

Autonomous forest health monitoring

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Background: Resilient Forests 2019-2023

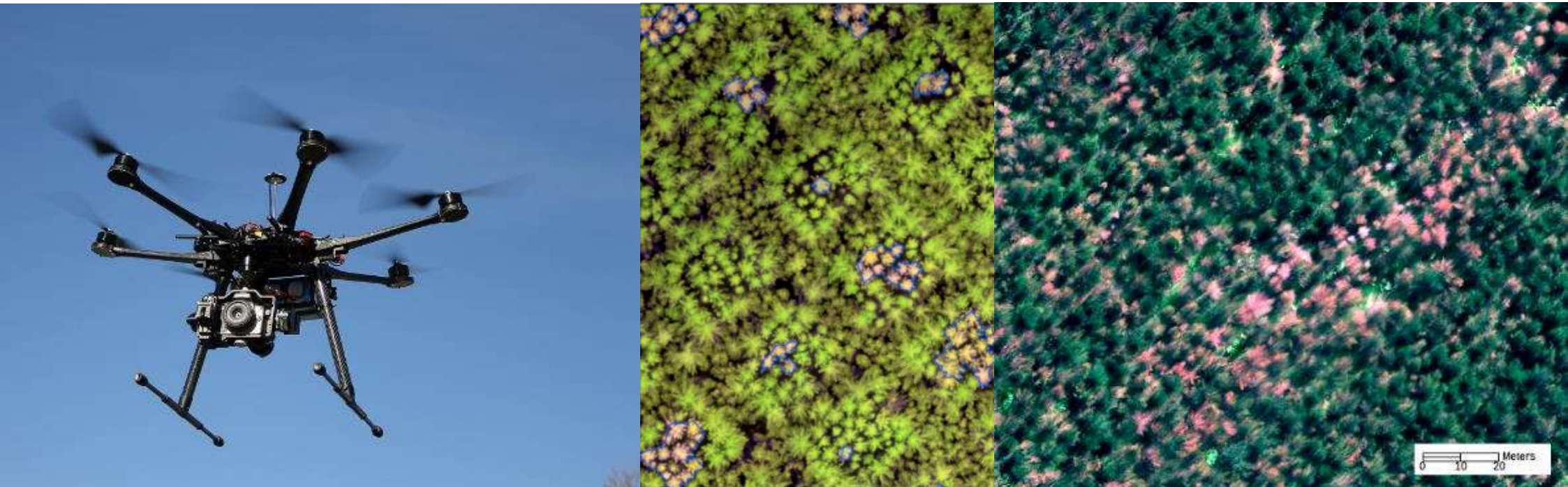
Remote sensing for impact assessment – focus on red needle cast

Tree and stand-level studies

2019: Trial evaluating scoring and impact at tree level - Fraser et al. (2022)¹

2021: Sensor network IoT (dendrometers, canopy sensors, env. sensors)

2022-2023: Kinleith copper exclusion trial + New trial on East Coast



Background: Resilient Forests

Landscape-scale studies

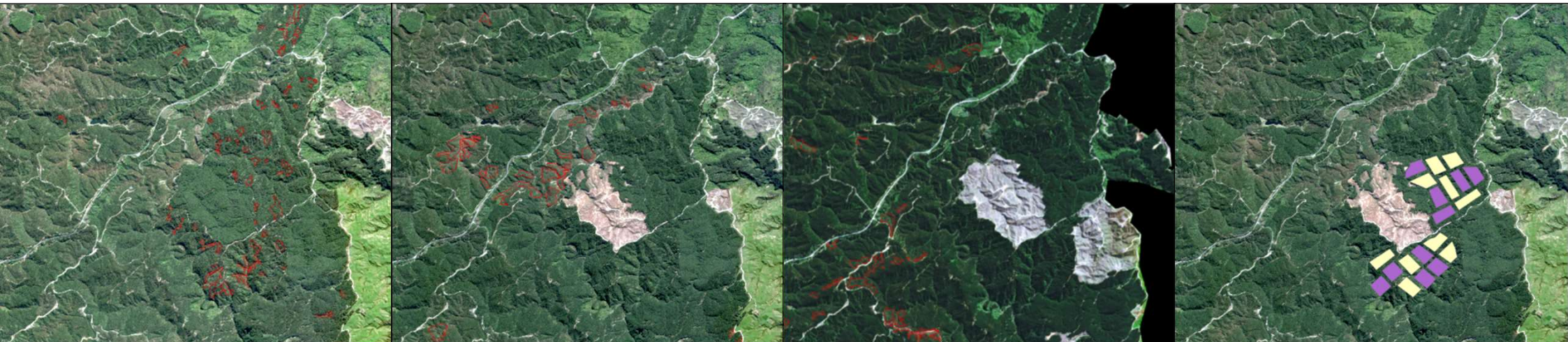
2019-2020: RNC severity and prediction (Tan et al. 2020)²

Must move from roadside observation using remote sensing

2019: Very-high resolution satellite imagery trialed

2020: 'Virtual' monitoring trials on East Coast established

Spatiotemporal drivers of disease + ML predictive model



Towards autonomous forest health monitoring

- High-resolution imagery: Automatically map RNC – can be automated.
- We are only monitoring 5 sites.
- Can we somehow monitor **all** our planted forests?

Tip-and-Queue Approach

- ‘Tip’ from time-series trends in free imagery
 - Tell us where to look
 - Lower resolution = false detections & missed detections
- ‘Queue’ the purchase of higher-resolution imagery
 - Planet
 - Pléiades
 - WorldView
 - BlackSky etc.



New Zealand at Night: NASA VIIRS

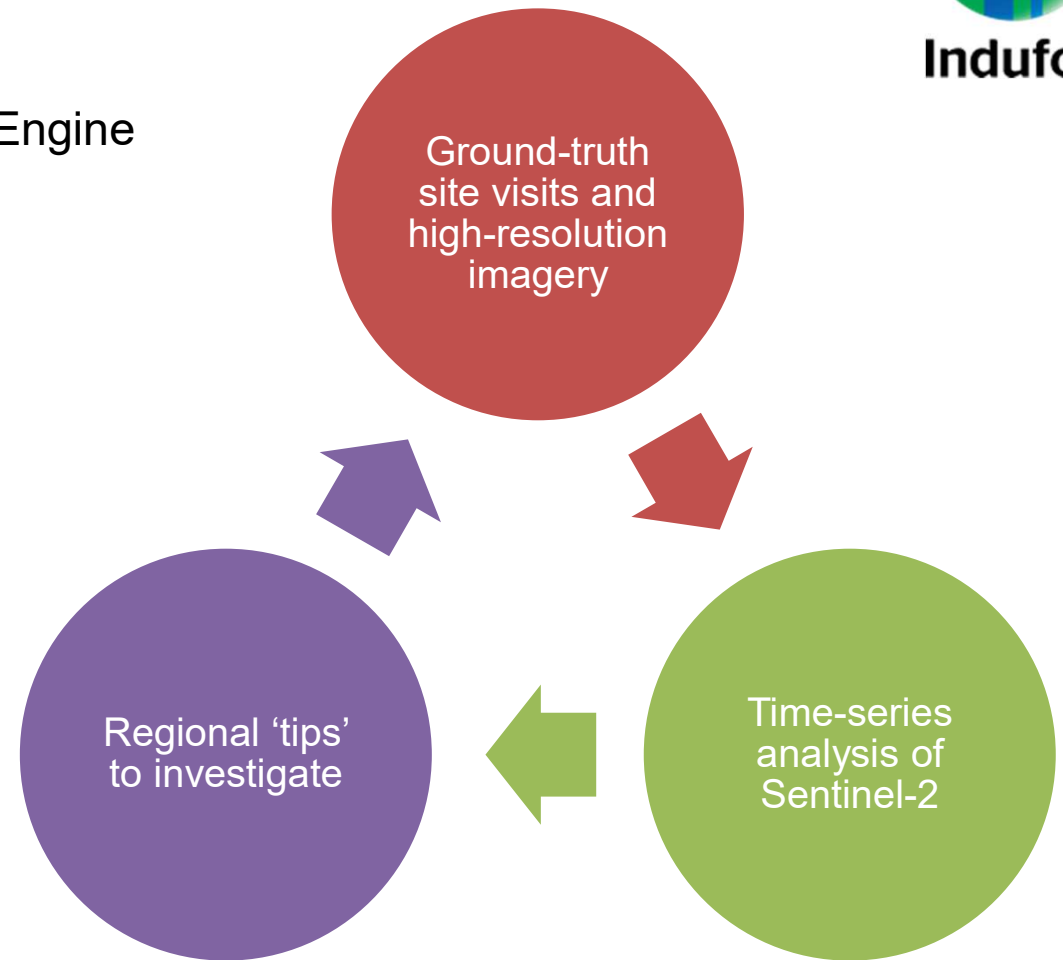
Towards autonomous forest health monitoring



Indufor

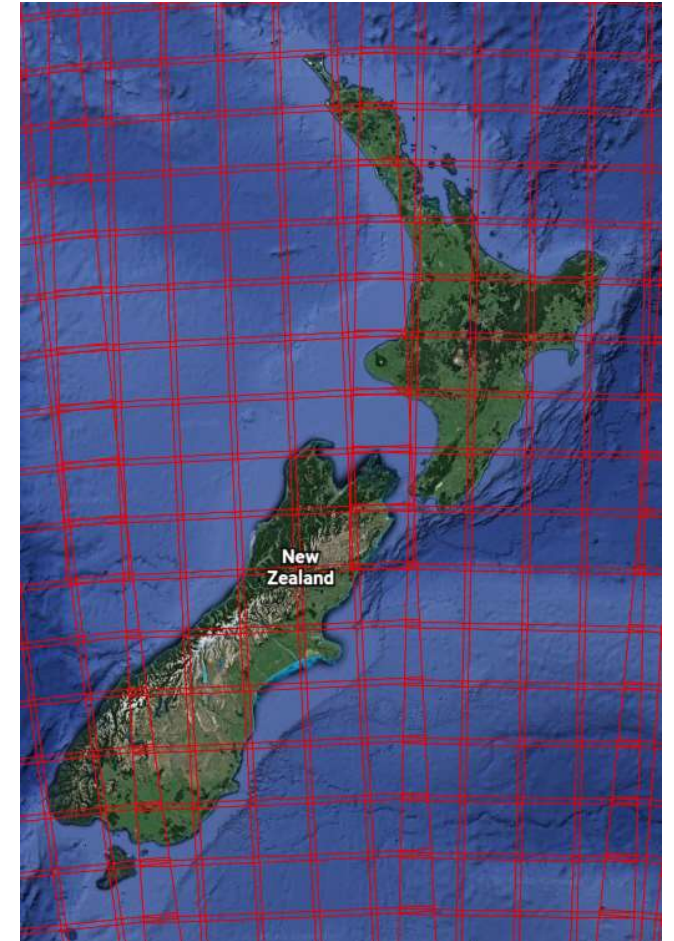
Automatic monitoring at scale

Monitor all planted forest using Sentinel-2
Infrastructure provided through Google Earth Engine
Indufor – Scion partnership



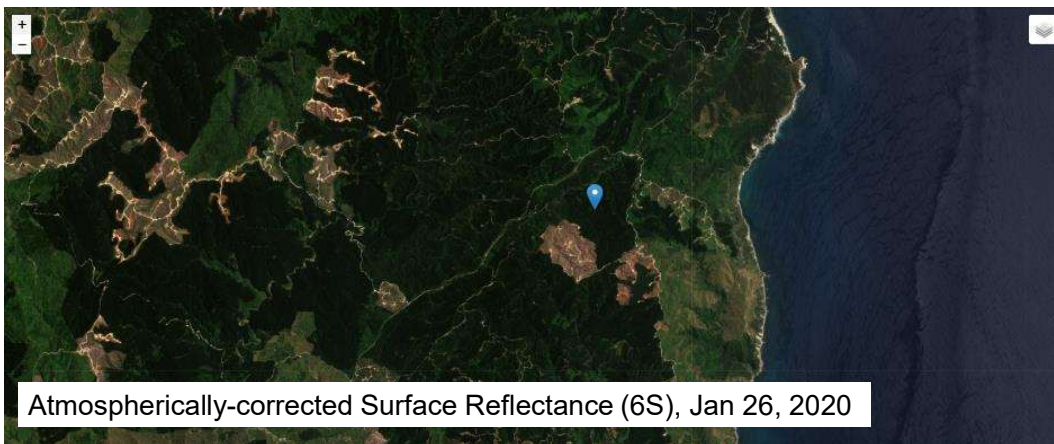
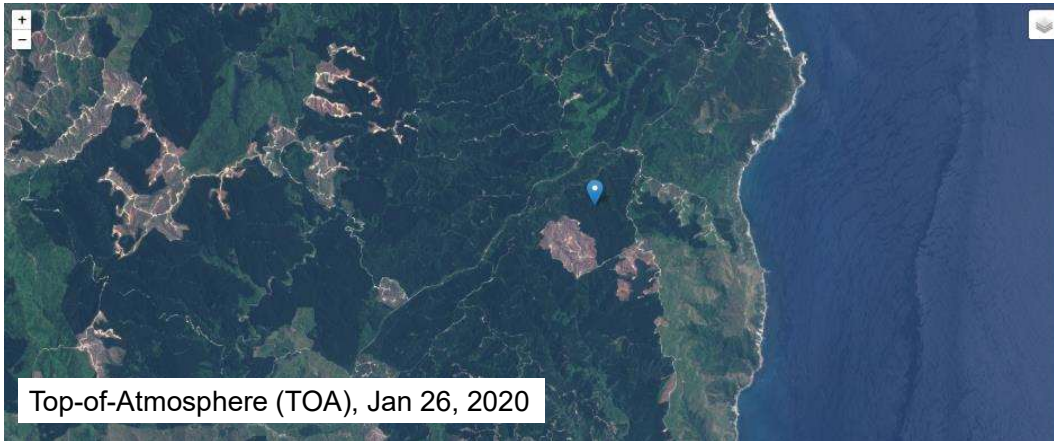
Large-scale monitoring: Sentinel 2

- 10 to 60 m spatial resolution
- 13 spectral bands
- Wide-scale grids cover New Zealand
- Regular data capture
- Five-day revisit time @ the equator ~ roughly 1-2 cloud-free image per month
- Can be used for monitoring forest health through time



Large-scale monitoring: Sentinel 2

Atmospheric Correction

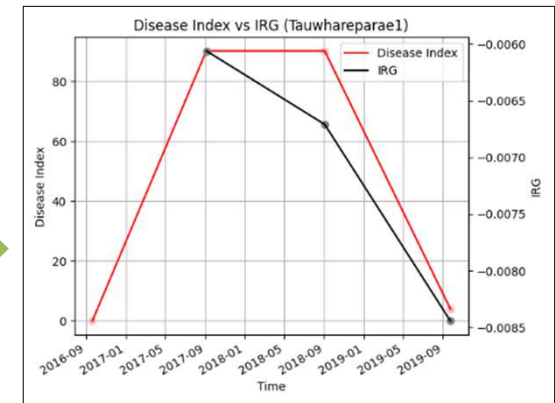
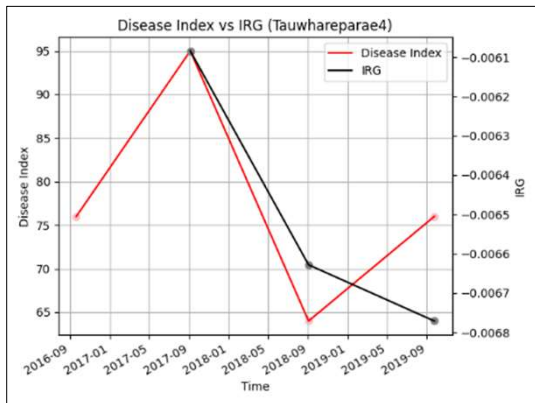
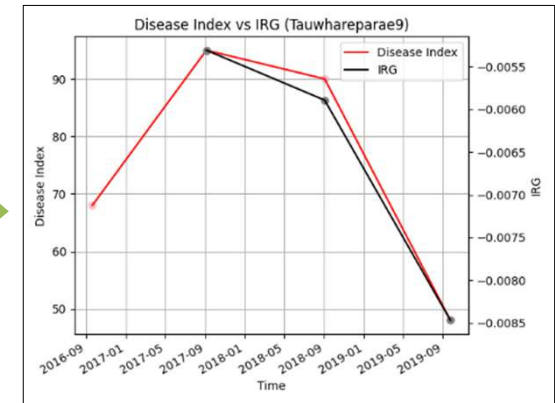
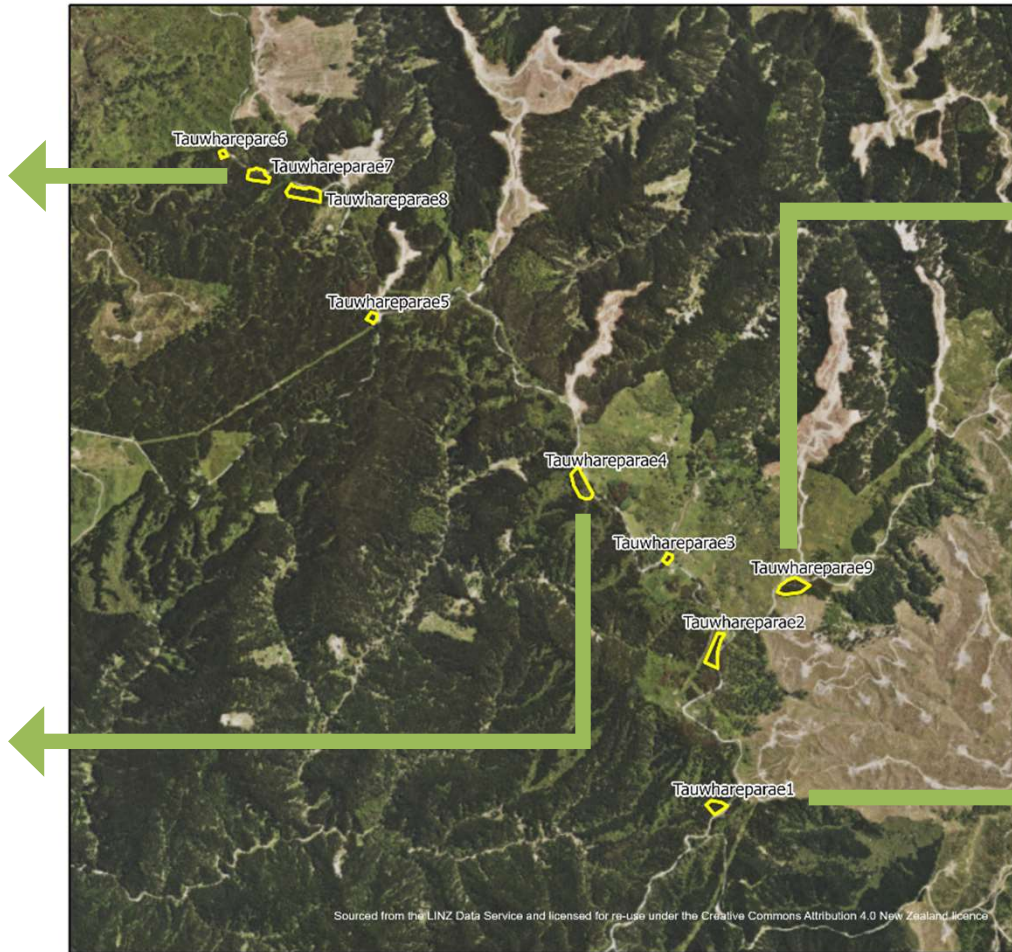
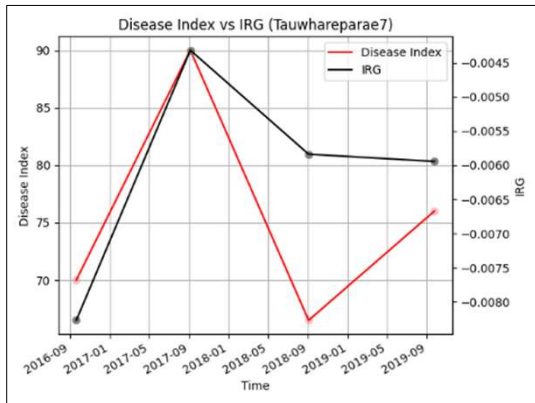


Cloud Masking



Improvements in algorithm can increase data retrieval quantity and quality

Sentinel 2: Trend Detection



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Scaling the Approach



- Indufor's Google Earth Engine routine
- Even with GEE the approach is expensive
- Limit to 'exotic forest pixels'
- Integrate with Forest Mapping project



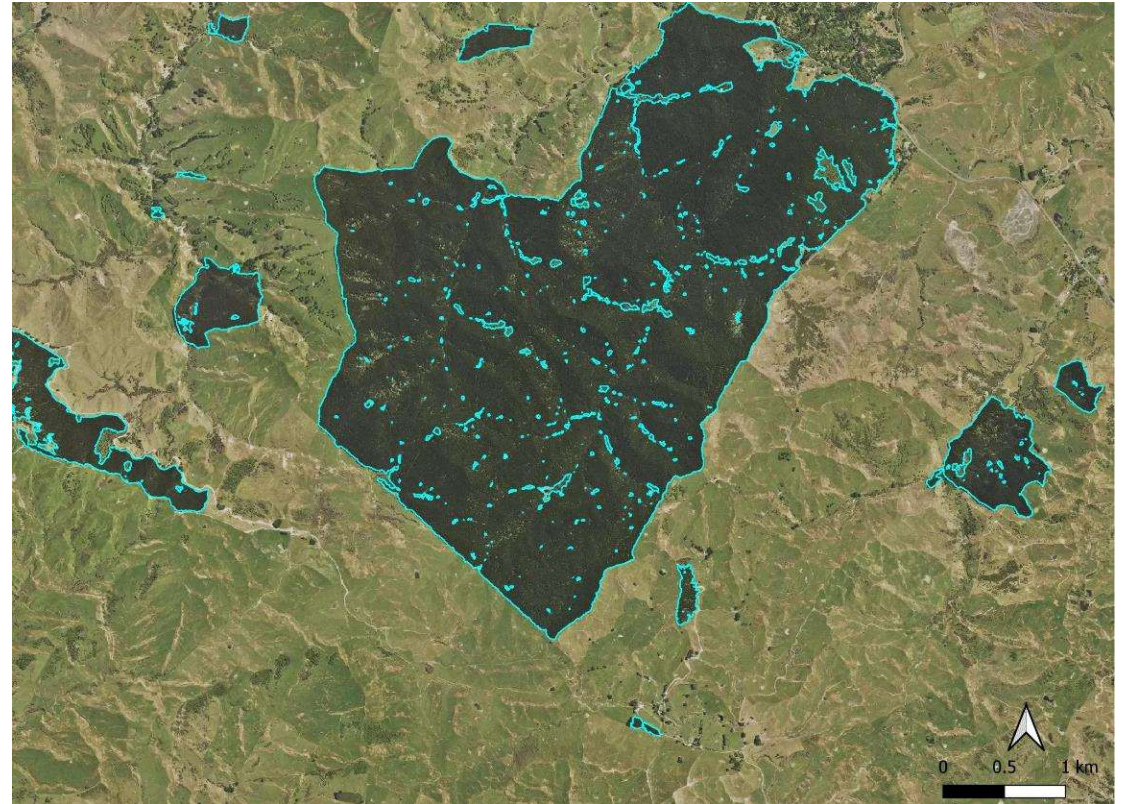
High-resolution forest mapping

- Deep learning segmentation dataset and model
- High-resolution aerial imagery



High-resolution forest mapping

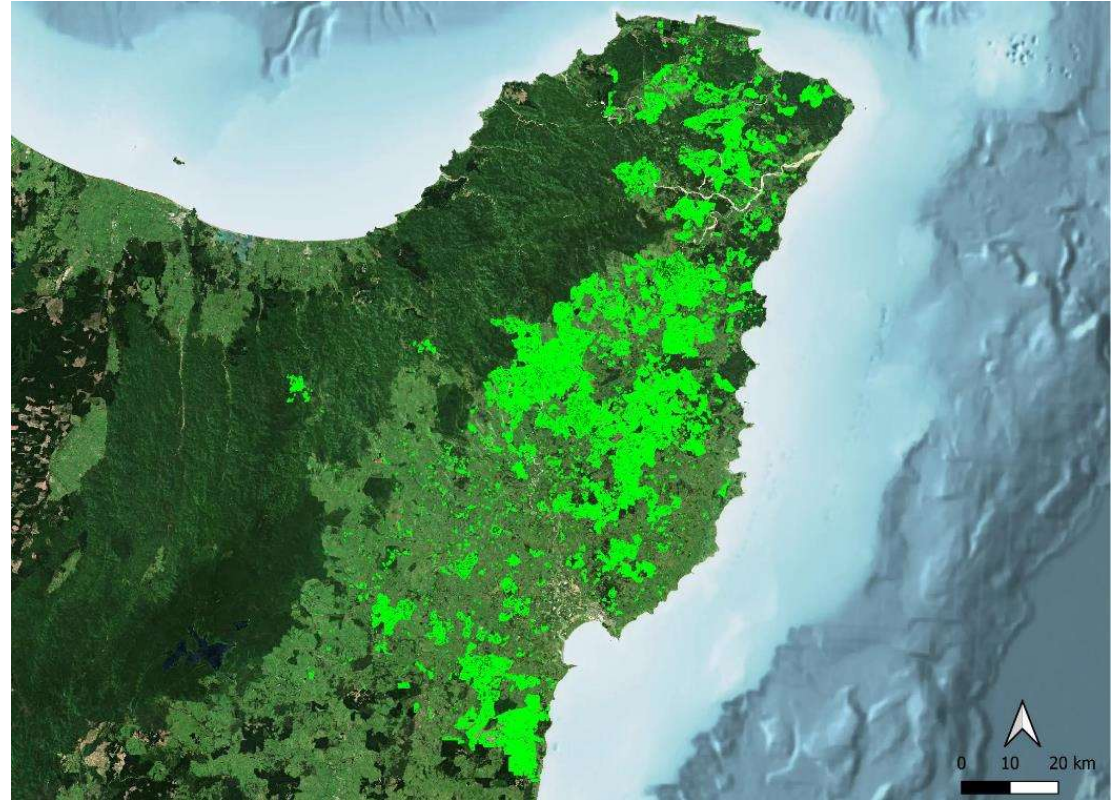
- Stand boundary mapping
- Net stocked area



Forest health monitoring: Next steps

- Integrate regional boundaries
- Implement tip-and-queue system for 2023/2024
- Pathway from research to production
- Always looking for more data!

Live demo of the app



Acknowledgements

- Mike Baker at Manulife
- Juken Forests NZ
- Brent Rogan and the SPS Biosecurity team
- Alan Tan
- Ellen Leonardo
- Honey Estarija
- Damien Sellier
- Ian Hood
- Additional thanks to those who have anonymously contributed RNC locations

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Tuesday, 13 June 2023