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Technical report for Local Land Services

Report on the suitability to produce sawlogs of private property forests in Southern NSW PNF code region

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Published by the NSW Department of Primary Industries

Report on the suitability to produce sawlogs of private property forests in Southern NSW PNF code region

First published May 2024

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Acknowledgments

Mr Nick Cameron for initiating the project and providing expert opinion. Dr Amrit Kathuria for her leading contribution to the development of a commercial forest model, a forest site index model, and a forest yield association group model. Local Land Services, NSW Spatial Services and Forestry Corporation of NSW for data sharing and technical support. Dr Sam Hislop for LiDAR data processing and analysis.

Reference number PUB24/546

ISBN: 978-1-76058-798-7

Contents

Introduction

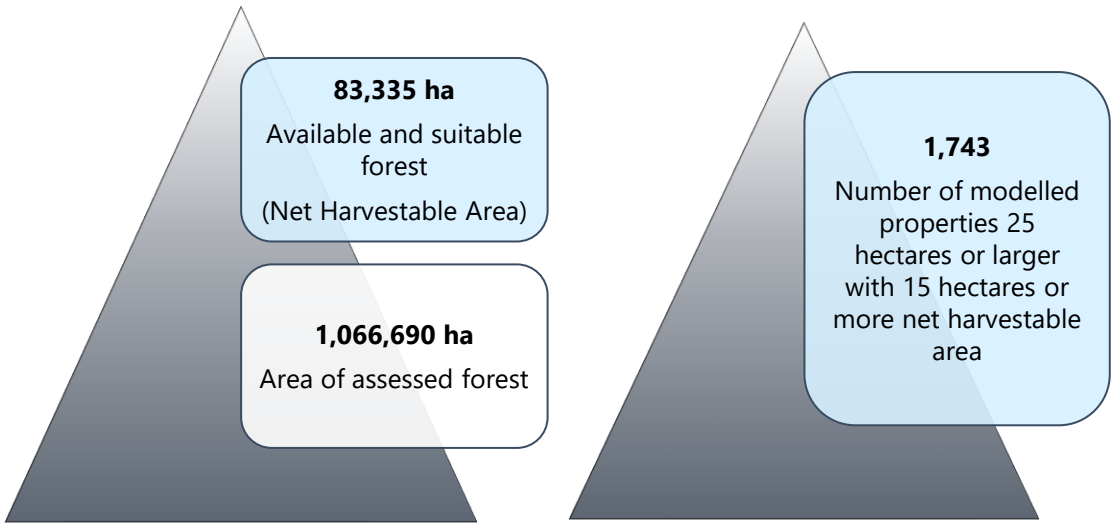
DPI Forest Science has developed a comprehensive method aimed at evaluating the availability and suitability of native forest for private native forestry operation purposes. The method was applied to the 1.1 million hectares of private native forests across the NSW Sothern PNF code region. A total of 1,743 properties with property land size of 25 ha or over, and over 15 ha of native forest available and suitable for sawlogs production within the property boundary have been selected for the evaluation. The selected properties cover 315,135 hectares of native forest. A modelling process using six parameters enabled each property to be individually assessed and classified into a private native forestry suitability class. This report outlines the methodology employed during this assessment and provides an overview of the derived modelled outcomes.

Aim

To develop a model for evaluating the suitability of private property for native sawlog production in Southern PNF code region.

Key Findings

A summary of the key findings is presented in the figures below.



a) Private Native Forest Area b) No. of Properties

Figure 1. a) Area of private native forest assessed and modelled as available and suitable. b) number of properties suitable for PNF that were modelled

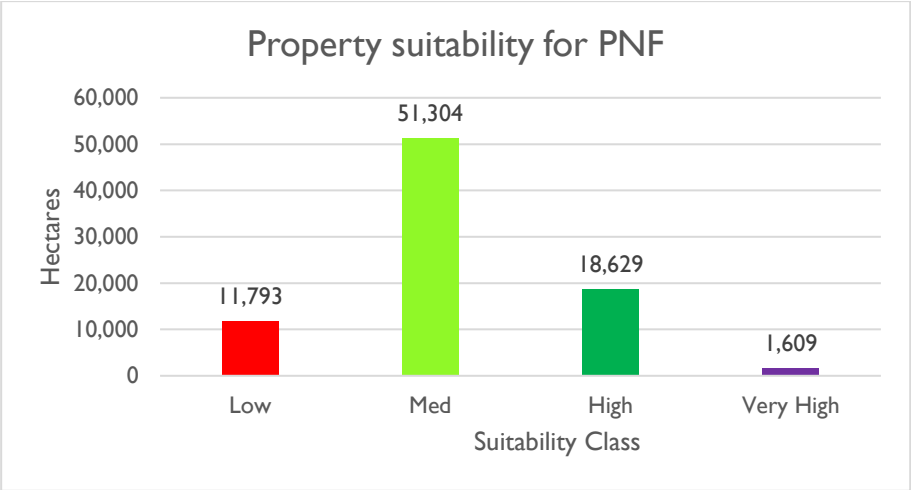


Figure 2. 83,335 ha of native forest available and suitable for PNF by suitability class

Disclaimer

The NHA dataset used as base layer for spatial analysis of current project was produced in 2021. To the best of our knowledge, the data was produced utilising the latest versions of the datasets available at that time. Legislative requirements and variations to the underlying spatial data has subsequently changed. Therefore, the NHA figures produced inside this report ranking private property suitability to produce sawlog should be considered current as of 2021.

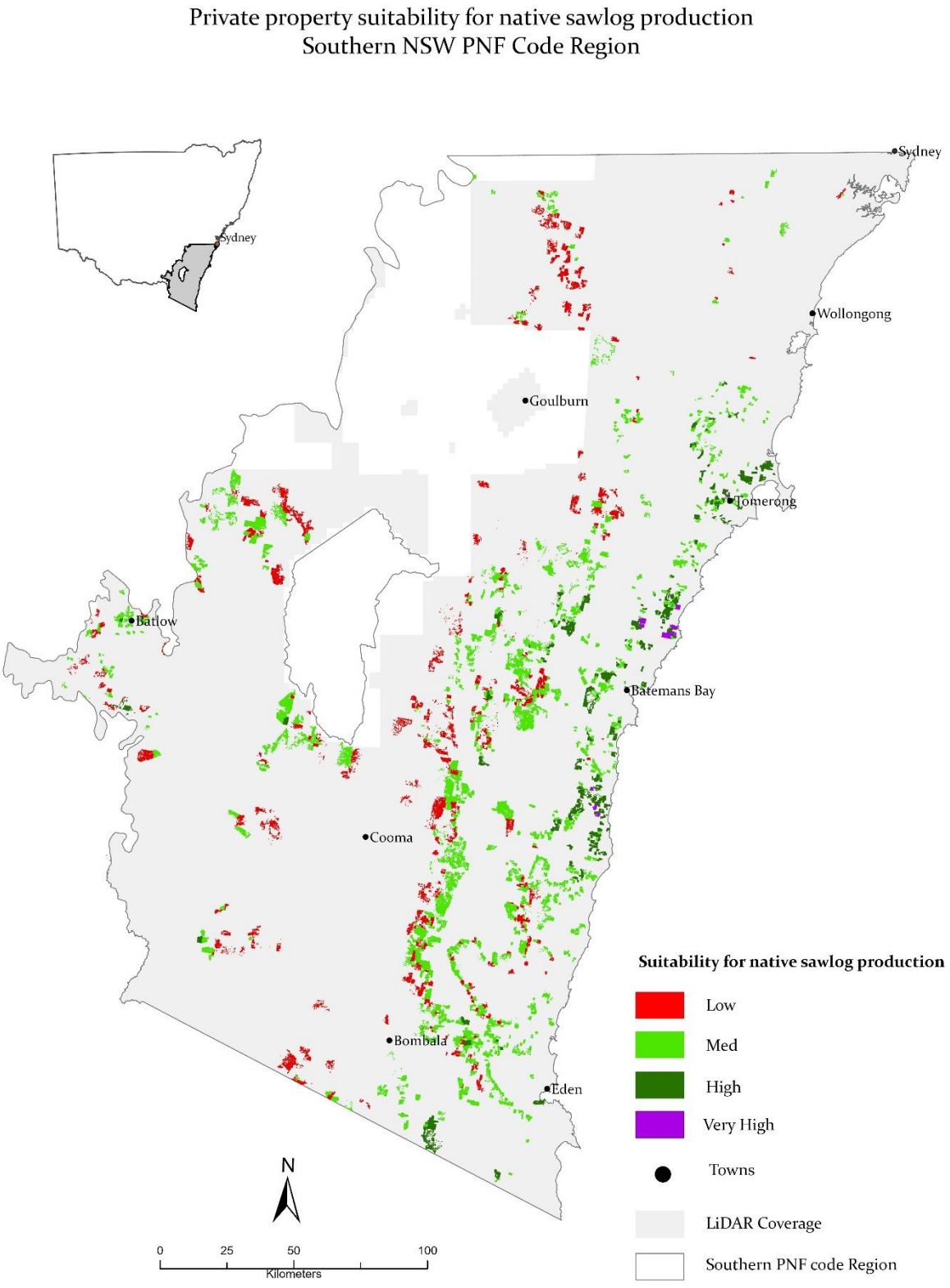


Figure 3. Distribution of private native forest available and suitable for PNF by suitability class

Method

Spatial Layers, Analysis Software and Geoprocessing Tools

The model was developed and run using ARC GIS Pro 3.1 and used specialised geoprocessing tools including the Network Dataset function and Network Analysis extension in Arc GIS Pro. Ten spatial layers were used in the model, a description of each is provided below:

i. A **NSW native forest cover layer** was derived from a national woody vegetation layer developed by the National Greenhouse Gas Inventory (NGGI2018). This layer was downloaded from data.gov.au in 2019 and refined by DPI forest science (Alaibakhsh, 2019) to match the Australian definition of a forest (SOFR2018). The woody vegetation layer included 3 classes. Class 2, illustrating areas with greater than or equal to 20 percent canopy cover, was selected and used as the base woody vegetation layer. Then, using plantation layer (provided by DPI Plantation unit), EPI Land zoning (EES), Land use 2013 (SEED data portal), and horticultural land layers from QSpatial live data portal some exclusion classes were removed to create a 20 percent canopy cover forest layer for NSW (NSW forest extent interactive reports).

ii. A **Southern NSW PNF Code region** boundary layer was created by DPI Forest Science (Alaibakhsh, 2020) using IBRA7 regions layer. The Sydney CBD latitude (33° 52' 2.71" S) was also used to define the Northern boundary.

iii. A **NSW Spatial Services Lidar** extent layer was sourced from Spatial Services. This layer was clipped to the Southern NSW PNF Code region. It was found that the LiDAR data has not been captured over the Northwest part of the project area.

iv. **Cadastre NSW** layer detailing boundaries of private properties in Southern NSW. This layer was downloaded from Spatial Services collaboration hub (NSW Land Parcel Property Theme - Property , Spatial Services Customer Hub) in Feb 2024. Details of individual owners were kept confidential.

v. The **Public Roads** layers for NSW accessed from NSW Transport Theme - Road Name Extent | Spatial Collaboration Portal in February 2024. A shapefile of all public roads within 100 km from the region's boundary was created.

vi. A **NSW digital elevation model** layer was derived from Spatial Services LiDAR data (Hislop, 2021).

vii. A layer detailing the location coordinates of **Southern NSW wood processing facilities** was sourced from Forestry Corporation of NSW, last updated in 2024. From the layer the location coordinates of wood processing facilities that process hardwood were selected.

viii. A layer identifying **private native forest available and suitable for timber production** on the NSW south coast was used to refine the area of forest to be

modelled. This layer was developed by DPI Forest Science for LLS in 2021 (Alaibakhsh et al, 2022), hence, any post 2021 changes or updates of the underlying spatial layers have not been applied. The layer was created by removing forest subject to regulatory operating exclusions (more than 40 spatial layers), environmental exclusions, as well as forest classified as non-commercial (Kathuria et al, 2022). Details of the methodology are contained in a report titled '*Technical report on estimating available Private Native Forest for timber harvesting in Southern NSW (Regulatory and Environmental exclusions'*.

ix. A layer detailing the **forest yield association groups of the NSW south coast** was used to differentiate between preferred and non-preferred forest types that are non-commercial (e.g., rainforest). The layer was developed by DPI Forest Science (Kathuria et al, 2023) for LLS. The methodology that was used to generate this layer and information on its accuracy is detailed in a report prepared for LLS titled *Report on Forest YAG Mapping NSW North Coast and South Coast NSW*.

x. A **forest site quality layer** was used to differentiate forest based on its productivity and timber yield potential. This layer was developed by DPI Forest Science for LLS (Kathuria et al, 2022). Details of the methodology that was used is contained in a DPI report titled *Site Index Mapping for Private Native Forest, North and South Coast NSW using LiDAR Data*

Caveats and limitations

NHA layer is a static dataset and was created utilising more than 40 spatial layers current as 2021, therefore, any post 2021 changes or updates of the underlying spatial layers have not been applied.

The modelling of property suitability for PNF considered the availability and suitability of a property's native forests over the longer term. The existing silvicultural condition and growth status of the forest was not considered. Silvicultural condition and growth status are a product of past management events and practices and as such vary over time and from one property to the next. For example, a property may be classified as highly suitable for PNF based on its size, location, terrain, species mix and site quality but may not currently contain merchantable timber due to having been recently harvested or impacted by wildfire.

The views or attitudes of the owners of the modelled properties were not considered. A separate study (DPI 2017) on the Northern code region, examined this issue and found that not all landholders are inclined towards PNF; so, classifying a property's forests as suitable for PNF does not mean that they will be managed for this purpose.

Technical caveats

- LiDAR data wasn't available for the entire Southern PNF Code Region. The project's area of interest was limited to the LiDAR data coverage area.
- Fire and harvesting effects were not considered.
- P2. Distance by road to wood processing facilities

    - Due to lack of active wood processing facilities across Southern region, the distance from the closest facility (only one facility) has been estimated.
    - We only looked at the sawmills not firewood or pulp processing facilities.
- P4. Terrain roughness
    - we evaluated DEM variation within the NHA of the properties not the region or whole property.

Modelling Parameters

Six attributes known to influence timber production suitability were selected as modelling parameters:

- P1. Net harvestable area (NHA)
- P2. Distance by road to wood processing facilities
- P3. Slope
- P4. Terrain roughness
- P5. Forest Yield Association Group
- P6. Forest site quality

Each modelling parameter was assigned four suitability categories, namely, 'Very High (4)', 'High (3)', 'Med (2)' or 'Low (1)'. The stratification process was based on an analysis of the measured values for each parameter using knowledge of their influence on commerciality. A detailed explanation of the process for each parameter is provided later in the report.

P1 - Net harvestable area

P1 - Explanation

For a property to be eligible for modelling it had to be 25 hectares or greater in size and have 15 or more hectares of native forest contiguous net harvestable area. For modelling purposes, all the areas of assessed forest within a property were summed.

Properties that didn't meet the size criteria were not considered viable for commercial forestry but may still support small scale timber harvesting operations, particularly if harvesting and processing is undertaken by the landholder.

All commercial harvesting operations incur 'fixed' and 'partially fixed' costs. These costs include forest assessment/inventory, preparation of a forest operations plan, floating of harvesting equipment to the site, road maintenance and upgrades. These costs are commonly in the order of $5000-$10,000. Depending on the contractual arrangement these costs may be borne by the landholder or the harvesting contractor. Regardless of who pays, for the operation to be commercially viable, the income from the sale of timber needs to exceed these costs.

When costs are dispersed over a small number of hectares, harvesting becomes less viable. In contrast when setup costs are distributed over a large forest (200 hectares or greater) the unit cost becomes immaterial.

Table 1 details the classification of the NHA into forestry suitability classes based on the cost per net harvestable hectare.

Table 1. P1-Net harvestable area (NHA) forestry suitability classes

Suitability Class	Very High (4)	High (3)	Med (2)	Low (1)
Net harvestable area (ha)	≥ 200	≥ 100 to < 200	≥ 50 to < 100	≥ 15 to < 50
Harvest planning, setup, and maintenance costs ($/ NHA)	Low	Med	High	Very High

P1 - Modelling process

The following spatial layers were used to derive the NHA:

- Southern NSW PNF Code Region boundary (Alaibakhsh, 2020)
- Cadastre NSW property boundaries (NSW Land Parcel Property Theme - Property , Spatial Services Customer Hub)
- NSW forest cover (Alaibakhsh, 2019)
- NSW Spatial Services Lidar coverage
- Private native forest available and suitable for timber production layer produced in 2021 (Alaibakhsh et al, 2022)

To generate the NHA layer the following steps were followed:

1. Properties in the Cadastre NSW layer with total property land area of less than 25 hectares were removed.
2. The NSW Forest Cover layer was intersected with the Southern NSW PNF Code Region NSW boundary, the Spatial Services Lidar extent layer, and the clipped Cadastre NSW property layer.
3. The private native forest available and suitable for timber production layer was overlayed and removed from the clipped Forest Cover layer.
4. Properties with less than 15 hectares of net harvestable forest were removed.
5. What remained was classified as the Net Harvestable Area (NHA) layer.

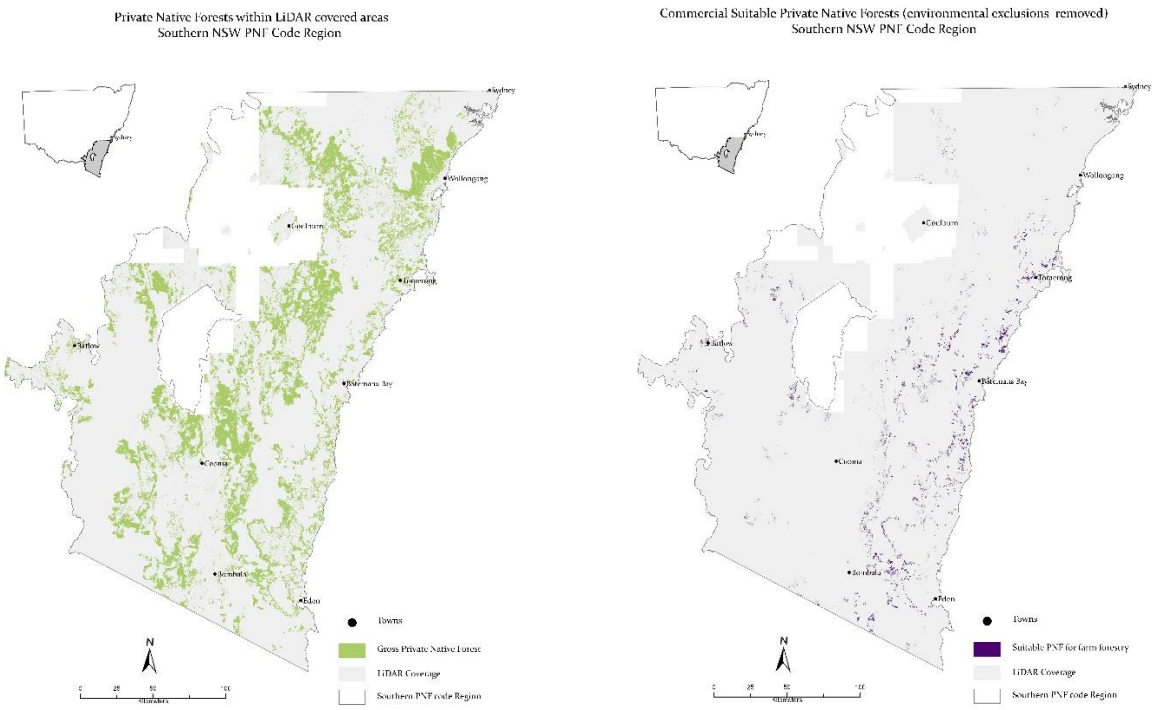
The modelling process revealed that 1.27 million hectares of privately-owned land in the Southern NSW PNF Code region has native forest cover. 1.1 million hectares (84%) of this forest had Spatial Services LiDAR coverage.

Of the 1.1 million hectares of assessable forest, 0.67 million hectares was available after applying regulatory and environmental exclusions. This reduced to 83,335 hectares after

removing non-commercial forests[1] and properties with less than 15 net harvestable hectares. The net harvestable area (Figure 5b) was distributed across 1,743 properties.

Figure 4. Example of the process followed to derive the net harvestable area on a forested property.

[1] Non-commercial forest is defined as native forest that is incapable of producing high-quality logs based on its height and form.

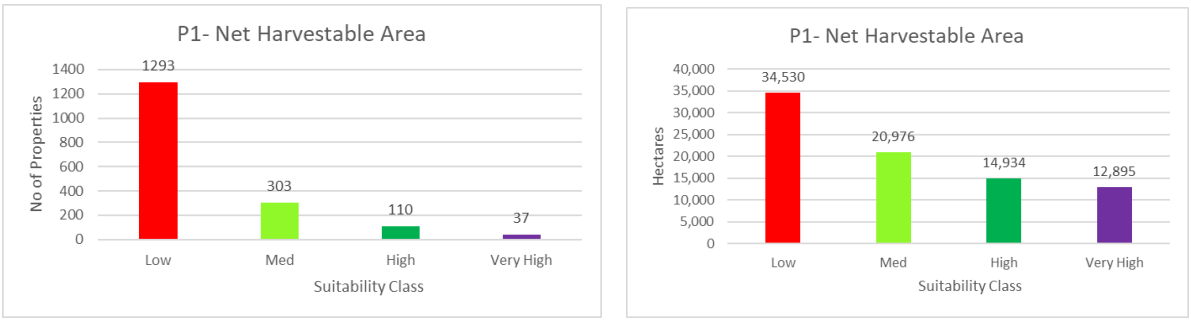


a) **b)**

Figure 5. Map a) The gross area of private native forest (1.1 million hectares) with LiDAR coverage. Map b) The net harvestable area (83,335 hectares) of private native forest that was modelled and rated.

P1 – Modelled result

Almost three-quarters of the assessed properties (n=1293) had less than 50 hectares of net harvestable area, putting them in the 'low' suitability class (Figure 6a). Together these properties accounted for 34,530 hectares or 41% of the total net harvestable area (83,335 hectares). In contrast only 2% properties were classified as very high suitability (200 or more hectares of net harvestable area) accounting for 15% of the net harvestable area.



a) b)

Figure 6 – a) Property count by net harvestable area suitability class b) NHA by NHA suitability class

In most parts of the Southern Region, the size of the harvestable area (NHA) on a property was quite variable, with no discernible distribution trends (Figure 7).

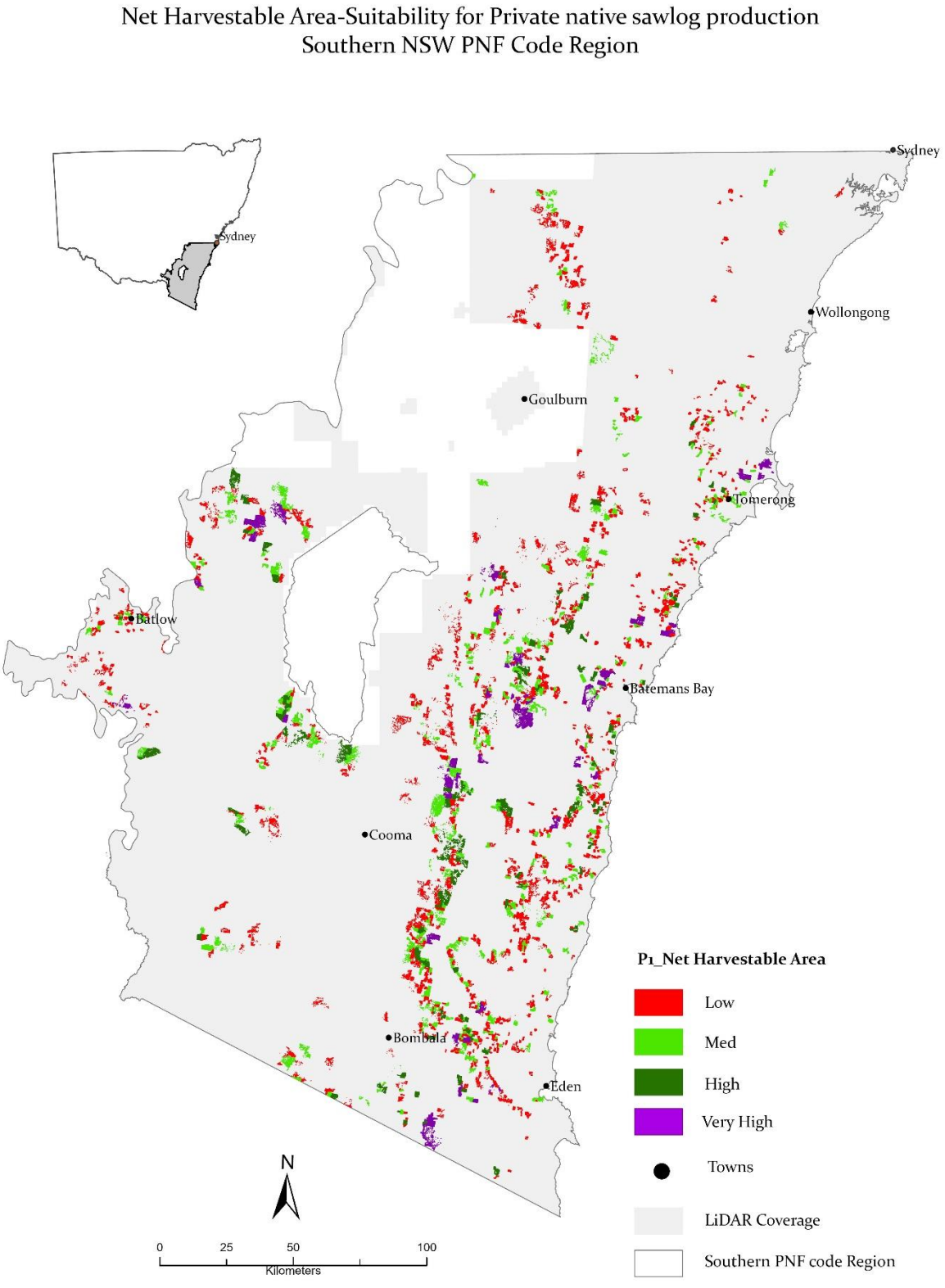


Figure 7. Suitability for PNF based on the size of the net harvestable area

P2 – Log Haulage distance

P2 – Explanation

To realise the timber values from a native forest, trees must be harvested, and their log products delivered by road to wood processing facilities[2] (WPF). Determining the distance by road from a property to its nearest wood processing facilities enables the cost of log haulage to be estimated. Properties located close to wood processing facilities will have low log haulage costs while those situated in remote localities will have high costs.

On the NSW south coast (within 100 km from the region's border) there are very few wood processing facilities that process hardwood logs (Figure 8). Each facility has discrete markets which gives rise to specific log mix preferences.

To be able to sell a range of different log types and obtain the best market price log producers often sell their logs to multiple wood processors. Due to the small number of processors, only the distance by road to a property's nearest wood processing facility was calculated and modelled (Table 2), the distance and so cost of the suitability classes are conservative.

Table 2. P2- Distance by road to wood processing facilities - suitability classes

Suitability Class	Very High (4)	High (3)	Med (2)	Low (1)
Average distance by road to closest three wood processing facilities (km)	≥ 0 to < 15km	≥15 to < 25km	≥25 to < 50km	≥ 50km
Log haulage cost ($/m3)	Low	Med	High	Very High

[2] Note some landholders undertake onsite milling using portable milling equipment. This scenario was not modelled

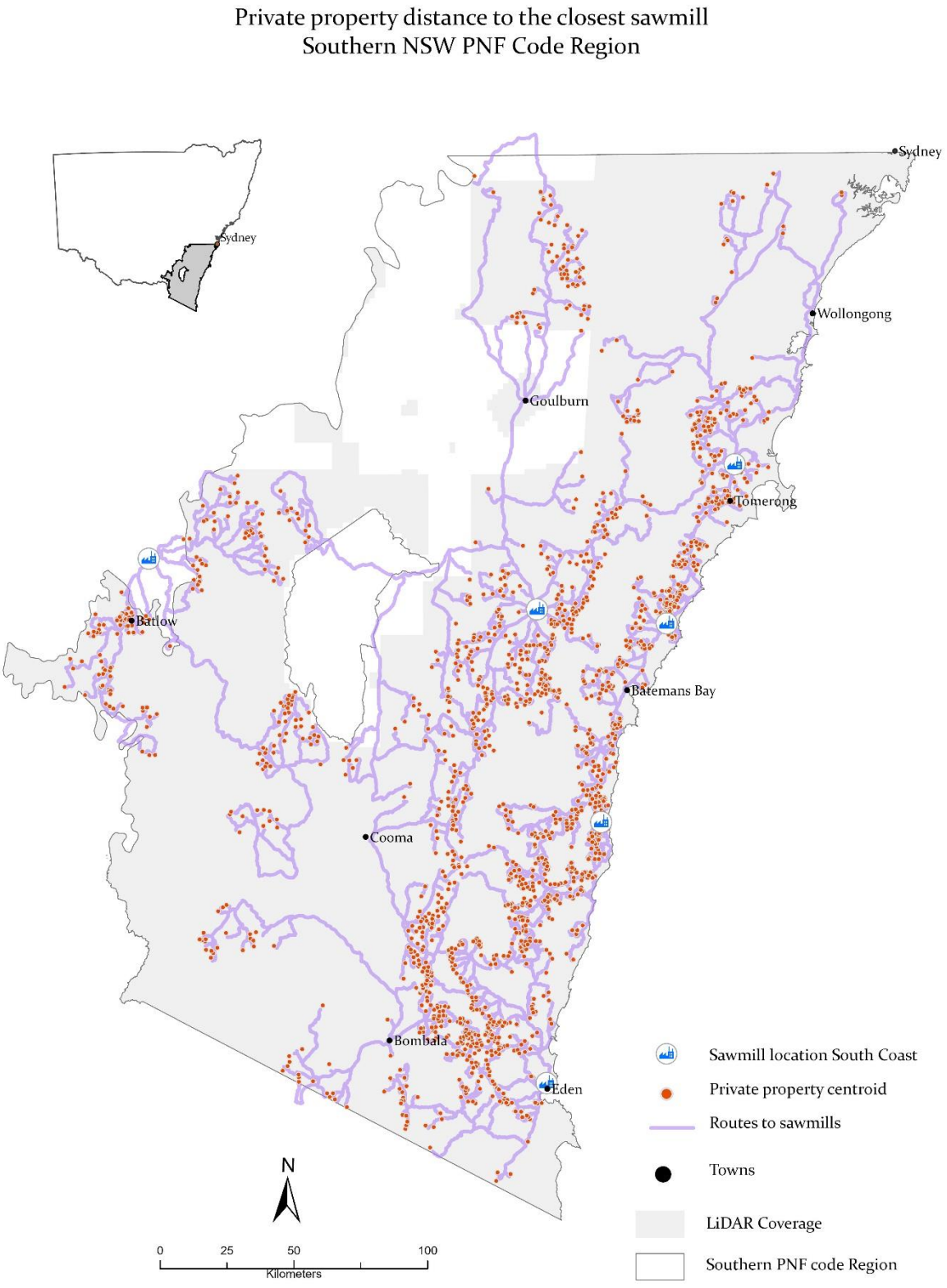


Figure 8. Road network connecting properties to the hardwood processing facilities (source: FCNSW).

P2 - Modelling Process

For modelling purposes, we assumed the landowner would sell their hardwood logs to the wood processing facility located nearest to their property. The following spatial layers were required to calculate this distance:

- Cadastre NSW (Spatial Services Customer Hub)
- Centroid of each of the 1,743 properties identified in the cadastral boundary layer
- NSW Wood Processing Facilities (FCNSW)
- NSW Public Roads (Spatial Collaboration Portal)

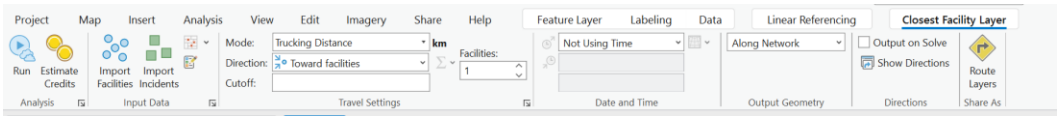
The procedure to model log haulage distance was as follows:

i. First, the "Create Network Dataset" function was used to convert the road layer into a network dataset (Figure 9a).

ii. Then, using the "Network Analysis" toolset the "New Closest Facility" tool was used to calculate the distance by road from each property to the closest wood processors facility.

iii. In the "New Closest Facility" tool, wood processors facilities were assigned to "Facilities", whilst the centroids of the 1,743 properties were assigned to the "Incidents". For both "Facilities" and "Incidents", "Search Tolerance" and "Location Snap Options" were set to a suitable distance (~500 km) (Figure 9b-c).

iv. In "Closest Facility Properties" (Figure 9), "Impedance" was set to "Length (Meters)" and "Facilities to Find" was set to 1. In the "Network Locations" tab, "Search Tolerance" was set to a suitable distance (500 Km) and "Snap to" was set to "Closest".

a) 

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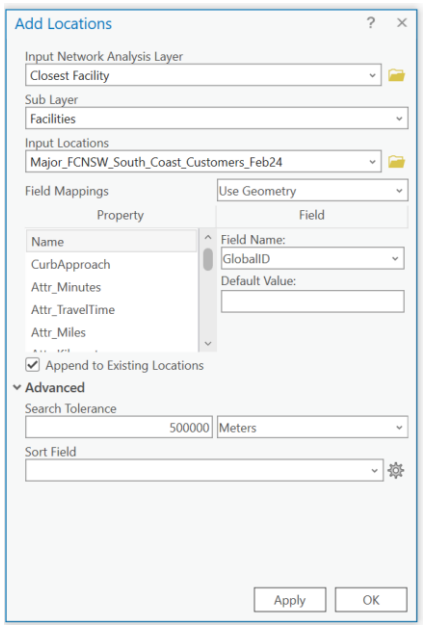

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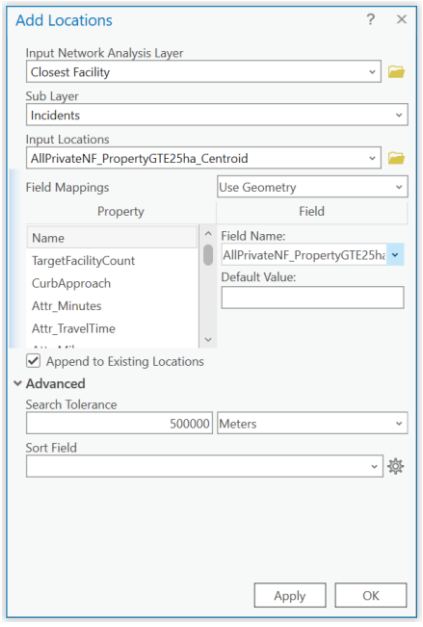


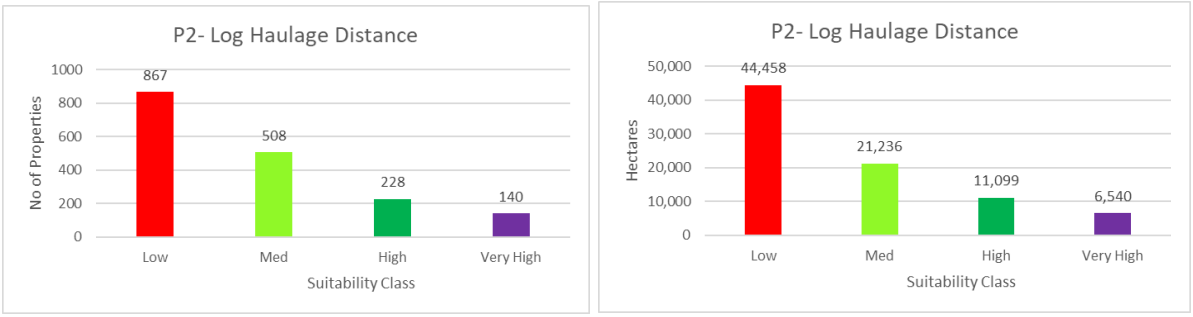
Figure 9. Parameters setting in "Closest Facility Properties" using ArcGIS Pro. a) Closest facility toolbar, b) assigning 'Facilities' parameters, and c) assigning 'Incident' parameters.

v. The distance by road from each property to the closest wood processors facility was calculated by clicking on "Run" in the "Closest facility" toolbar (Figure 9a). The output (in table format) was accessed by right-clicking on "Routes" in the "Closest facility" dataset. Using the "pivot-table" function in Excel, the distance by road from each property to the closest wood processors facility was calculated.

vi. Finally, the 1,743 properties were classified as Very High (i.e., ≥0 to < 15 km), High (i.e., ≥ 15 to < 25 Km), Med (i.e., ≥ 25 to < 50 Km) or Low (i.e., ≥ 50 Km) based on their average distance to the closest WPFs.

P2 – Modelled Result

Log haulage distances between a property and its nearest wood processing facility were found to be aligned with the property's proximity to the Princes Highway as there are few east-west road routes in the Southern region (Figure 11). Properties located near these features were classified as high or very high. The Princes highway runs right through the region roughly following the coast (typically ~10 kms inland).



a) b)

Figure 10. a) Property count by log haulage distance suitability class b) NHA by log haulage distance suitability class

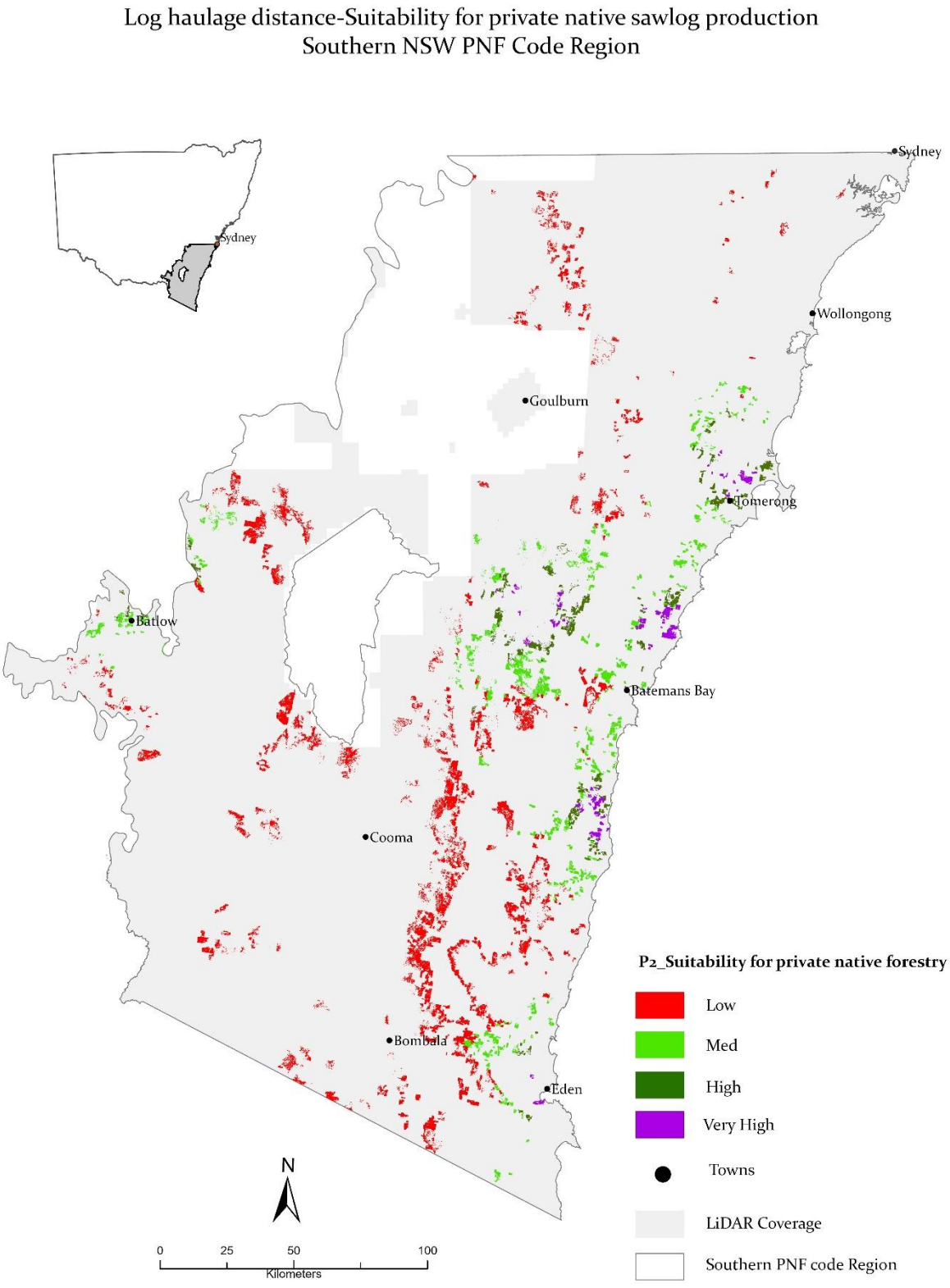


Figure 11. Suitability for PNF based on the distance to the nearest wood processing facilities.

P3 - Slope premium

P3 - Explanation

Harvesting machinery can operate on slopes up to 30 degrees. However, on slopes over 20 degrees, harvesting difficulty increases (the time it takes to harvest a tree), as does fuel use. Slope increases the overall cost of harvesting which in turn reduces the value of the timber being harvested. The proportion of a harvestable areas that exceeds 20 degrees is therefore an important component of assessing a property's suitability for forestry (Table 3).

Table 3. P3-Slope premium suitability classes

Suitability Class	Very High (4)	High (3)	Med (2)	Low (1)
Proportion of net harvestable area with slopes over 20 degrees (%)	< 10%	≥ 10% to < 25%	≥ 25% to < 50%	≥ 50 to 100%
Harvesting cost ($/m3)	Low	Med	High	Very High

P3 – Modelling Process

Three different layers were used to calculate this parameter:

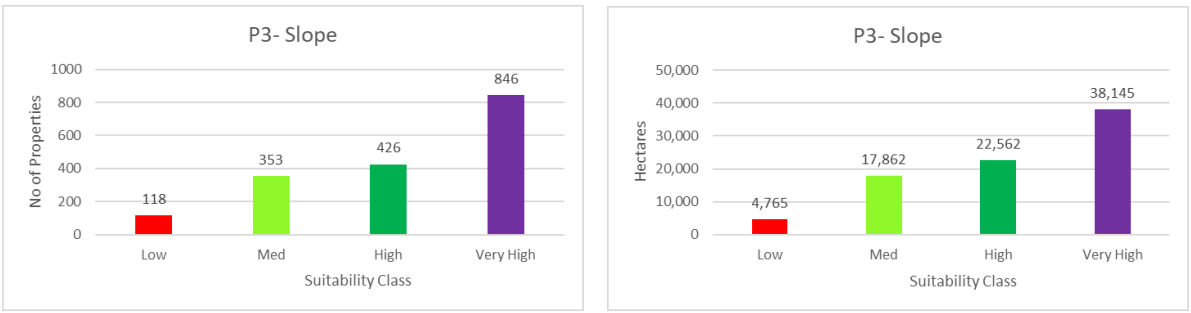
- Net Harvestable Area (NHA) layer (this layer that was derived from the process detailed in P1)
- NSW Cadastre (Spatial Services Customer Hub)
- The NSW digital elevation model (DEM) (Hislop, 2021)

The DEM was employed to create slope layer within the NHA for each of the 1,743 properties. The area with slope ≥20° within the NHA was then calculated (Figure 12). The extent was expressed as a percentage by dividing its value by the total NHA. Finally, the 1,743 properties were classified as either Very High (<10% over 20°), High (≥10 to <25% over 20°), Med (≥25 to < 50% over 20°) or Low (≥50 to 100% over 20°) based on the % value.

Figure 12. Mapping the area with slope ≥ 20° within the NHA of each property.

P3 – Modelled Result

When ranked according to slope, properties were relatively evenly spread across the four slope suitability classes. The greatest number of properties (almost half) were found to have less than 10% of their net harvestable area having slopes over 20 degrees, putting them into the very high suitability class (Figure 13).



a) b)

Figure 13. a) Property count by slope suitability class b) NHA by slope suitability class

Properties with a very high slope suitability class rating (gently sloping) were spread through the Southern region (Figure 14).

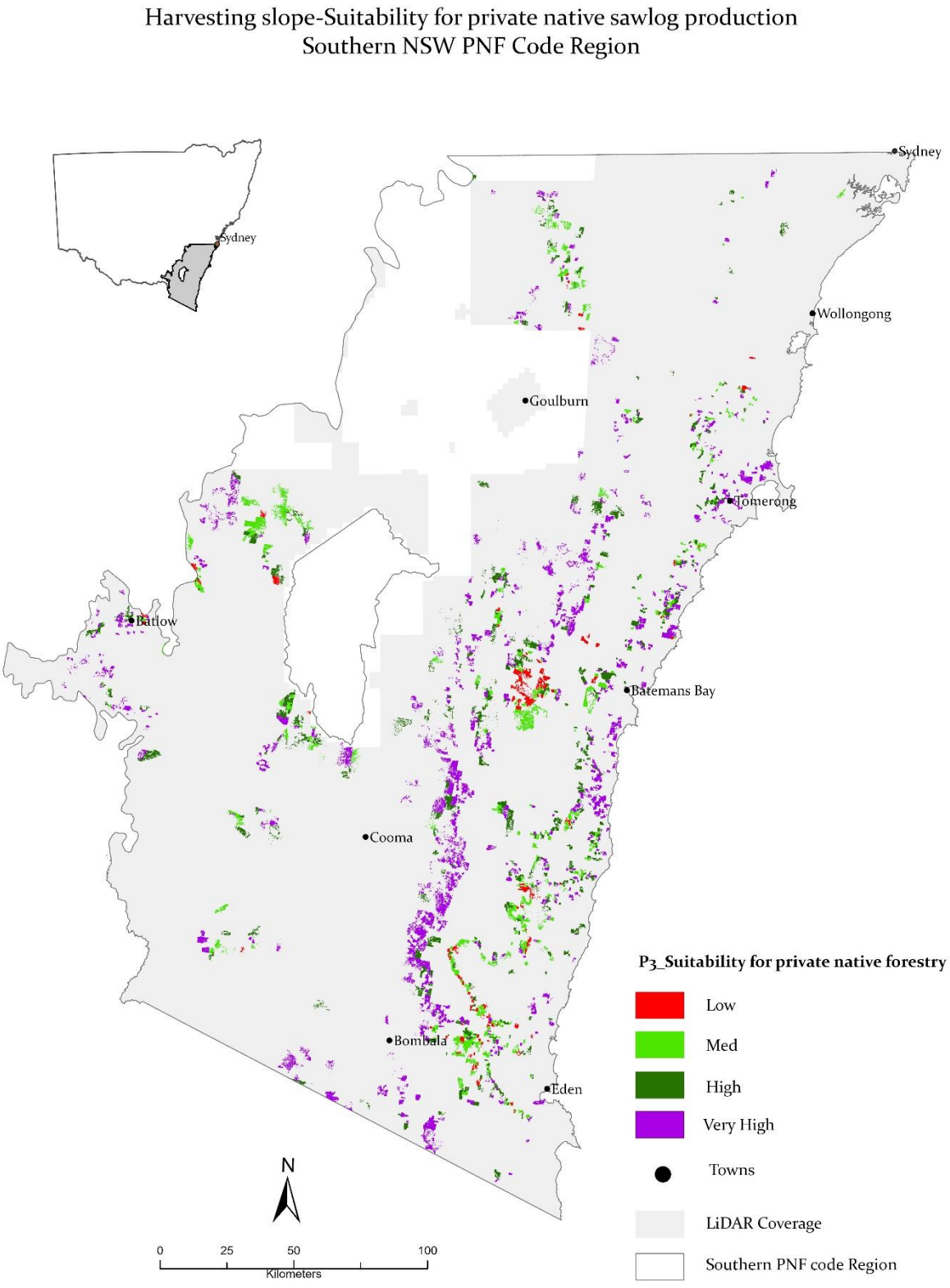


Figure 14. Suitability for PNF based on the proportion of the NHA that has steep slopes

P4 - Terrain roughness

P4 - Explanation

Terrain roughness (variability in elevation) was used as an indicator of roading and harvesting cost. Terrain roughness affects the contiguity of the net harvest area and the density of roads and log dumps. In rough terrain the net harvest area tends to be more fragmented, roads and tracks are more expensive to construct as they involve more cut and fill, and a greater number of drainage feature crossings are required. In rough terrain there tends to be fewer roads. Fewer roads and dumps equate to longer snig distances which has a direct effect on harvesting cost.

Table 4. P4-Terrain roughness suitability classes

Suitability Class	Very High (4)	High (3)	Med (2)	Low (1)
Variability in elevation within the NHA (σ)	(1^{st} σ)	(2^{nd} σ)	(3^{rd} σ)	(>3^{rd} σ)
Roading and harvesting cost ($/m3)	Low	Med	High	Very High

P4 – Modelling Process

Two of the three layers used to map slopes over 20 degrees were used to calculate Terrain roughness, namely:

- The private property cadastral layer (Spatial Services Customer Hub)
- The NSW digital elevation model (DEM) layer (Figure 15)
- Gross forest area of the property (Alaibakhsh et al, 2019)

Rather than use the net harvest area the terrain model was based on the gross forest area. By doing so it gave a more holistic account of the terrain roughness across all the forested parts of the property, as these will be likely have roading.

The standard deviation (σ) of a Digital Elevation Model (DEM) is a common measure of terrain roughness (Grohmann et al., 2011). For each of the 1,743 properties, the standard deviation (σ) of the DEM within gross forest area was calculated using Arc GIS Pro Zonal statistics tool. Standard deviation values were grouped into 4 categories using 1^{st} σ, 2^{nd} σ, 3^{rd} σ and >3^{rd} σ. Finally, the 1,743 properties were classified to Very High (1σ), High (2σ), Med (3σ) or Low (> 3σ) based on the σ values of the layer (Figure 17 & Figure 18).

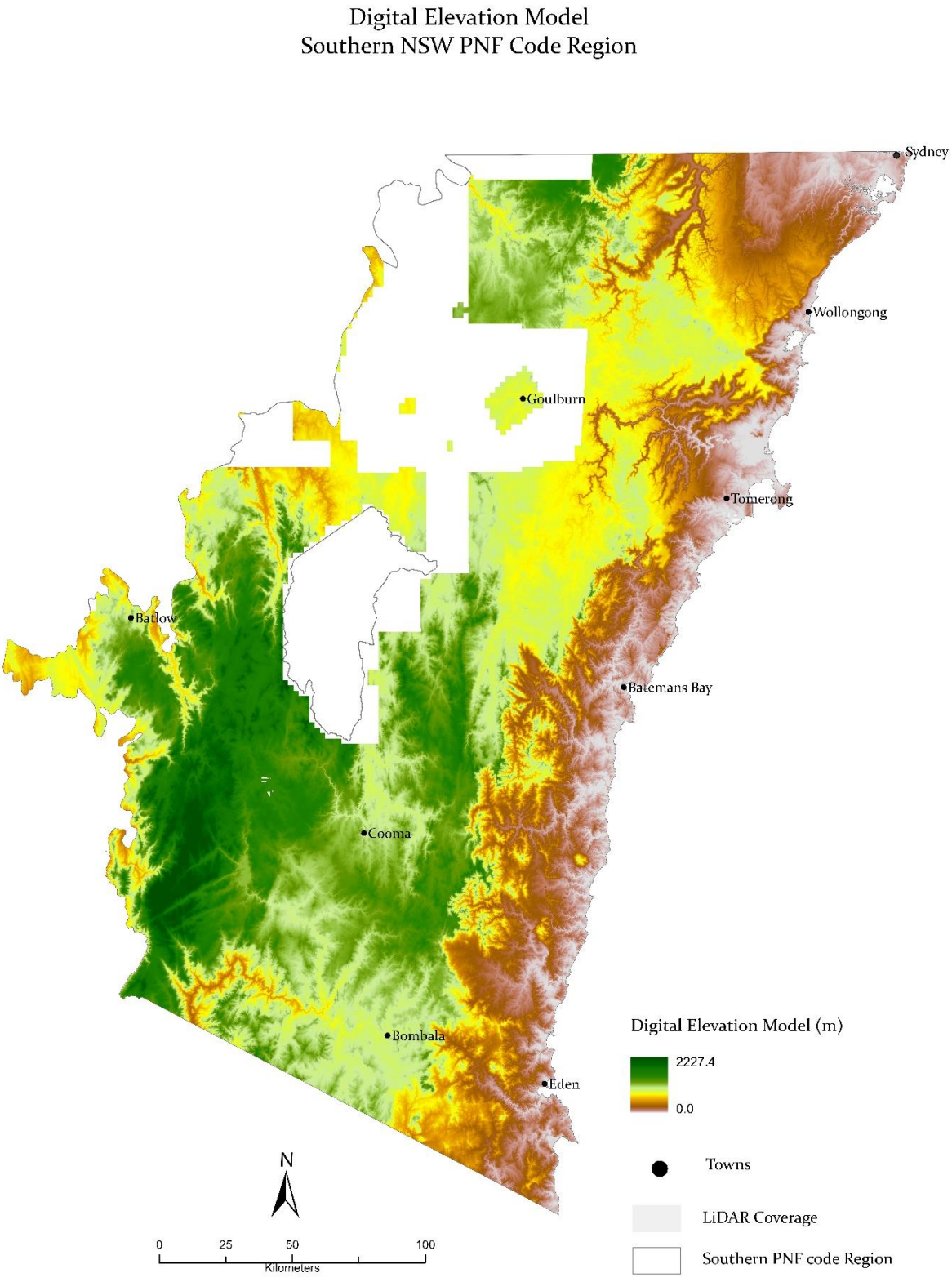


Figure 15. Digital elevation model covering the study area

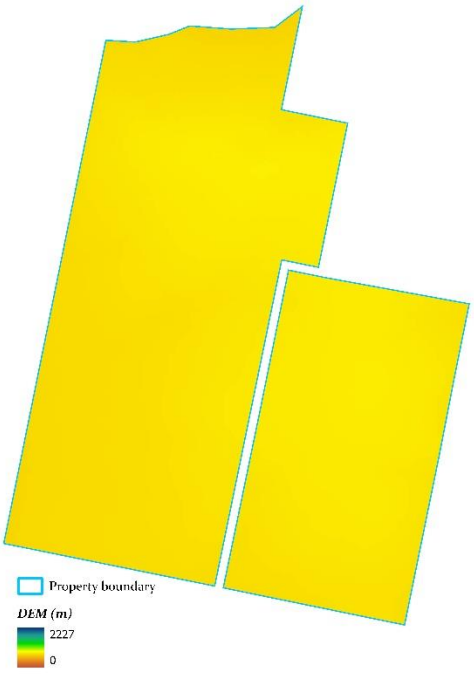
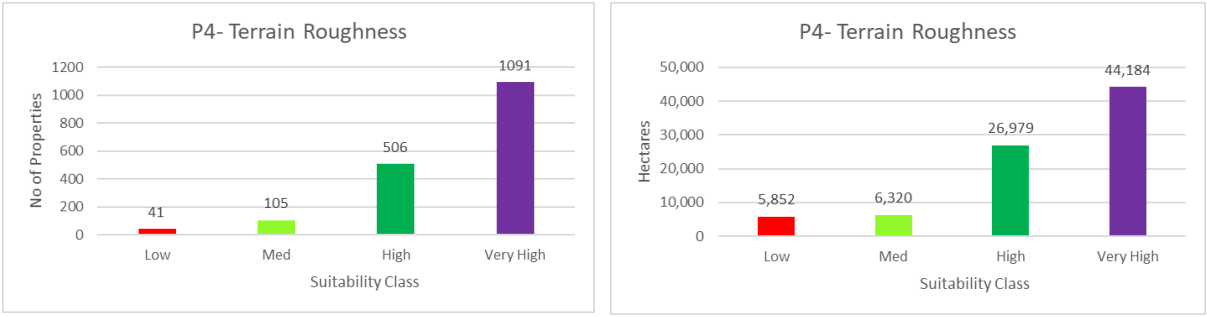


Figure 16. Example of variation in elevation of an individual property

P4 – Modelled Result

Close to 92% of properties and 85% of the net harvestable area was classified as having high or very high suitability for forestry based on terrain roughness.



a) b)

Figure 17. a) Property counts by terrain suitability class b) NHA by terrain suitability class

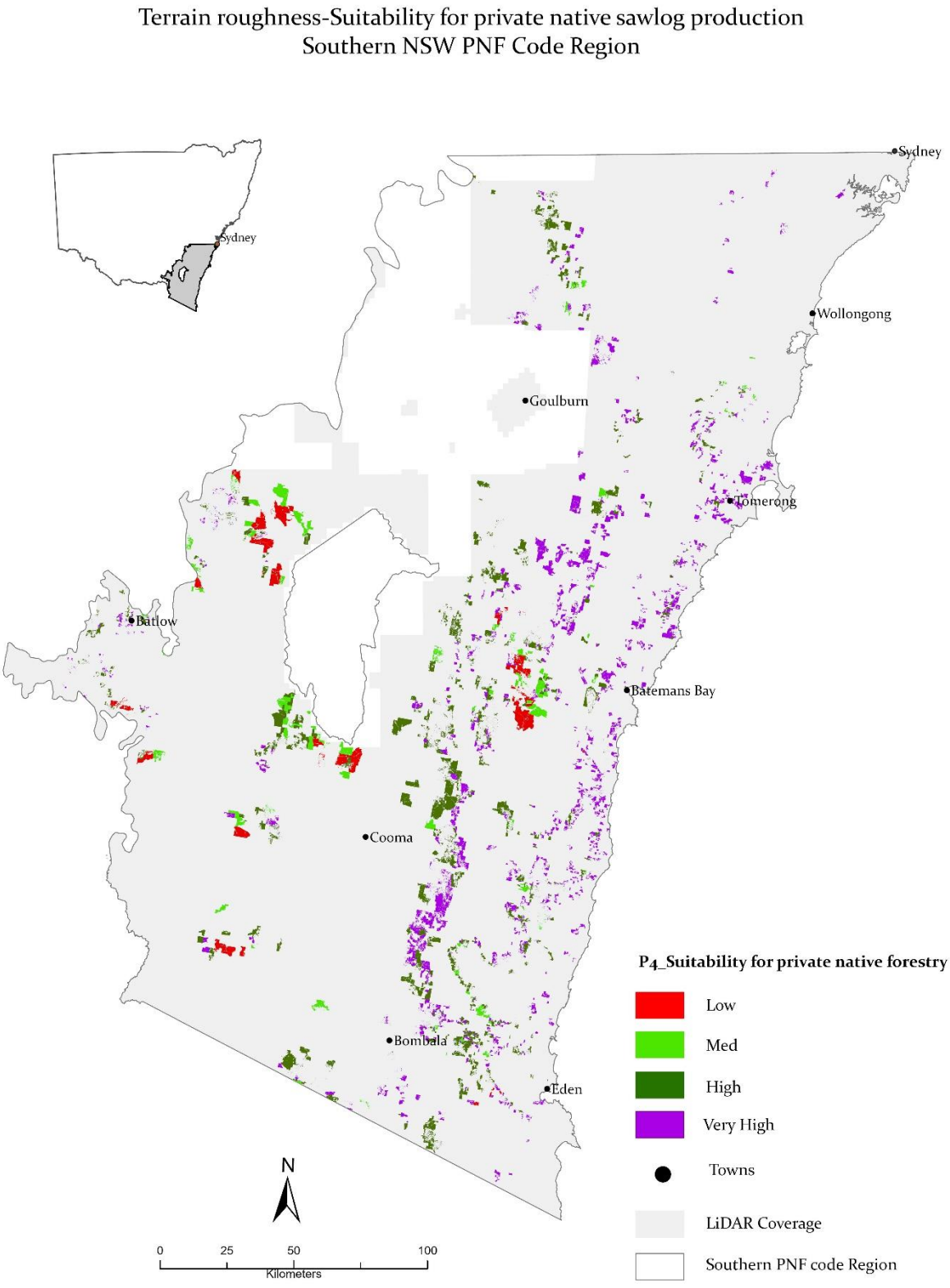


Figure 18. Suitability for PNF based on the roughness of the terrain within the NHA

P5 – Yield Association Group (timber value)

P5 - Explanation

There are around ten commercial tree species which grow naturally in the Southern NSW PNF Region. The market value of the timber generated by these species ranges from low (non-preferred) to very high (preferred).

To guide the assignment of tree species to a timber value class we were guided by the Forestry Corporation of NSW's Hardwood Log Value Pricing System (LVPS). The LVPS, which applies to high value hardwood logs produced on public land, differentiates log values based on their species, size, quality, and geographic location.

Most timber species grow naturally in association with other species. It is therefore not practicable to map the location of every species. The mapping of forest into more generic yield association groups (YAGs), however, provides a useful guide to the commercial species mix. In the case of common preferred species, namely, Alpine Ash and Spotted Gum, the YAG map can identify the locations where these species are dominant in the mix.

Consideration, through inference, was also given to log value based on size and log quality. For a given quality of log, the timber in large diameter logs (60 to 80cms) is more valuable than the timber in small diameter logs (30 and 40cms). Similarly, for a given log size, logs which are sound and free of large branch knots are valued more highly than logs which contain a higher proportion of internal defect.

The YAG map was used as an indicator of log size as follows. The YAG map classifies forests based on the height of the mature trees, namely, dry sclerophyll forest (up to 25 metres), semi-moist and taller dry forest (25 metres up to 35 metres) and tall moist forest (35 metres and higher). Taller mature trees generally have thicker and longer boles (trunks) than shorter trees so tree height can consequently be used as a proxy for log size.

For log quality certain species are less defective than others. For example, preferred tree species like Spotted Gum typically produce a higher proportion of high-quality log (low in defect) than non-preferred Tableland gum-Peppermint. Taller trees are also more likely to produce a log of high-quality. This is because a tall tree is less likely to have had its growth or health impacted[3].

P5 – Modelling Process

To predict timber stumpage value, we used the NSW DPI Forest Yield Association Group (YAG) Map of the NSW South Coast (Kathuria et al, 2023). This map classifies the forest into ten broad groups as detailed in Table 5. Each YAG type (excluding rainforest) was assigned

[3] When this occurs, trees incur stress which makes them more prone to insect and fungal attack which gives rise to log defect

to a timber stumpage value class, namely - Very High (4), High (3), Med (2) and Low (1) (Table 5).

Table 5. Rating system applied to the forest YAGs used in the model

YAG groups Southern	average log size	average log quality	species mix value	Weighted Commerciality
Alpine Ash	High	Very High	Very High	Very High
Moist Coastal	Medium	High	High	High
Spotted Gum	Medium	Very High	Very High	High
Brown Barrel - Messmate	High	Medium	Low	Medium
Coastal Dry	Low-Medium	Low-Medium	High	Medium
Silvertop Ash	Medium	Low	Medium	Medium
Yellow Stringybark - Gum	Medium	Medium	Medium	Medium
Negligible Productive Types	Low	Low	Low	Low
Tableland Gum - Peppermint	High	Low	Low	Low
Rainforest	N/A	N/A	N/A	N/A

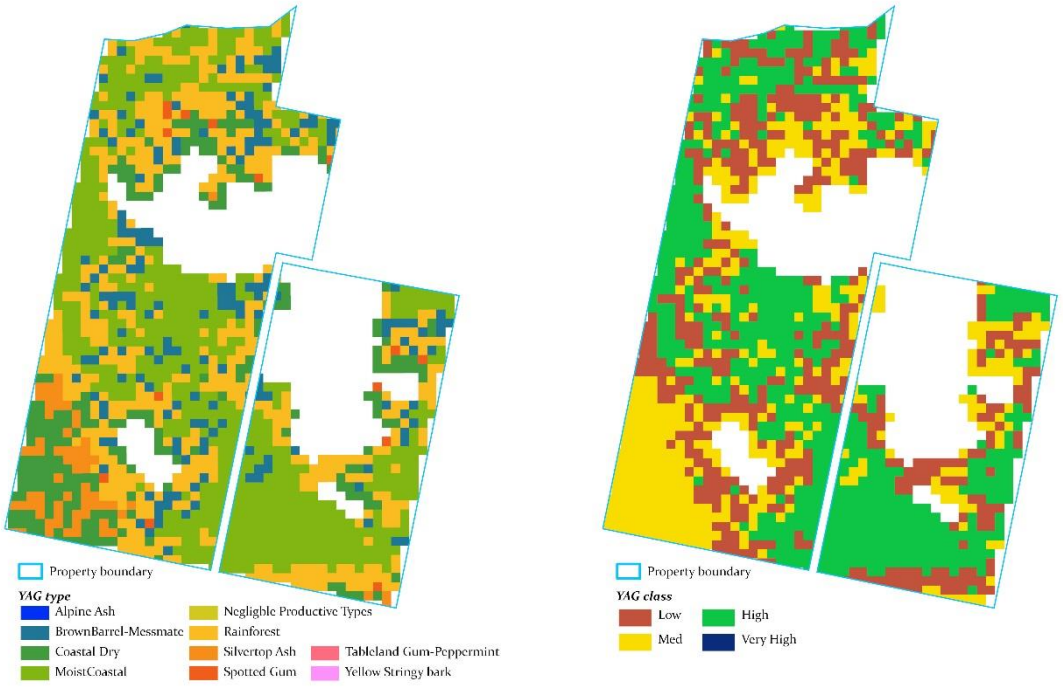
The way the assessment criteria were used to assign a YAG to a class was as follows:'

- Log size[4] - as per table 5
- Log quality – as per table 5
- Species - On the south coast there are over 10 commercial eucalypt species. Eucalypts which are preferred and available in quantity to the market were valued more highly. Of all the YAGs, Alpine Ash (*Eucalyptus delegatensis*) were assigned to the highest stumpage value category. In contrast, species from the Tableland gum-Peppermint YAG are least preferred by the market and, consistent with the Forestry Corporation of NSW's LVPS, were assigned the lowest stumpage value.
- Of the three assessment criteria, log quality and species mix were given an equal weighting and log size was given a lower weighting.

Using the weighted average stumpage value classes detailed in Table 5, the % coverage of each YAG within the NHA of the 1,743 properties was calculated. The % coverage was calculated using the "Tabulate Intersection" tool in ArcGIS Pro. Finally, the weighted average was calculated using the % coverage of the four groups within the NHA as weight.

Finally, the 1,743 properties were classified as Very High (i.e., ≥ 3.5), High (i.e., ≥2.5 and <3.5), Med (i.e., ≥1.5 and < 2.5) or Low (i.e., <1.5) based on their weighted average values (Figure 20 & Figure 21).

[4] Large logs (60cm and 80 cm cdub) attract higher stumpage prices than smaller logs (30-40 cm cdub).

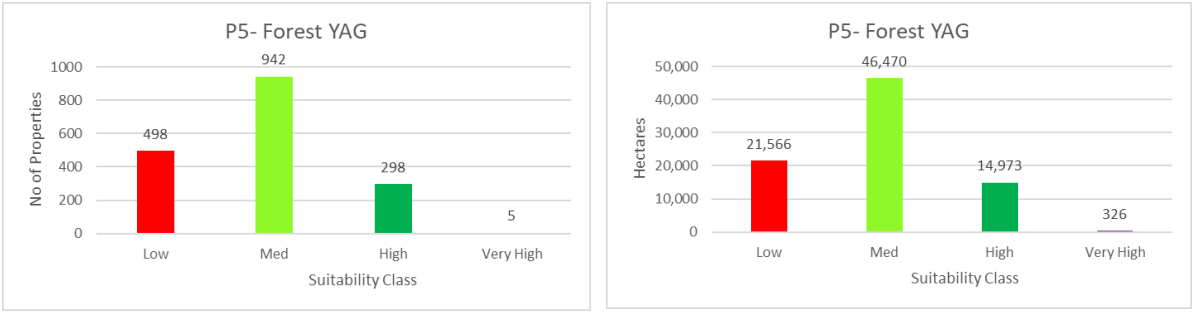


a) b)

Figure 19. a) YAG map (Kathuria et al, 2023) of a property and b) Classification into the YAG suitability classes

P5 – Modelled Result

Only 17% of properties and 18% of the net harvestable area received a high or very high suitability rating for its forest yield association group mix. Most properties and most of the net harvestable area fell into the medium suitability class (Figure 20).



a) b)

Figure 20. a) Property count by YAG suitability class b) NHA by YAG suitability class

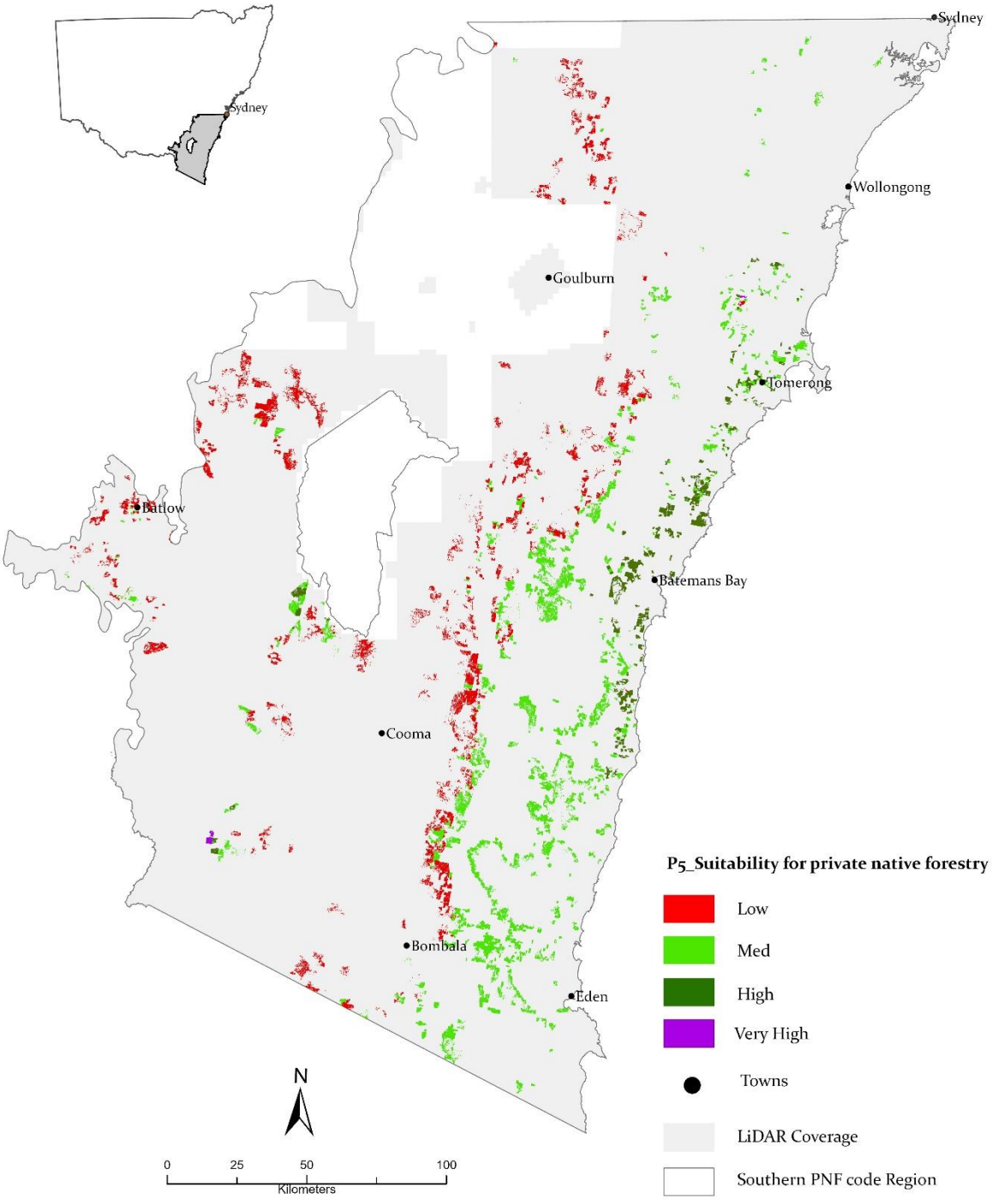


Figure 21. Suitability for PNF based on the Yield Association Group mix

P6 – Mature Canopy Height

P6 - Explanation

The height to which a forest grows naturally (its mature canopy height) is a good indicator of its overall site productivity (Geyer et al. 1987) and its capacity to yield commercial timber.

P6 – Modelling Process

We used NSW DPI's Site Index layer (Kathuria et al, 2022), (Figure 22), to obtain canopy height data of private native forest that were greater than or equal to15 hectares. Height values in metres were grouped into 4 categories:

- 1. Low ≤25m,
- 2. Medium >25 and ≤ 30m,
- 3. High >30 and ≤35m
- 4. Very High >35.

For each of the 1,743 properties, the percentage coverage of each height category was calculated (i.e., "Tabulate Intersection" tool in ArcGIS Pro) within the NHA of the properties. Then, for each of the properties, weighted average height was calculated using the % coverage of each height category as weight. Finally, the 1,743 properties were classified as Very High (i.e., ≥ 3.5), High (i.e., ≥2.5 and <3.5), Med (i.e., ≥1.5 and < 2.5) or Low (i.e., <1.5) based on the weighted average height values of each property based.

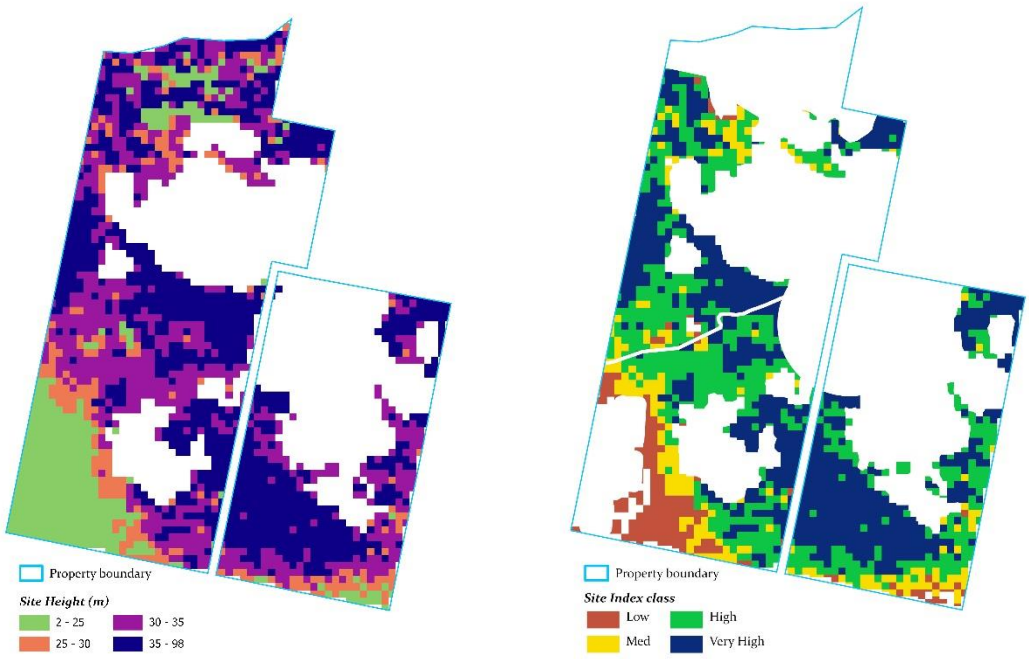
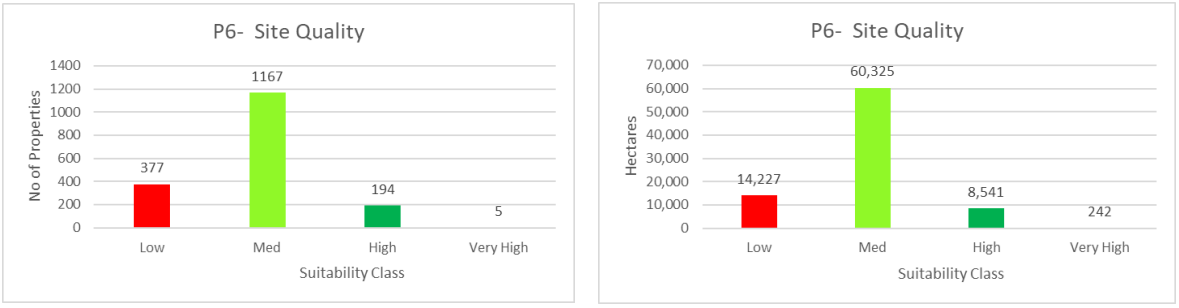


Figure 22. Site quality index (Kathuria et al, 2022) and site index classes for NHA of a selected property

P6 – Modelled Result

Similar to the modelled result for YAGs, only 11% of properties and 10% of the net harvestable area was assessed as having a high or very high suitability based on canopy height. 67% of all properties and 72% of the net harvestable had medium suitability (Figure 23).



a) b)

Figure 23. Suitability for PNF based on Site Quality

There is little discernible pattern of site quality evident (Figure 24), excepting better site quality near rivers.

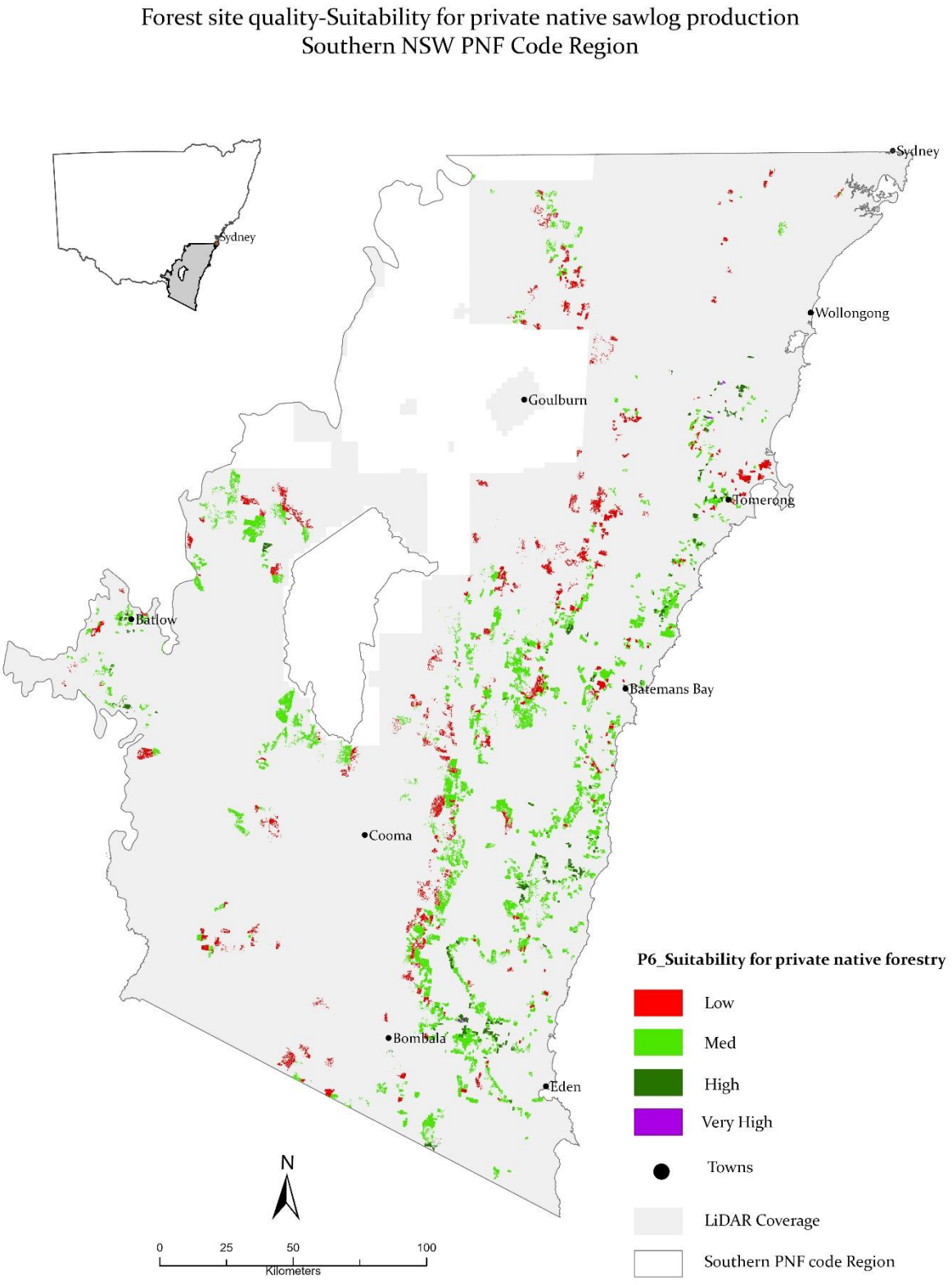


Figure 24. Suitability for PNF based on site index model (canopy height)

Weighting of modelling parameters

The use of six discrete modelling parameters provided a comprehensive picture of the physical and biophysical attributes of 1,743 individual properties on the NSW South Coast.

To determine the overall suitability of each property for private native forestry it was necessary to assign a weighting to each modelling parameter.

In assigning a weighting, consideration was given to the relative effect of each parameter on commerciality. Consideration, based on expert knowledge, was given to the effect on operational expenditure, timber yield, timber price and timber revenue.

Four of the six parameters, namely P1, P2, P5, and P6 were assigned a weighting of 20%. P3 had some commonality and overlap in its effect on commerciality with P4, so both parameters were assigned a lesser weighting of 10%. When combined, the weightings total 100% (Table 6).

Table 6. Modelling parameter weightings showing the factors used to calculate them

ID	Modelling Parameter	Parameter Weighting
P1	Net harvestable area (NHA)	20%
P2	Distance by road to wood processing facility	20%
P3	Slope premium	10%
P4	Terrain roughness premium	10%
P5	Yield Association Group	20%
P6	Site Index model (Canopy height)	20%
	Total	**100%**

Combined Results

The results of the suitability of properties for PNF when all modelling parameters were combined and weighted are presented in Figure 25, Figure 26 and Figure 27.

Most properties (63%) and most of the net harvestable area within them (62%) was found to have a 'medium' suitability for private native forestry.

14% of properties and 22% of the net harvestable area was found to have a 'high' suitability for private native forestry. Bigger properties are on average more suitable for forestry than smaller properties, despite only 20% weighting to the NHA.

Very few properties (0.4%) and very little net harvestable area (2%) was found to have a 'very high' suitability for private native forestry.

Properties that had 'low' overall suitability accounted for 22% of properties by number but only 14% by area.

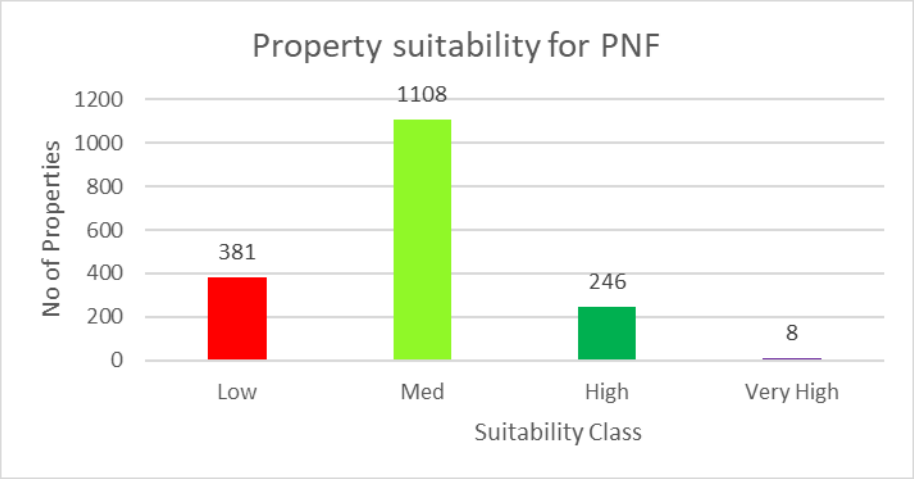


Figure 25. Property counts by suitability class using all modelling parameters

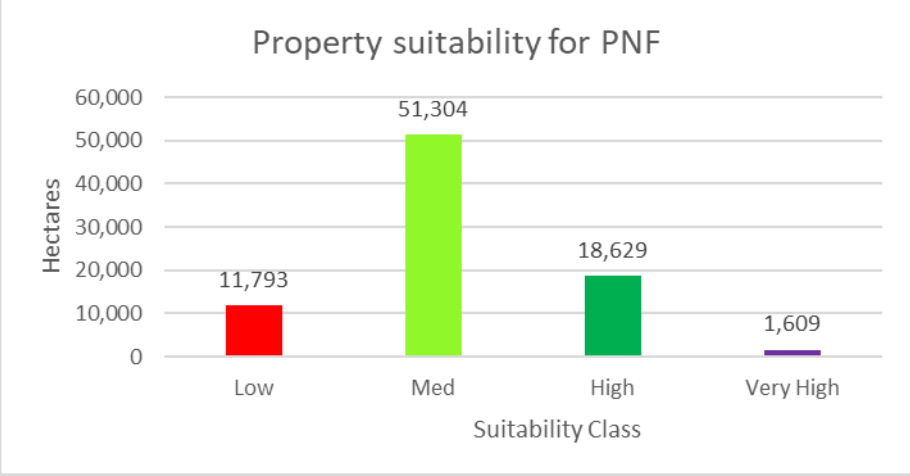


Figure 26. Net harvestable area by suitability class using all modelling parameters

The properties that had ‘high’ or ‘very high’ suitability were located mainly between 10km and 50km, from the coast between Tomerong to Eden and closer to wood processing facilities.

Properties with a ‘medium’ suitability were evenly distributed across the entire study area.

Properties classified as having ‘Low’ suitability for private native forestry were mainly located more than 50 kilometres from the coast and a longer distance to wood processing facilities. Patches are noticeable north of Goulburn, north of Cooma and south of Bombala.

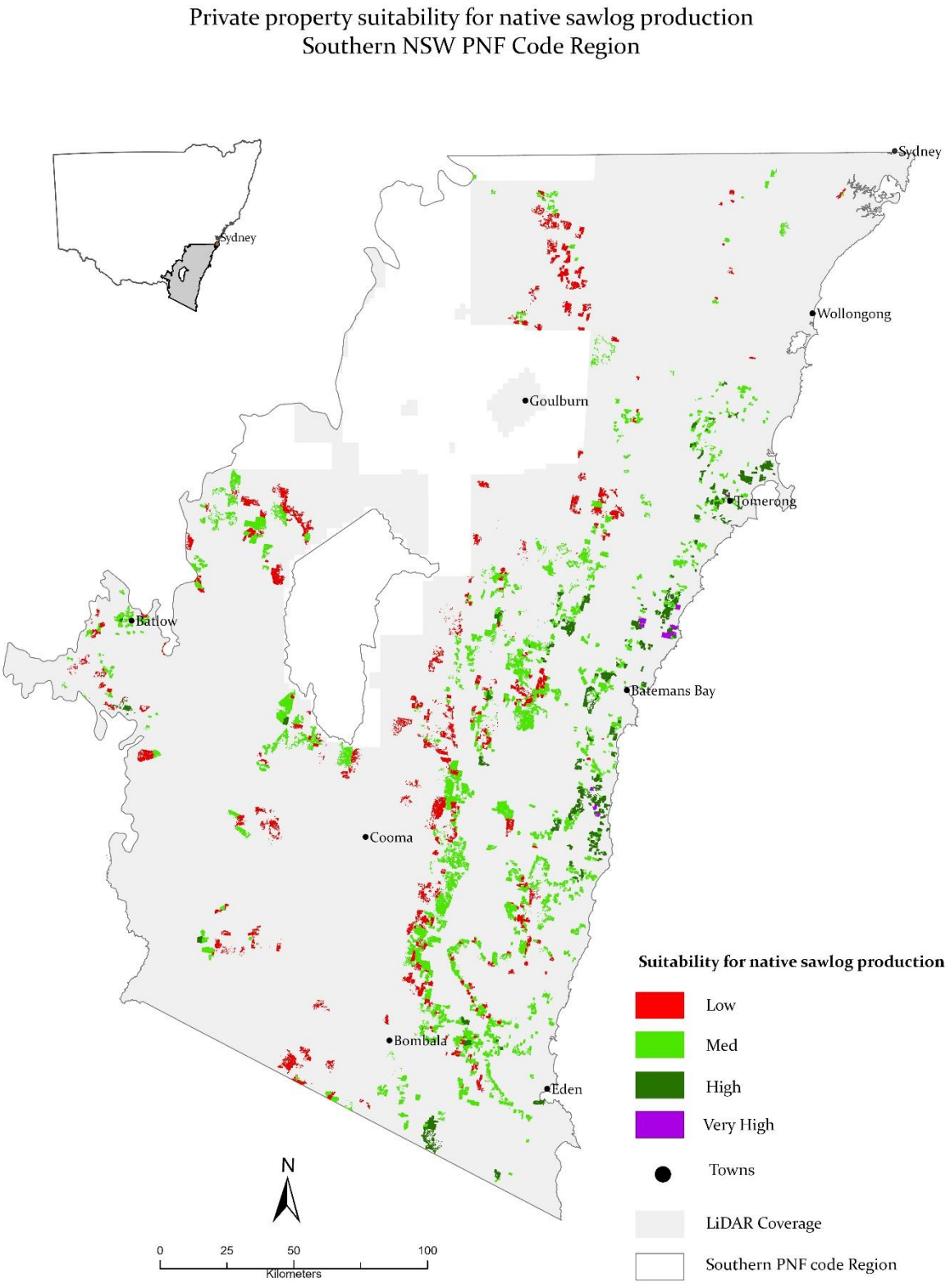
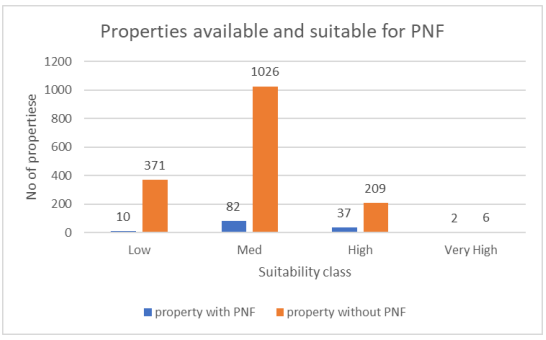


Figure 27. Suitability of private property for private native forestry in Southern NSW using all modelling parameters

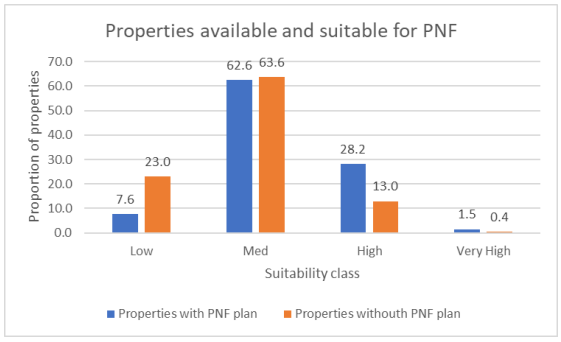
Properties with and without a PNF Plan

A comparison was made of the modelled results with the properties that have an existing PNF Plan approval. The findings are presented in Figure 28. They show that of the 1,743 properties that were modelled, 131 (7.5%) already have an approved PNF Plan.

Of the 1,612 properties that didn't have an approved PNF Plan, 209 (13%) were classified as 'high' suitability, 1,026 (63.6%) as 'medium' suitability, and 371 (23%) as 'low' suitability. Interestingly, there were almost twice as many properties with a PNF Plan that were classified as 'high' suitability (28.2%) as there were properties without a PNF Plan (13%). The proportion of properties without a PNF Plan classified as having 'low' suitability (23%) were three times more than the proportion of properties with a PNF Plan (7.6%).



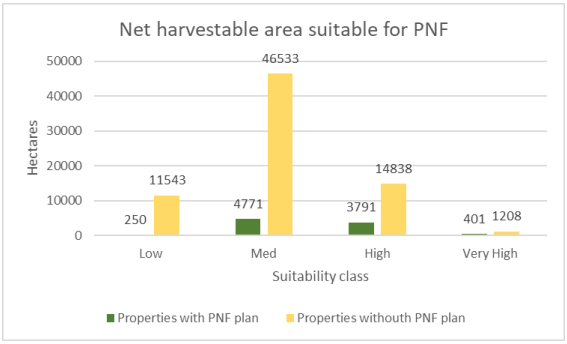
a)



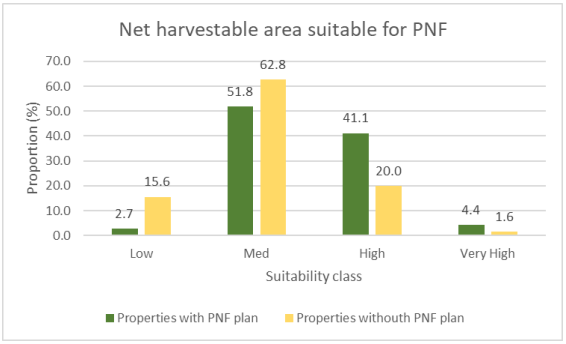
b)

Figure 28. Comparison of the suitability of properties for PNF, with and without an approved PNF Plan. a) property count, b) property percentage

Looking at the percentage of the net harvestable area with and without a PNF Plan (Figure 29) the results were quite different. 9,214 hectares of forest (11%) had an approved PNF Plan while 74,121 hectares of forest (89%) didn't. Majority of the properties from both categories were classified as 'Med' suitability class, (51.8% with a PNF plan and 62.8% without a PNF plan). Of the forest classified as 'high' suitability, proportion of the properties with a PNF plan were twice as the proportion of properties without a PNF plan, 41.1% & 20% respectively. The trend was reversed for 'low' suitability. Of the forest with a PNF Plan only 2.7% was classified as 'low' suitability while 15.6% of forest without a PNF Plan had a 'low' suitability classification.



a)



b)

Figure 29. Comparison of the suitability of properties for PNF, with and without an approved PNF Plan. a) NHA b) NHA percentage

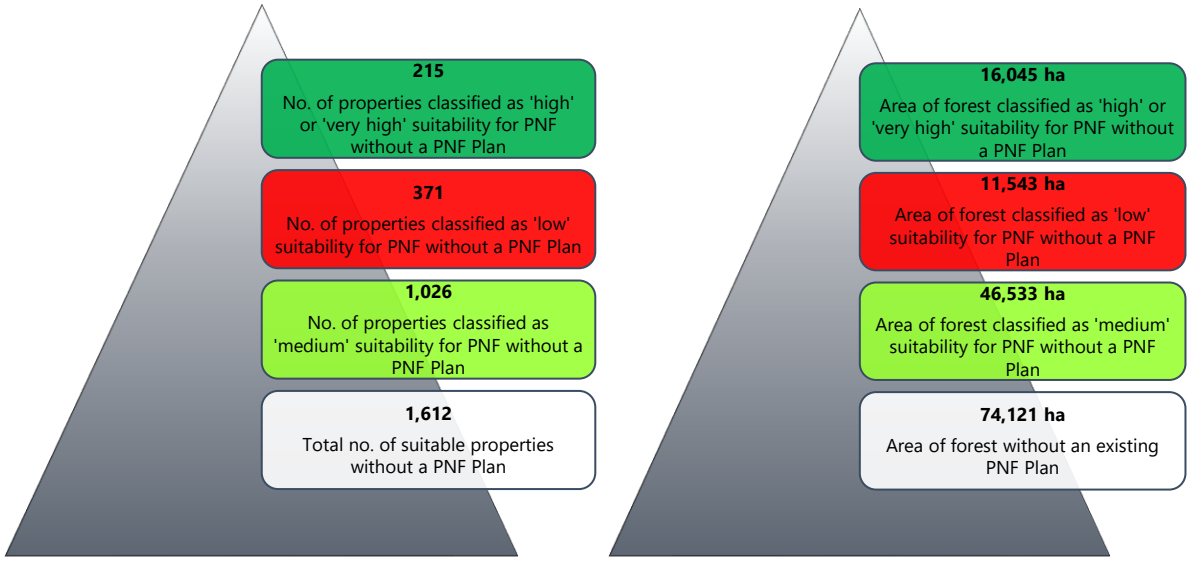
Discussion

The findings of this study shed new light on the availability and suitability of private native forests for timber production in the Southern region and the factors which influence this.

Modelling the suitability of South coast properties for private native forestry (PNF) followed the methodology of the previously undertaken project for North coast by DPI Forest Science in 2021 (Alaibakhsh et al, 2021). This study built on the 2021 project using the same general approach but benefited from more sophisticated modelling techniques as well as the different PNF Code of practice regulation for the Southern PNF region.

Modelled property suitability for PNF showed strong results for 'Med' & 'High' suitability classes for properties with an existing PNF Plan.

Analysis of the forest not covered by a PNF Plan reveals that much of it is uncommercial or has low suitability for PNF due to steep/rough terrain, low forest height, undesirable species mix or being remote from processing facilities. Approximately 62,500 hectares of net harvestable area that did not have an approved PNF Plan was classified as 'medium', 'high' or 'very high' suitability. This area was spread over 1,241 properties. Further detail is provided in Figure 30. Reasons why these properties are not engaged in PNF was not investigated but represents an opportunity for development of PNF in the future.



a) b)

Figure 30. a) Property count by suitability class without an approved PNF Plan within the study area b) Net harvestable area by suitability class without an approved PNF Plan within the study area.

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