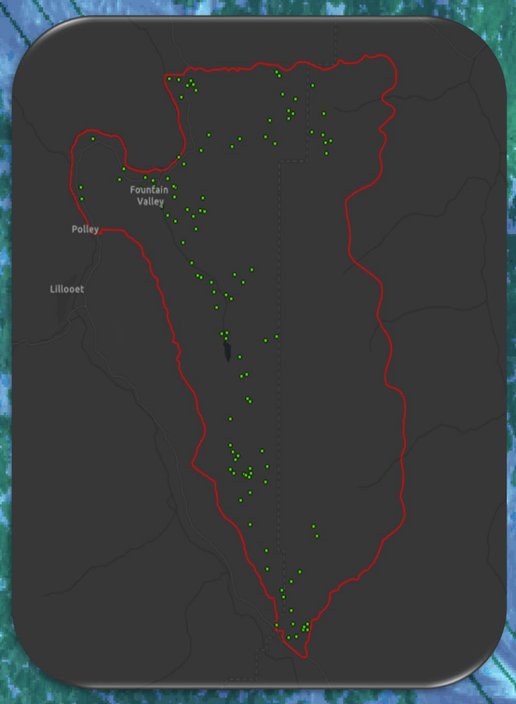
High-Resolution Wildfire Fuel Mapping Using LiDAR

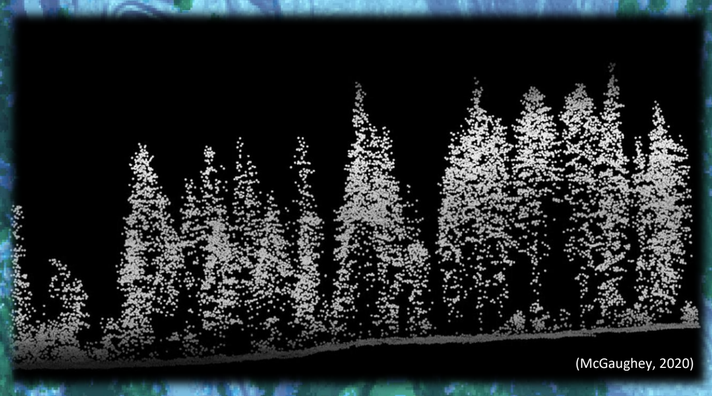
Patrick Robinson
MSc. Candidate, NRES Forestry, UNBC
A Collaboration with the Xaxli'p Community Forest

Background:

This project is part of a multi-year collaboration between the Xaxl'ip people of the St'at'imc Nation and UNBC researchers, Patrick Robinson, Dr. Scott Green, and Dr. Che Elkin, with support from the Pacific Institute of Climate Solutions, the Canadian Forest Service, and the BC Wildfire Service. In its essence, this project is a community directed initiative and the objective of this phase of the work is to use high resolution aerial laser scanning (LiDAR) data to provide forest structural information that can directly aid the Xaxl'ip community in ongoing restoration and climate adaptation planning efforts, specifically focused on wildfire risk mitigation. Previous work and existing data have established that, like to many other areas across the continent, the territory is facing significant risk of catastrophic stand replacing wildfire. To address this risk effectively, the spatial distribution and connectivity of hazard fuels types is being mapped using LiDAR data, providing forest structural information in much greater detail than previously existed. Defining structure and distribution of forest fuels can enable prioritized management planning and climate adaptation action. The image below shows the vertical profile of a forest stand measured using LiDAR data. Key structural characteristics relating to forest fuel-loading can be extracted from this high-resolution three-dimensional data type.



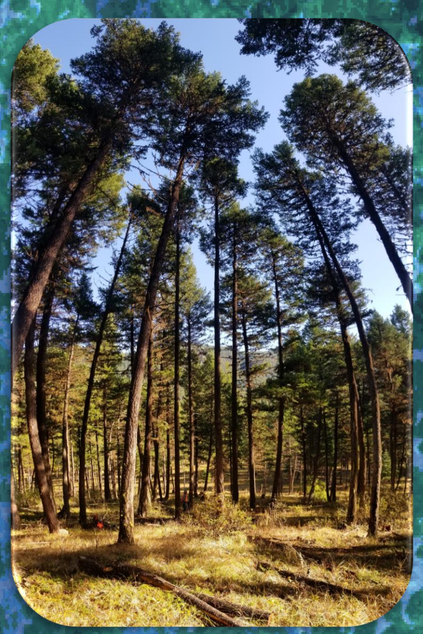
The map above shows the study area boundary and the sample plot locations for field data collection. Field measurements relating to forest structure and fuel characteristics were collected to train machine learning models to predict fuel attributes from the LiDAR data. The image above on the right shows one of the field crew trucks perched on a slope overlooking the community below, with Fountain Mountain in the background.



Data Visualization:

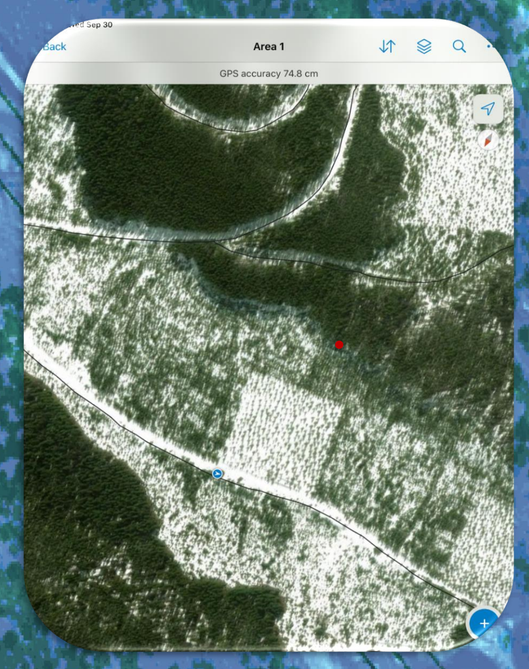
A central component of this project is focused on providing immediately useful tools and map products to the land managers responsible for forest management planning. Arc GIS Online was used to create a comprehensive GIS decision support platform, that provides user-friendly access to important spatial data visualizations. This enables community-directed management planning and helps to facilitate collaboration and ultimately the co-development of management solutions. The Web Mapping Tool is composed of the following components as seen in the series of screen shots to the right:

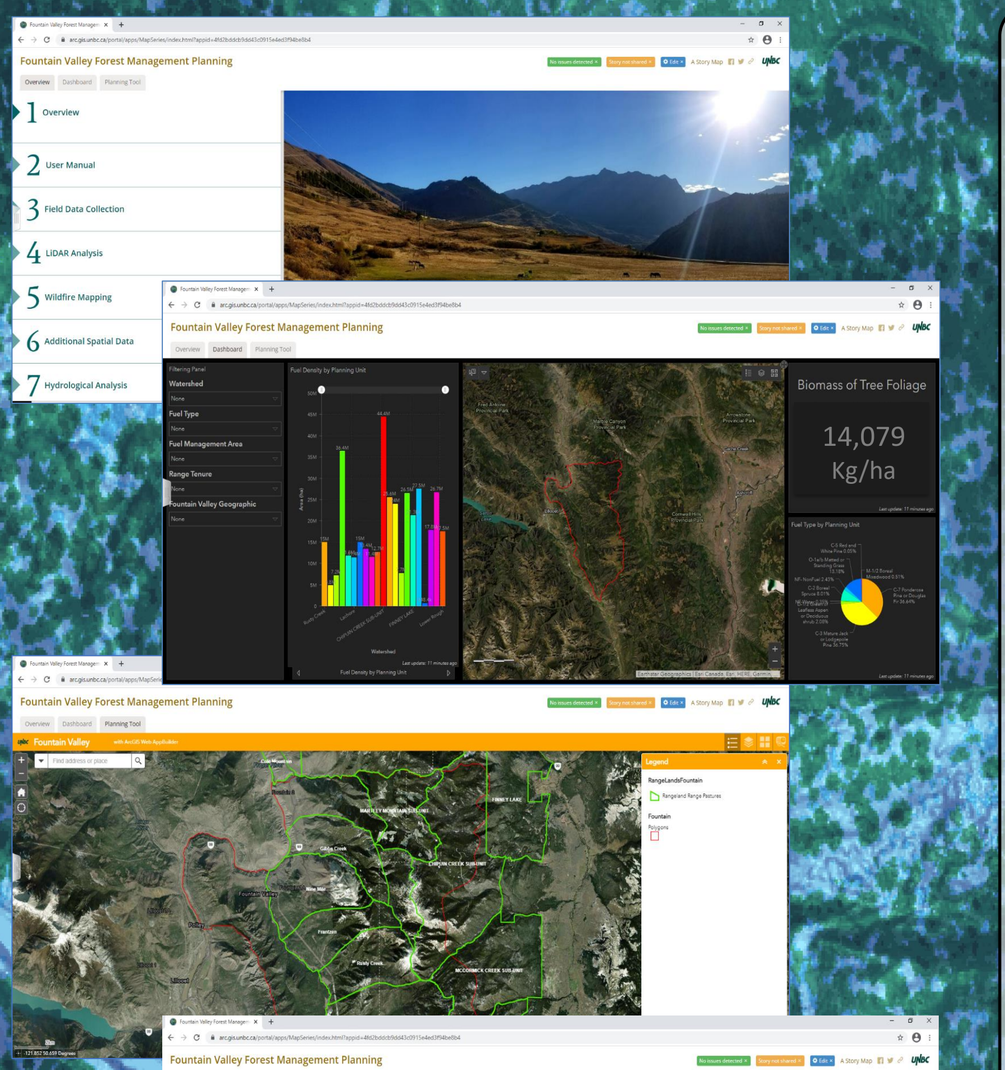
- **Overview -** User manual for dashboard and planning tool including a general description of the analysis preformed.
- **Dashboard -** Interactive data visualization and summary statistics of resultant layers.
- **Planning Tool** - Web mapping tool providing user-friendly data exploration and operational planning utility.



Field Work:

The field work component of this project utilized Arc GIS online web maps in combination with the Collector for Arc GIS mobile app. The web maps were used for preliminary field sample plot mapping, enabling the sample plot location to be displayed in relation to satellite imagery base maps, road layers and fine scale topo lines. In addition, spatial datasets used for the determination of the random stratified sampling design, such as fuel type layers, and slope/elevation values were also included in the field data collection maps. The maps allowed for real time field data collection planning and organization in a way that enabled flexibility and adaptation on the fly, ensuring that each data collection crew was achieving maximum efficiency. The image to the right shows a screen shot of the collector for Arc GIS mobile app being used for field navigation to sample plot locations (blue dot shows location of field crew, red dot shows the sample plot location).





Analysis in Arc GIS Pro:

- **LiDAR Visualization, Data Preparation, and Layer Symbology in Arc GIS Pro:**

Producing DSM's/DEM's, Slope Models, Height Metrics, and Summary Forest Density Surfaces.

- **Hydrologic Mapping in Arc GIS Pro:**

Using the high-resolution DEM provided by the LiDAR data, ESRI's hydrological modeling techniques (ESRI B, 2021) are applied for:

- Watershed delineation
- Stream order and flow direction
- General hydrologic sensitivity

- **Generating Resultant Layers for Web Map:**

This process is key for enabling the summaries in the screening widget as well as the overall dashboard functionality. A series of overlays are applied to create the layers and attributes necessary for creating the desired dashboard functionality and assessment tool report summaries. This enables interactive data visualization and summaries of fuel metrics such as fuel densities (understory, ladder, main canopy), canopy base height, canopy bulk density, canopy fuel load, fuel connectivity etc., as well as forest types and values such as past burned areas, harvested areas, ecosystem restoration areas, timber volumes, biomass values, etc. All important variables to consider in community forest management planning.

Contact:

robinsonp@unbc.ca

References:

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