NSW GOVERNMENT Natural Resources Commission

Webinar: Forest monitoring using LiDAR

Coastal IFOA Monitoring Program 2024

The webinar will start shortly

NSW Department of Primary Industries and Regional Development

Forestry Corporation

NSW Department of Climate Change, Energy, Environment and Water

Crown Lands

Natural Resources Commission

NSW Forest Monitoring Steering Committee

Aboriginal Affairs

Local Land Services

The University of Melbourne

Australian National University

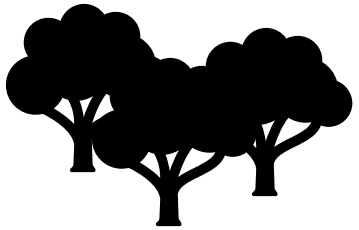
The University of Sydney

Measuring forest change on NSW state forests using LIDAR

Prof. Scott Brown, Zac Coates & Garston Liang

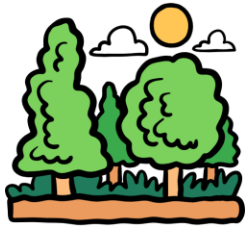
University of Newcastle

Webinar Overview

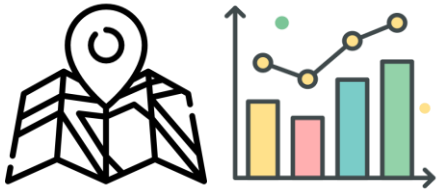


1. Project overview and key findings

2. What is airborne LiDAR?



3. Why use LiDAR for examining forest structure?



4. Detailed analyses & customised mapping

5. Novel analyses, & future applications for LiDAR

Research overview

Research commissioned under the Coastal IFOA Monitoring Program to:

- **analyse forest structural diversity** across a study area on state forests to assess the influence of management (harvesting, prescribed fire, exclusions), natural disturbance and topographic position

- **map average canopy height and average canopy cover** at the compartment scale and at the local landscape area scale for each LiDAR capture area.

Key research findings in study area

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- Canopy top **height and canopy** coverage **recovered after harvest events** across a range of slope classes
- Different areas showed **comparable rates of canopy regrowth** over time **despite variations in harvesting intensity**
- **Similarities are seen** in canopy structure between areas **managed for timber production** and **exclusion areas managed for conservation** on state forests
- **Harvesting influenced** vertical and horizontal distribution of biomass, but this **returned to pre-harvest levels** within ten years
- Differences in canopy top heights due to **different fire severities** can be observed via LiDAR

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Special Thanks

Johanna Voeste

Tin Nguyen

Finley Guilhaus

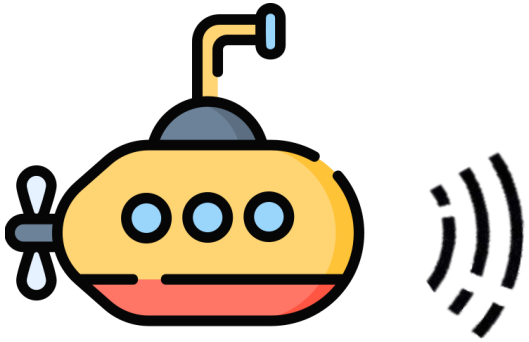
Jess Grimmond

What is LiDAR?

Light **D**etection **a**nd **R**anging

Used to remotely measure geographical features.

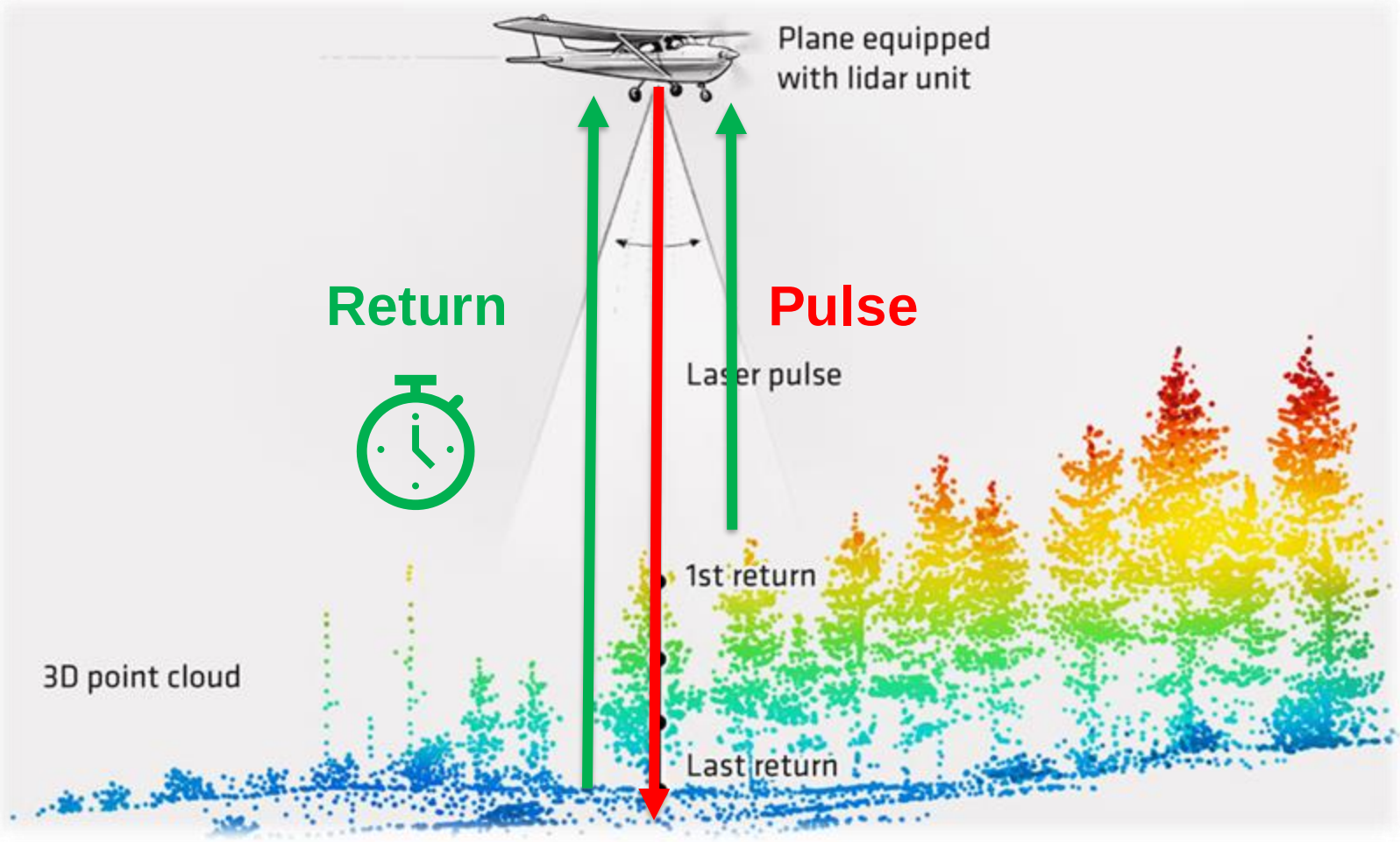
SONAR
Sound waves



RADAR
Radio waves

LiDAR
Light

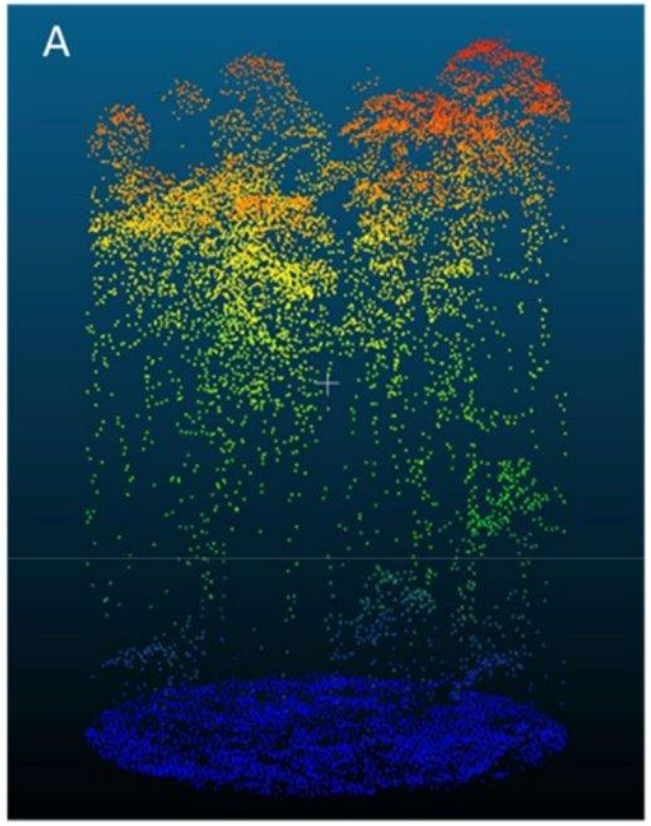
What is LiDAR?

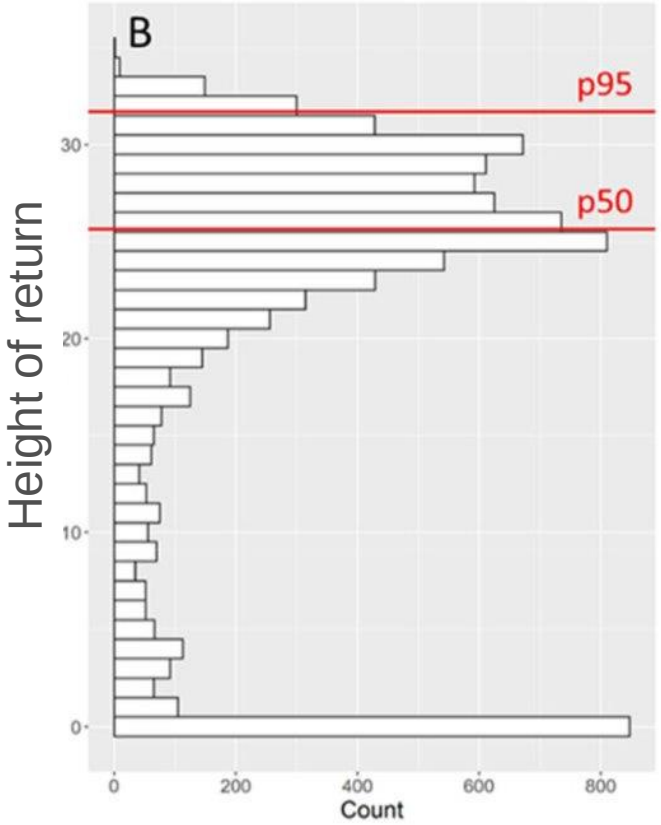


Altitude of plane

Height of return

What does LiDAR tell us?





Point cloud of returns (A)

Monitor forest characteristics from statistics

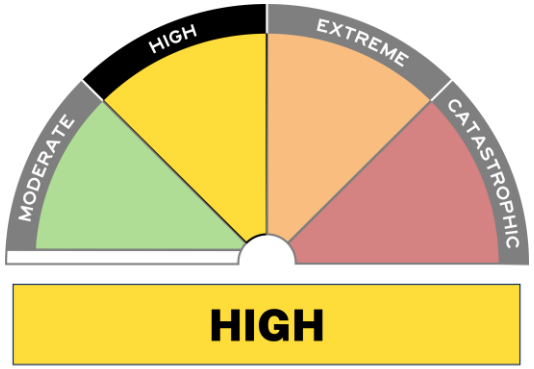
Why use LiDAR?

Resource-saving:

1) Cover massive areas (State forests cover 2 million ha. ~ size of Wales)

2) More efficient and more detailed tree height data collection.

3) Monitoring forests over time (fires, natural & human disturbance)

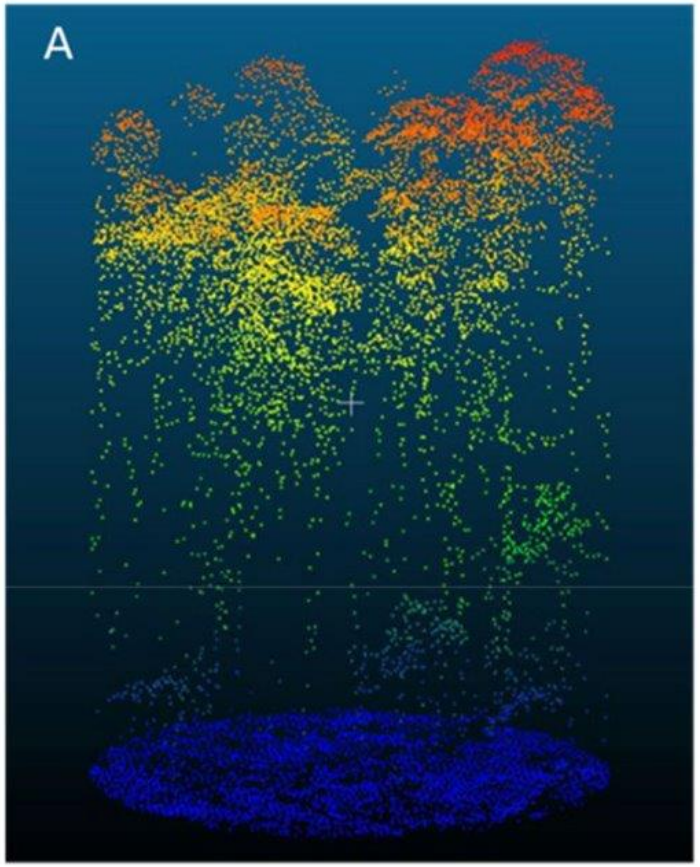


Analysing LiDAR data

ArcGIS Pro

Comprehensive software for mapping & analysis.

Proprietary software with built-in functions.



Open-source software

R or Python with extensive customisable functions.

Free, widespread accessibility.

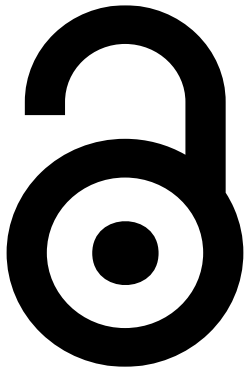
Flexible & transparent.

Analysing LiDAR data

1) Powerful analysis tools, verifiable data processing

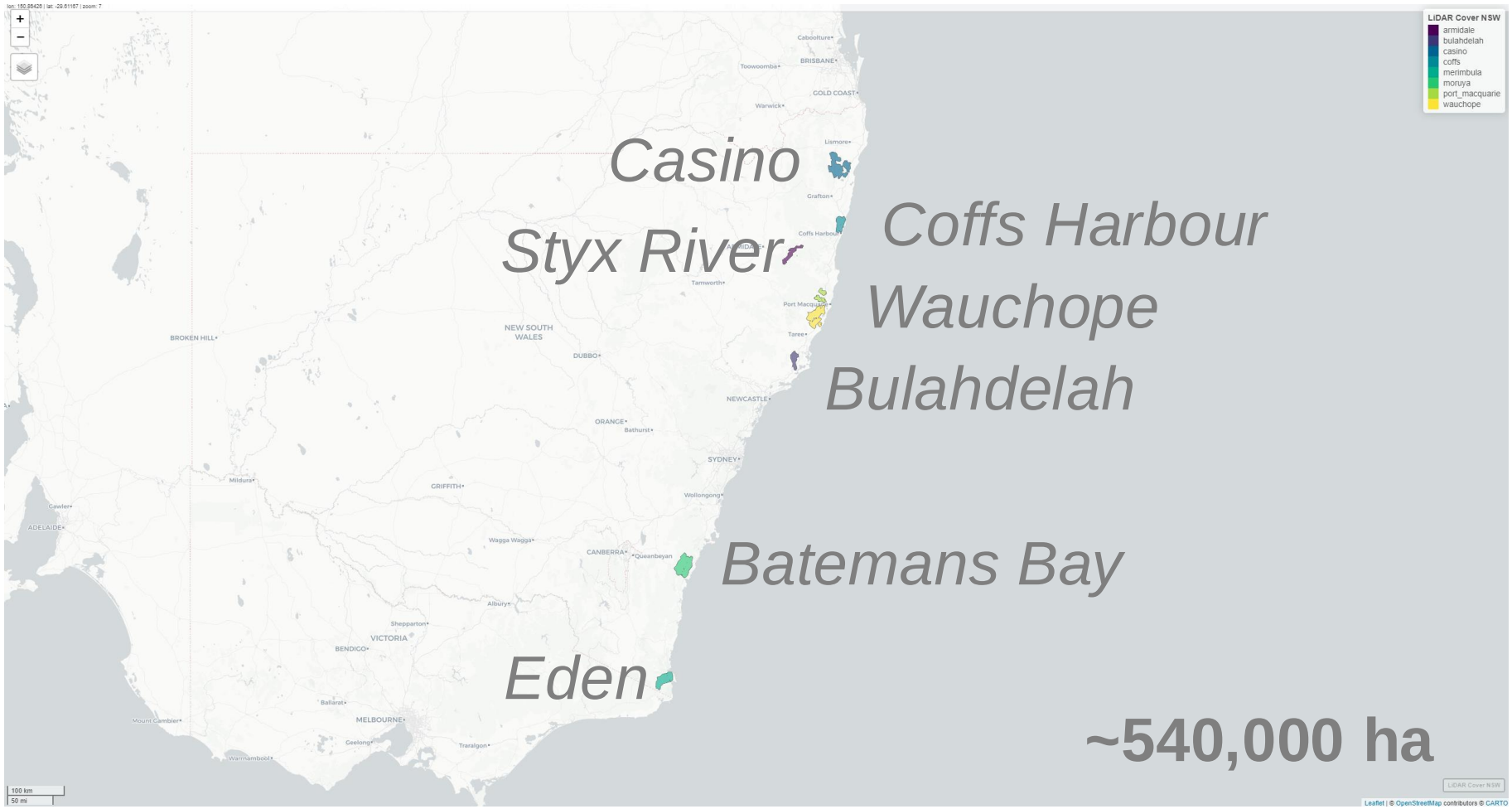
2) Generate statistics, maps, & insights on common hardware.

3) Removes cost as barrier to access.



Forest monitoring using Airborne LiDAR

LiDAR in State Forests (Coastal IFOA Monitoring Prgm)



What did we do?

7 regions
47 State Forests

Over 10TB LiDAR data

- 2012, 2016, 2023

Many other resources & data

Separate datasets

What does this provide?

Field and Satellite Data

- Fire severity ('19/20)
- History of other disturbances
- Landform features
- Forest Type

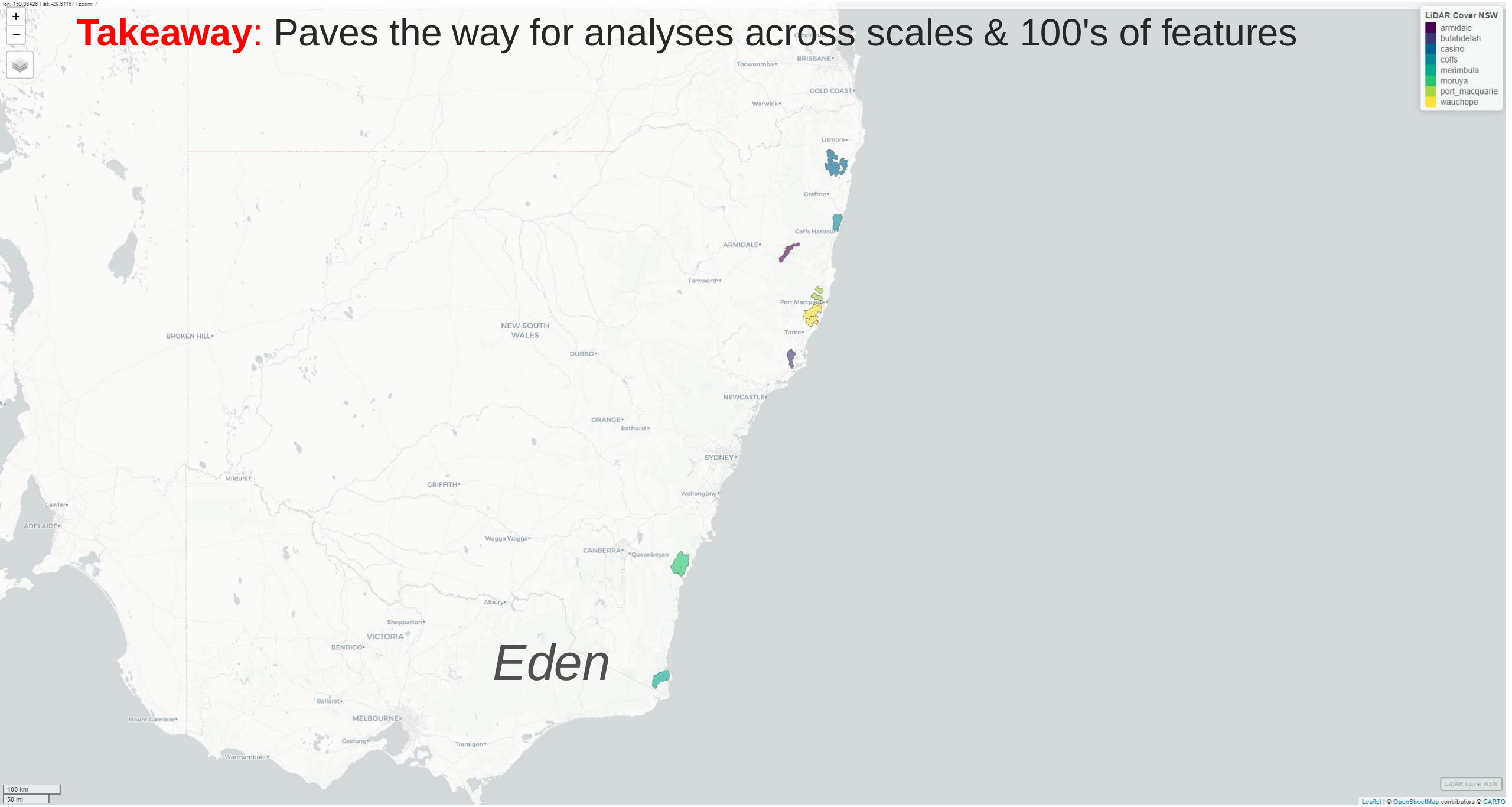
Examine forest dynamics

- Impacts of slope
- Regrowth after disturbances
- Differences based on forest features
- Differences based on area categorisations

Over 6 million
30m x 30m Pixels

Forest structure at scale & in detail

Takeaway: Paves the way for analyses across scales & 100's of features



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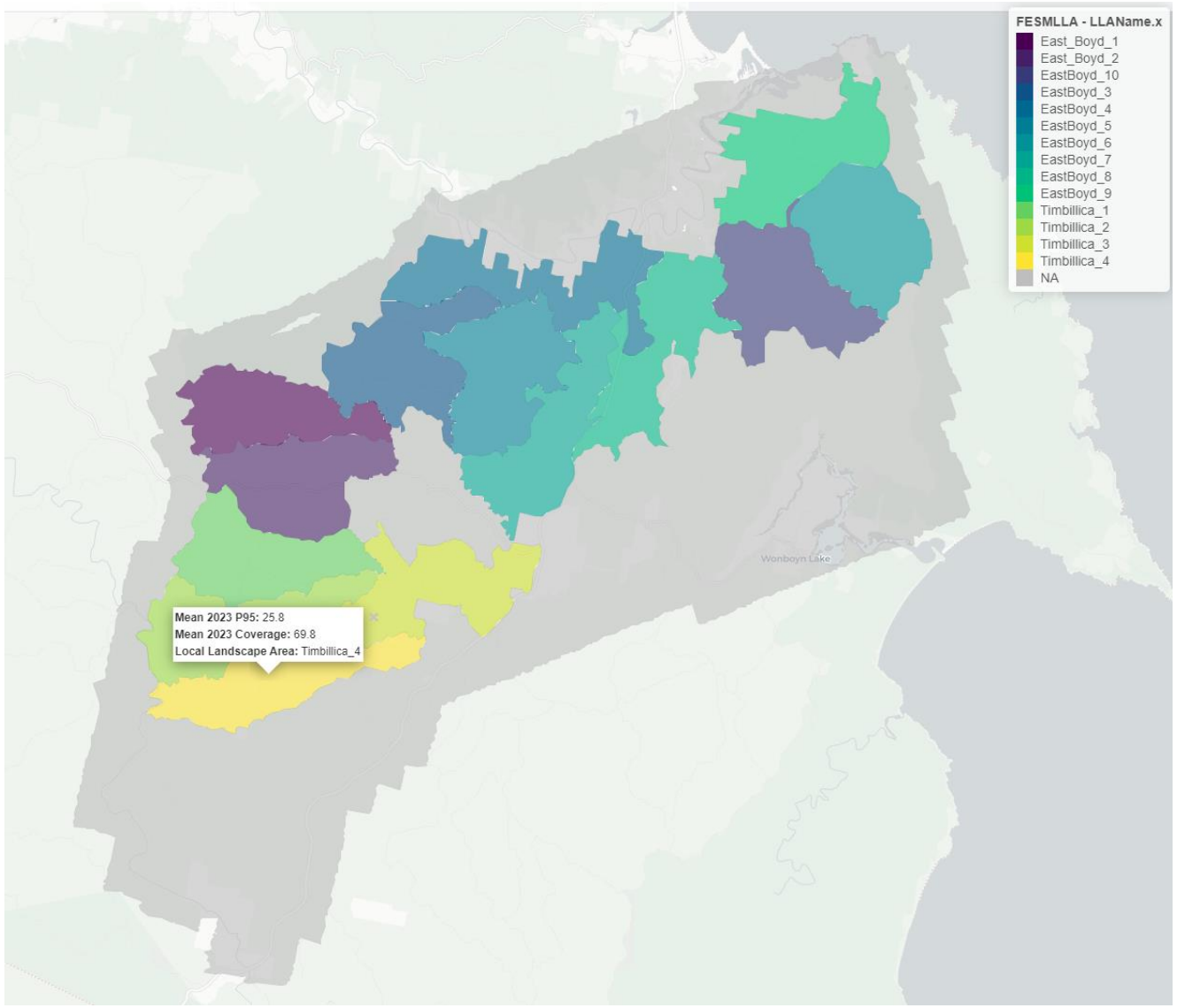
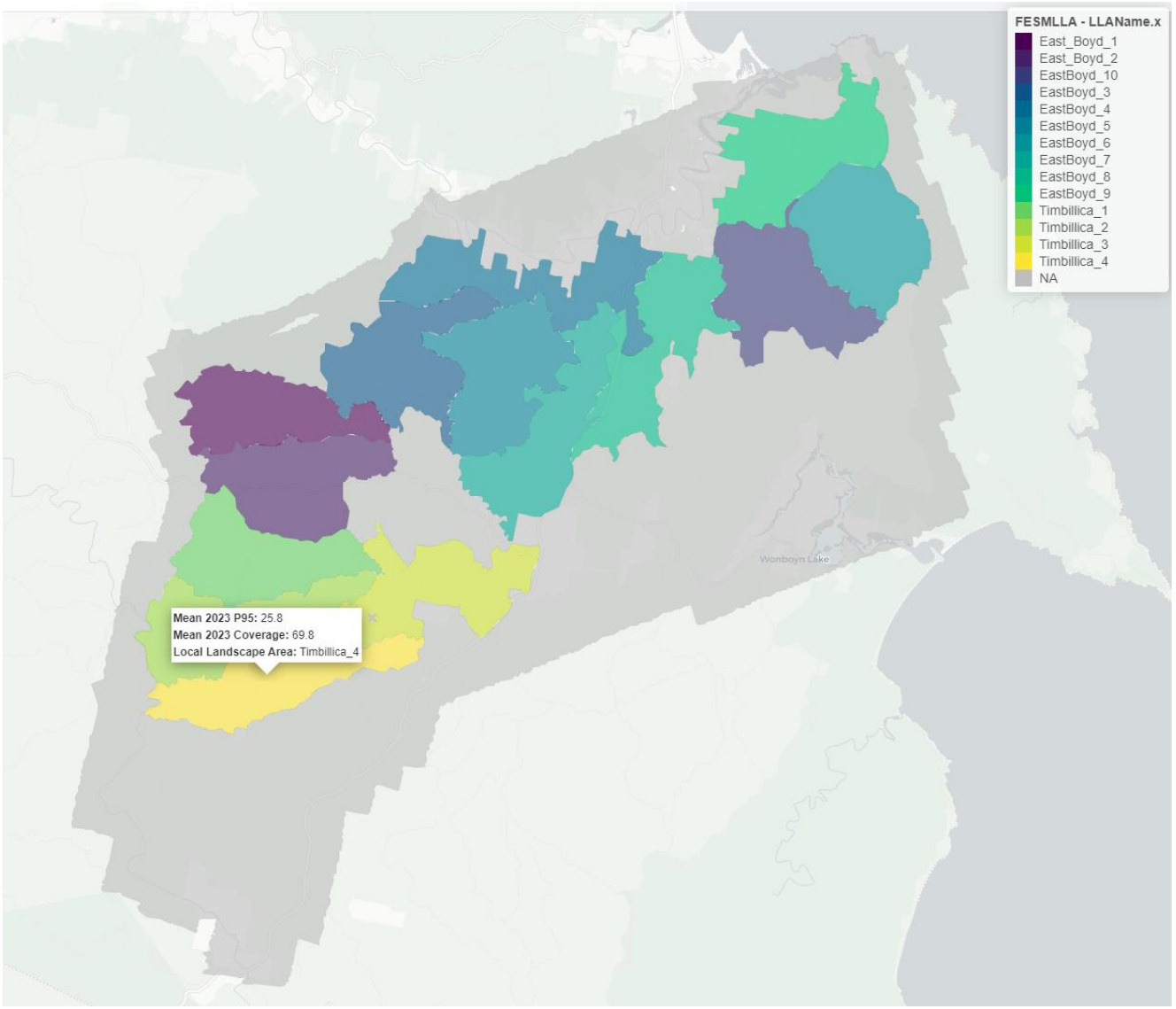
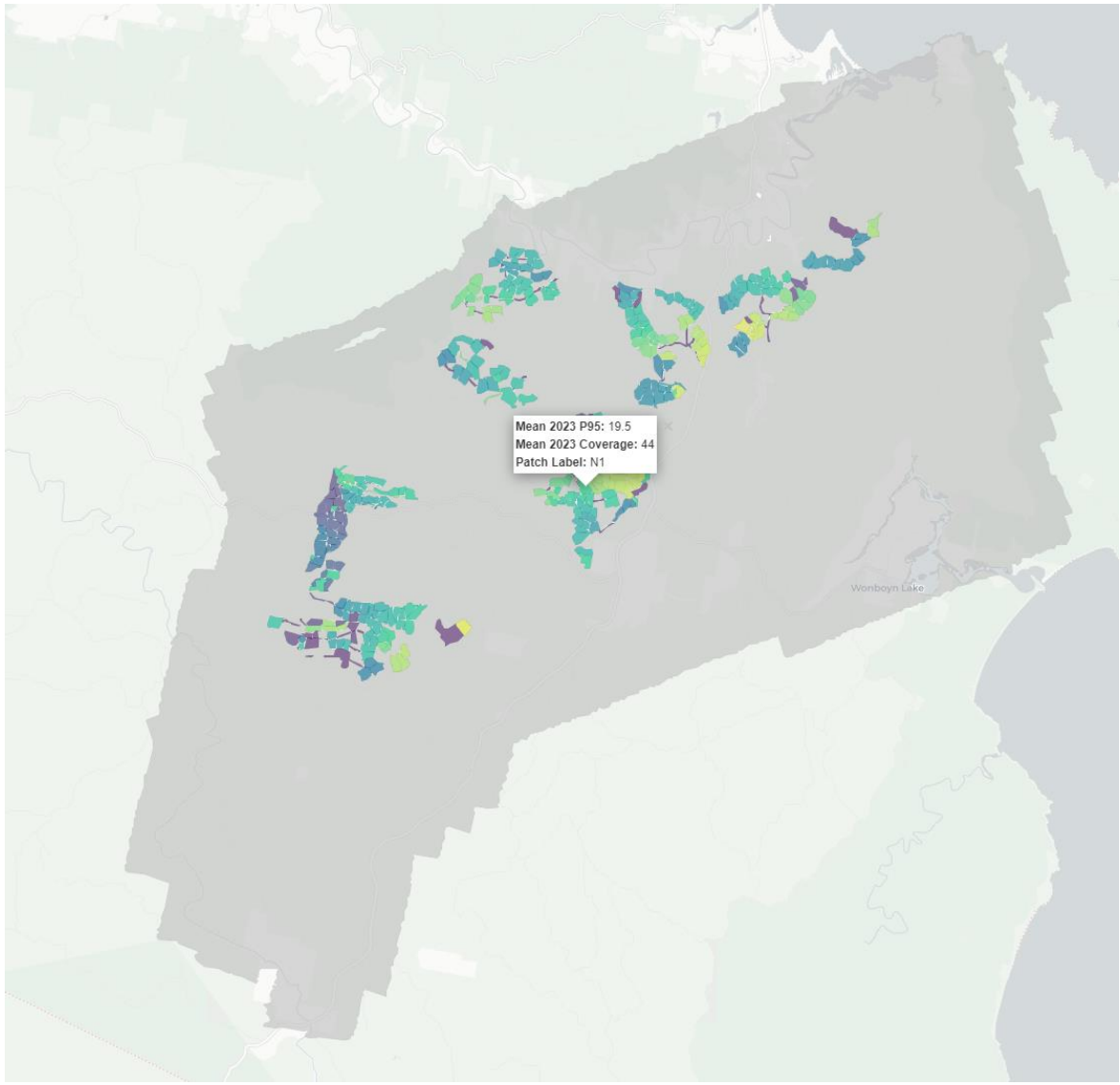


15 Local Landscape Areas

Takeaway: Paves the way for analyses across scales & 100's of features

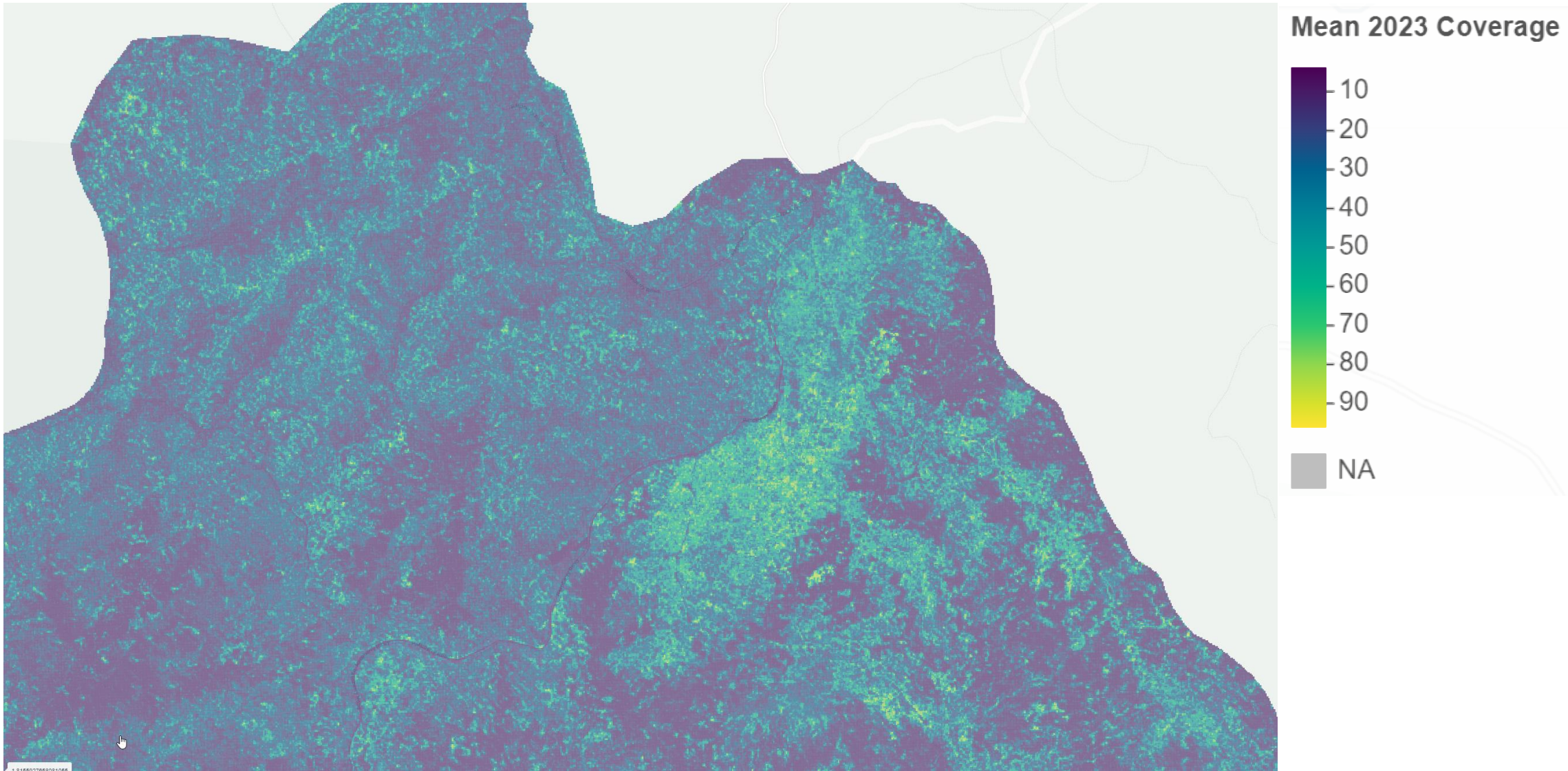




15 Local Landscape Areas & 196 Patches

Over 800,000 **30m x 30m Pixels**

5m x 5m Resolution Understory & Regeneration Map >15cm <3m Canopy Coverage



Spatial data takeaways

For all 7 forest regions, the data support analyses at many levels of detail.

- Extract broad statistics, e.g., forest terrain characteristics (patch-details)
- Specific detail to examine understory density for habitats

For webinar, we focus on broad trends & regions.

Provide wider array of analyses in the **NRC report.**

Takeaway: Paves the way for analyses across scales & 100's of features

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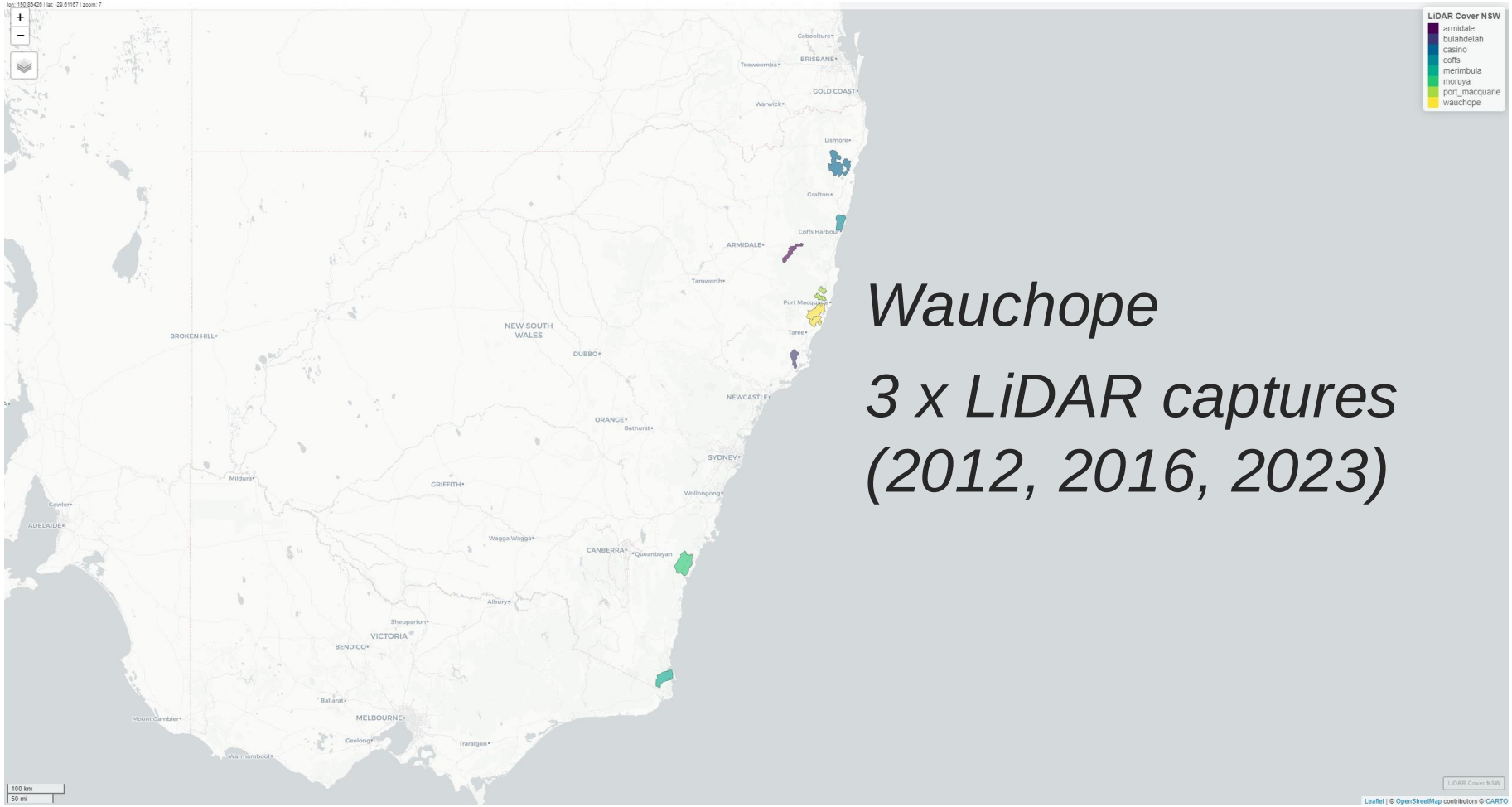
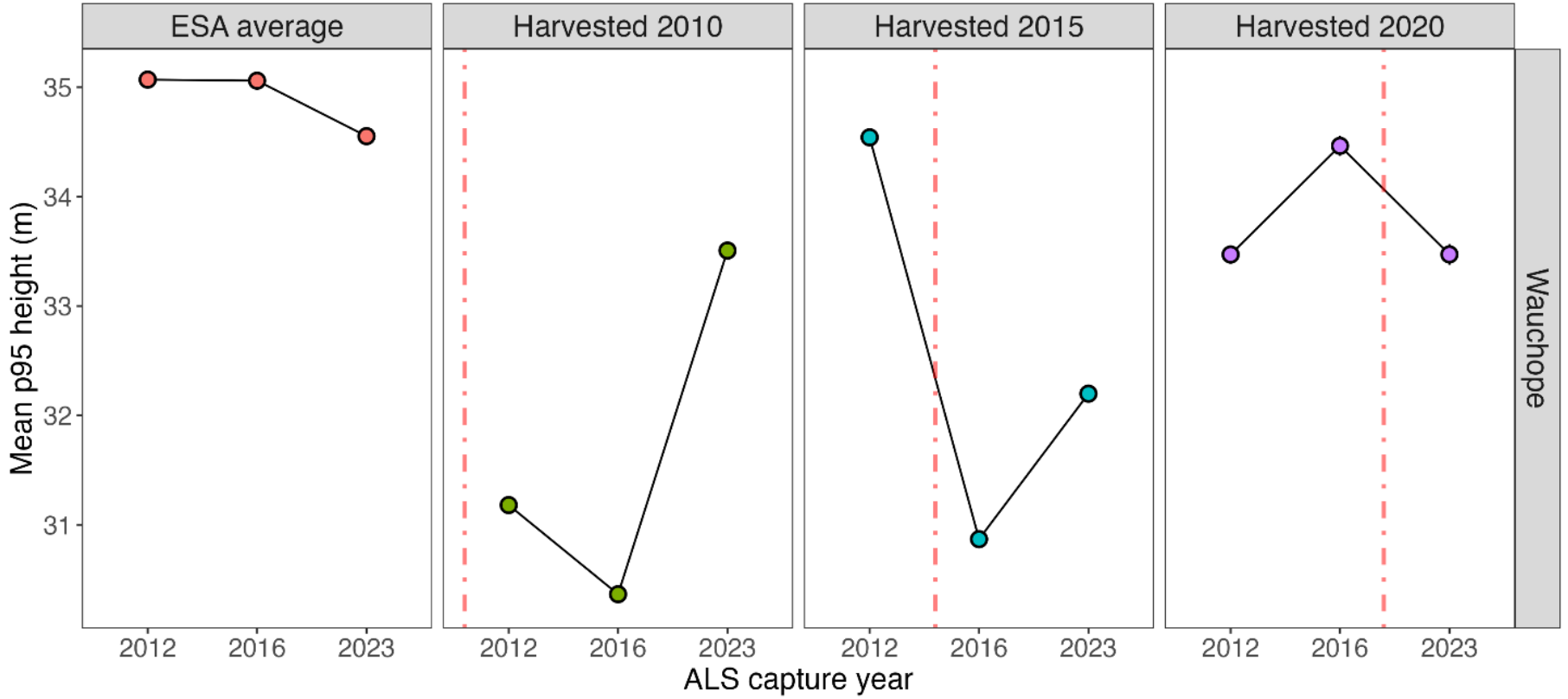
Regrowth over time

LiDAR in State Forests (Coastal IFOA Monitoring Prgm)



Regrowth trends over time

Analyse trends over time. Integrate future LiDAR captures.



Takeaway: Longitudinal LiDAR demonstrates regrowth in heights over time

Regrowth trends over time

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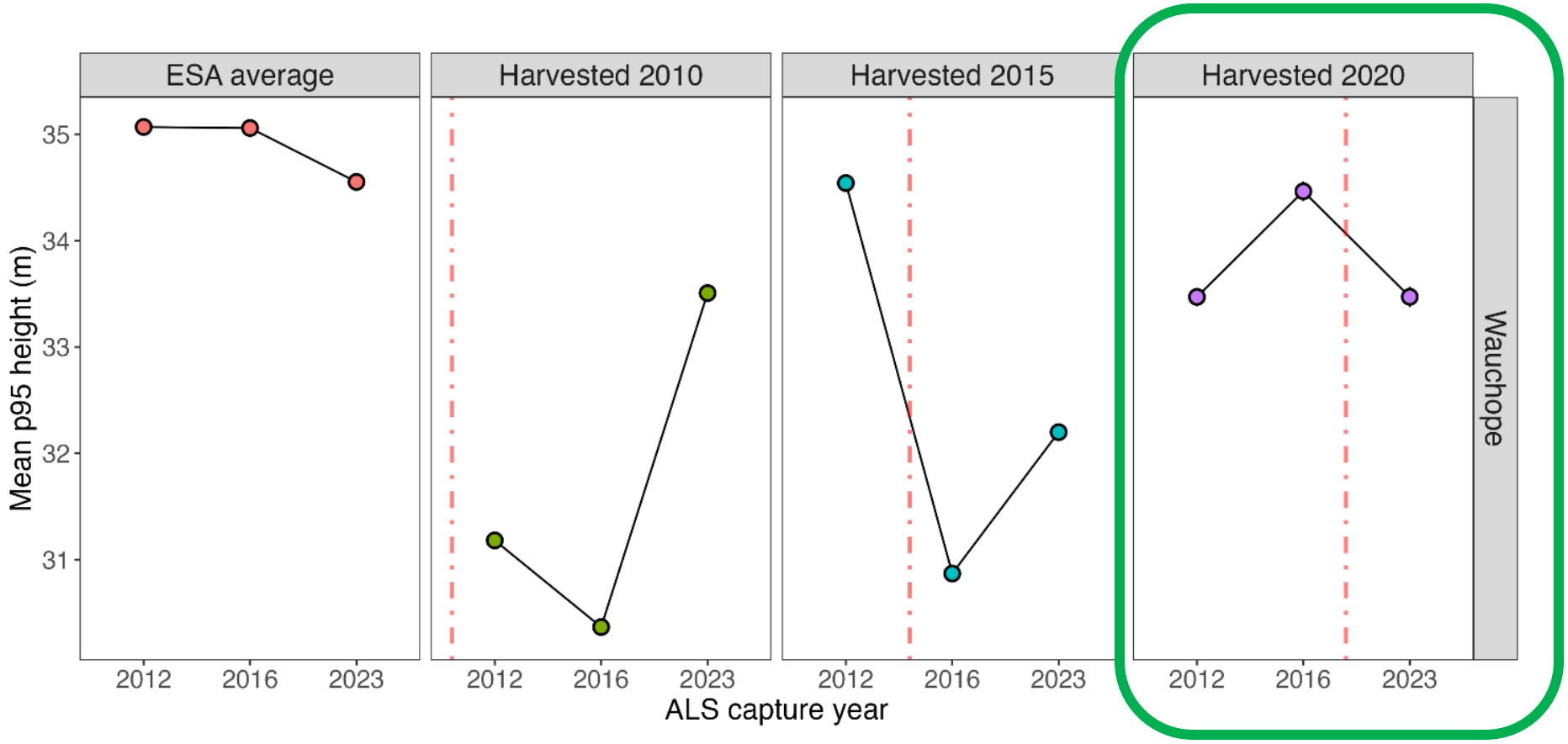
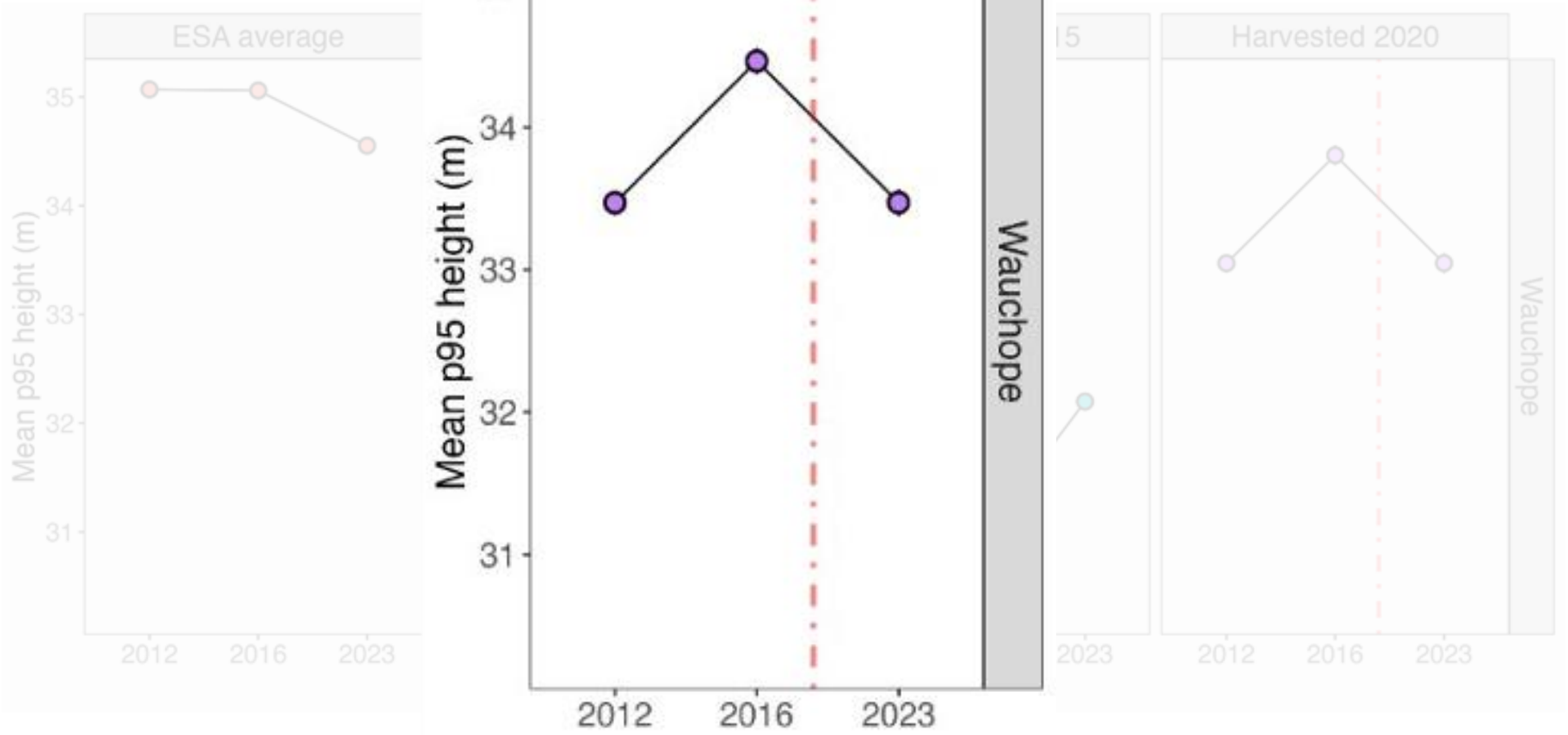


Regrowth trends over time

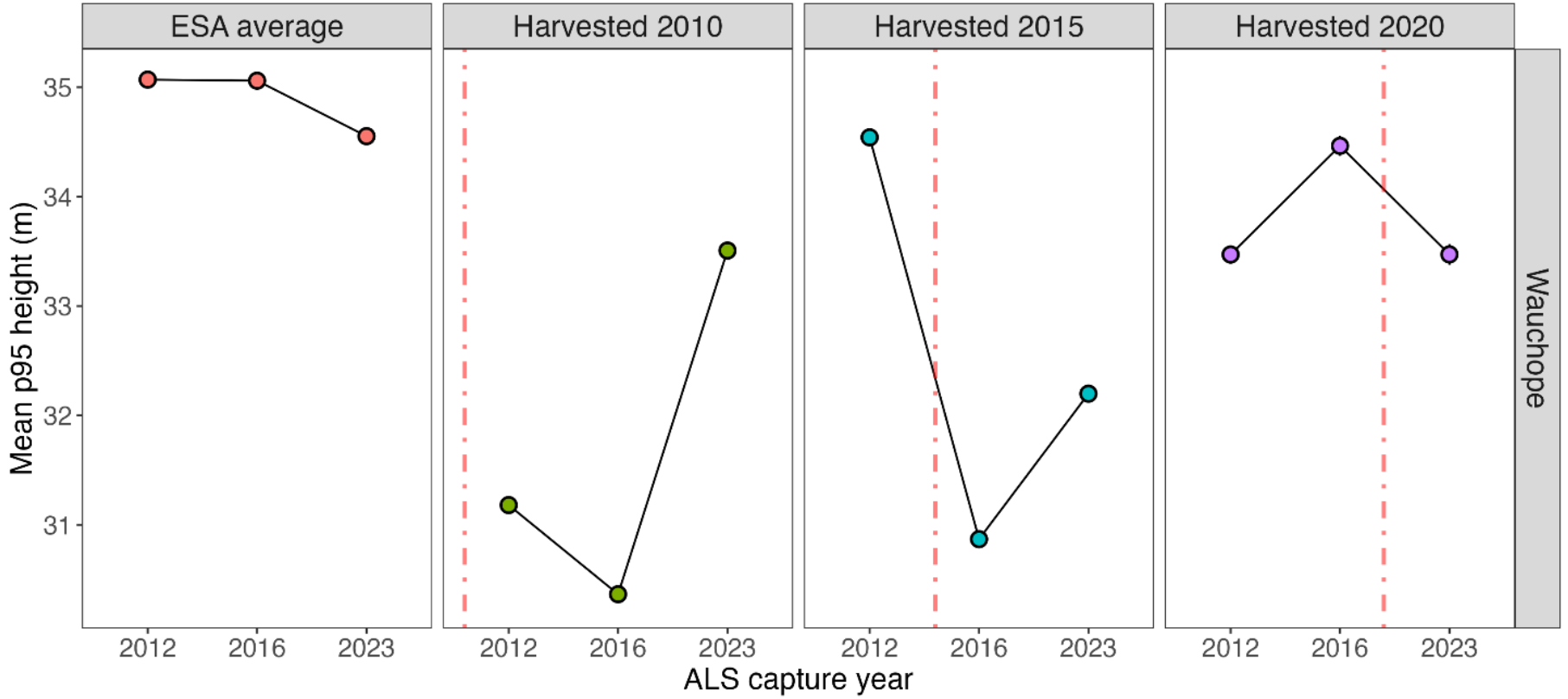
Analyse trends over ti



DAR captures.

Regrowth trends over time

Analyse trends over time. Integrate future LiDAR captures.

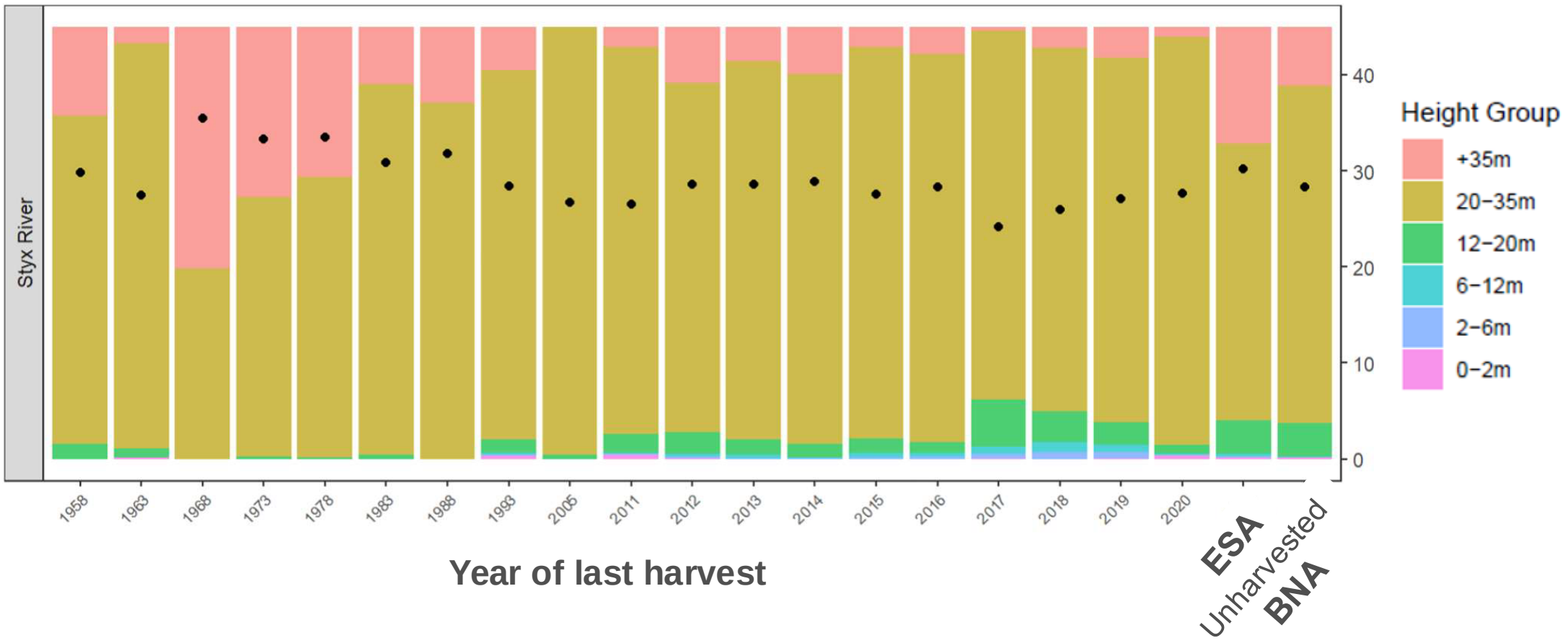


Takeaway: Longitudinal LiDAR demonstrates regrowth in heights over time

Different forests, different structures

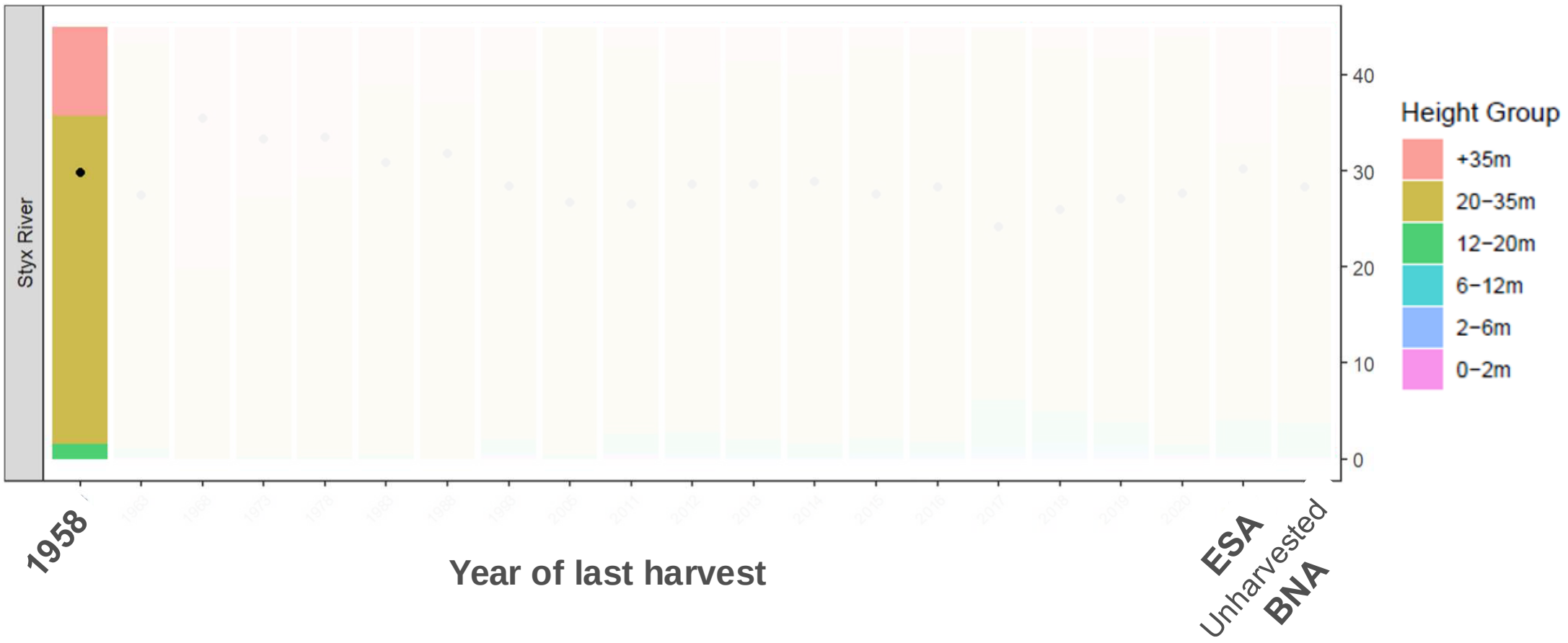
LiDAR in State Forests (Coastal IFOA Monitoring Prgm)

Silvicultural history and forest recovery



Takeaway: Height-group categorisation tracks changes in forest structure

Silvicultural history and forest recovery



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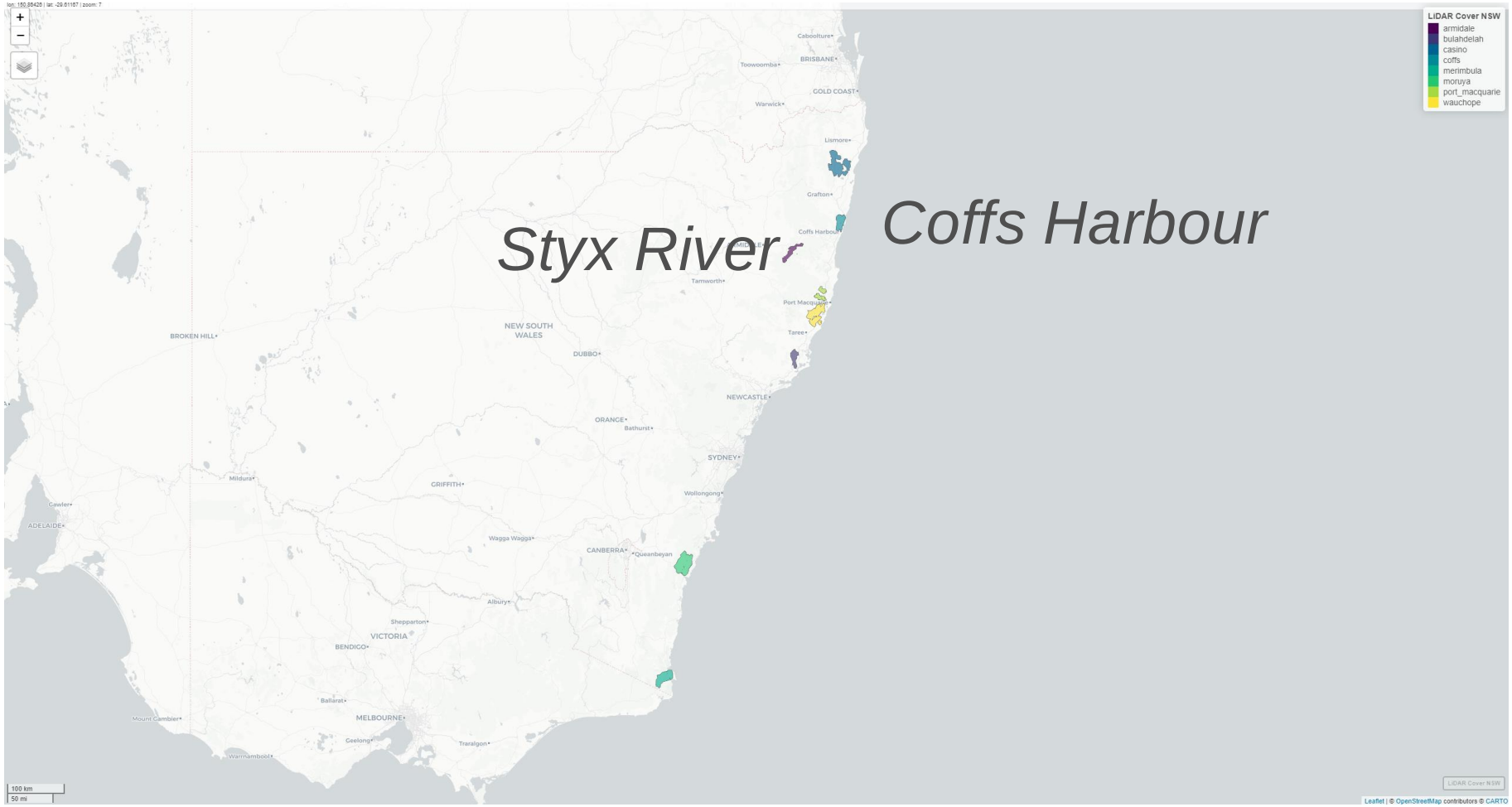
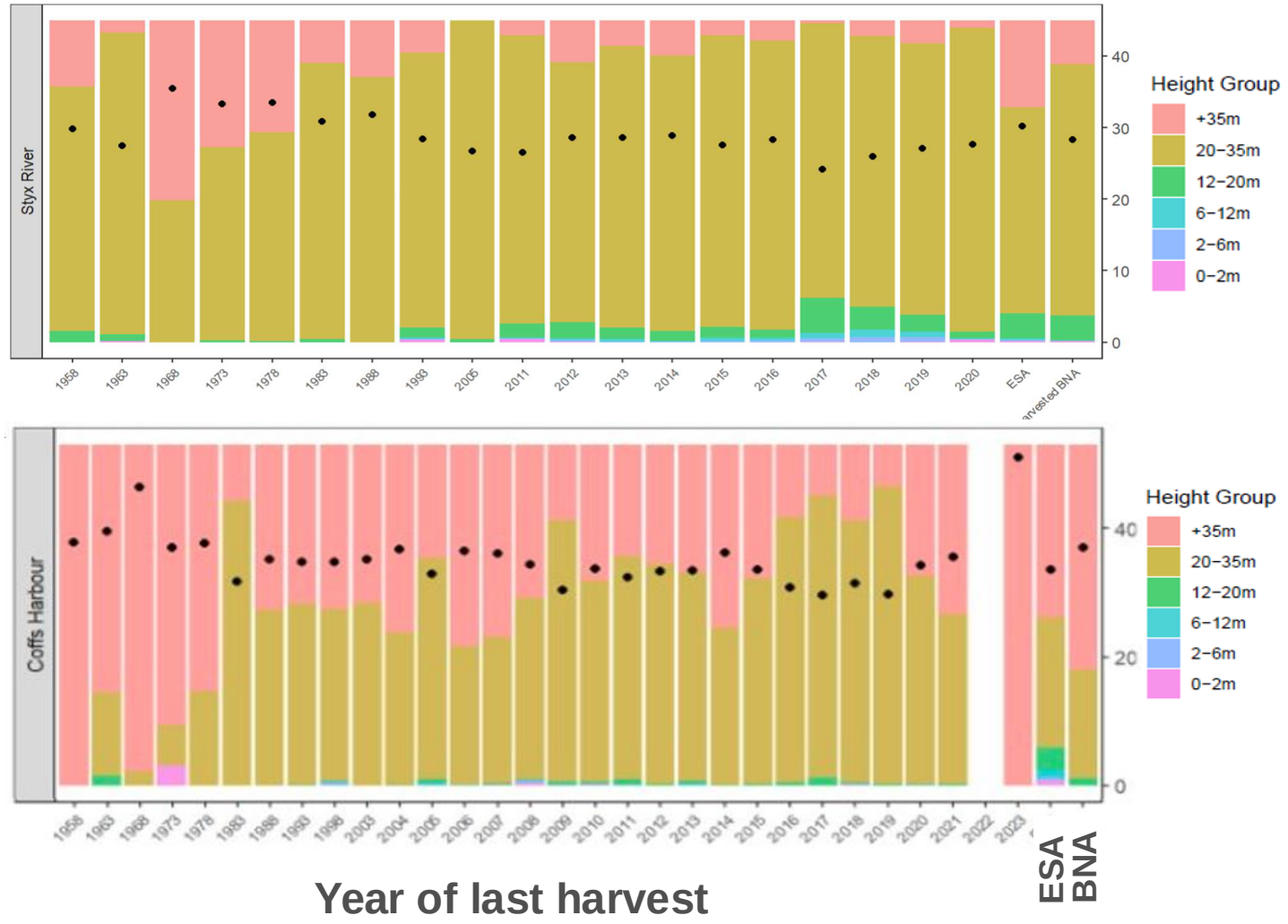


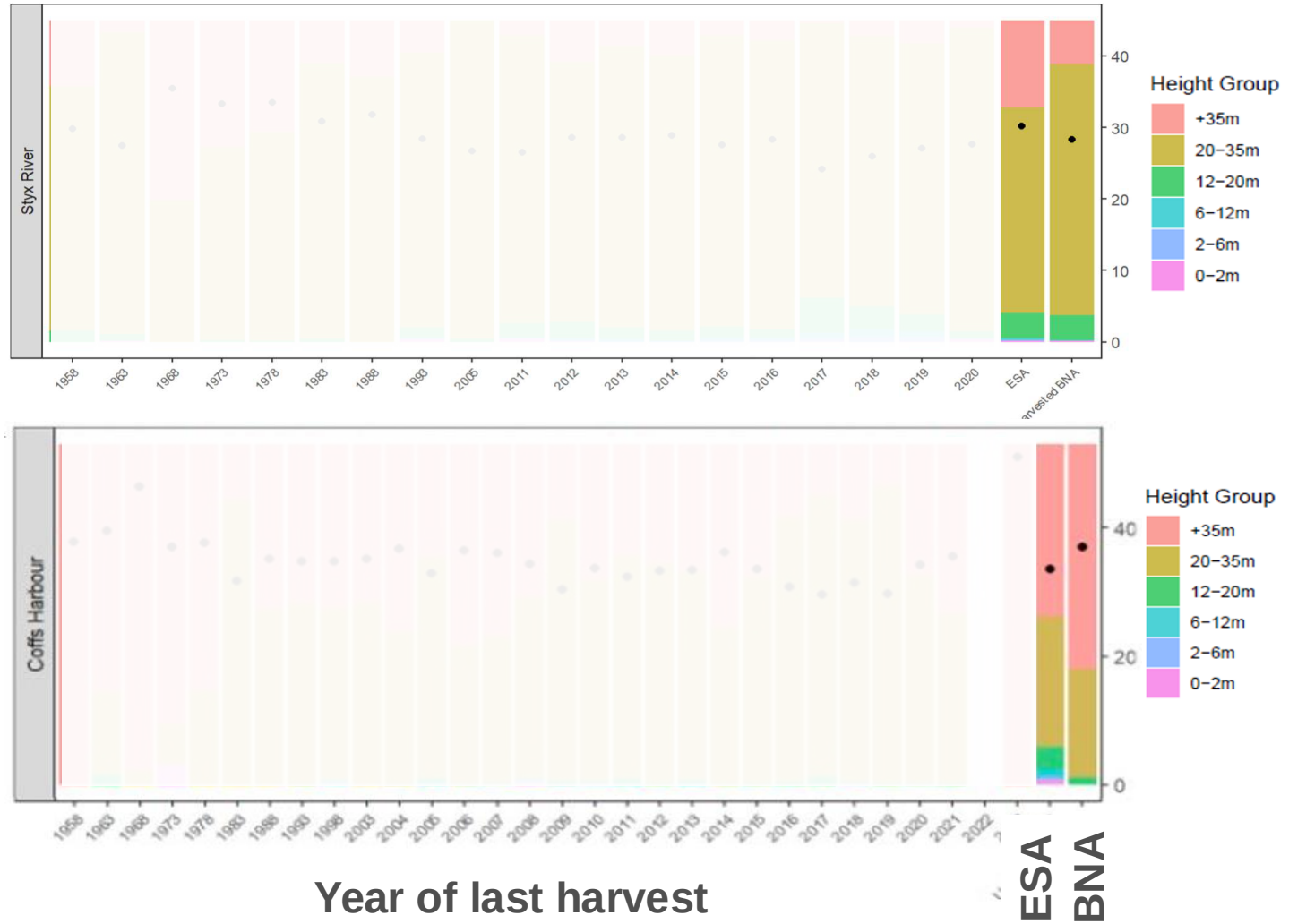
Differences between forests



- ESA = Environmentally significant area
- BNA = Unharvested base net area

Takeaway:
Height-group categorisation tracks changes in forest structure

Differences between forests



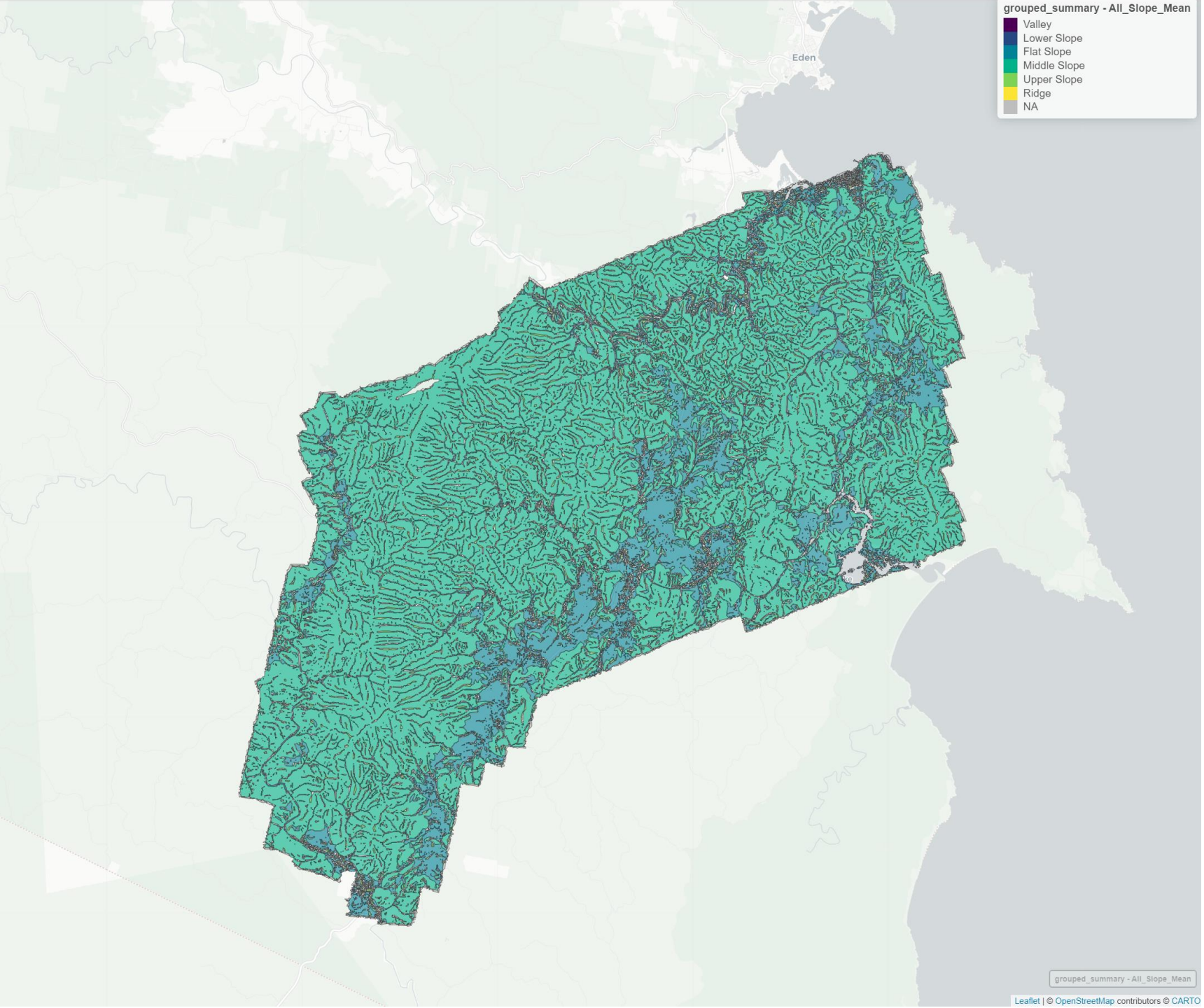
- ESA = Environmentally significant area
- BNA = Unharvested base net area

- Proportionally, forest composition in Coffs Harbour is comprised of taller trees (+35m category)

Takeaway:
Height-group categorisation tracks changes in forest structure

Forest characteristics, landform, & fires


lon: 150.86426 | lat: -29.61167 | zoom: 7
LiDAR Cover NSW
armidale
bulahdelah
casino
coffs
merimbula
moruya
port_macquarie
wauchope
Caboolture
BRISBANE
Toowoomba
GOLD COAST
Warwick
Lismore
Grafton
Coffs Harbour
ARMIDALE
Tamworth
Port Macquarie
Taree
NEW SOUTH WALES
BROKEN HILL
DUBBO
NEWCASTLE
ORANGE
Bathurst
SYDNEY
Mildura
GRIFFITH
Wollongong
Gawler
ADELAIDE
Wagga Wagga
CANBERRA
Queanbeyan
Albury
Shepparton
VICTORIA
BENDIGO
Eden
Ballarat
Mount Gambier
MELBOURNE
Geelong
Traralgon
Warrnambool
100 km
50 mi
Leaflet | © OpenStreetMap contributors © CARTO



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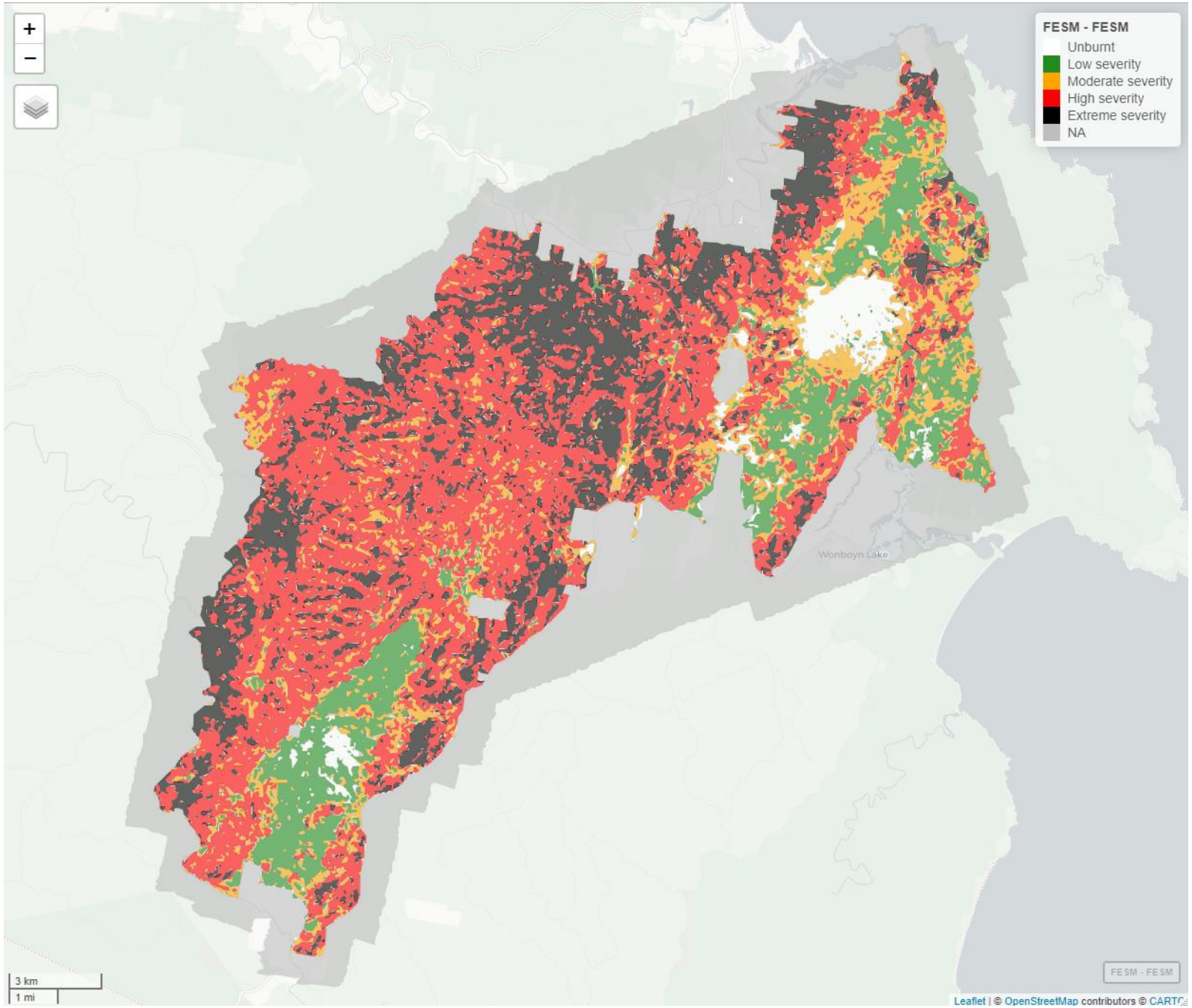
Landform characteristics: *Eden*



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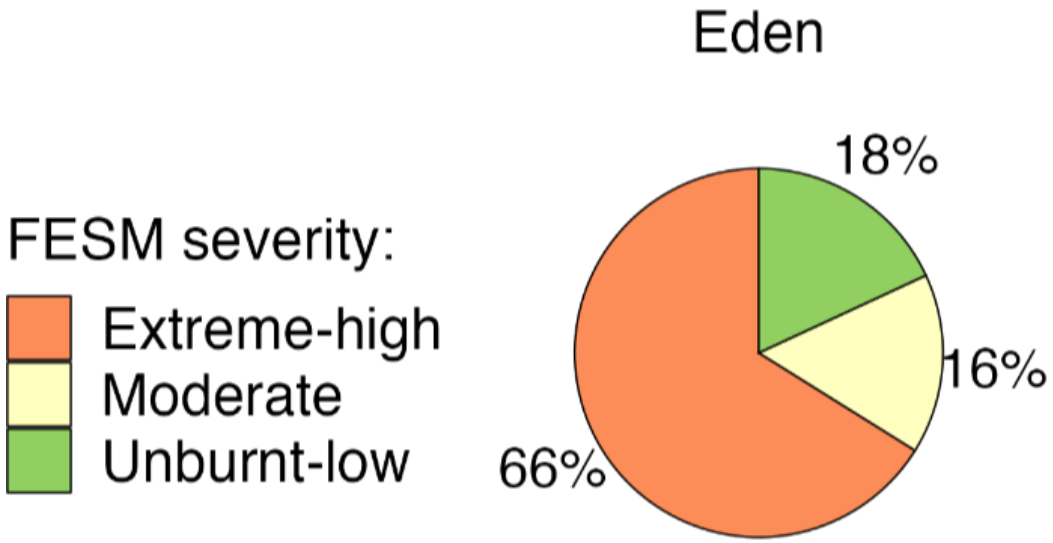
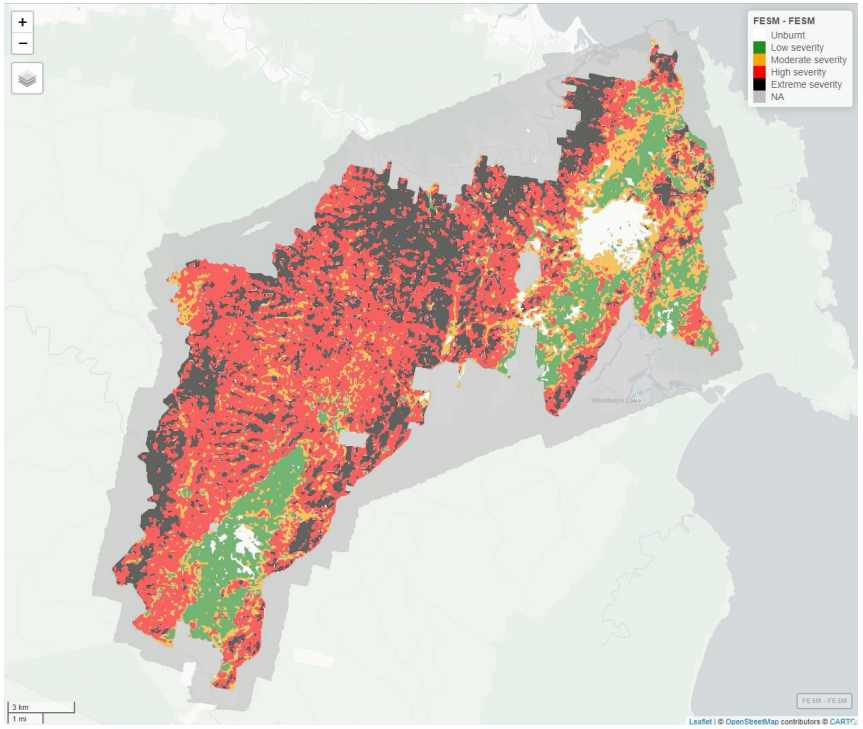
Fire severity '19/'20 (FESM)

Eden

Impacts of Fires

- Examining the proportion of State Forest area impacted by fires

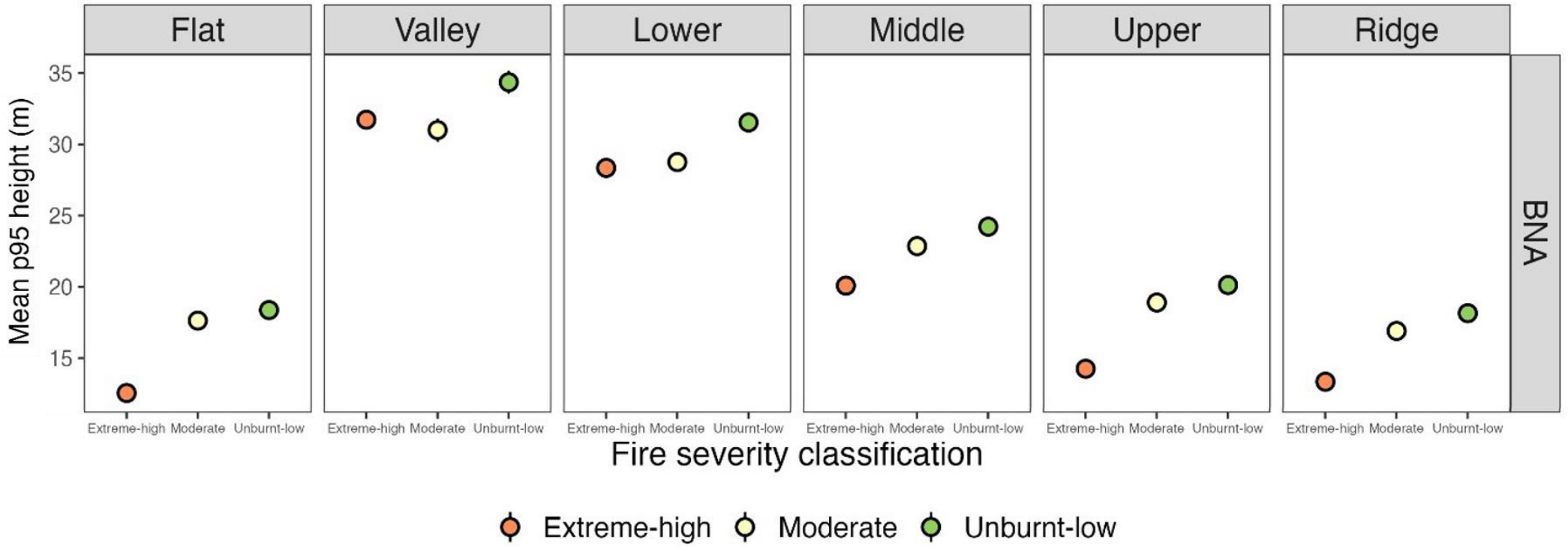




Combining analyses of interest

Q: How did landform in Eden affect bushfire severity?

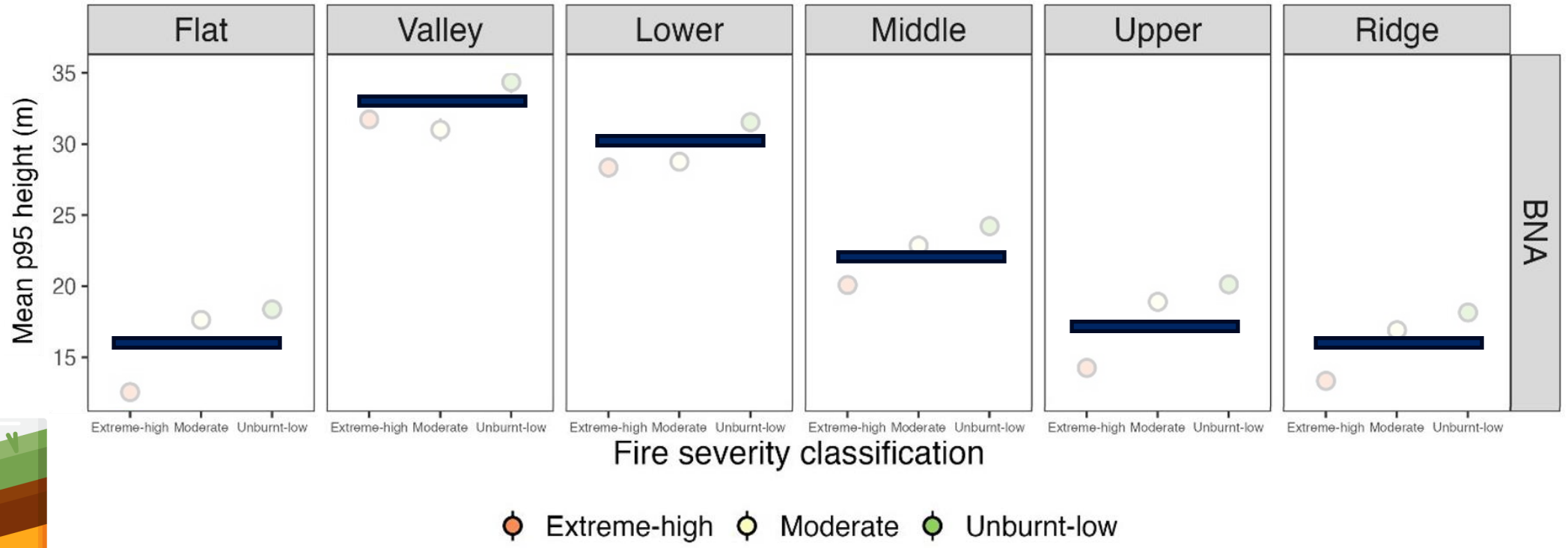
Combining analyses of interest



Combining analyses of interest

Takeaways:

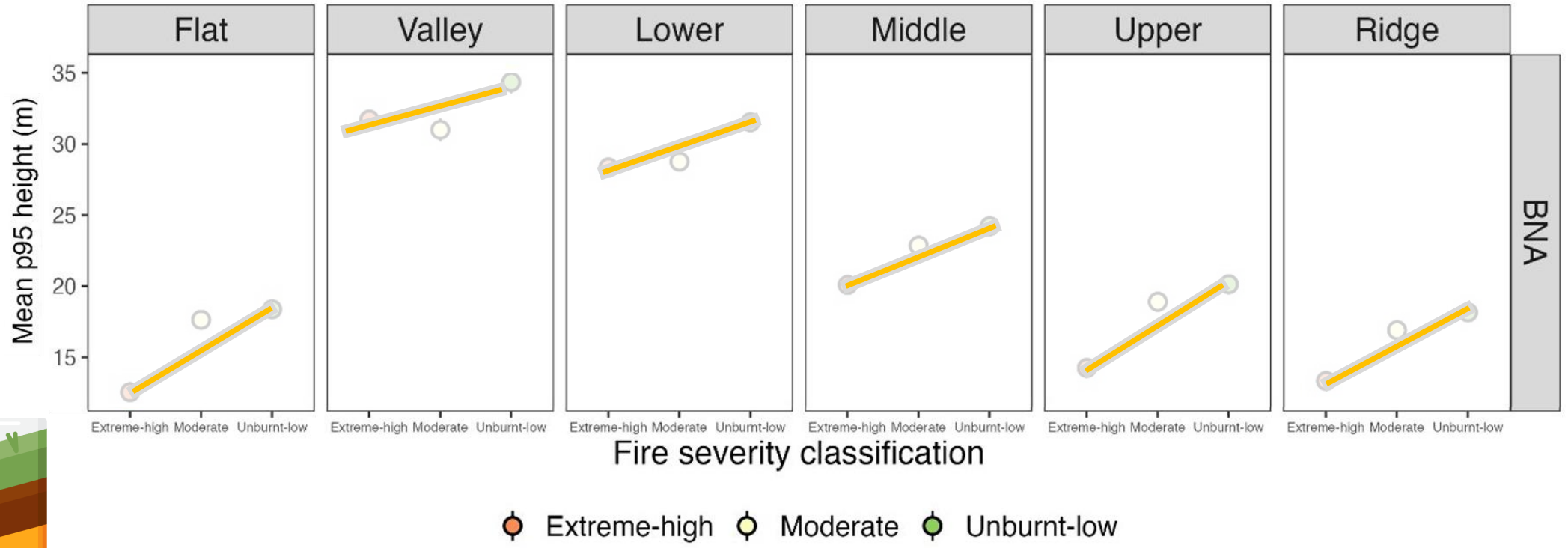
1. Key forest characteristics (e.g., landform) affect tree growth



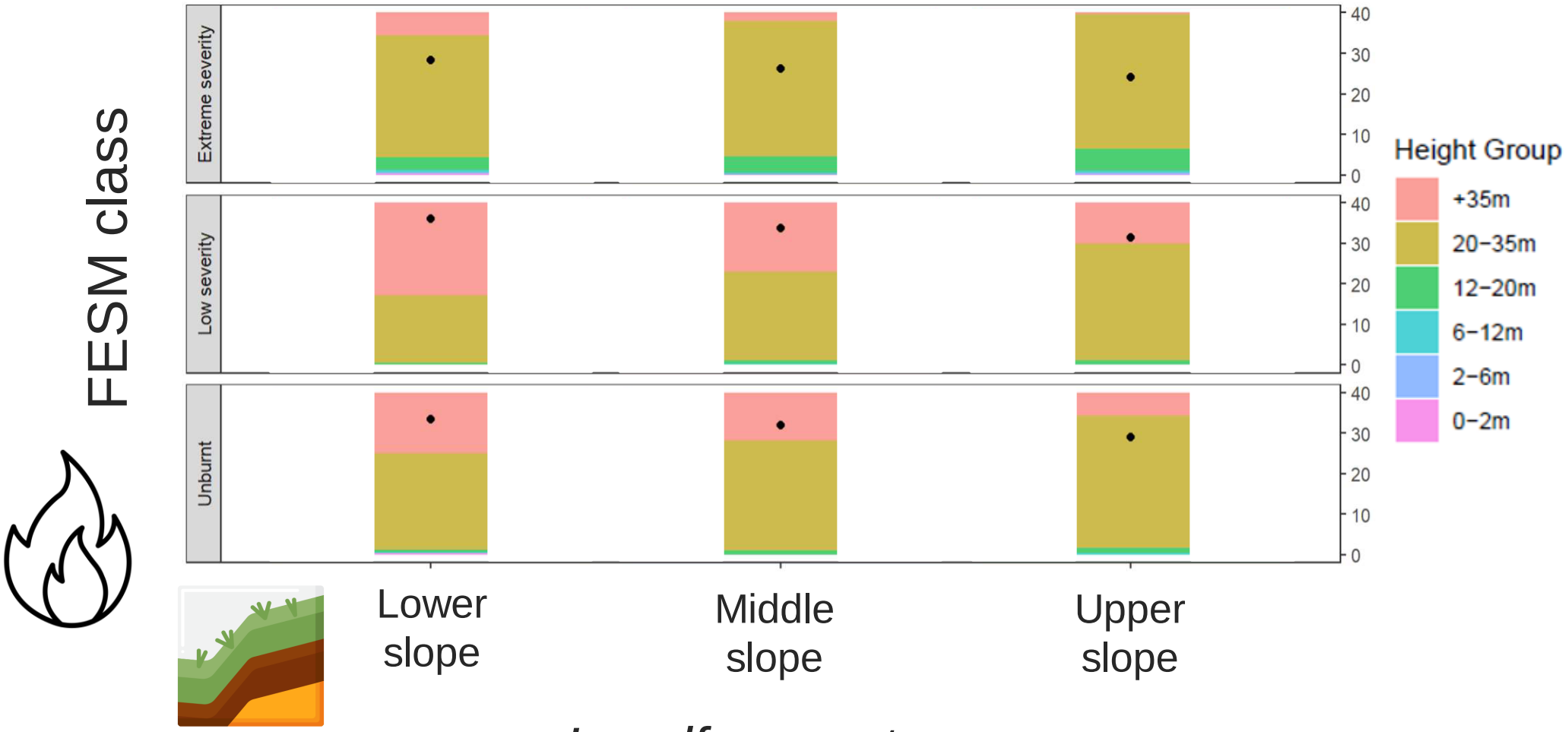
Combining analyses of interest

Takeaways:

1. Key forest characteristics (e.g., landform) affect tree growth
2. Impact of fire differs across landform categories.



Fire severity (FESM) & landform features



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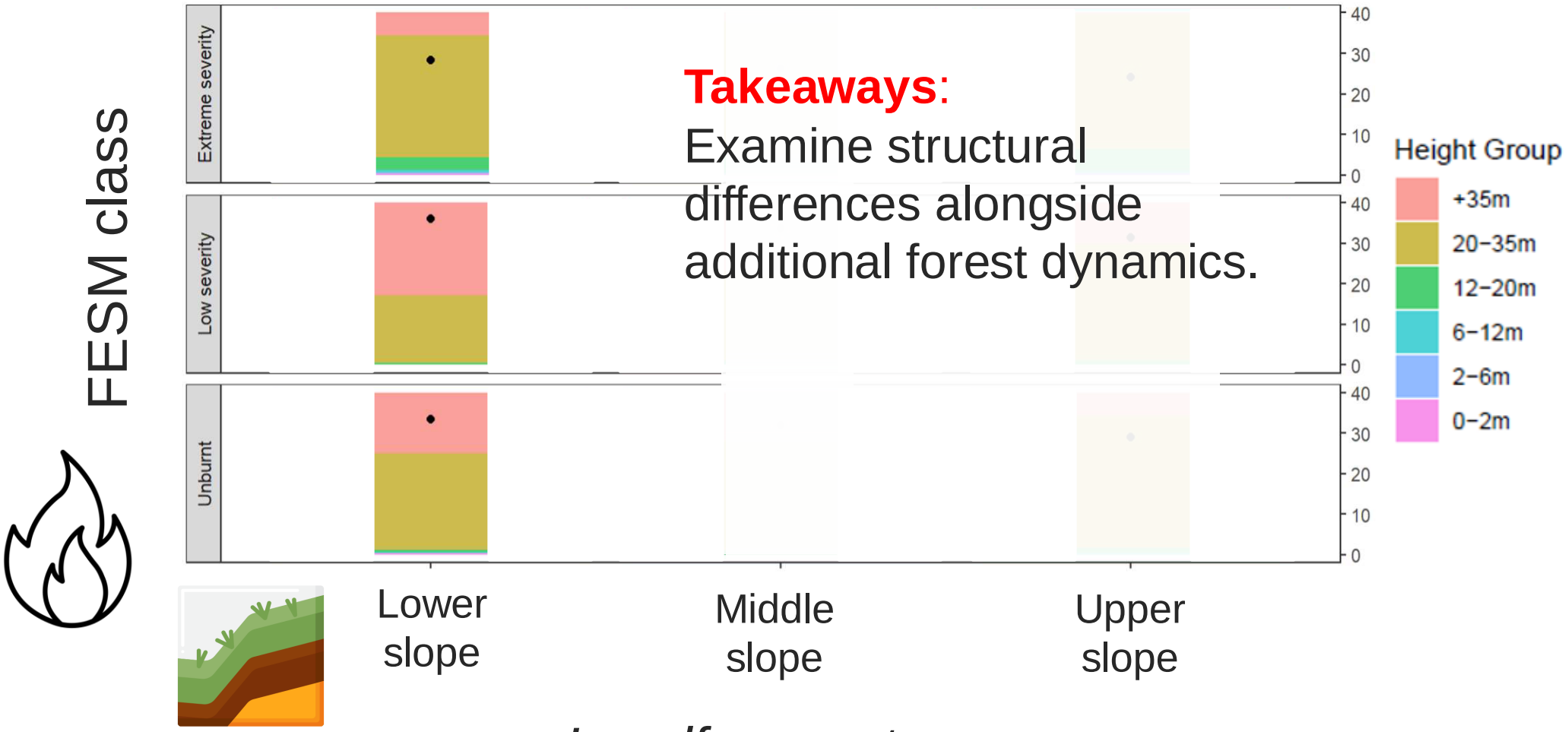


Takeaways:
Examine structural differences alongside additional forest dynamics.

Publicly available outputs

Reports available here:
https://www.nrc.nsw.gov.au/ifoa-mer-forest-health

Extensive analyses of all 7 regions:

Stage 1 Report: **Monitoring forestry outcomes using Airborne LiDAR**

Stage 2 Report: **Retrospective analysis of forest structure change**

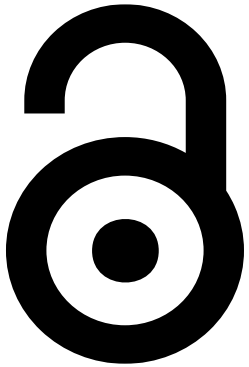
Webmaps: **Coastal IFOA forest structure analysis**

Beyond the graphs

Using the data yourself

Single unified dataset (LiDAR, field & FESM)

- From **+10TB** to **12GB**



Open access data & processing scripts

- Open-source software
- R Statistical program

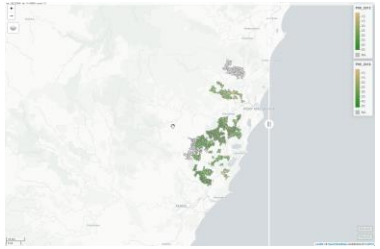
Recreate all analyses & maps on common hardware

Overview

Data disparity problem

Unified solution

Dynamic info-graphics



Extra analyses

?

Future for LiDAR analyses

- Utilise new technology to allow for more precision in monitoring

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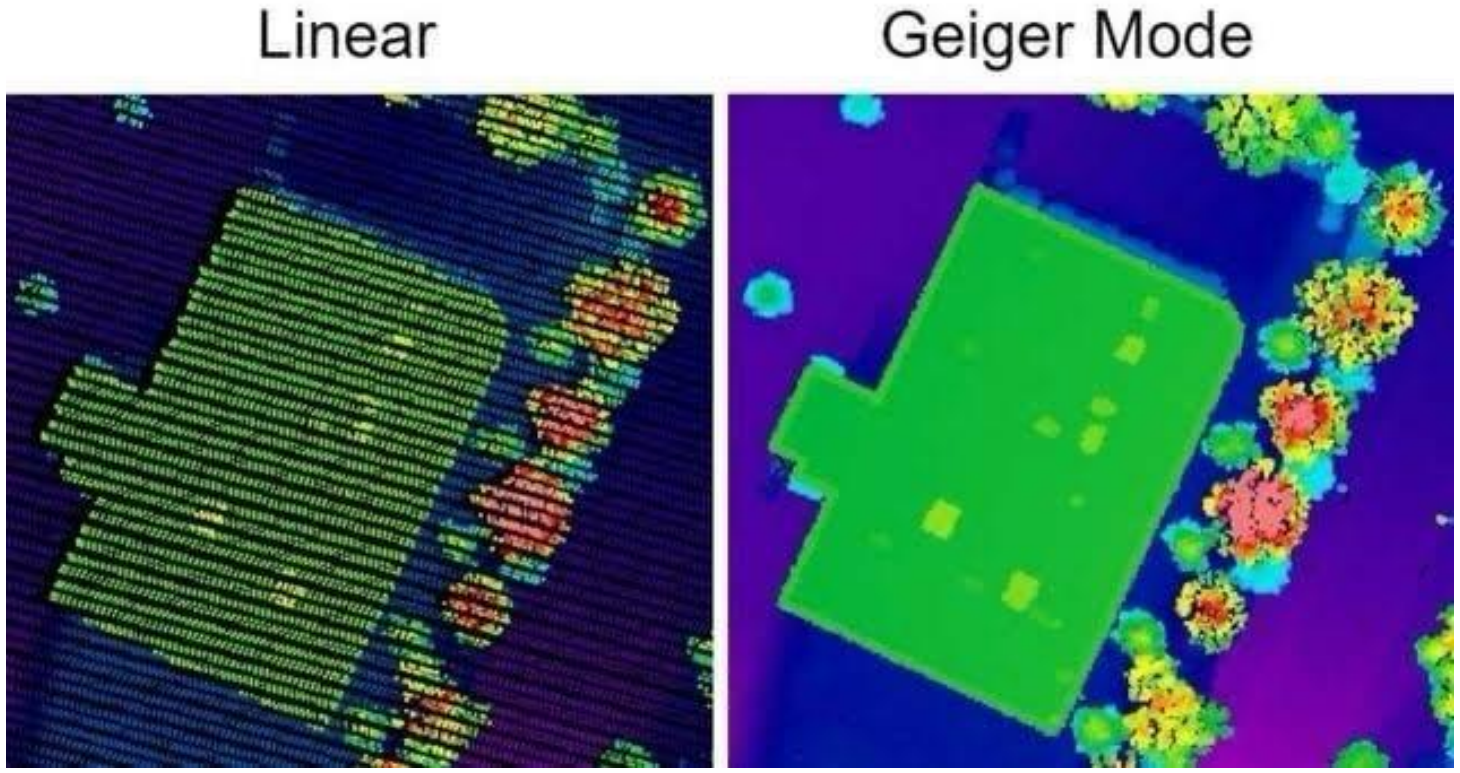

Future for LiDAR analyses

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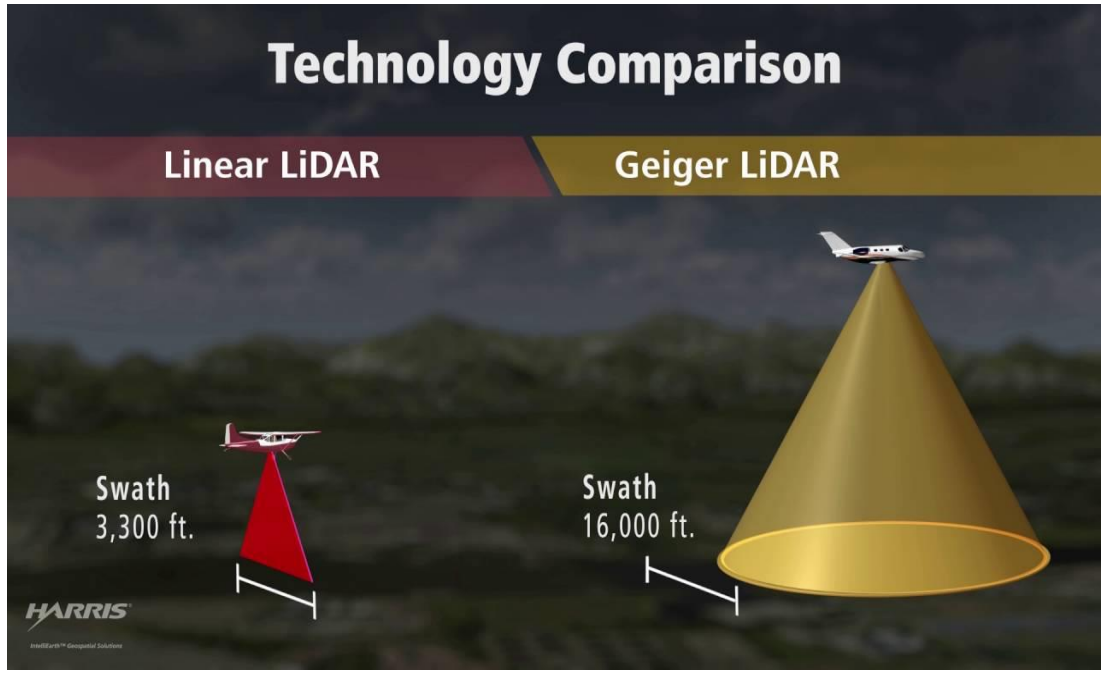

Future for LiDAR analyses

- Utilise new technology to allow for more precision in monitoring
- Examine different metrics of interest, such as metrics that may be related to wildlife habitats.

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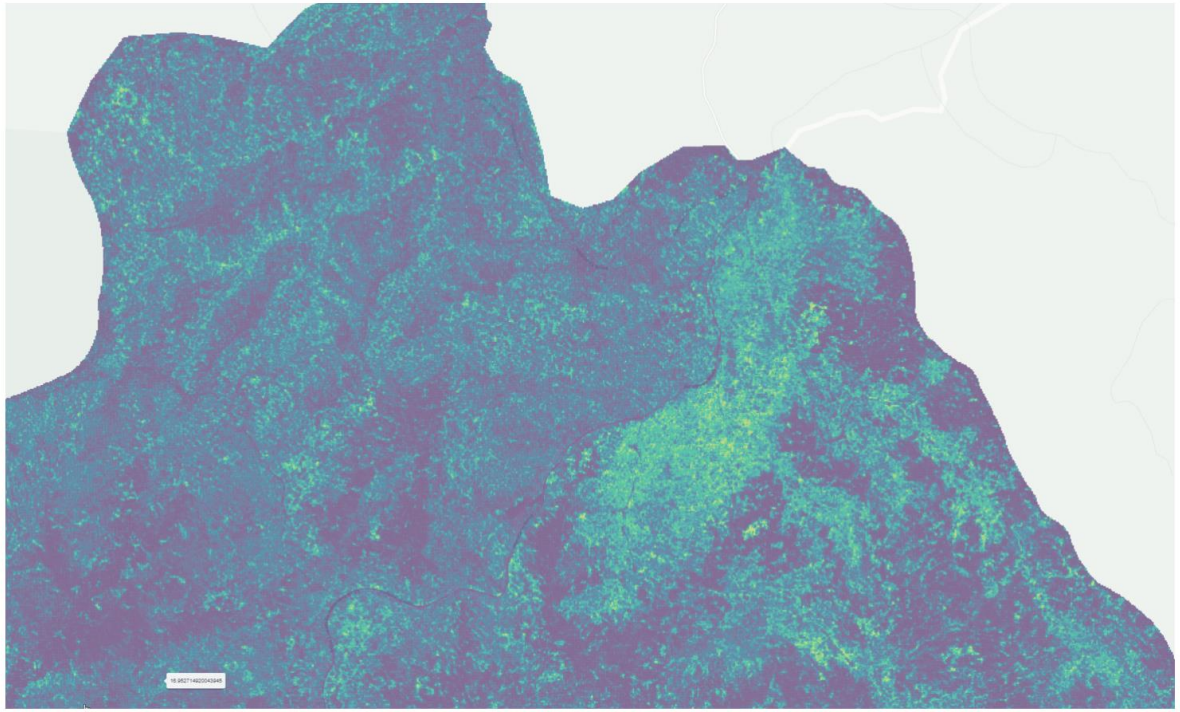
5m x 5m Resolution Understory and Regeneration Map
>15cm
<3m Canopy
Coverage



Future for LiDAR analyses

- Utilise new technology to allow for more precision in monitoring
- Examine different metrics of interest, such as metrics that may be related to wildlife habitats.
- Integrate additional field data and link to existing data set, such as geotagged audio and video recordings of wildlife

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Take-home messages

1. Unified LiDAR datasets into accessible, open format from common hardware.

2. Analyses provides insights into the dynamics of forest structure, composition, and regeneration following harvesting events in NSW State Forests

3. By integrating LiDAR with other spatial data and employing various analytical methods, this research offers a multifaceted understanding of forest ecosystems.

Reach out & contact us if you're interested.

scott.brown@newcastle.edu.au | garston.liang@newcastle.edu.au | zac.coates@uon.edu.au

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Q&A

Professor Scott Brown, University of Newcastle

Professor Patrick Baker, Professor of Silviculture and Forest Ecology, University of Melbourne

Dr Sam Hislop, Land Sector Carbon Analyst, FlintPro

Todd Maher, Director, Natural Resources Commission

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Thank you for joining us today!

This webinar will be available shortly on the Commission's website nrc.nsw.gov.au

The Commission will post responses to unanswered questions on the Commission's website.

Any further questions or feedback please contact us nrc@nrc.nsw.gov.au

Webinar Survey: Forest monitoring using LiDAR