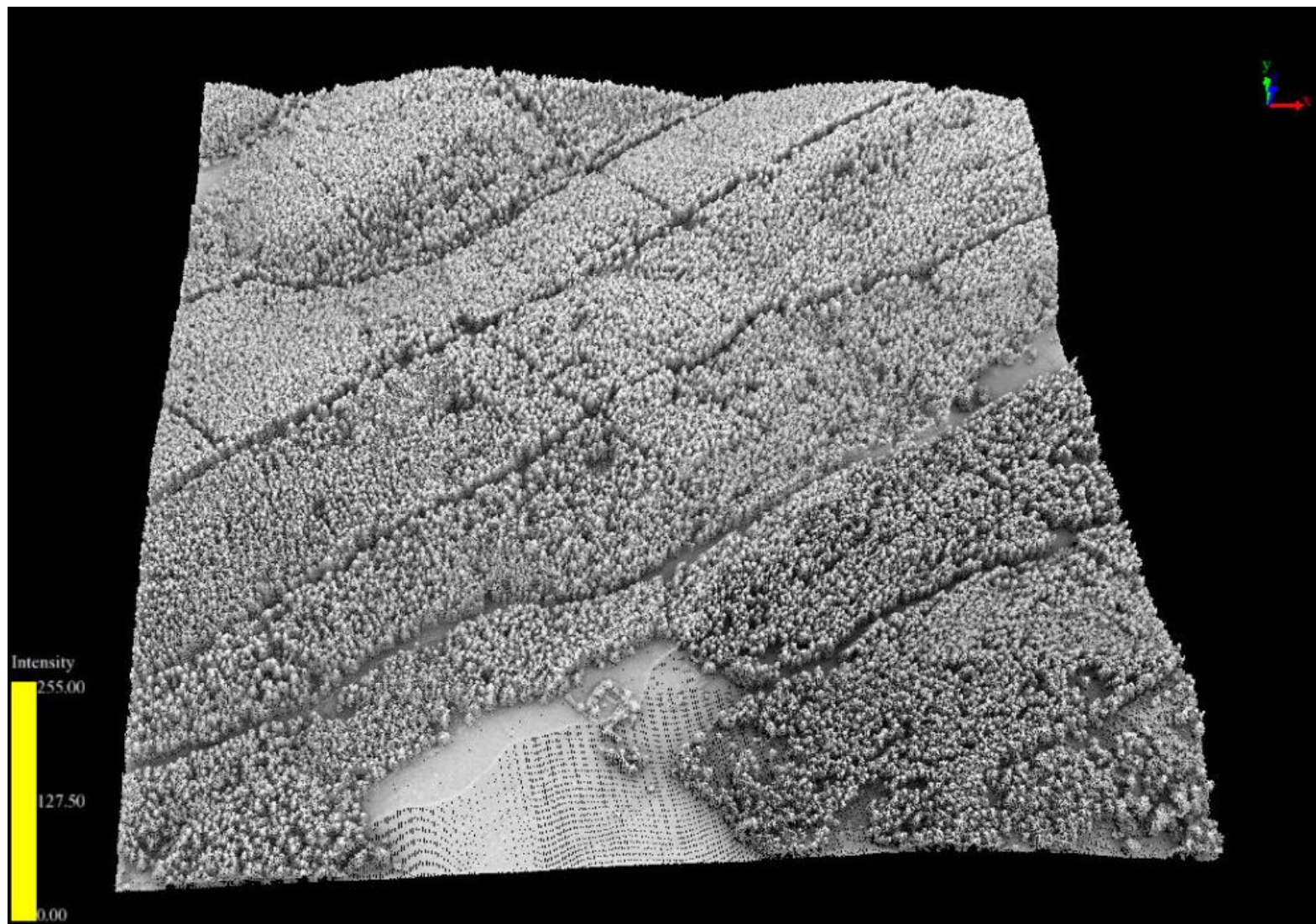
LiDAR survey 2012 - Catastrophic wind damage after the storm



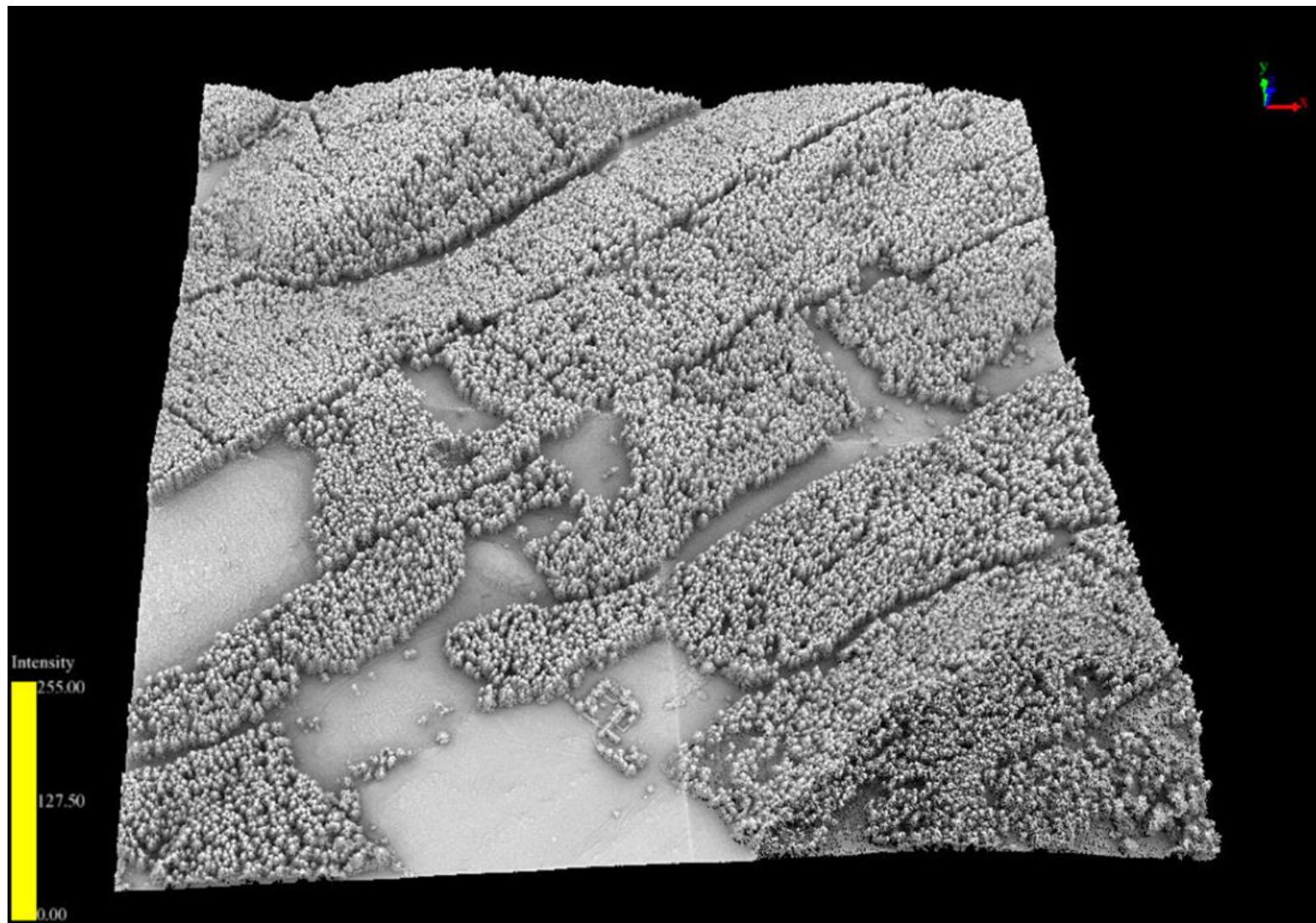
Note: windthrow happening in the most vulnerable parts of the stand after being exposed to a new gap. Lying trees can be observed in the image.

Note: Catastrophic damage affecting the area previously thinned

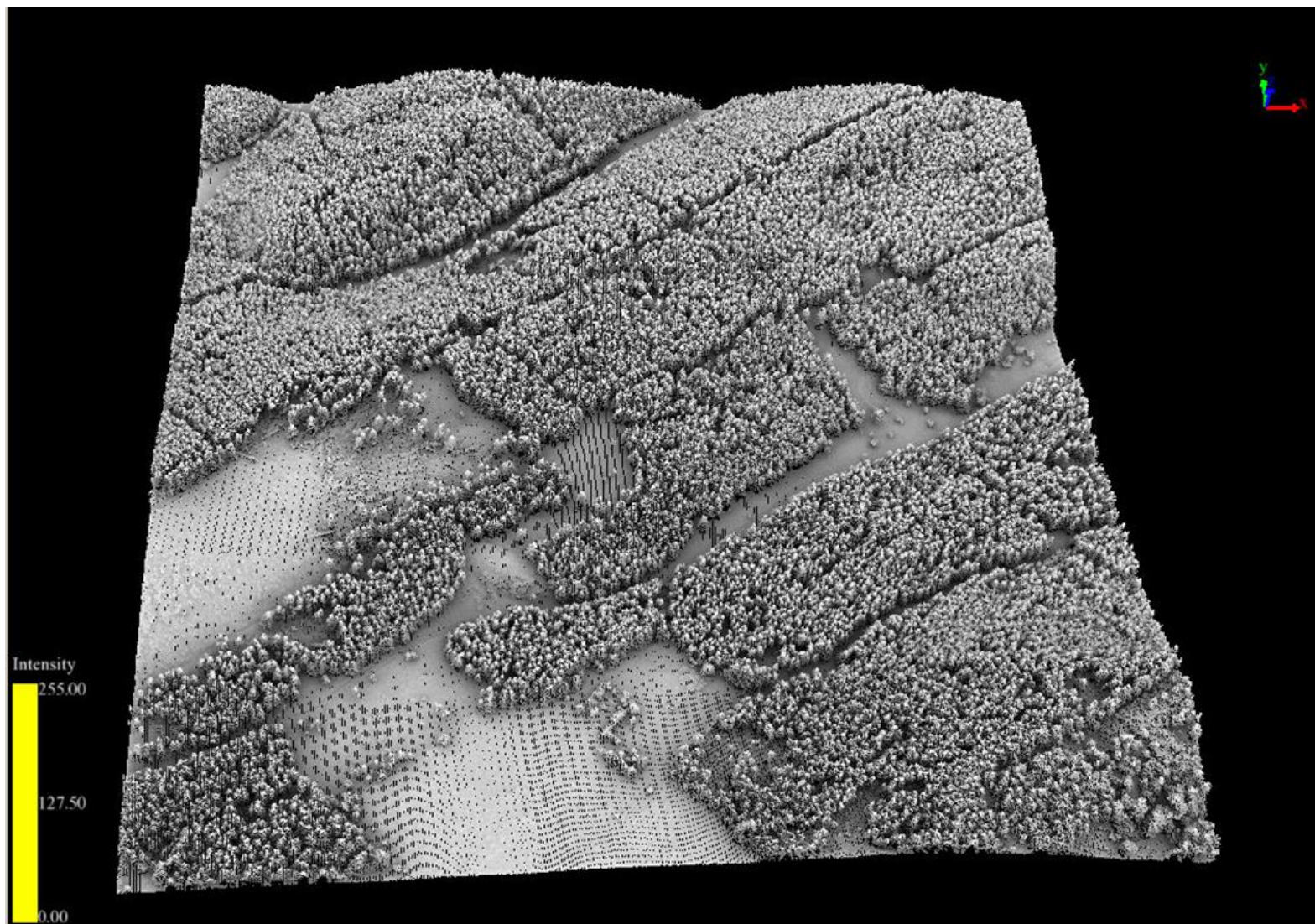
Aberfoyle 2002



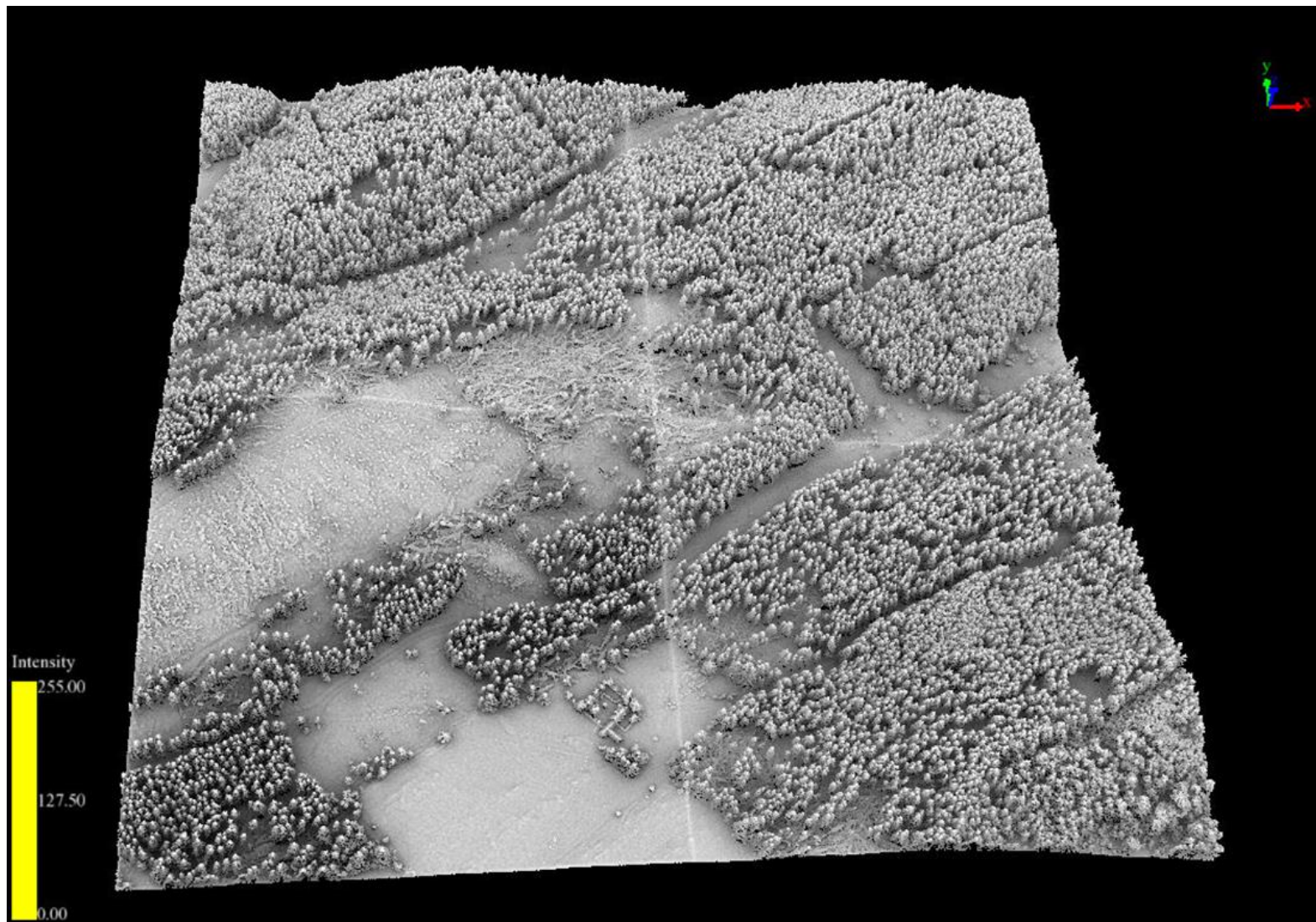
Aberfoyle 2006

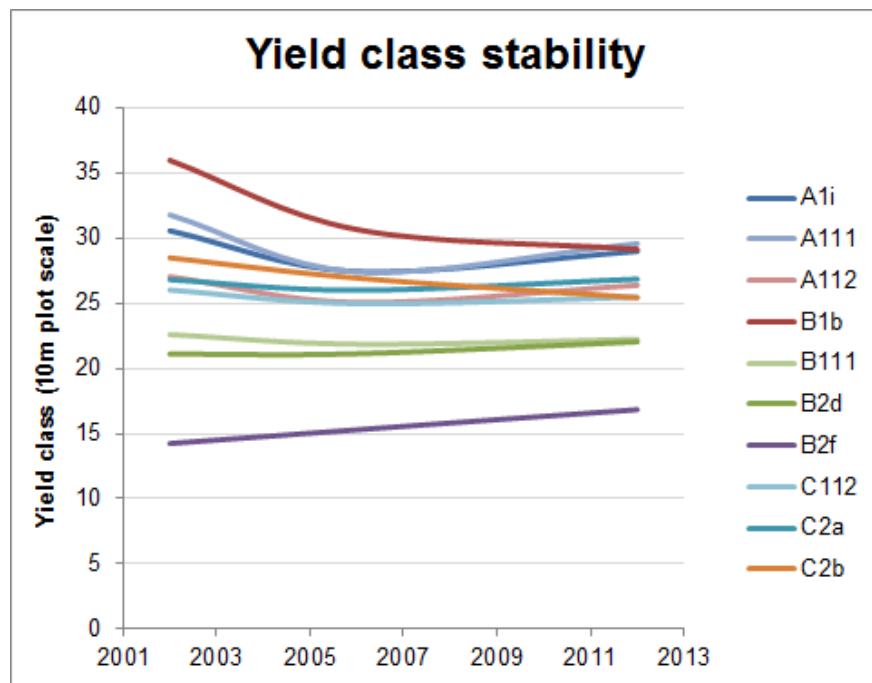
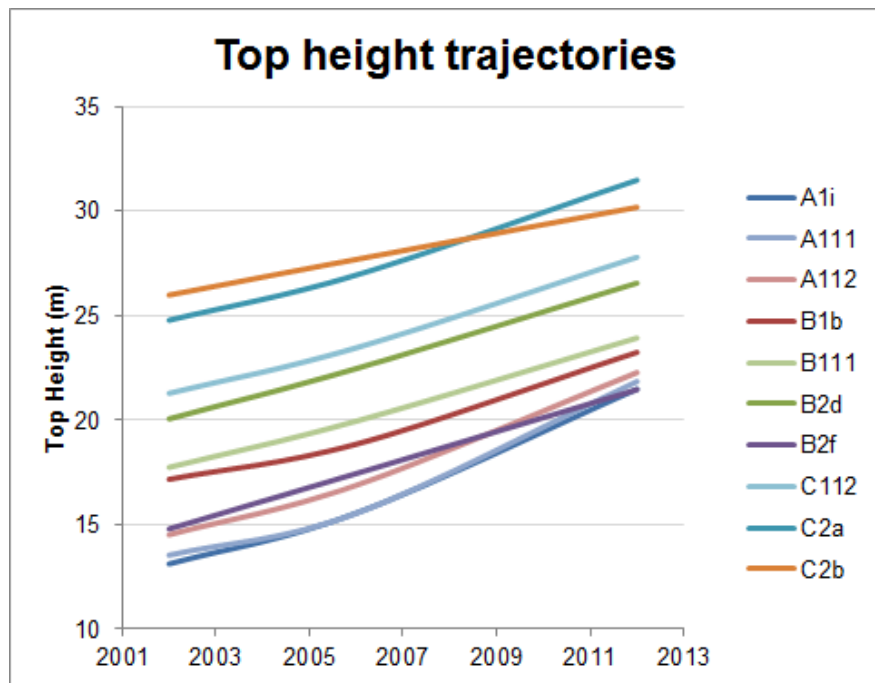


Aberfoyle 2008

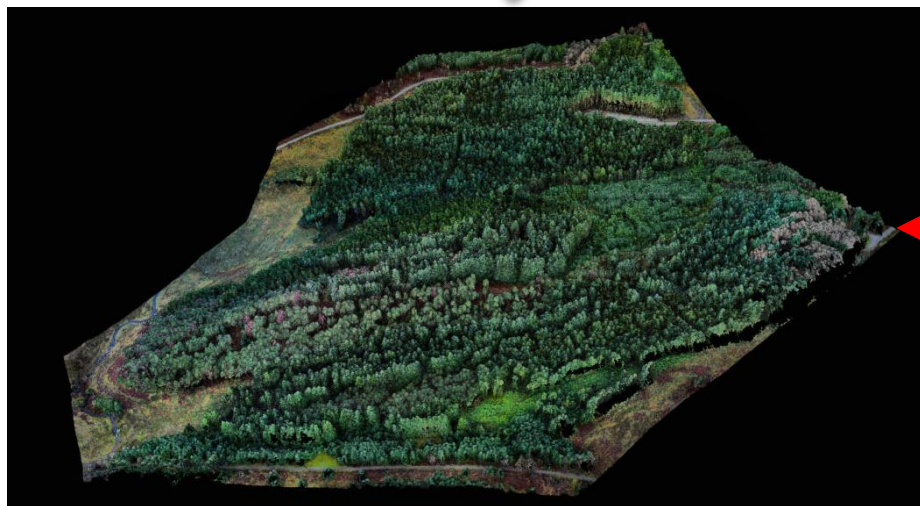
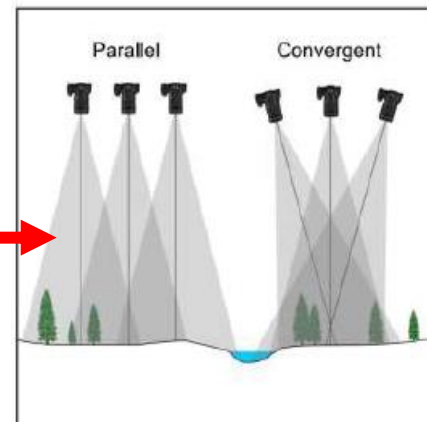
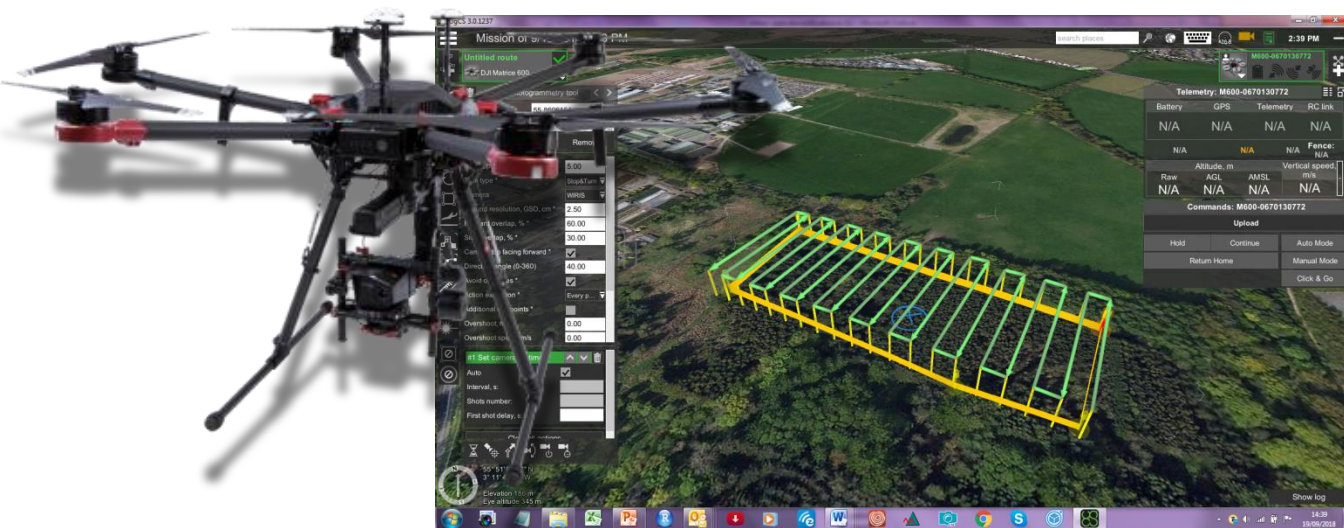


Aberfoyle 2012



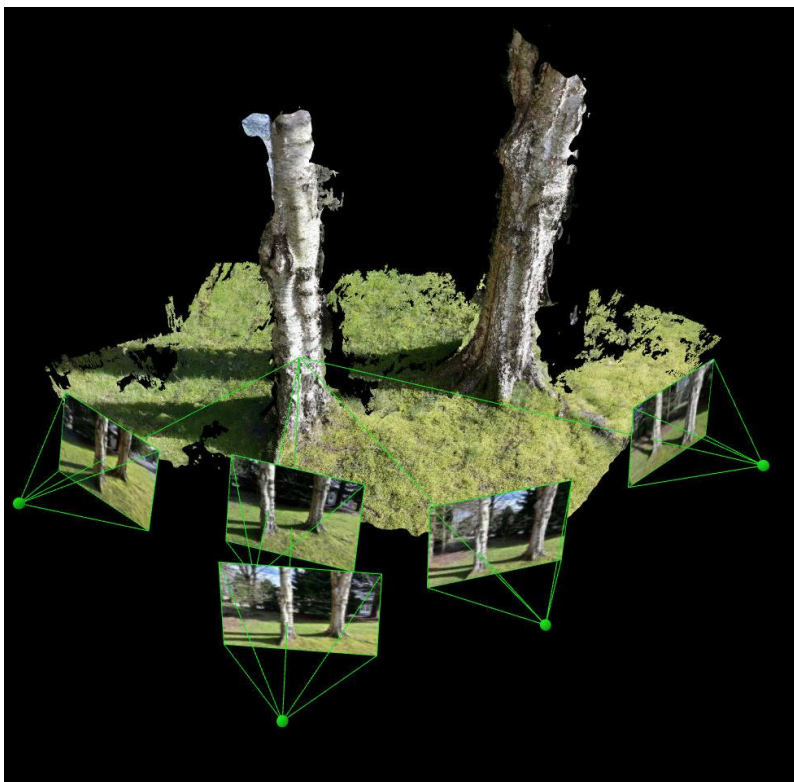


Suarez et al., 2014



Structure from Motion

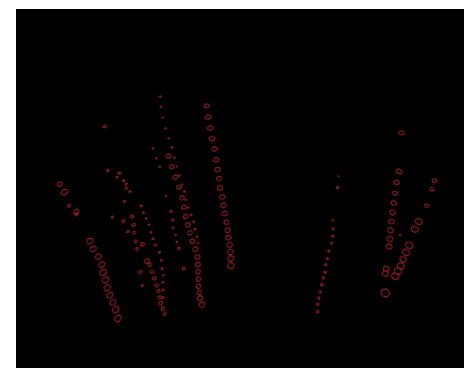




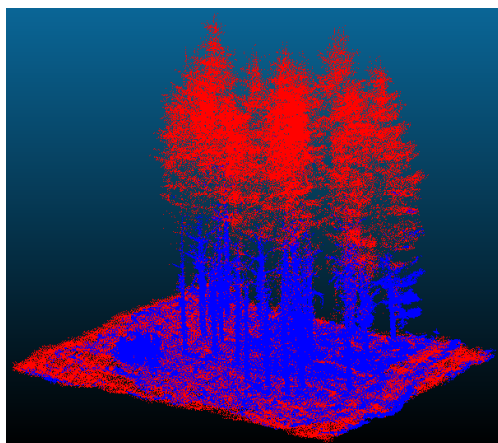
Capturing dbh with a mobile phone



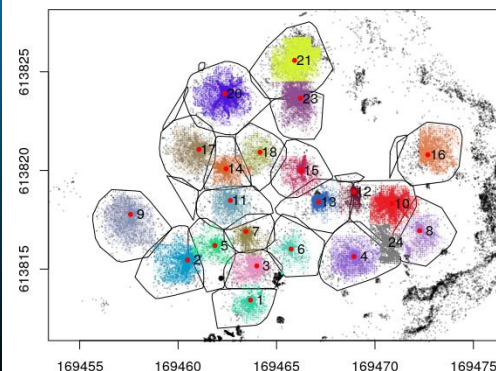
Terrestrial Laser Scan



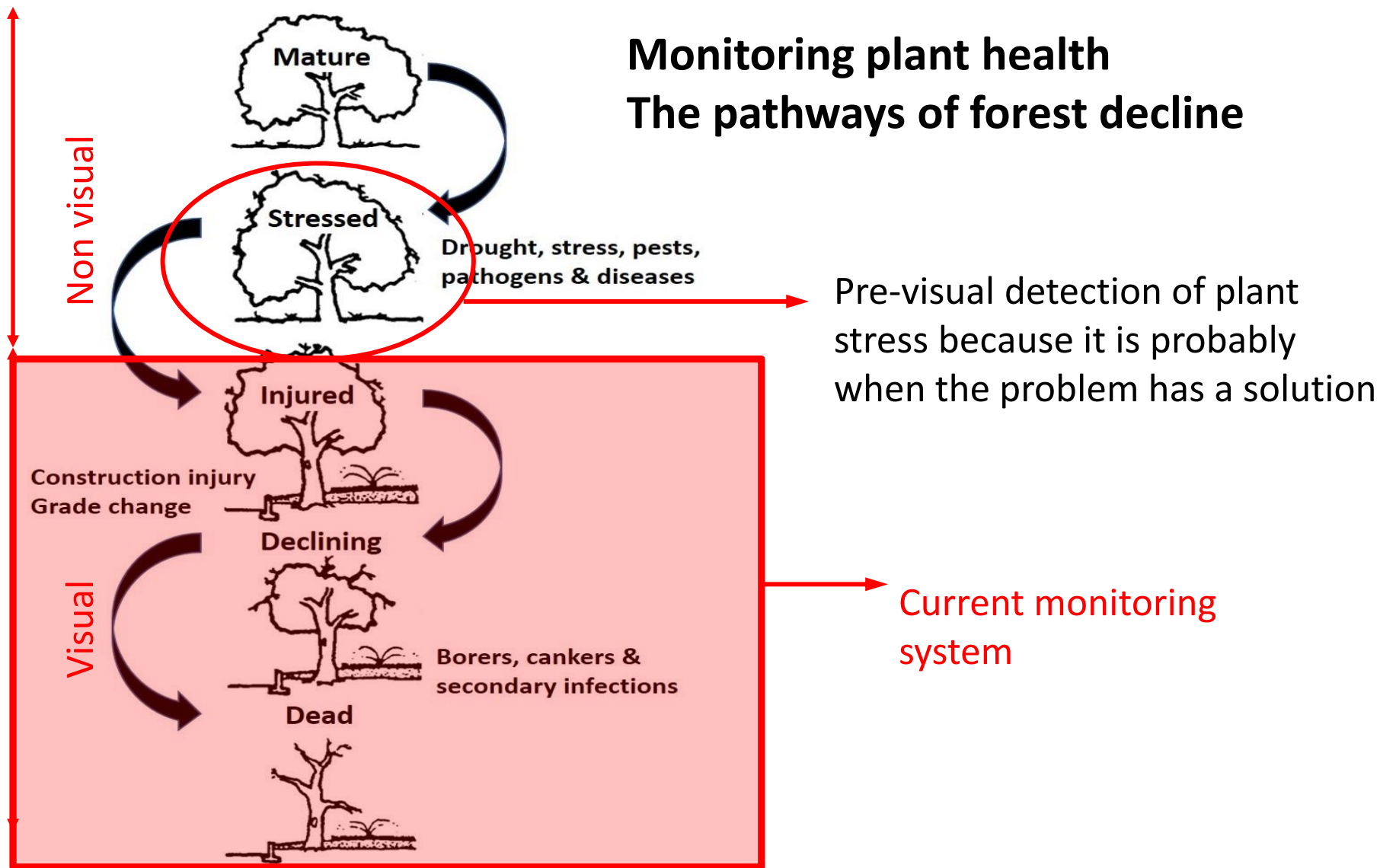
Dbh segments



Data fusion:
TLS and LiDAR



Canopy delineation

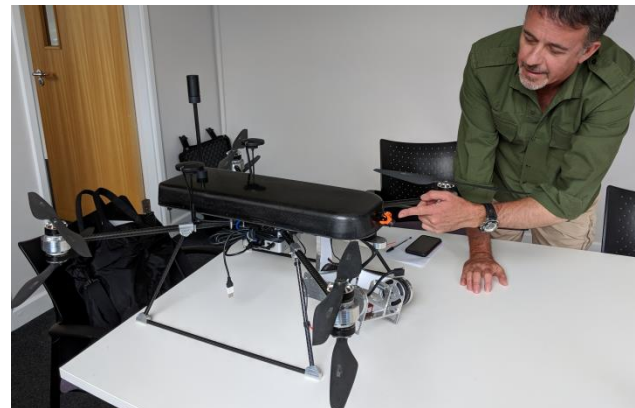


Hyperspectral camera at NRS

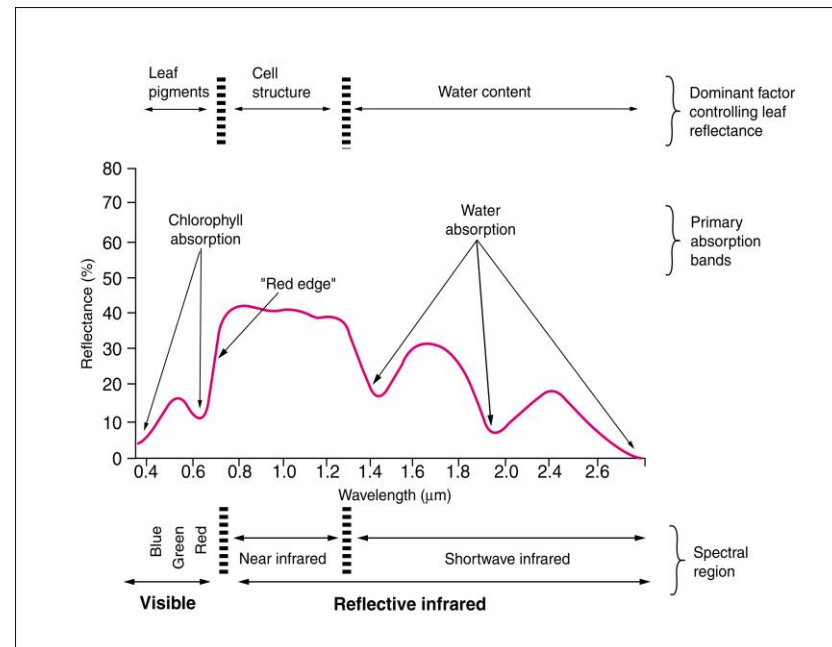
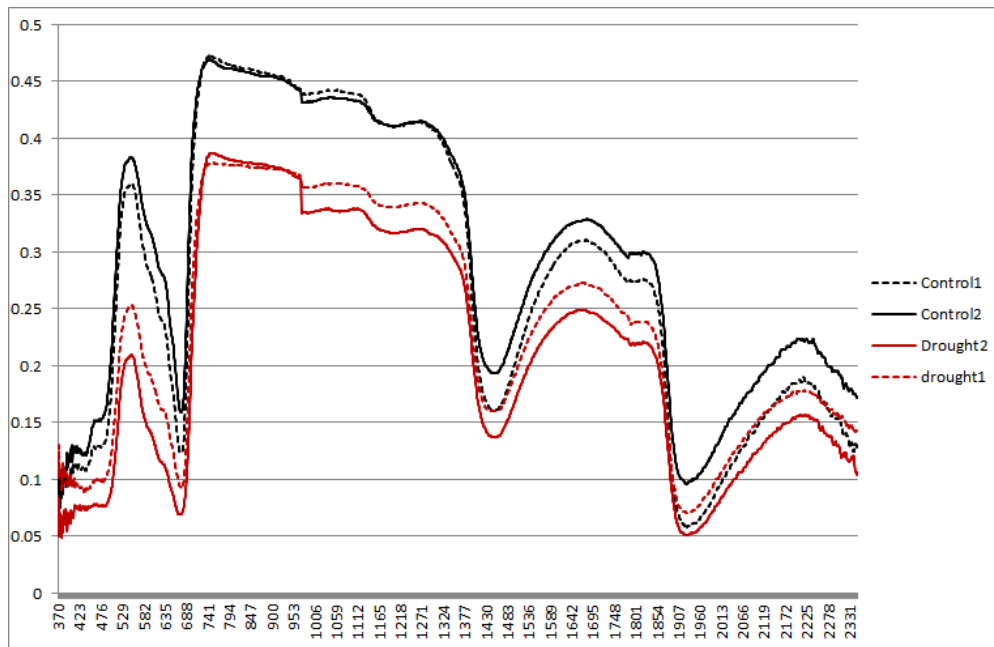


Pika L

Spectral Range (nm)	400 – 1000
Spectral Resolution (nm)	2.1
Spectral Channels	281
Spatial Channels	900
Max Frame Rate (fps)	249
Bit Depth	12
Weight (lb / kg)	1.3 / 0.6
Dimensions (cm)	10.0 x 12.5 x 5.3
Connection Type	USB 3.0
Operating Temperature (°F / C)	41-104, 5-40
f/#	2.4
Pixel size (µm)	5.86
Avg. RMS Spot Radius (µm)	6
Smile (peak-to-peak) (µm)	4
Keystone (peak-to-peak) (µm)	5

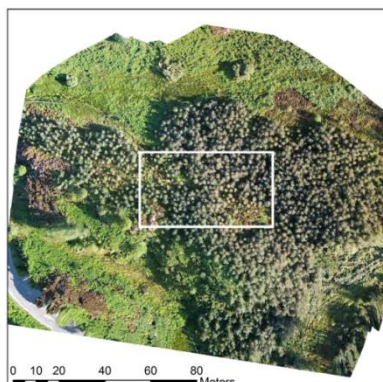


Growth room drought experiments with spectroradiometer (ASD) Japanese larch

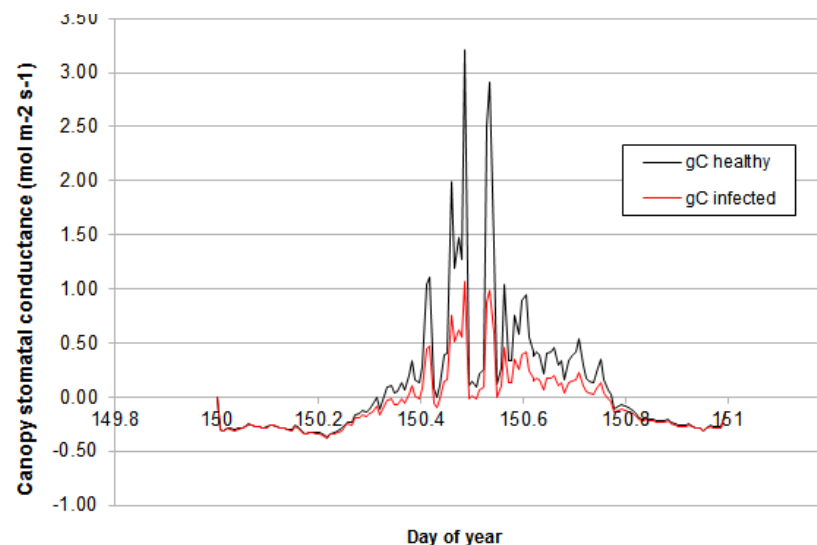
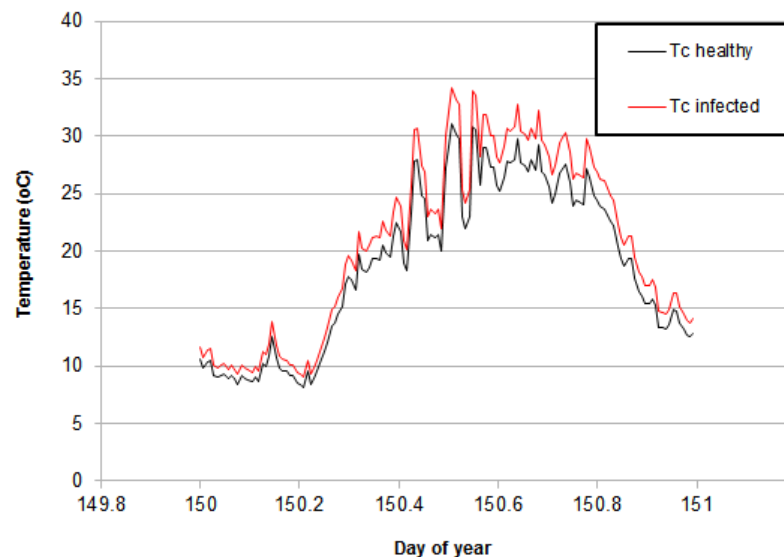


	Control 1	Control 2	Drought2	Drought1
Pigment Specific Normalised Difference (PSNDc)(Blackburn, 1998)	0.56	0.51	0.66	0.58
Carotenoid Concentration Index (CRI550)(Gitelson et al., 2003, 2006)	1.07	0.80	2.79	1.86
Carotenoid Concentration Index (CRI7000)(Gitelson et al., 2003, 2006)	0.90	0.72	2.45	1.70
Photochemical Reflectance Index (PRI) (Gamon et al., 1992)	-0.13	-0.11	-0.19	-0.15
Carotenoid Concentration Index (RNIR*CRI550)(Gitelson et al., 2003, 2006)	2.54	2.20	5.73	4.32

DNB monitoring using a thermal sensor – Study area in Aberfoyle



Resolution: 640 x 512px
 Temperature scale: -40°C to +550°C
 Temperature sensitivity: 30 mK
 Accuracy: $\pm 2\%$ or $\pm 2^\circ\text{C}$
 Weight: 400g
 Spectral range: 7.5 – 13.5 μm
 Can be operated on video and image acquisition



Thank you

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slide 20