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

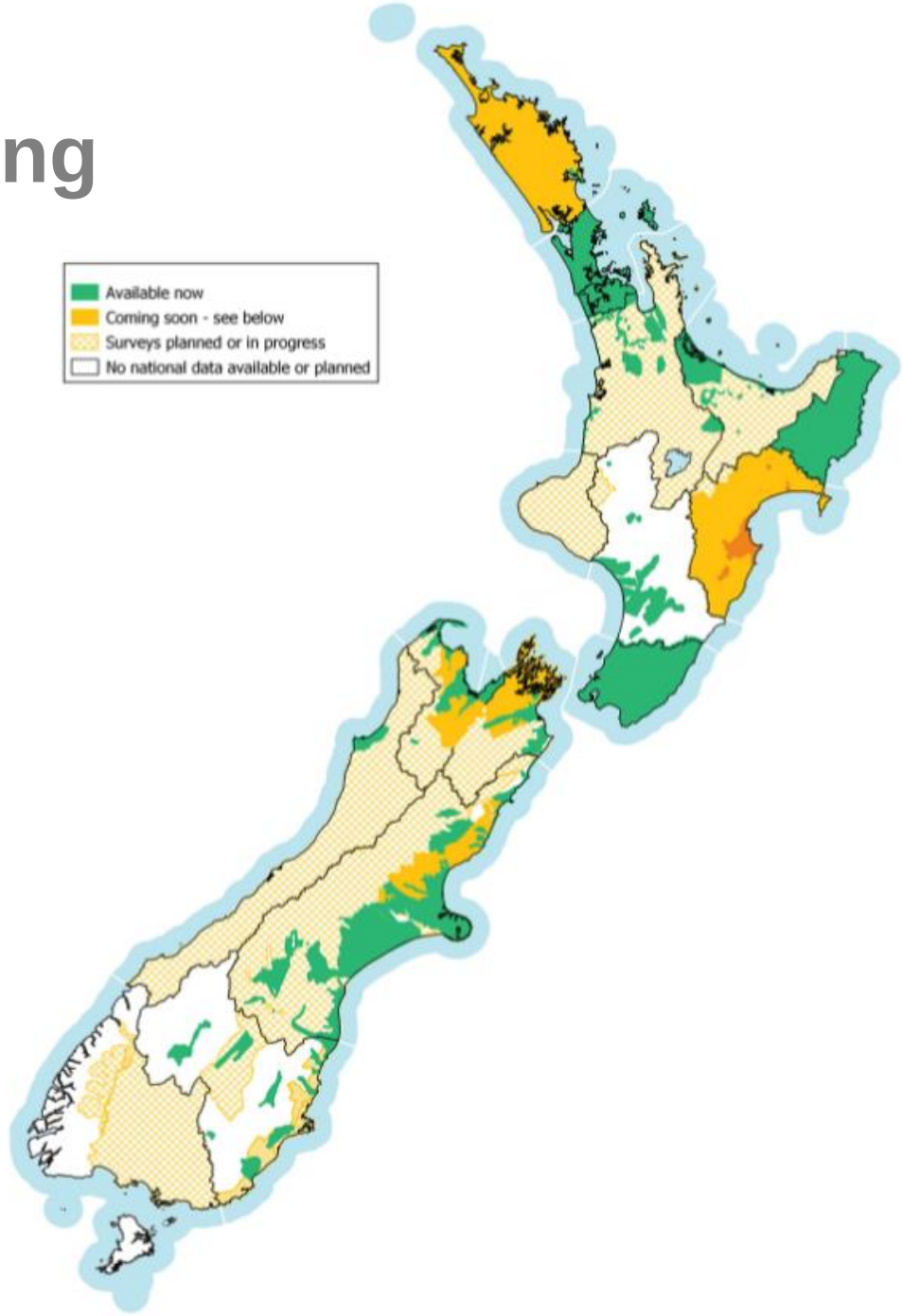
Measuring forests:

- 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)

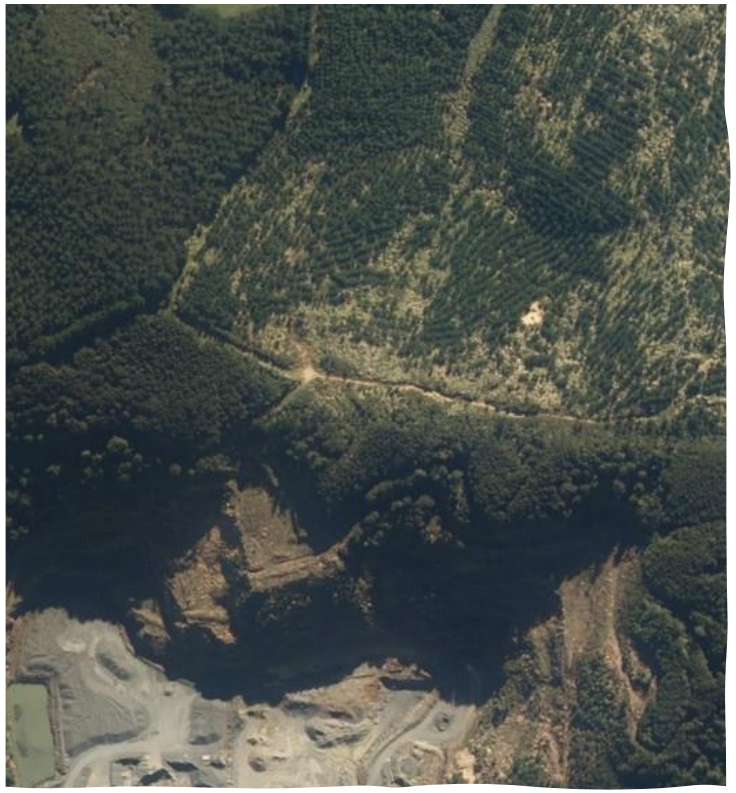


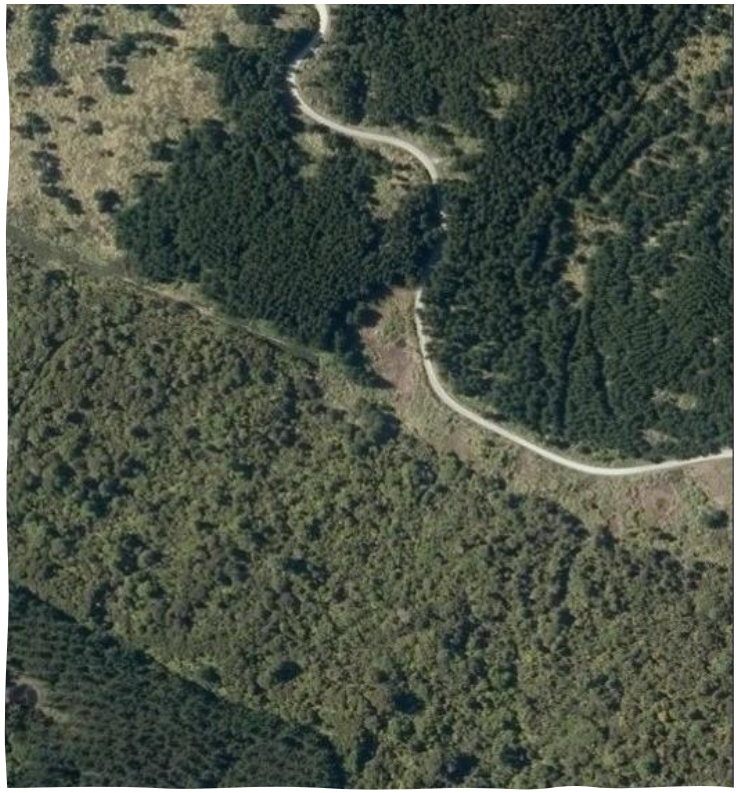
Opportunity for remote sensing

Measuring forests:

- LiDAR is essential
- First… we need a high-resolution map of all the forest
- basemaps.linz.govt.nz

Step 1: High-resolution exotic forest map using DL





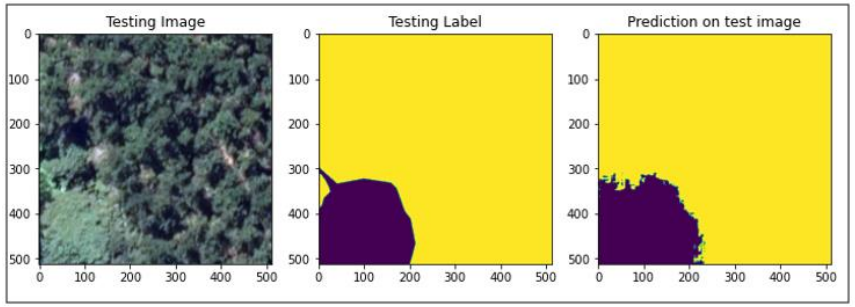
Step 1: High-resolution exotic forest map using DL

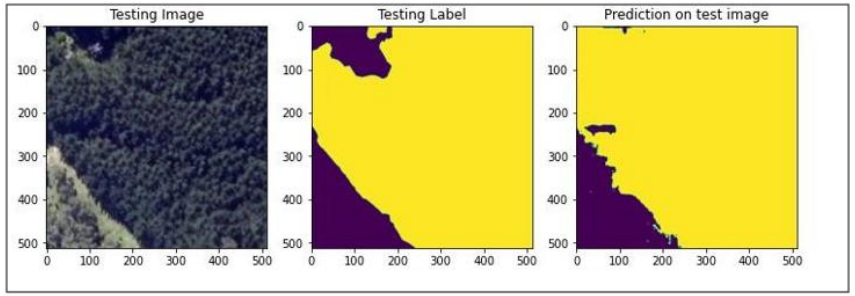
Proof of Concept

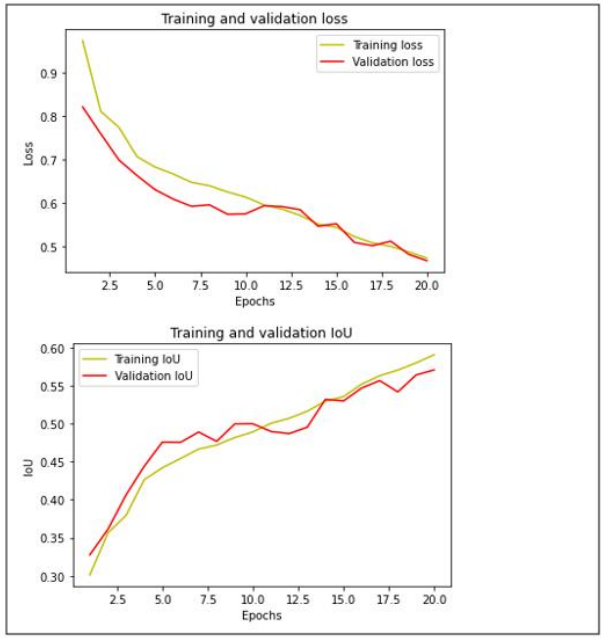
~ 500 1:1K tiles

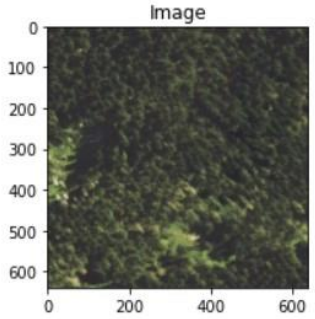
Prototyping

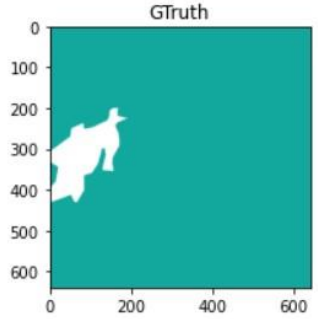
- ~ 80-85% foreground accuracy (0.7-0.8 IoU)
- Classification Task: 98% accuracy

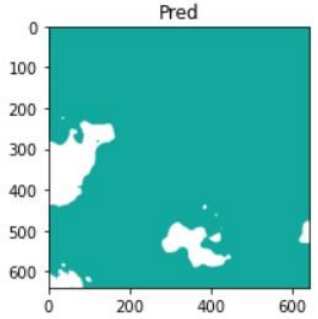










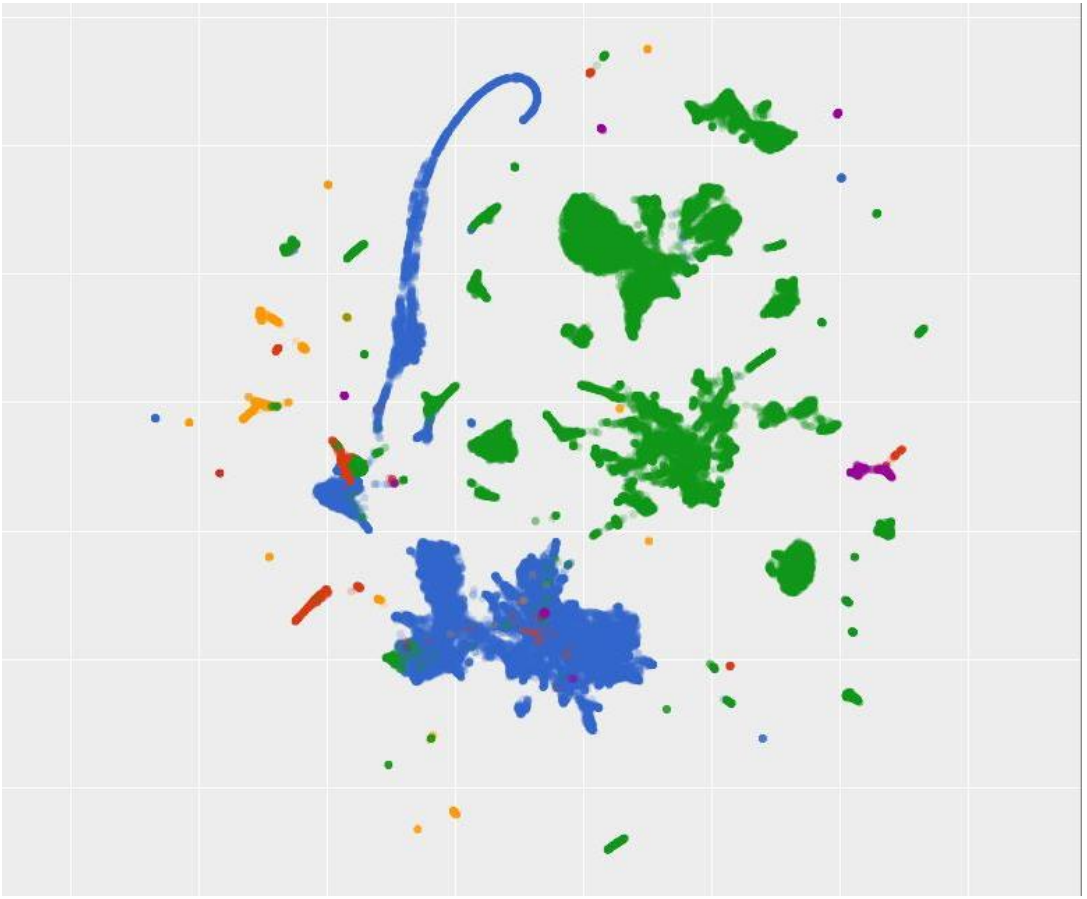


Iterative Dataset Development

- ~ 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



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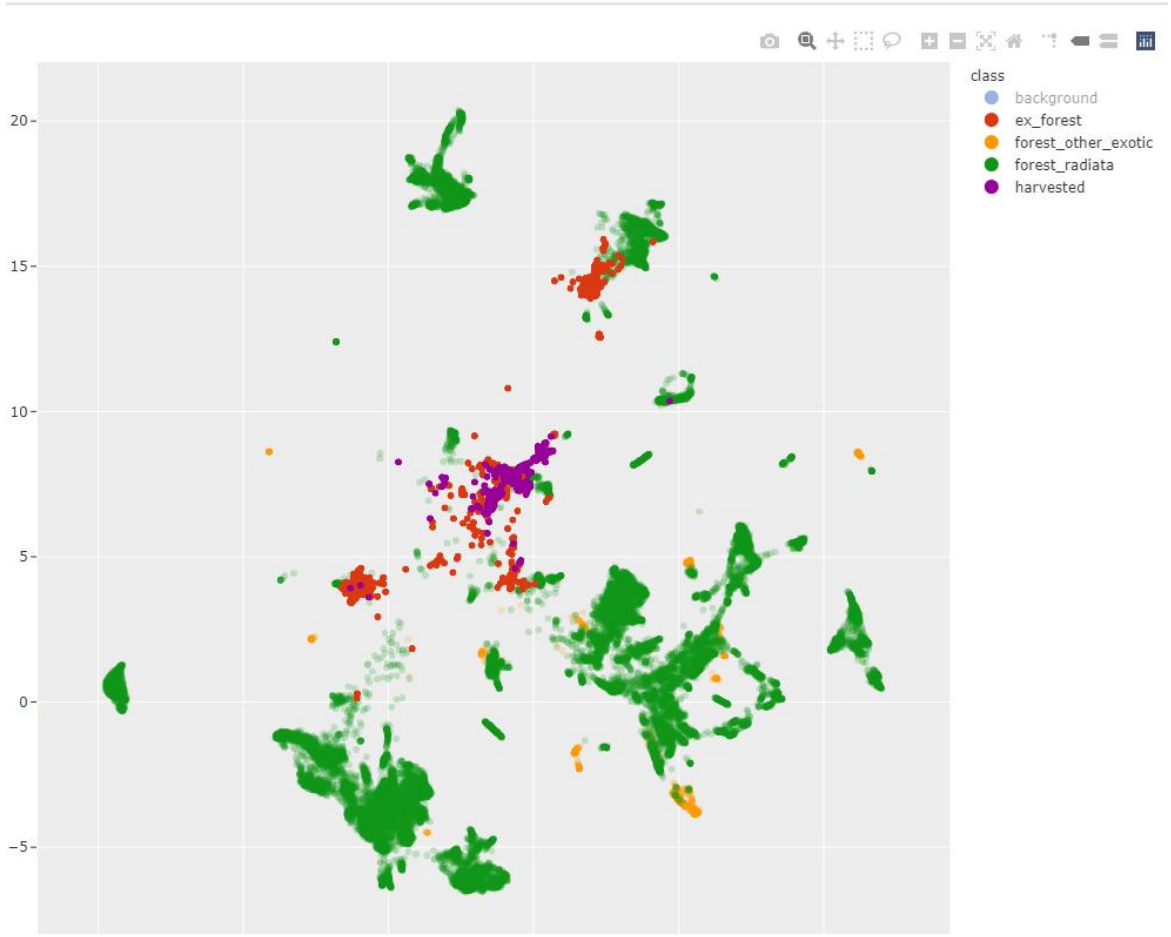
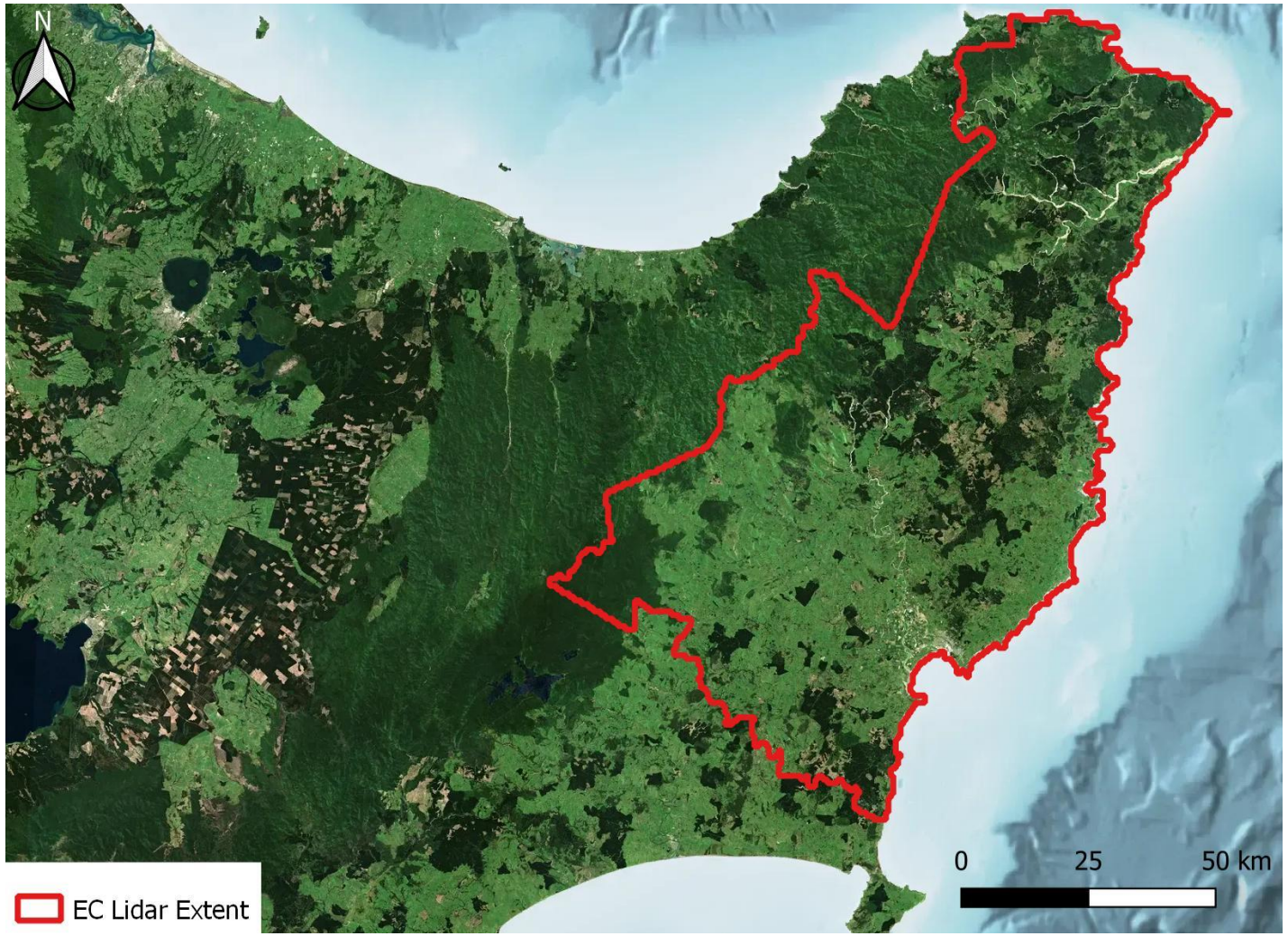


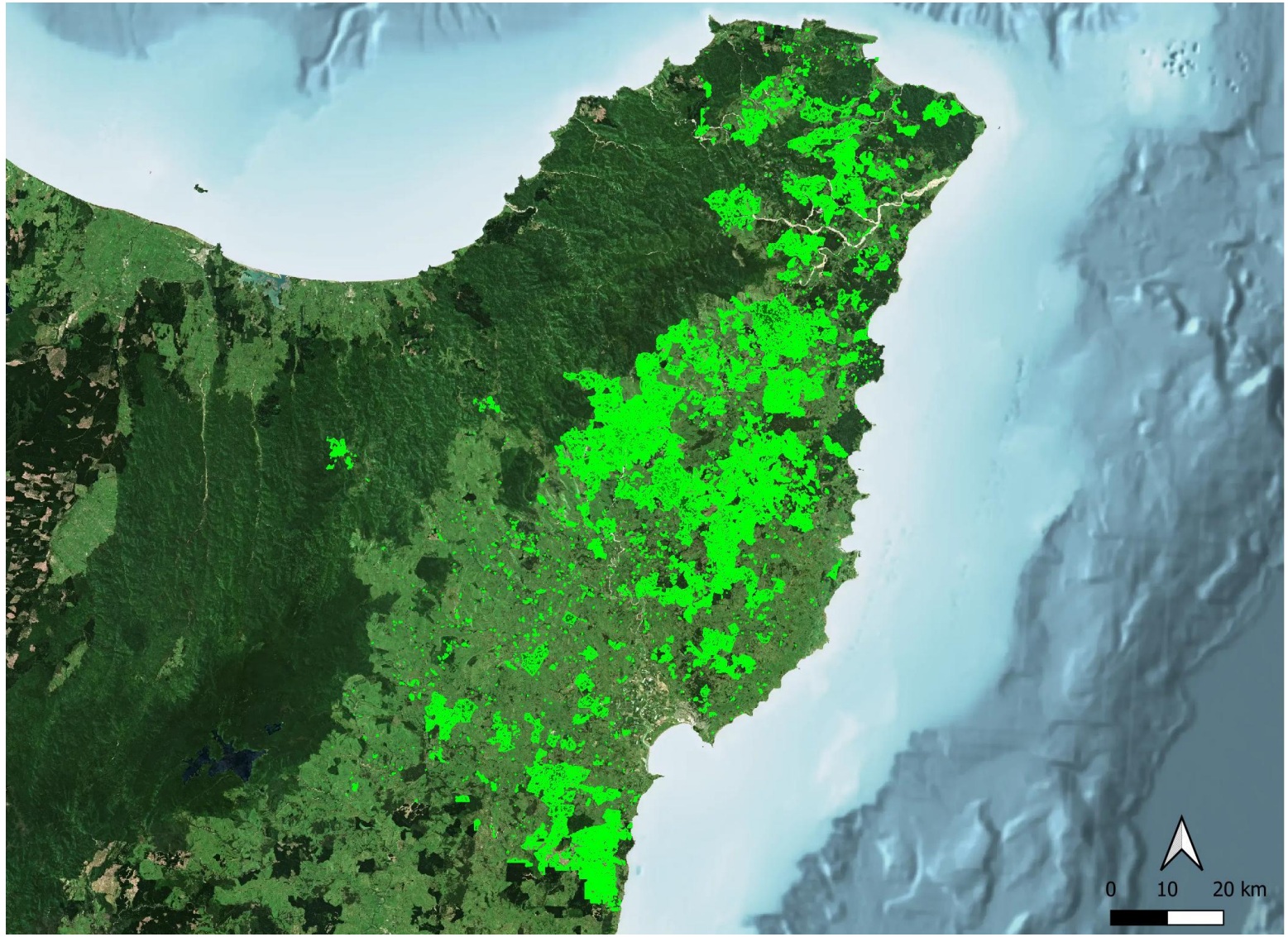
Iteration 2: Regional predictions

- Gisborne Lidar 2018-2020
- Imagery 2017-2019
  - 30cm
  - 8700 km^2



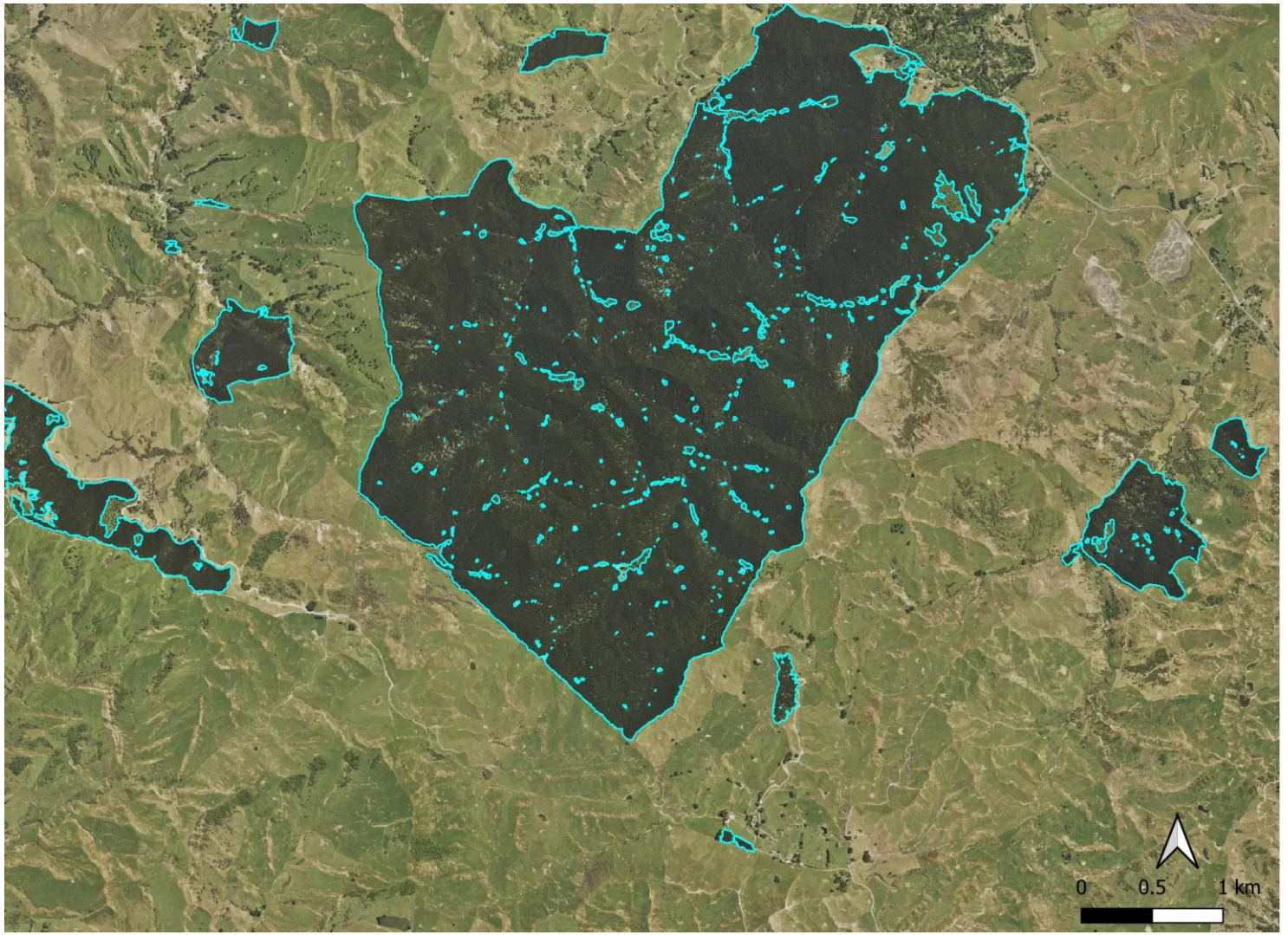
Iteration 2: Regional predictions

- Generally good at planted forest
- Large-scale inference
- 350km^2 data



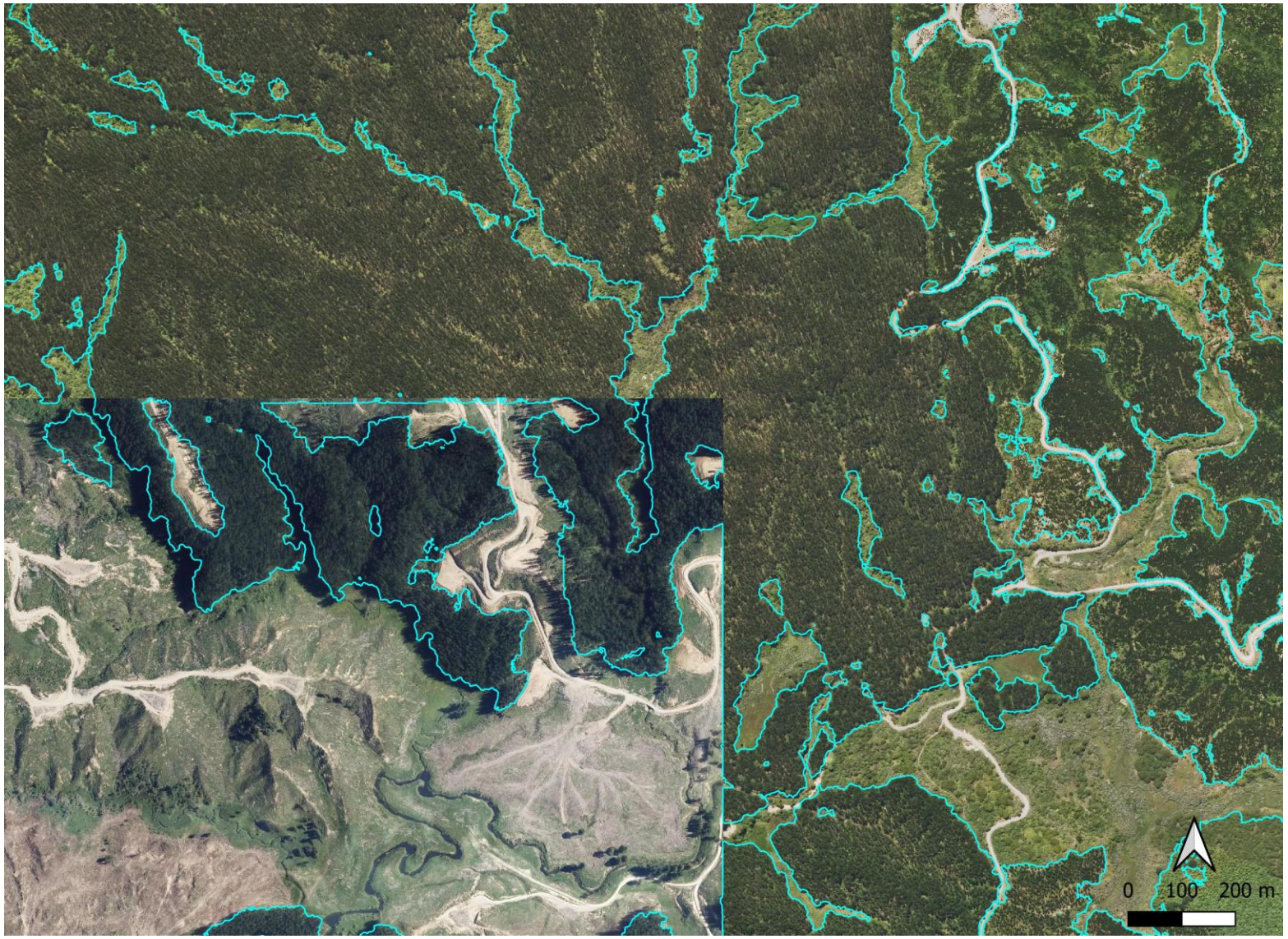
Iteration 2: Regional predictions

- Stand boundary mapping
- Net stocked area



Iteration 2: Regional predictions

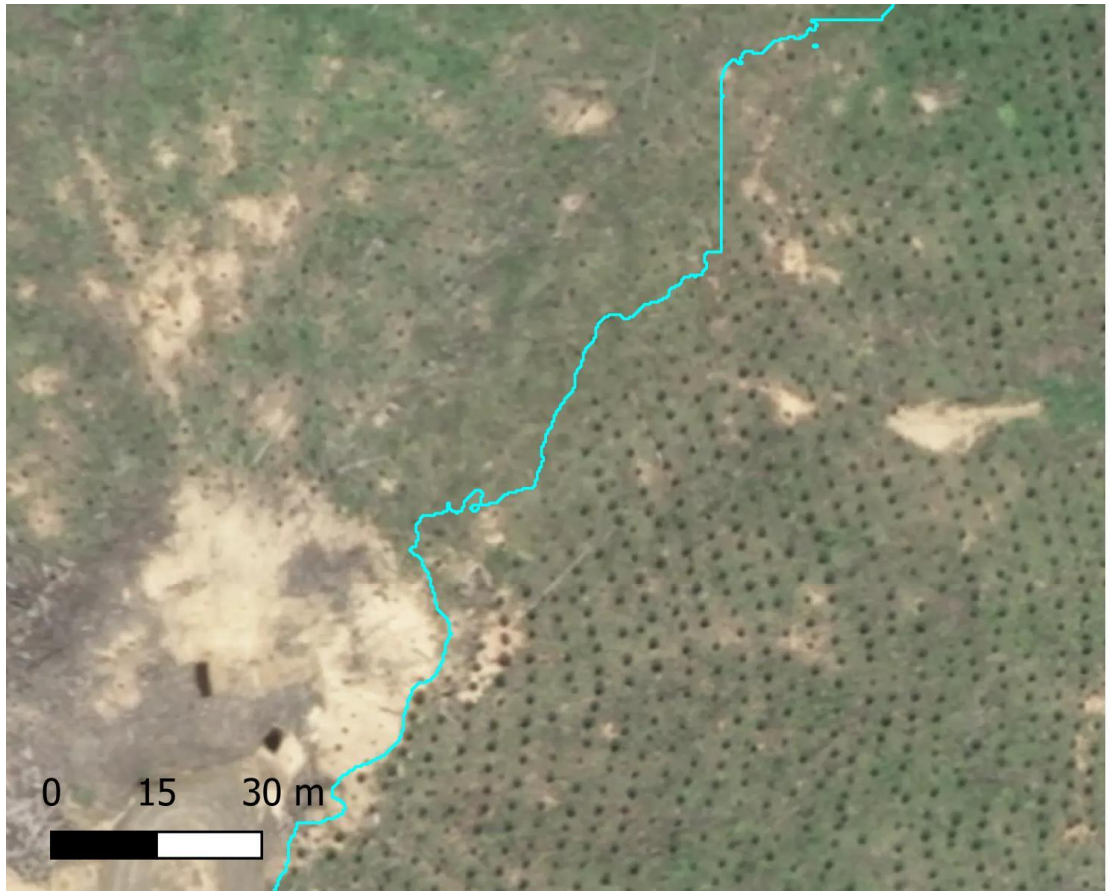
- Varied imagery

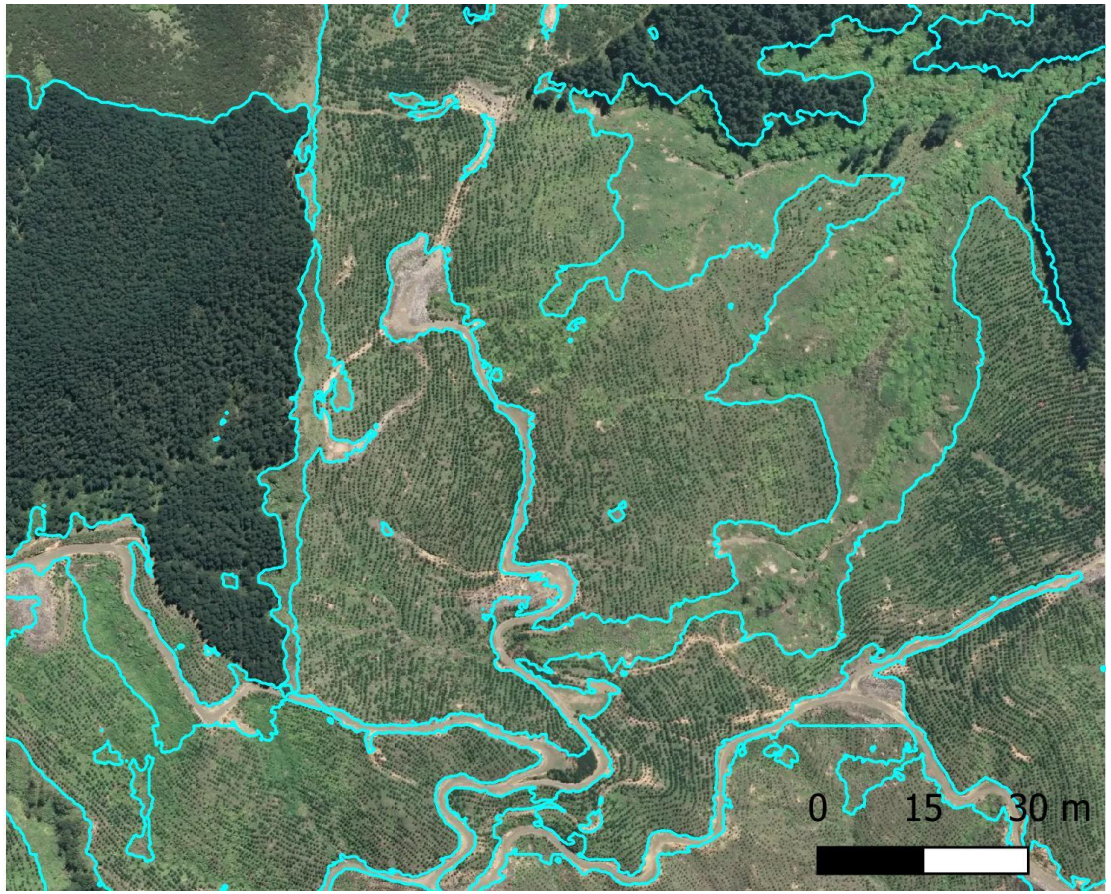


Iteration 2: Regional predictions

- Edge cases

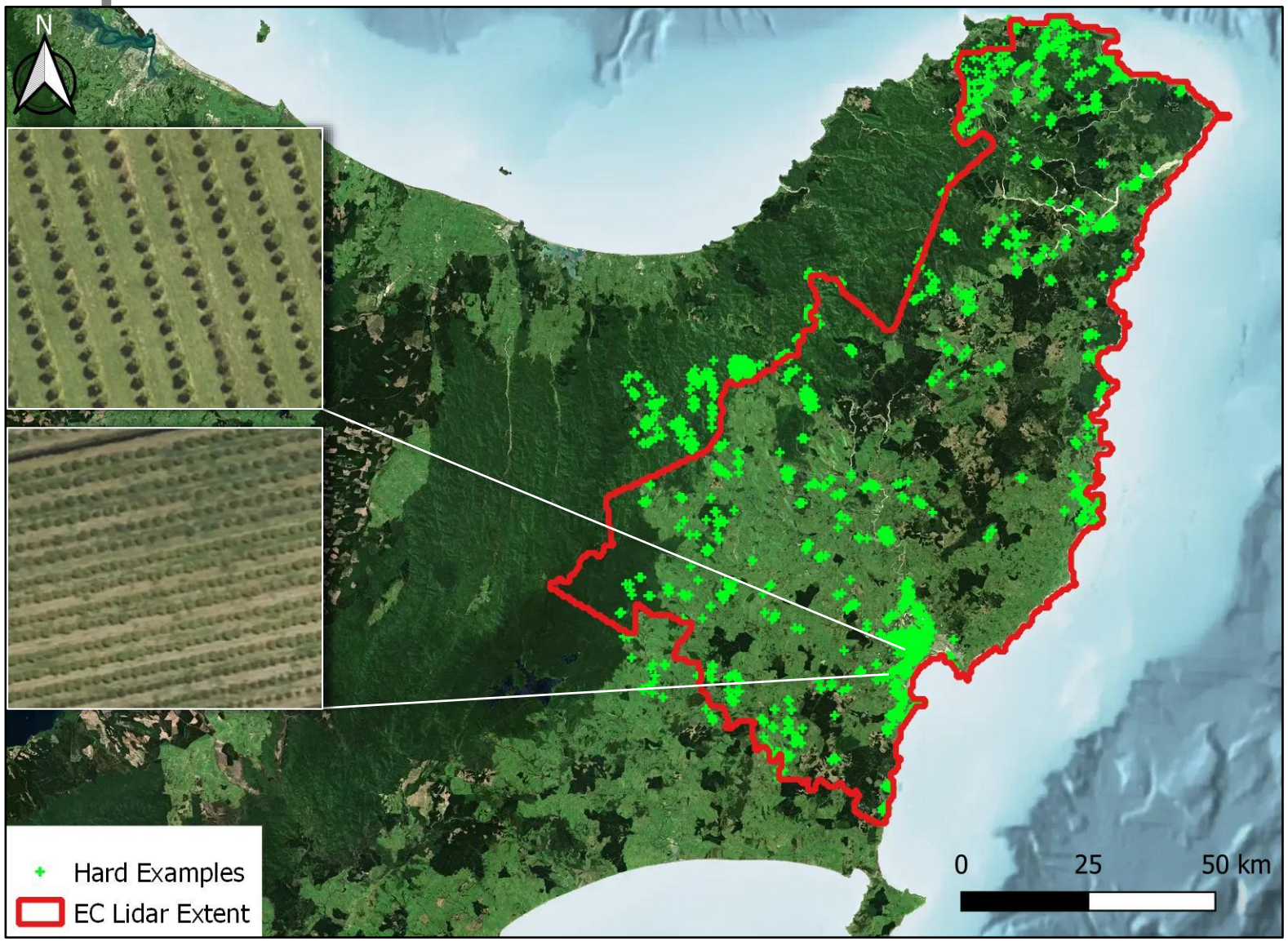
Iteration 2: Regional predictions





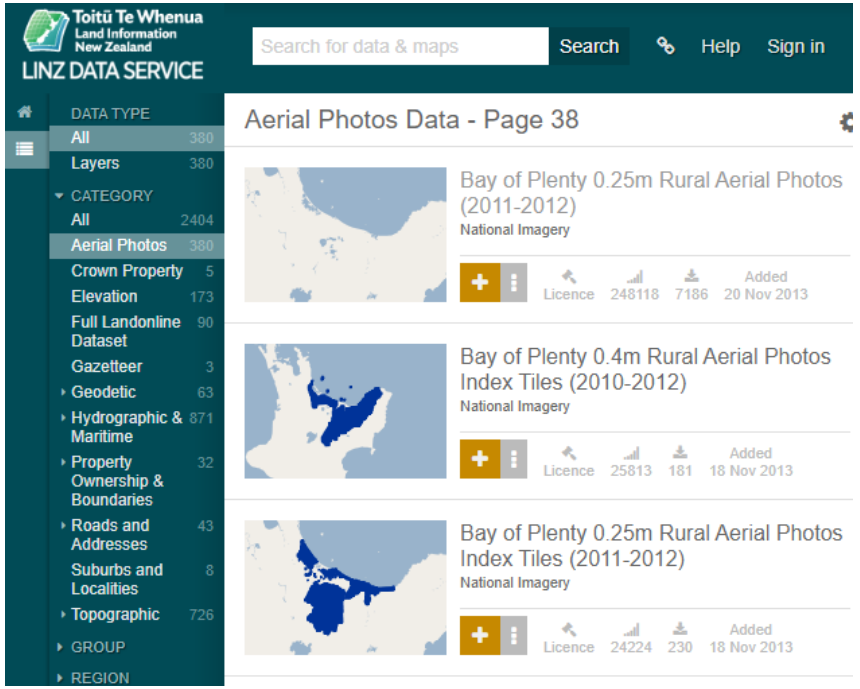
Iteration 3: Next steps

- 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



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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