

# Mapping Planted Forests at Scale

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# Overview

- How do we know how much planted forest there is there in New Zealand?
- Where is the planted forest?
- Land Cover Database
- National Exotic Forest Description (NEFD)
  - Self reported
  - Survey based
  - Nursery surveys
  - Woodlots are challenging

# Overview

- New Zealand's goal: Net Zero 2050
- Abatement is hard for many sectors (agriculture, transport)
- ...so we will be planting trees...lots of trees...in lots of places

## Perspective

- 1.75 M ha P. radiata in total
- Depending on how we do this... **0.7 - 1.7 Mha** of new forest
- What happens when large-scale afforestation by smaller growers
  - On-farm incentives
  - Carbon (+timber) foresters
  - Alternative species
  - Māori growers
- **We need new ways of monitoring this planting**

# Opportunity for remote sensing

Measuring forests:

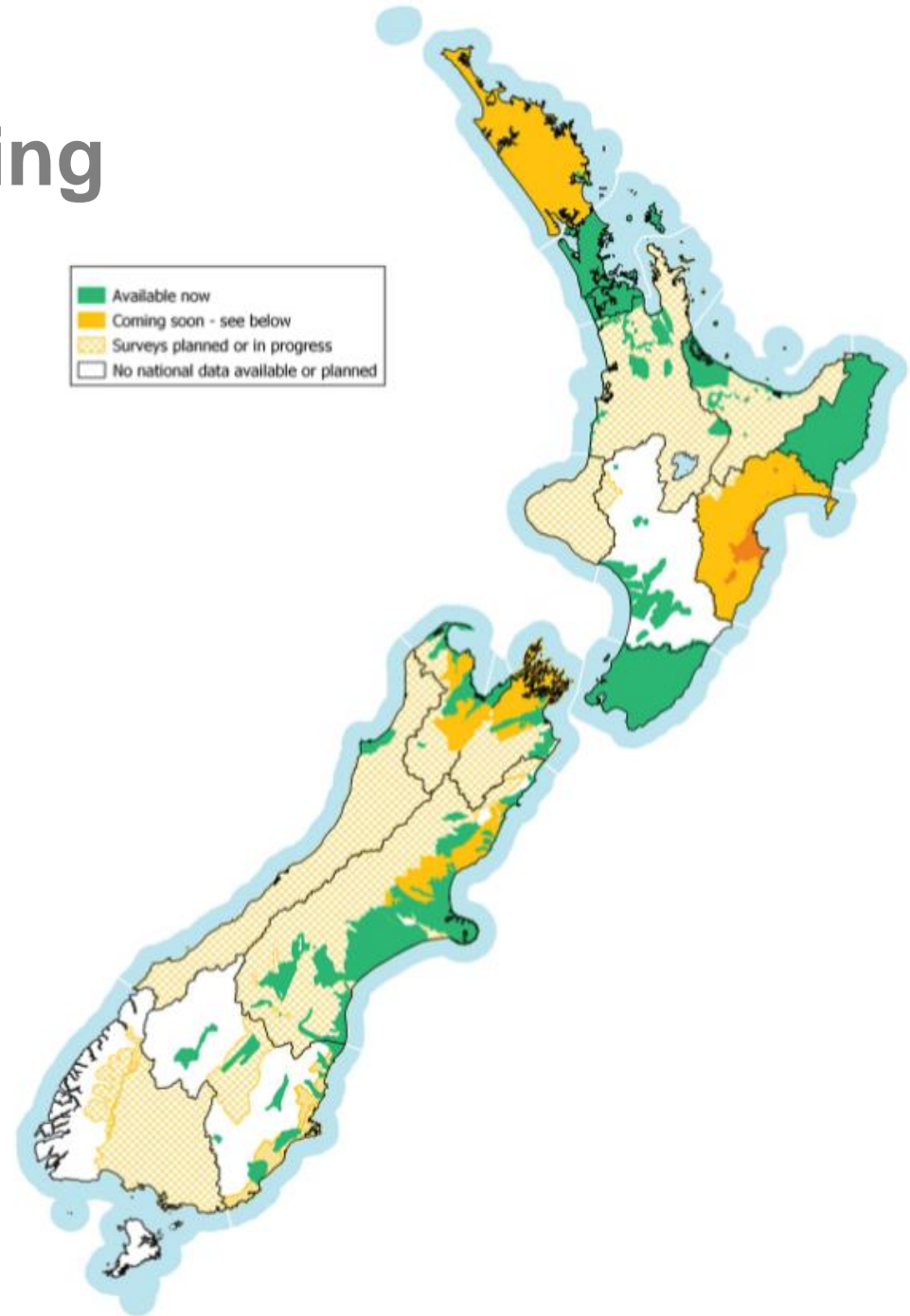
- Satellite Remote Sensing
- Sentinel-2
- Resolution is challenging for woodlots
- Species is harder from satellite
- Detection age > ?



# Opportunity for remote sensing

Measuring forests:

- LiDAR is essential:
  - Height
  - Volume
  - Stocking
  - Carbon
  - Age (indirect)

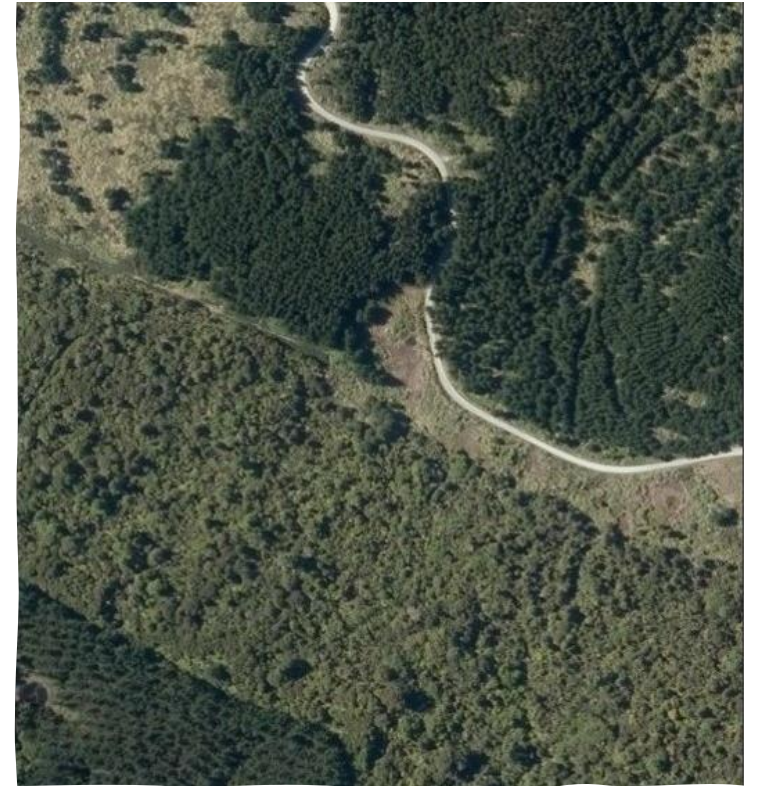


# Opportunity for remote sensing

Measuring forests:

- LiDAR is essential
- First... we need a high-resolution map of all the forest
- [basemaps.linz.govt.nz](http://basemaps.linz.govt.nz)

# Step 1: High-resolution exotic forest map using DL



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Proof of Concept

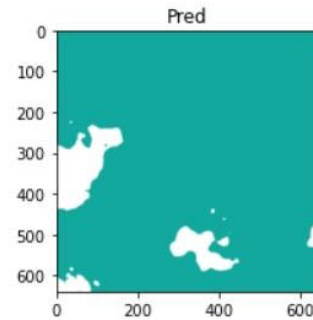
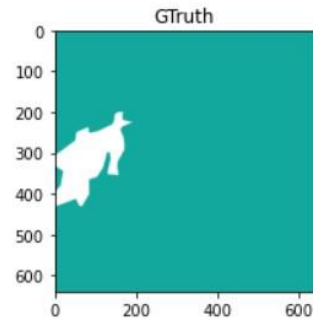
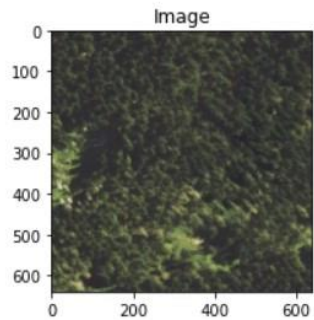
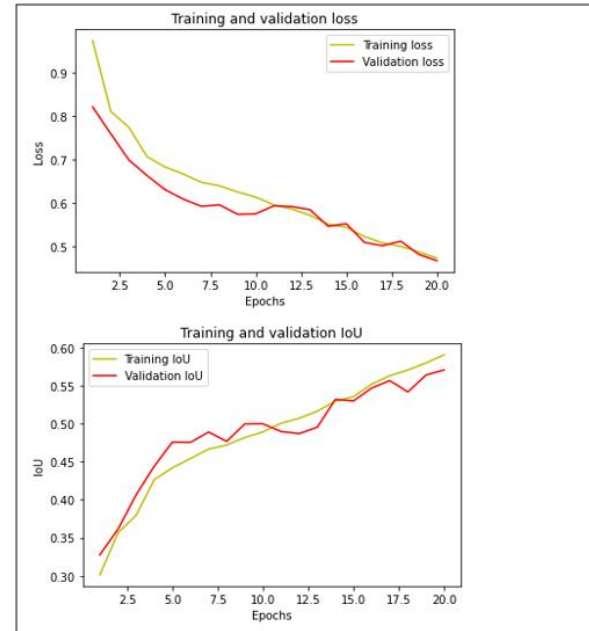
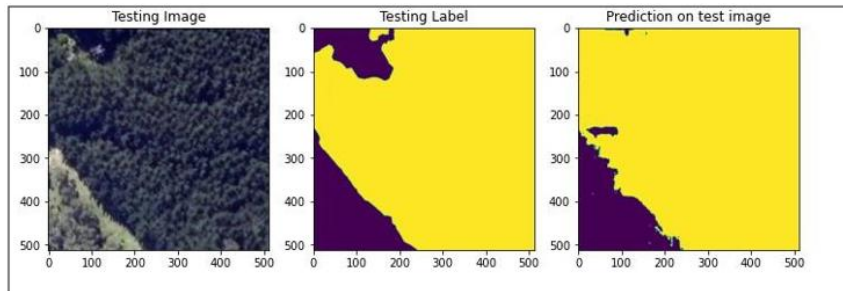
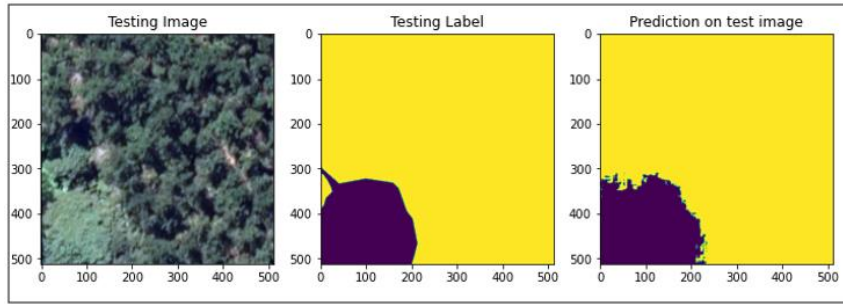
~ 500 1:1K tiles





# Prototyping

- ~ 80-85% foreground accuracy (0.7-0.8 IoU)
- Classification Task: 98% accuracy

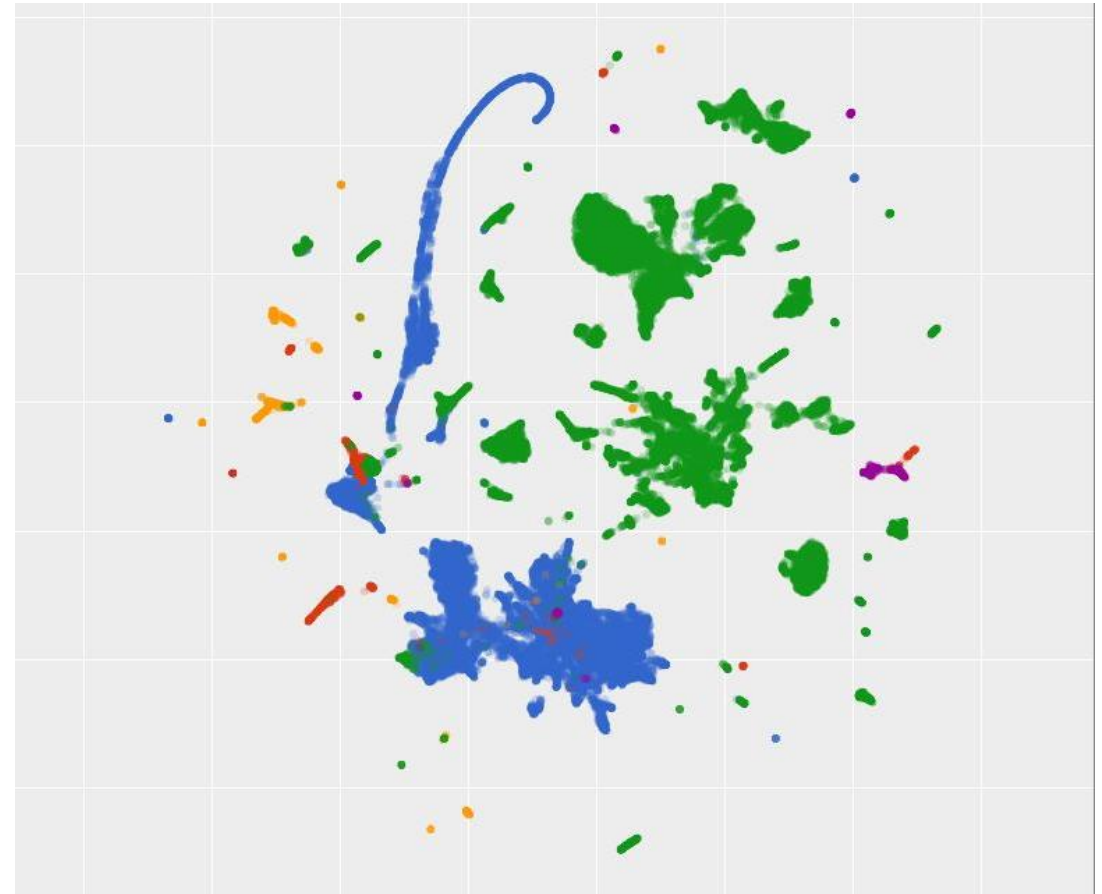


# Iterative Dataset Development

- ~ 80-85% foreground accuracy (0.7-0.8 IoU)
- Classification Task: 98% accuracy

## Version 2

- Use image embeddings
  - Refine or re-enforce labels
- Interrogate the model: loss vs. embedding
- Find rare/underrepresented examples
- Targeted labelling
- Write an annotation manual

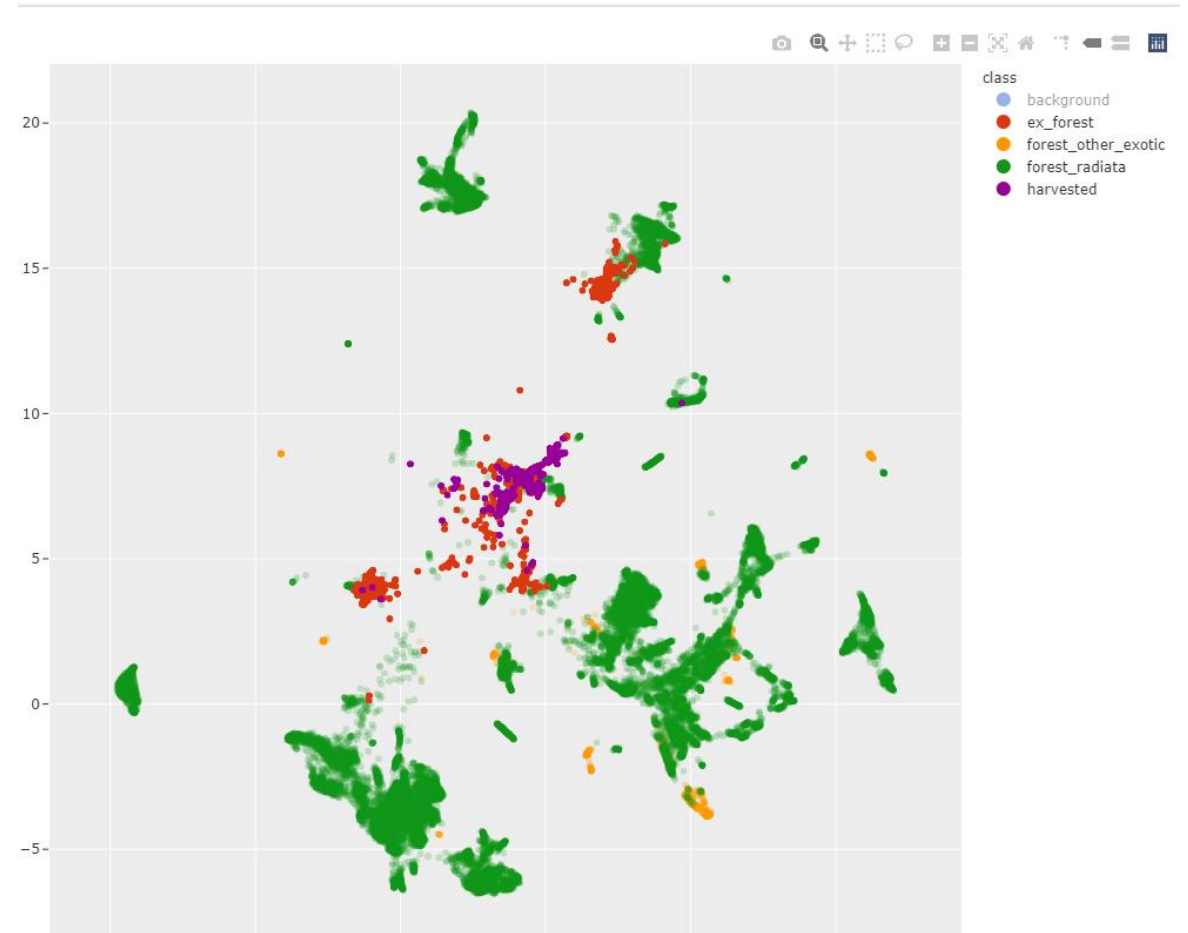


# Iterative Dataset Development

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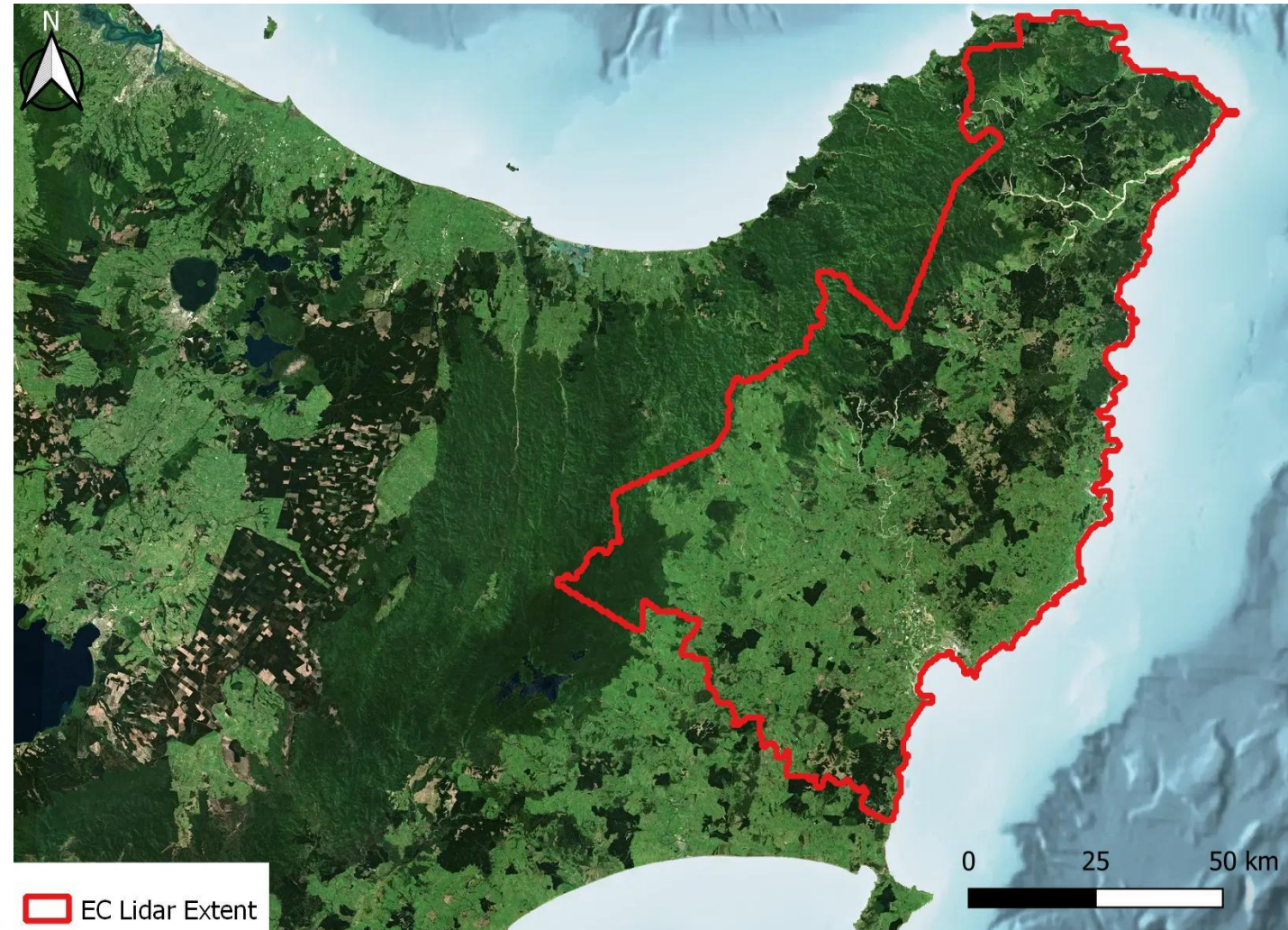
## Version 2

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# Iteration 2: Regional predictions

- Gisborne Lidar 2018-2020
- Imagery 2017-2019
  - 30cm
  - 8700 km<sup>2</sup>



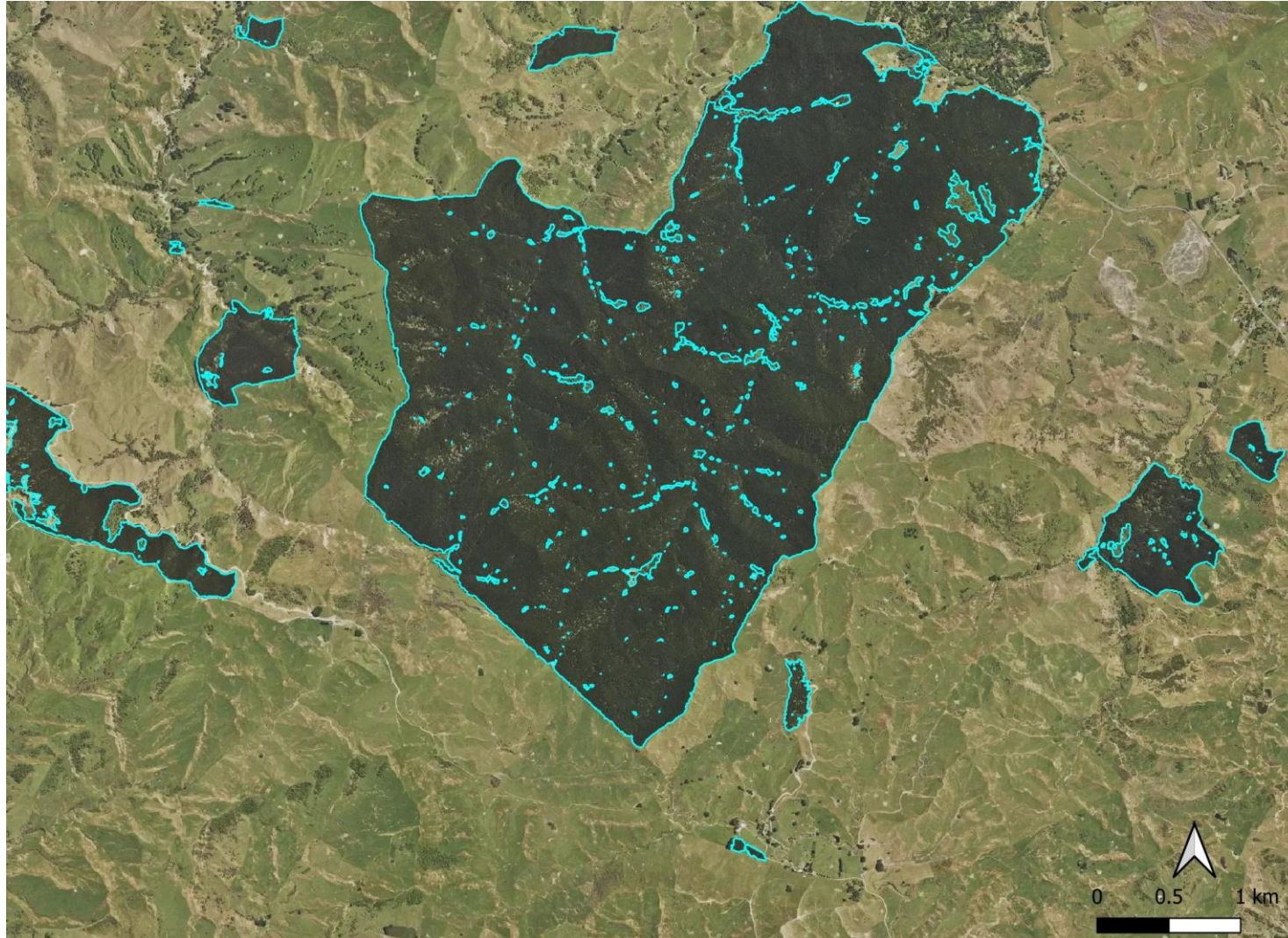
## Iteration 2: Regional predictions

- Generally good at planted forest
- Large-scale inference
- 350km<sup>2</sup> data



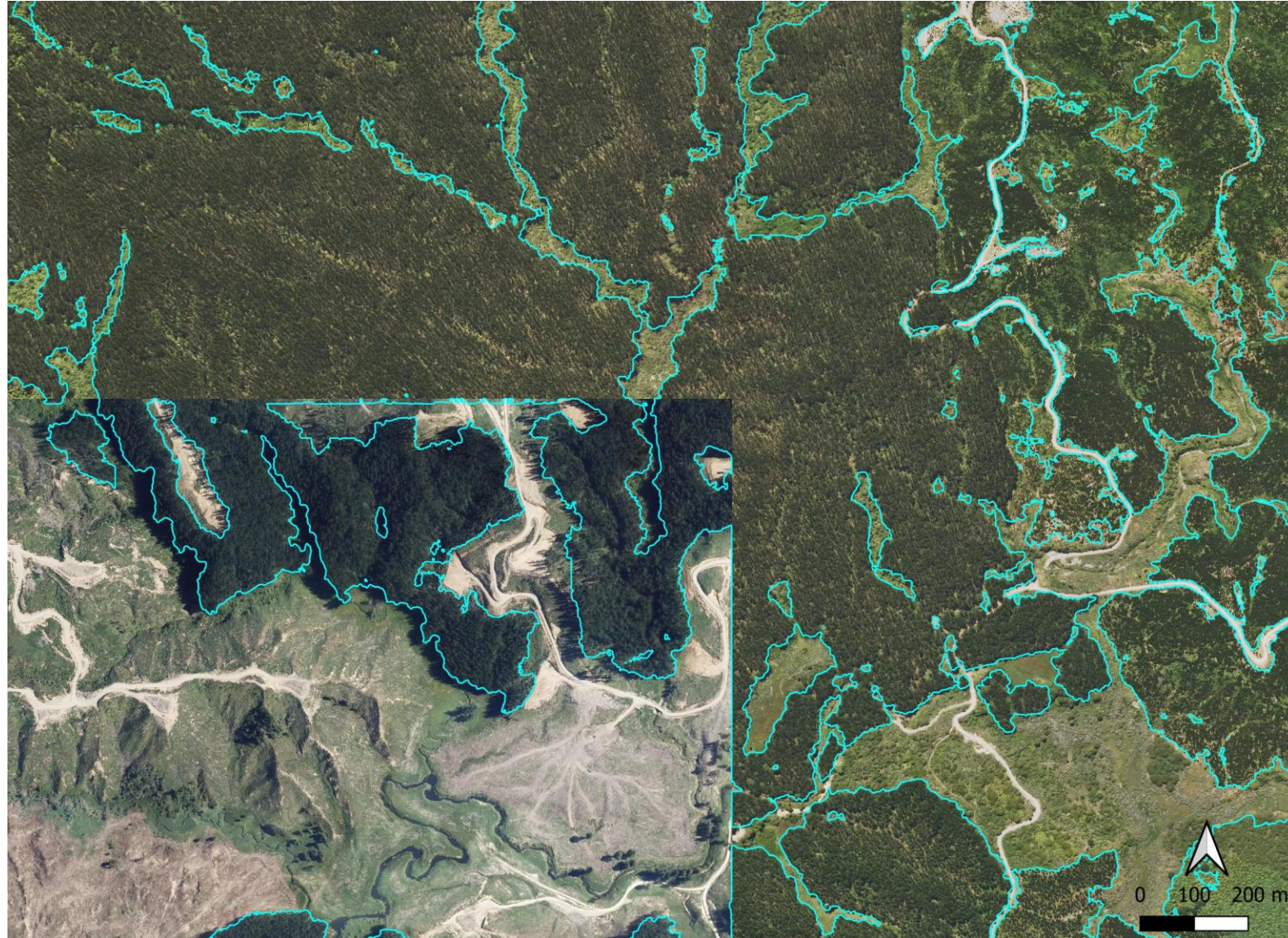
# Iteration 2: Regional predictions

- Stand boundary mapping
- Net stocked area



# Iteration 2: Regional predictions

- Varied imagery



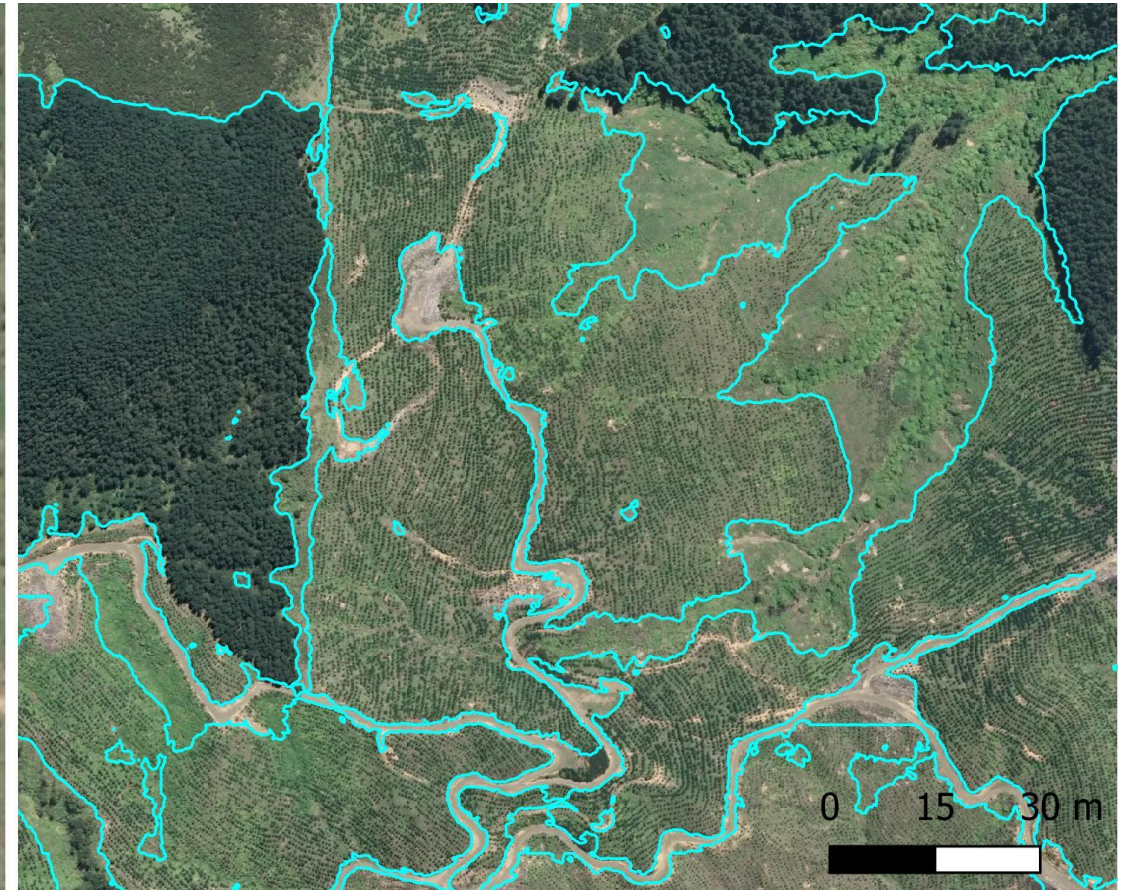
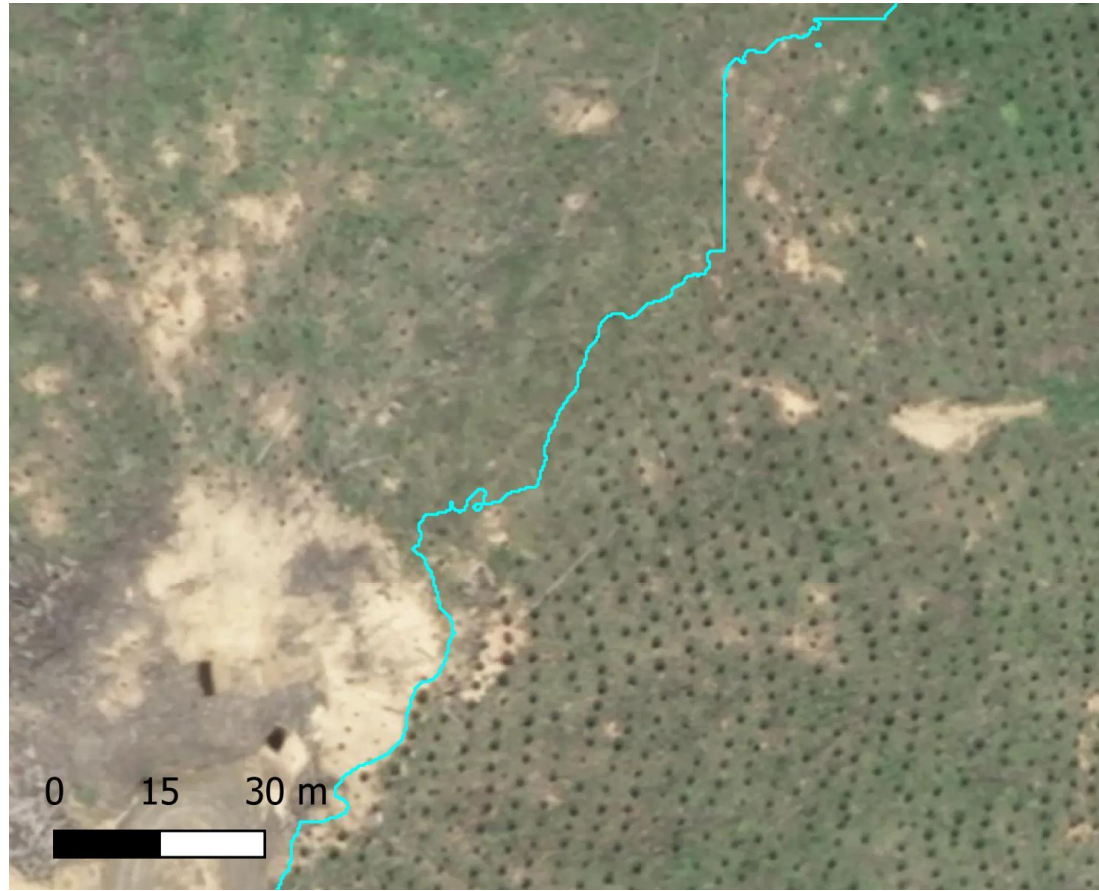
# Iteration 2: Regional predictions

- Edge cases



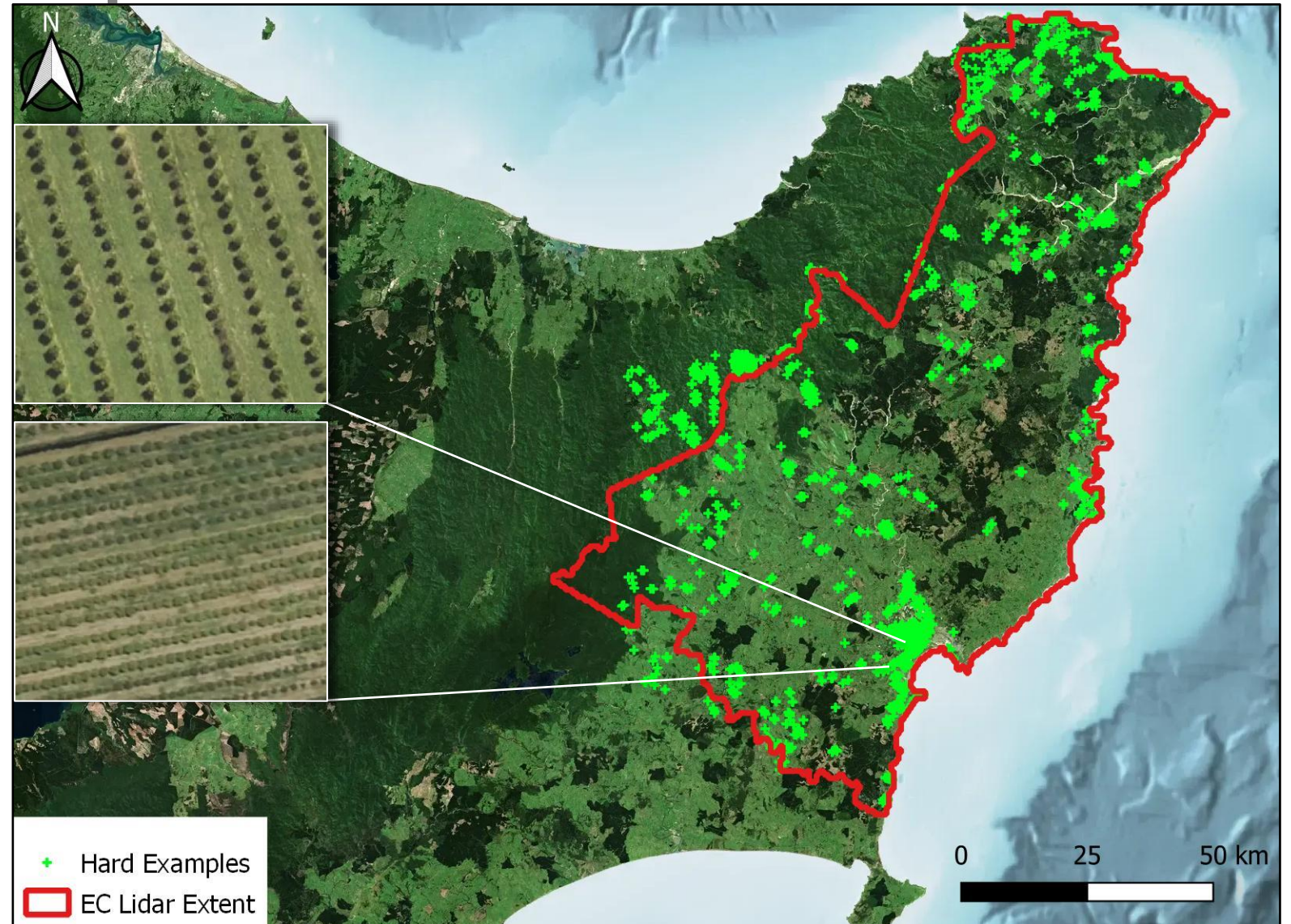


# Iteration 2: Regional predictions



# Iteration 3: Next steps

- Hard examples
  - False positives
  - False negatives
  - Relabel
  - Retrain
- Continuous pipeline



# Backend infrastructure

- Cloud-based workflow - AWS
- Cost-effective training (commodity cloud)
- Accelerated inference
- Lots of cleaning in GIS
- Over a decade of imagery on LDS
- Run the model on past, current and future imagery

The screenshot displays the LINZ DATA SERVICE interface. The header includes the logo for Toitū Te Whenua Land Information New Zealand, a search bar with the text "Search for data & maps", and navigation links for "Search", "Help", and "Sign in". The main content area is titled "Aerial Photos Data - Page 38". On the left, a sidebar menu lists various data types and categories, with "Aerial Photos" selected. The main content area shows three data entries, each with a map thumbnail, a title, a "National Imagery" label, and a row of icons for actions like "Licence", "Download", and "Added".

DATA TYPE	Count
All	380
Layers	380
CATEGORY	
All	2404
Aerial Photos	380
Crown Property	5
Elevation	173
Full Landonline Dataset	90
Gazetteer	3
Geodetic	63
Hydrographic & Maritime	871
Property Ownership & Boundaries	32
Roads and Addresses	43
Suburbs and Localities	8
Topographic	726
GROUP	
REGION	

Title	Licence	Download	Added
Bay of Plenty 0.25m Rural Aerial Photos (2011-2012)	248118	7186	20 Nov 2013
Bay of Plenty 0.4m Rural Aerial Photos Index Tiles (2010-2012)	25813	181	18 Nov 2013
Bay of Plenty 0.25m Rural Aerial Photos Index Tiles (2011-2012)	24224	230	18 Nov 2013

# Beyond mapping: DigitalTwin (updateable)

- Indufor
  - National Lidar
- Sentinel2 Composite
- MAJA composite product (CNES)
- GEE composite (Indufor)
- Age of establishment?
- Goal: Snapshot -> Digital Twin using remote sensing
- **Ground truth** - inventory data, stand boundaries, stand records



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