NORTHERN HEALTH SERVICE DELIVERY







TRADITIONAL OWNER-LED DEVELOPMENT

AGRICULTURE & FOOD



Northern forestry and forest products industry situational analysis

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CRCNA
DEVELOPING NORTHERN AUSTRALIA

NORTHERN FORESTRY & FOREST PRODUCTS INDUSTRY SITUATION ANALYSIS

CRCNA
DEVELOPING NORTHERN AUSTRALIA

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The CRCNA recognises the value of knowledge exchange and the importance of objective peer review. It is committed to encouraging and supporting its research teams in this regard. The author(s) confirm(s) that this document has been reviewed and approved by the project's steering committee and by its program leader. These reviewers evaluated its:

- originality
- methodology
- rigour
- compliance with ethical guidelines
- conclusions against results
- conformity with the principles of the Australian Code for the Responsible Conduct of Research (NHMRC 2018),

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Online access to maps

Higher-resolution copies of selected maps presented in this report can be accessed via the **ABARES Forests Australia website** at https://www.agriculture.gov.au/abares/forestsaustralia/forest-data-maps-and-tools/forest-maps

These online maps include:

- Forests in northern Australia, by forest type
- Forests in northern Australia, by forest subtype
- Forests in northern Australia, by forest tenure
- The Indigenous forest estate, by land ownership and management category for northern Australia
- National plantation inventory regions in northern Australia
- Native forest available for commercial wood production in northern Australia

1.0 Executive Summary

This report provides a high-level synopsis on the Northern Australian forestry and forest products industry, and describes its challenges, and potential solutions and opportunities for further policy development, research or investment. The following sections of the report should be informed by and read in conjunction with the literature review, workshop reports, more detailed indigenous literature review and image library, included as appendices.

The major opportunities and associated needs are summarised in the **Opportunities and Needs Matrix** section of the report. This information can be used to develop a roadmap for the future development of the forestry and forest products industry in northern Australia. Figure 1 provides an emerging roadmap outlining these opportunities, actions for outcomes and overarching needs, derived from the project.

A key aim of the project was to raise the visibility of the forestry and forest products industry in northern Australia and identify growth opportunities with policy makers, industry, regulators and stakeholders, and to contribute to the establishment of an Industry Development Alliance with a life beyond the project. To this end, the project partners have established an alliance which includes a number of relevant state departments, industry bodies, companies and landowners.

The next steps from the alliance will be to work with relevant key influencers on priority actions, including:

- identification of new research and development proposals, arising from this analysis;
- targeted briefings at key policy forums and meetings (e.g. Northern Australia Ministers forum, Forestry Ministers Council, senior officer groups); and
- greater industry collaboration and partnerships in northern Australia (e.g. conferences, field trips, demonstration trials, joint development and/or investment proposals and projects).

Key priority actions and intended impacts for the further development of the northern forestry and forest products industry are discussed in more detail in the **Strategic Recommendations** section. The study identified six key recommendations across two areas of primary focus: removal of barriers for downstream processing and value-adding for forest product and timber markets; and addressing barriers to new plantation investment and production forestry carbon opportunities.

The six recommendations (in no particular order) for action were:

1. Build and maintain the newly formed industry and cross-jurisdictional agency alliance to promote forest sector development across Northern Australia.
2. Promote indigenous forestry development through better engagement models and commercial arrangements between industry and indigenous landowners, and build indigenous forestry capacity and understanding of commercial forest resources including through forest resource inventory.
3. Development of secure access arrangements for supply from crown native forest land (i.e. leasehold) in northern Queensland.
4. Develop a market research study into the potential supply and demand for wood products from Northern Australia, including key markets and supply chain needs (e.g. regional infrastructure).
5. Assess silvopastoral opportunities as a vehicle for new commercial tree plantings.
6. Review Emissions Reduction Fund (ERF) barriers to carbon market access for forestry activities, with priority on the ‘water rule’ requirement for new plantations.

Figure 1. An emerging roadmap for the Northern Australian forestry and forest products industry



In addition to identifying key themes and strategic recommendations for the northern forestry and forest products industry, the project identified key regional forestry resources and the current industry status. This information is summarised in Table 1 providing a snapshot of industry capacity and potential to grow.

In aggregate, the northern Australia forestry and forest products industry is estimated to have an annual production output in the order of $84 million, and supports more than 1240 direct jobs and around 1860 direct and indirect jobs. However, these estimates have considerable uncertainty given data limitations and a reliance on only partial information collected through this project. It is also worth noting that key sectors of the industry have to date largely been based on establishing the underlying plantation forest resources for downstream processing and export markets. This is the case for the maturing plantation forest resources of African Mahogany, Indian sandalwood and Acacia, that are now approaching or only recently transitioned to harvest age and sale into markets.

Consequently, over the next five to ten years, there is **scope for the forestry and forest products industry to double or treble in output value to up to $300 million per annum**, as a consequence of increasing harvest levels, expansion of forest resources and potential for downstream processing and value-adding. These opportunities could also generate **up to 600 direct jobs in the forest products industry,** which includes opportunities in both the native forest and plantation sectors. The potential for industry growth can be demonstrated with reference to some of the following scenarios and examples:

- the African Mahogany resource in the Northern Territory has a projected net present value at harvest age of $390 million, and an expansion plan of 20% of the current estate is being considered, which would equate to an additional $78 million in projected value at harvest; together with second rotation growth productivity of 15-20% from genetic selection and R&D;
- stimulating new softwood plantation establishment of 10,000 hectares in Far North Queensland, via silvopastoral systems and removing carbon market access barriers, could generate an extra $32 million in sawn timber output per year, and create 150 direct jobs; while a 20% increase in productivity of the existing Far North Queensland softwood estate could generate an additional $10 million per annum in sawn output;
- the sandalwood plantation resource in northern Australia is maturing, with a recent sale of $8.4 million from 12,000 harvested trees with an average price of $78,000 per tonne of heartwood (Quintis 2020), indicating growing international buyer interest;
- indigenous engagement in native forest management for timber production can generate large employment and production benefits, where if 10% of the private forest with commercial potential was actively managed for timber, for example, this would represent 660,000 hectares. This area could generate $15 million in selectively harvested log income per year and produce $100 million worth of sawn timber annually, while creating around 370 direct jobs for indigenous communities and industry partners; and
- the Wik Timber operations over the next 20 years to salvage harvest the Rio Tinto mining lease of 5000 hectares per year in Western Cape York could generate 70 direct jobs, $6 million in annual log harvest income and up to $38 million in sawn product per year, with opportunities for mine site reforestation with native regrowth and plantations for future timber production.

These scenarios have not taken into account underlying cost structures and supply chain requirements, where industry growth will be assisted by the assumed implementation of the Recommendations in this report and the development of a better policy enabling environment and de-risking of future investment in the industry.

Table 1. Northern Australia forestry and forest products industry snapshot

Key region	Native forests	Plantation forests	Industry processing and harvesting activities	Infrastructure priorities
NORTHERN AUSTRALIA	• **13 million ha – identified with commercial potential**	**Total area ~ 100,000 ha**	• **Refer main activities below**	
NORTHERN QUEENSLAND	• **24.2 million ha – indigenous ownership or management** • **23.6 million ha – leasehold** • **7.7 million ha - private**	**Total area ~ 38,500 ha**	• **$54 million per annum in timber output** • **1500 direct and indirect jobs**	
Cape York	• Rio Tinto mining leases – Wik Timber harvest rights including state timber sales permit over 20 years covering 100,000 ha • Other traditional owner resources • Crown leasehold forests	Wik, Wik Waya mine rehabilitation plantation opportunity includes over 40,000 ha over the next 30+ years	• Interest in local processing from indigenous owners • Recent allocation of 50,000 tonnes over 10 years of crown leasehold resource (Cape York Timber) • Small number of hardwood sawmills processing crown resources (allocations due to expire)	
Far North Queensland (other than Cape York)		• 15,000 ha - softwood pine • 1,500 ha - Indian sandalwood • 500 ha - African mahogany	• Softwood sawmills in Mareeba and Ravenshoe (Simms Group) • Softwood sawn timber sold into local and eastern seaboard markets • Small network of growers around Townsville	• Quaids road upgrade from Kuranda to Mareeba & Ravenshoe • Road upgrades for B-double access from commercial forests to local mills
NORTHERN TERRITORY	• **18.7 million ha – indigenous ownership or management** • **13.5 million ha – private** • **9.3 million ha - leasehold**	• **Total area ~ 51,000 ha**		
East Arnhem	• Traditional owner resources		• Hardwood sawmill in Nhulunbuy (Gumatj) • Provide sawn products to local markets	
Tiwi Islands	• Traditional owner resources • Could support small-scale processing operations	• 32,000 ha - acacia pulpwood • Interest in replanting with hardwood species to increase yield and market value	• Woodchip processing and wharf facilities on Melville Island • Provide export chips for pulp and bioenergy markets • Exported 196,000 green metric tonnes in 2017-18 valued at USD$11 million	
Douglas Daly and Katherine		• 13,000 ha – African mahogany • Yet to reach harvest age • Interest in selective breeding/seed improvement for second rotation to increase yield • Interest in silvopastoralism with cattle • 6,000 ha - Indian sandalwood	• Evaluating wood processing options and markets • $390 million – projected value of African mahogany plantation estate at harvest age	*Douglas Daly* • Fleming road sealing for 35 kms • Cadell road sealing for 20 kms • Oolloo road upgrade • Grid power for value adding (processing) • Communications networks • Accommodation facilities and community infrastructure
NORTHERN WESTERN AUSTRALIA	• **3.2 million ha – indigenous ownership or management**	• **Total area ~ 10,000 ha**		
Ord River – southern Kimberley		• 9,500 ha – Indian sandalwood • Interest in silvopastoralism for weed control and related benefits • 377 ha - African mahogany	• Oil processing facilities in Albany and Perth • Sandalwood grown for domestic and export pharmaceutical, fragrance and ceremonial markets	

Note – total plantation figures for Northern Australia do not match the ABARES data reported in Table 8 in section 4.4 Plantations, due to more recent data being available and the inclusion of irrigated sandalwood plantations which are regarded in this study as a forestry enterprise.

2.0 Introduction

Northern Australia, as defined by the area north of the tropic of Capricorn in Queensland and Western Australia, and including all of the Northern Territory, encompasses 53% of Australia's land mass and contributes 10.7% of Australia's GDP, despite only accounting for 5.5% (1.3 million) of the Australian population, including approximately one quarter of Australia's Indigenous population.

Despite the potential of an extensive landmass, and broad forest areas (approximately 63 million hectares, refer map below), remoteness and extremes of climate have limited the potential of the region, including the forestry and wood products industry. The northern Australian forestry and forest products industry, at least in terms of wood product processing and value chain activity, currently is small scale, geographically fragmented and diverse.

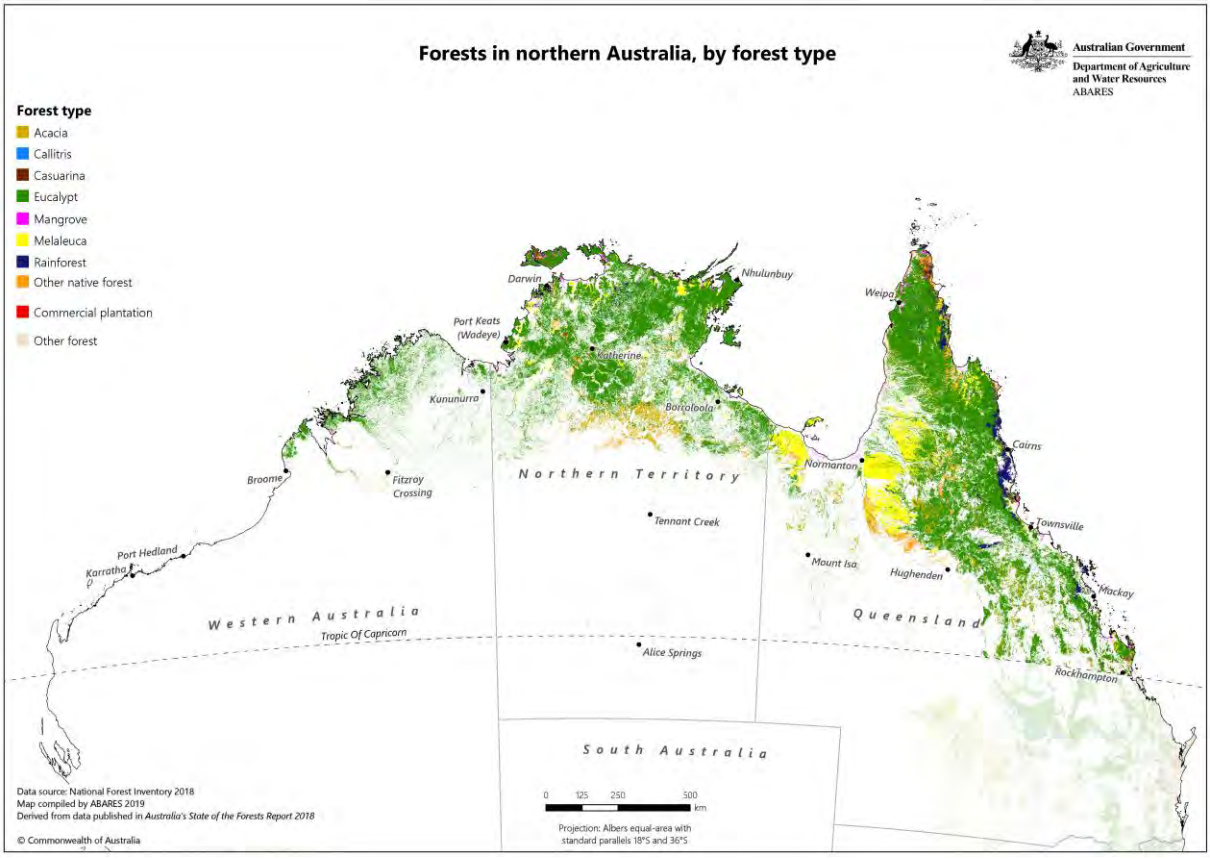


Figure 2. *Source: ABARES* (https://www.agriculture.gov.au/abares/forestsaustralia/forest-data-maps-and-tools/forest-maps)

3.0 Current context of northern Australian forestry

In aggregate, northern Australia has 13 million hectares of native forest that has been rated as available and suitable for commercial wood production (ABARES 2019, data provided for this project). Even though 97% of this area is rated as low commerciality under historical criteria, this represents a large potential resource for future development.

In addition, there is around 15,000 hectares of softwood (mainly *Pinus caribaea*) plantation in Far North Queensland (e.g. around Mareeba), approximately 1,500 hectares of teak (*Tectona grandis)* plantation (Qld), approximately 13,000 hectares of African mahogany (*Khaya senegalensis*) plantations (NT) and an estimated 500 hectares of red mahogany (*Eucalyptus pellita)* plantations (Qld), all intended primarily for higher-value, solid wood products. There is also approximately 32,000 hectares of Acacia (*Acacia*

mangium) plantations for pulpwood production in the Northern Territory. In addition, there is approximately 17,000 hectares of Indian sandalwood (*Santalum album*) plantation in northern Australia, comprising 6,000 hectares in the Northern Territory, around 9,500 hectares in northern Western Australia and 1,500 hectares in the Burdekin and Lakeland Downs regions of north Queensland.

Given the extensive forest resources of northern Australia, and the potential to target climatically and otherwise suitable expansion of the plantation forestry assets, the opportunities are equally broad.

This is particularly the case when plantation expansion occurs in proximity to major processing opportunities and existing port facilities. Either or both types of infrastructure can assist in addressing major challenges that include the geographic remoteness of some parts of northern Australia and transport distances to wood processing facilities, ports and population centres. The situation is little different for native forest opportunities.

As stakeholder feedback identified, key opportunities are consistently constrained by logistical challenges and economies of scale that will be best overcome by an integrated and regional approach. An integrated agribusiness development approach that creates a range of enterprises using common infrastructure, for example, is likely to yield greater benefits than a single enterprise or sector focus.

Regardless of whether in plantations or native forests, trees sequester and store carbon, long into the future. Wood products can also store carbon for long periods of time.

Policy measures that include ensuring there is an adequate price on carbon for plantations, native forests and wood products, will provide assistance to expansion of the forestry and forest products industries in northern Australia. It is notable that currently, native forests involving wood production activities are not eligible for carbon credits and are thus unable to participate in carbon pricing or trading schemes.

Providing security of access and supply is necessary to ensure that commercial viability can be translated into success at the business and community level.

In addition to addressing any policy and regulatory impediments to new plantation forestry opportunities, adequate financial investment models or measures are required to deal with the risks from catastrophic losses such as from cyclones. While these climatic risks are well-understood, there needs to be an effective range or availability of financial products or services (e.g. insurance markets) to facilitate investment.

There are also areas for further consideration by Government, especially as they relate to access to native forests for wood production. The available data demonstrates that, in northern Australia, 13 million hectares has been identified as having low to high wood commerciality.

In regard to the 22 million hectares of private forest and the 34 million hectares of leasehold forest in northern Australia, specific measures to support forestry activities may assist in addressing some of the barriers to development of this resource.

4.0 Consistent themes, despite the diversity

Despite the regional diversity, there are consistent themes for forestry across northern Australia:

- Specific areas of land are available for **expansion of plantations** in northern Australia, dependent upon suitable soils, rainfall and access to markets;
- **Broad areas of native forest** exist, but there is a need for **improved forest inventory and assessment of commercial potential**
- More **certain native forest resource security arrangements** (whether on private or public land) will support future investment in processing, downstream value adding and employment;
- Expansion of forestry and forest products industries requires **meaningful engagement models between industry, investors and resource owners (particularly traditional owners);**
- **Silvicultural understanding** needs to be improved and supported through expertise and training for private native forestry (particularly among traditional owners and to support expansion of Indigenous forestry opportunities) to raise and maintain future productivity and sustainable wood supply;
- **Silvopastoral systems** (particularly beef cattle and timber) are likely to be important to the viability of both plantation and native forestry on the one-hand and the expansion of livestock operations, on the other hand. There is emerging a clear need for trials and applied research to test business models and potential commercial benefits of these systems, particularly as a possible solution to deal with up-front land costs and low early cash flows and early weed and grass (fuel) control;
- **Carbon incentive schemes** could play a greater role in supporting expansion of forestry operations in plantations and prospectively related to native forests[1] (including private native forests), noting that most current opportunities fall within environmental projects that do not involve wood harvest activities;
- **Infrastructure needs** are significant across northern Australia, linking resource with processing for local markets and export (port) opportunities; and
- **Climatic and weather-related risks**, while the risks of catastrophic events such as cyclones are generally well-understood, there need to be effective **financial models or services that can deal with these risks to facilitate investment.**

These themes are important because they assist in defining the broad opportunities for future development and what is required to realise them. There are also related to improving or building upon what is already in place – in terms of the forestry activities in the key identified regions and the role they can play in supporting the development of more diversified economies in northern Australia.

[1] *Native forests involving wood production activities are currently not eligible for participation in carbon pricing or trading programs or schemes.*

5.0 Established opportunities

Arising from the themes in available literature and stakeholder feedback, the opportunities for forestry and forest products in northern Australia include:

- **More certain long-term wood supply arrangements for effective utilisation of crown leasehold lands** on which eucalypts are growing and which is potentially available for hardwood processing (north Queensland).
- Extension of **Indigenous forestry management and wood products manufacturing** and supply (East Arnhem Land, NT and Cape York, Queensland).
- **Scope for silvopastoral systems** to provide an additional driver for investment in new greenfield plantations, owing to the additional cash flows from livestock and reduced operating costs from weed and understory grass control.
- Further development of the **sandalwood industry** for products supporting ceremonial, pharmaceutical and personal care purposes (WA, NT and Qld).
- Increased productivity and quality of **hardwood fibre pulp plantations,** most likely from *Acacia mangium* to suitable eucalyptus species, with expected continuation of export market strength (Tiwi Islands, NT).
- Establishment of further **climatically suitable plantation species** (e.g. African mahogany and *Eucalyptus pellita*), and scope for combined co-beneficial agribusiness such as silvopastoralism (Douglas-Daly to Katherine region, NT, and Townsville – Burdekin region, Qld).
- Maintenance and expansion of the well-established **softwood plantation estate** and further processing developments (wet tropics regions of north Queensland, and Byfield in central Qld).
- Potential harvesting of **native forests** on all tenures, dependent on the information derived from the native forest inventory.

6.0 Case studies provide some examples of both opportunities and needs

CASE STUDY: WIK TIMBER



Perhaps this is just the tip of the iceberg for mining operational land clearing practices in Australia going forward.
Australian Forests & Timber News December 2017

"Imagine if we can demonstrate that we can collect sawlogs for our sawmills, process some for veneer, utilize some logs for power poles and then utilize the rest as woodchips to generate electricity for Aurukun through Indigenous owned business and replace diesel power generators. And all of this from forest resources that have been traditionally cleared and burnt for over 50 years,"
Gina Castelain, MD of Wik Timber.

- Wik Timber Holdings is an Indigenous business and the timber harvesting, wood chipping and seed collection operations will provide jobs for local Aboriginal people resident in and around Aurukun and Napranum. The Wik Timber project recently purchased two Tigercat machines for its logging operations south of the Embley River, on the Western Cape York Peninsula. They harvest timber, ahead of Rio Tinto Aluminium's land clearing, which allows the mining giant access to the abundant supply of Bauxite.
- With harvesting, transport and port access planning complete, the logging operations are now in their initial stages. When at full scale, the business will produce up to 125,000 tonnes of timber and other forest products annually for international and domestic markets. Annual turnover is expected to be around $6 million. The operations will employ 70 local Aboriginal people.
- Demand for the various products is expected to come from Chinese, Vietnamese and domestic sawmillers and manufacturers of timber- based products. In addition, power transmission poles will be marketed to electricity distributors, Rio Tinto Aluminium will require railway sleepers, and Rio Tinto Aluminium and others will demand chips for mine rehabilitation.

CASE STUDY: MAREEBA SOFTWOODS



The region of Far North Queensland has a well-established softwood plantation growing, processing and marketing supply chain, based around the Atherton Tableland and Hinchinbrook Coast.

There is approximately 15,000 hectares of softwood plantation in the region comprising Caribbean pine (Pinus caribaea) and Hoop pine (Araucaria cunninghamii) species. These plantations were mostly developed by the state government for future timber supply and regional development goals, and were subsequently privatised in 2010 with the sale of the estate to HQPlantations.

- This mature resource has facilitated investment in downstream processing with the two integrated mills of Mareeba Softwoods and Ravenshoe Timber producing sawn timber and landscaping products from an intake of around 45,000 cubic metres per annum, for local demand in the Cairns region and broader eastern seaboard markets.
- This is an example of of the largest timber supply chain in northern Australia, with direct timber sector employment of over 200 people in the Cairns local government area alone.
- However, to maintain long-term competitiveness in a global market, there is a need to expand the resource and improve the economies of scale in growing and processing, together with reducing high input costs such as energy.
- The region does have sufficient rainfall, good soils and relatively lower land costs compared to other prospective areas elsewhere in Australia, which can support future plantation expansion. The challenges will be to develop suitable engagement and investment models with relevant stakeholders including local land owners, co-investors and councils. Reducing energy costs, such as better incentives for the utilistion of wood waste for bioenergy, would also improve processing competitiveness and expansion.



Aerial view of Mareeba softwoods sawmill. Image credit: Daryl Killin.

7.0 Integrating opportunities and needs

These opportunities were confirmed, refined, extended upon and amended in the workshops. The following table, developed from the workshops and with subsequent stakeholder input, incorporates all of the identified opportunities and needs, but to inform the development of clear action priorities, also identifies broad activity streams:

- Regulatory
- Research
- Development
- Market

Table 2. Major opportunities and needs matrix	Region/s	Stream
OPPORTUNITY: Expansion of downstream processing and value-adding - given the large potential native forest resource, there is an opportunity for expanded processing, but this is dependent upon security of access to supply of resource, given capital and investment financing requirements. Any future plantation expansion would also need access to appropriate processing and/or value-adding markets. **NEED: Security of access to supply of resource** - particularly for native forests, for land under all tenures, to facilitate decision-making and investment. In Far North Queensland, there are also good prospects for pine plantation resource expansion, requiring assessments of land availability investment models and anticipated returns, with landowners; the same applies to other expansion of the plantation resource for other species elsewhere in northern Australia. **NEED**: **Effective engagement models** - between industry, private forest owners and investors, particularly for Indigenous owned and managed forests. **NEED**: Assessment of climate and weather-related risks, and potential mitigants for plantation expansion, including from a modern commercial perspective. Assessments to include but not be limited to cyclones and to consider both insurance and co-equity mechanisms.	All regions and species	Regulatory (Crown land) and Development (Private Native Forestry, Plantations) Research and Development
OPPORTUNITY: Mine site revegetation - add value to existing extensive mining land-use activities through revegetation with productive forest species (e.g. timber, bioenergy). **NEED:** requires silvicultural information for native forests and for suitable plantation species, and market information to inform decisions as to scale and specific opportunities.	Cape York East Arnhem Land	Research and Development

OPPORTUNITY: Expansion of silvopastoral systems - maximise returns in native forests and generate new investment in greenfield plantations, through joint production of timber and livestock via improved revenue streams and business cash flows. This has significant potential for new plantation development, which has stalled in recent decades, due to a lack of commercial investment drivers. **NEED:** research trials and extension of silvopastoral systems that are regionally specific to site conditions, climate and species. More information is also needed on the commercial merits of silvopastoralism systems in terms of net returns, and a possible way to deal with up-front land costs and low early cash flows for new plantations, and as a means for cost-effective weed and grass control.	Far North Queensland Cape York Douglas Daly	Research and Development
OPPORTUNITY: Sustainable local employment, including for Indigenous people - provide long-term, skilled and self-sufficient employment opportunities, across northern Australia, including in remote Indigenous communities. **NEED:** extend and establish business models aiming to extract maximum value from forestry resources (trees) in the regions and communities where the resource is found. **NEED:** requires training and skills development opportunities and integration with national training and skills recognition arrangements, for business development and management, through the entire forestry supply-chain to operator level.	All regions	Development (including training)
OPPORTUNITY: Supply to meet local and export demand for solid wood products - given remoteness of the region and proximity to end use markets, local suppliers may have a comparative advantage servicing local demand (northern Australia) as well as some specific export markets (e.g. Asia) which are projected to grow over time.	All regions	Market and Research

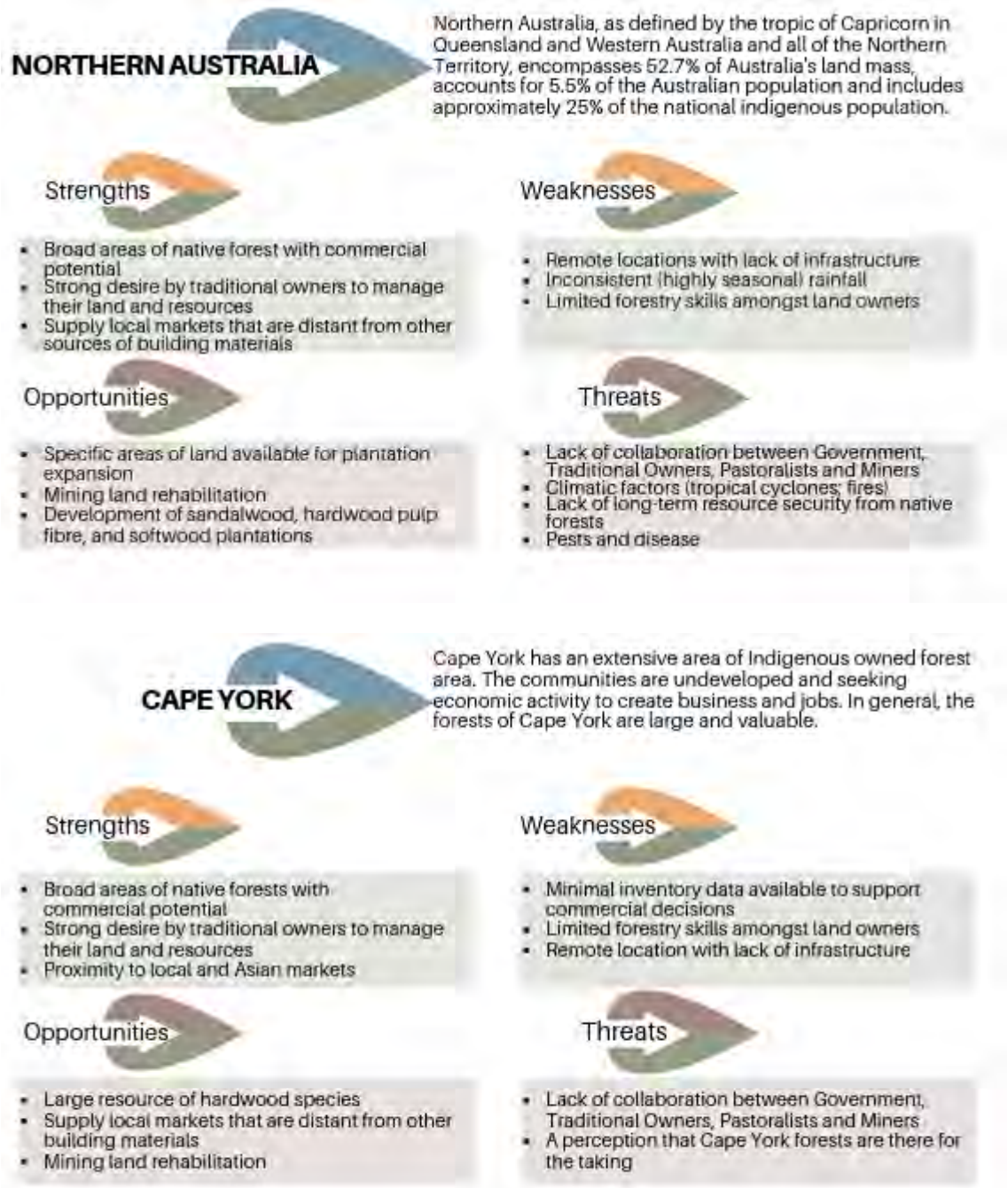
NEED: requires improved market information, and may require related forestry inventory and silvicultural information research on product mixes. **NEED**: **Infrastructure mapping:** identify key infrastructure (roads, ports, telecommunications etc.) requirements to develop local wood product supply chains in the relevant northern Australia forestry regions.	All regions	Market and Research
NEED: Carbon markets - carbon accounting research, especially for native forests, linked to the forestry inventory and silvicultural management; and review Emissions Reduction Fund (ERF) barriers to carbon market access for forestry activities, with priority on the 600mm 'water rule' requirement for new plantations.	All regions	Research and Regulatory
NEED: Forest inventory and silvicultural information - specifically required for native forests across northern Australia, to inform decision-making and forestry extension in the field.	All regions	Research and Development
NEED: Market information - especially for native species and for assessment of opportunities (particularly solid wood) at the local (northern Australia), national and export market levels.	All regions	Market and Research

8.0 SWOTs for Key Regions

A summary analysis of the Strengths, Weaknesses, Opportunities and Threats for northern Australia and separately for each of the regions follows.

Details can be found in the Literature Review.

Elements of the SWOT for northern Australia are relevant to all of the regional SWOTs, unless specified otherwise.



NORTH QUEENSLAND

Far North Queensland (excluding Cape York). Of all of Australia's plantation regions, North Queensland has the largest area of land on which softwood plantations may be potentially viable.

Strengths

- Well established softwood plantation resource with links to local downstream processing & markets
- Industry priority to increase estate and improve productivity

Weaknesses

- Inconsistent (highly seasonal) rainfall
- Processing technologies for African Mahogany plantations yet to be fully tested
- High energy costs

Opportunities

- Expansion of plantation softwood estate
- Silvopastrolisim in planted forests
- New investment in native hardwood processing
- Removal of long-standing regulatory burden offers new market opportunities

Threats

- For commercial production in the dry tropics, either irrigation or a good source of groundwater appears to be essential
- Tropical cyclones
- Lack of resource security from Crown owned native forests

NORTHERN TERRITORY

African Mahogany plantations in the Douglas-Daly catchment, expanding woodchip industry on the Tiwi Islands, vast indigenous owned forests across Arnhem Land.

Strengths

- Midway investment in new infrastructure (Tiwi Islands)
- Indigenous community leadership and engagement
- Supply export and local markets that are distant from other sources of building materials

Weaknesses

- Inconsistent (highly seasonal) rainfall
- Remoteness (e.g. distance to ports and markets)
- Limited access to maintenance and other technical support

Opportunities

- Plantation expansion in the Douglas-Daly catchment
- Eucalypts on the Tiwi Islands showing significant growing advantages
- Branded products for international markets

Threats

- Australia's vast northern tropical savannas are extremely flammable
- Water availability
- Pests and disease

9.0 Strategic Recommendations

This section outlines six strategic recommendations that propose solutions to the current challenges inhibiting the development of the northern forestry and forest products industry (refer Table 3). These recommendations have been developed with industry partners and stakeholders in northern Australia.

The key recommendations were relevant across two areas of primary focus:

- removal of barriers for downstream processing and value-adding for forest product and timber markets; and
- addressing barriers to new plantation investment and production forestry carbon opportunities.

The six recommendations (in no particular order) for action were:

- build and maintain the newly formed industry and cross-jurisdictional agency alliance to promote forest sector development across Northern Australia;
- promote indigenous forestry development through better engagement models and commercial arrangements between industry and indigenous landowners, and build indigenous forestry capacity and understanding of commercial forest resources including through forest resource inventory;
- development of secure access arrangements for supply from crown native forest land (i.e. leasehold) in northern Queensland;
- develop a market research study into the potential supply and demand for wood products from Northern Australia, including key markets and supply chain needs (e.g. regional infrastructure);
- assess silvopastoral opportunities as a vehicle for new commercial tree plantings; and
- review Emissions Reduction Fund (ERF) barriers to carbon market access for forestry activities, with priority on the 'water rule' requirement for new plantations.

Table 3. Strategic Recommendations				
#	**Key priority actions for sector development**	**Action owner and key partners**	**Pathways to implementation and timelines**	**Intended industry impacts**
	Removal of barriers for downstream processing and value-adding for forest product and timber markets			
1	Build and maintain the newly formed industry and cross-jurisdictional agency alliance to promote forest sector development across Northern Australia	*Action owner:* Timber Queensland *Key partners:* • NT Department of Primary Industry and Resources • Queensland Department of Agriculture and Fisheries • AgForce Queensland • The Cooperative Research Centre for Developing Northern Australia • University of Sunshine Coast • Project partner companies Other potential partners: • Forest and Wood Products Australia	Use the alliance to leverage further investment and partners to achieve priority actions. Pursue information sharing and cross-jurisdictional learnings and opportunities through workshops, field trips, conferences and joint work planning on R&D proposals and policy development.	Collaboration via the alliance will accelerate priority actions and impacts outlined below, as well as generate additional R&D investment over the next five years. Additional R&D collaboration and leveraging in the areas of: plantation nutrition, genetics, pests and silvicultural management to increase productivity.
2	Promote indigenous forestry development through better engagement models and commercial arrangements between industry and indigenous landowners, and build indigenous forestry capacity and understanding of commercial forest resources including through forest resource inventory	*Action owner:* University of Sunshine Coast *Key partners:* • NT Department of Primary Industry and Resources • Timber Queensland • The Cooperative Research Centre for Developing Northern Australia (CRCNA)	Develop a framework for 'best-practice' engagement and capacity building with indigenous land-owners in native forestry management and supply. Conduct field work and cultural research to identify recommended models for engagement between indigenous owners and the timber	More secure supply arrangements will reduce capital and financing risk and facilitate new timber processing investment and output. Better engagement models with indigenous land-owners and partners will increase utilisation of timber resources

		• Queensland Department of Agriculture and Fisheries Other potential partners: • North Australia Indigenous Land and Sea Management Alliance (NAILSMA) • Indigenous Land Corporations	industry (e.g. investors and processors). Develop proposals for improved native forest inventory on indigenous estate. These pathways to implementation will be further developed in consultation with the CRCNA's indigenous sectoral plan for Northern Australia.	that meet both economic and cultural needs. If 10% of the private forest with commercial potential was actively managed for timber, for example, this would represent 660,000 hectares. This area could generate up to $15 million in selective log harvest income per year and produce around 67,000 cubic metres of sawn timber worth $100 million annually. It could also generate up to 370 direct jobs for indigenous communities and industry partners.
3	Development of secure access arrangements for supply from crown native forest land (i.e. leasehold) in northern Queensland	*Action owner*: Timber Queensland *Key partners:* • Queensland Department of Agriculture and Fisheries • University of Sunshine Coast Other potential partners: • AgForce Queensland	Identify priority industry needs and engage with State Government on long-term planning for the utilization of crown land forest resources. Assess resource availability and implement tender arrangements for supply and promotion of long-term sawmilling investment.	Increased output of timber from extension and/or new supply contracts from crown native forest land. Without secure access, current short-term contracts will expire in next 1-2 years, with the loss of around 80 direct and indirect jobs. There would also be no pathways for new entrants and investment. Secure longer-term access could generate $13 million in annual sawn product from the

				current short-term volumes alone, with further opportunities for growth dependent on crown-land supply.
4	Develop a market research study into the potential supply and demand for wood products from Northern Australia, including key markets and supply chain needs (e.g. regional infrastructure), in consultation with ABARES	*Action owner*: Timber Queensland Key partners: • Solid/engineered timber and wood fibre industry • Sandalwood industry • University of Sunshine Coast • ABARES • Queensland Department of Agriculture and Fisheries • NT Department of Primary Industry and Resources • The Cooperative Research Centre for Developing Northern Australia (CRCNA)	Better market knowledge of domestic and export markets to assist processing (i.e. product choice) and management (i.e. forest silviculture) decisions to maximise returns and industry development. Identify key regional infrastructure needs (e.g. roads) to lower costs and improve industry delivery to market. Key regions: Far North Queensland and Cape York, Tiwi Islands, East Arnhem land, Douglas-Daly and Katherine; Ord River area (northern WA).	Better targeting of markets for development of fibre and timber products and growth of the industry. Better targeting of public and private infrastructure spending to improve industry supply chains.
	Addressing barriers to new plantation investment and production forestry carbon opportunities			
5	Assess silvopastoral opportunities as a vehicle for new commercial tree plantings	*Action owner*: Timber Queensland Key partners: • Central Queensland University • University of Sunshine Coast • Queensland Department of Agriculture and Fisheries • NT Department of Primary Industry and Resources	Further test and evaluate silvopastoral systems for delivery of enhanced enterprise profitability. Key drivers include: income diversification and early cash flows to offset tree establishment costs and delayed harvest returns, and weed and grass control.	Expansion of silvopastoral systems for enhanced commercial timber supply and related co-benefits (e.g. improved cash flows via livestock and carbon revenue and reduced risks to investors).

		• HQPlantations • African Mahogany Australia • The Cooperative Research Centre for Developing Northern Australia (CRCNA) • AgForce Queensland Other potential partners: • Meat and Livestock Australia • Forest and Wood Products Australia	Develop R&D proposals with key industry and R&D partners for applied field trials and bioeconomic assessments. Increase extension and demonstration activities based on new information.	Improved landholder awareness of silvopastoral systems as an alternative economic land use in northern Australia. Livestock productivity benefits from silvopastoral systems (e.g. reduced heat stress, improved calving etc.)
6	Review Emissions Reduction Fund (ERF) barriers to carbon market access for forestry activities, with priority on the 'water rule' requirement for new plantations	*Action owner:* Australian Forest Products Association Key partners: • Timber Queensland • Forest Products Commission of Western Australia • University of the Sunshine Coast	Industry engage with federal regulators on the Emissions Reduction Fund (ERF) 600mm average annual rainfall 'water rule' requirement for plantation activities. Review this barrier with a view to promoting a level-playing field for plantation activities relative to other vegetation management sequestration activities in the ERF. Develop a work plan to identify other opportunities for, and barriers to, production forestry carbon outcomes.	Addressing this barrier will increase access to carbon markets for timber plantation investment opportunities in northern Australia. Review/amendment would enable plantation forestry to access the Queensland Land Restoration Fund (LRF) which links to the ERF plantation method and regulation.

Notes – key assumptions underlying modelled potential impacts in this report include: softwood sawn product price of $600 per cubic metre; hardwood sawn product price of $1500 per cubic metre; hardwood log stumpage of $80 per cubic metre; native forest mean annual increment (MAI) of 0.29 cubic metres of sawlog per hectare; sawntimber recovery rate of 35% for native hardwood and 48% for plantation softwood; plantation softwood MAI of 15 cubic metres per hectare with 75% sawlog product; 1.95 jobs per 1000 cubic metres of native hardwood sawlog mill input; 1.53 direct jobs per 100 hectares of plantation (for a mature supply chain integrated with processing); an employment multiplier for total direct and indirect forest industry jobs of 1.5 for northern Australia and 1.7 for the native hardwood sector in northern Queensland. Sources for employment ratios and multipliers: Schirmer et al (2018); Downham et al (2019) and Bureau of Rural Sciences (2005). Davey and Dunn (2014) estimated over 95% of the private native forest in northern Australia with commercial potential to have an MAI for sawlogs of between 0.15 to 0.29 cubic metres per hectare. These estimates are based on broad spatial modelling and subject to variation. Active silvicultural management could also improve the MAI from native forests. Recent (unpublished) harvest trials of native forest regrowth sites from the 1970s in western Cape York, for example, have observed MAIs of between 0.8 to 1.0 cubic metres per hectare.

10.0 Appendices

APPENDIX ONE:	Literature Review
APPENDIX TWO:	Workshop Reports
APPENDIX THREE:	Review of indigenous forestry in northern Australia
APPENDIX FOUR:	Image library of key forest resources and processing activities

APPENDIX ONE – Literature Review

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Purpose

This situational analysis of northern forestry and forest products industry literature review identifies and describes key challenges faced by the northern Australian forestry and forest products industry, and subsequently explores potential solutions and opportunities for further discussion, research or investment.

The literature review was part of a staged process for analysis of forestry and forest products industry opportunities in northern Australia. The component elements included:

- the literature review, to inform and guide;
- stakeholder consultations and regional forums, for feedback; and
- a summary 'Overview Report'.

Stakeholder feedback and input from direct consultations has been incorporated into the literature review. Any stakeholder contribution that adds value, provides further information or even contradicts literature findings, is prefaced with **"*Stakeholder feedback*"** and formatted in italics.

Background and themes

Northern Australia, as defined by the tropic of Capricorn in Queensland and Western Australia, and including all of the Northern Territory, encompasses 52.7% of Australia's land mass and contributes 11.7% of Australia's GDP, despite only accounting for 5.5% (1.3 million) of the Australian population, including approximately one quarter of the national Indigenous population.

This initial review of published and otherwise available literature highlights the regional diversity of the industry and its opportunities, across quite distinct geographical regions and sectors in northern Australia.

Available literature contains some consistent themes:

- Specific areas of land are available for **expansion of plantations** in northern Australia; dependent upon suitable soils, rainfall and access to markets;
- **Broad areas of native forest** exist, but there is need for **improved forest inventory and assessment of commercial potential**;
- More **certain long-term native forest resource security arrangements** (whether for private native forests or for those growing on crown land) will support future investment in processing, downstream value adding and employment;
- Expansion of forestry and forest products industries requires **meaningful engagement models between industry, investors and resource owners** that is cognizant of economic and cultural needs, particularly with traditional owners given their ownership of significant areas of native forest;
- **Silvicultural awareness** needs to be improved and supported with expertise and training for private native forestry (particularly among traditional owners and to support expansion of Indigenous forestry opportunities) to raise and maintain future productivity and sustainable flows of wood;

- **Silvopastoral systems** (particularly beef cattle and timber) are likely to be important to the viability of both plantation and native forestry on the one-hand and the expansion of beef cattle operations, on the other hand;
- **Carbon incentive schemes** could play a role in supporting expansion of forestry operations, both in plantations and related to native forests (including private native forests);
- **Infrastructure needs** are significant across northern Australia, linking resource with processing for local markets and export (port) opportunities.

Findings and opportunities

Arising from these themes, the opportunities for forestry and forest products in northern Australia include:

- **More certain long-term wood supply arrangements for effective utilization of crown leasehold lands** on which eucalypts are growing and which is potentially available for hardwood processing (north Queensland).

  There is currently significant uncertainty over future wood security from crown land (i.e. with current contracts to small local mills about to expire). The Queensland Government is presently determining its policy on the 'future of timber production on state-owned land'. Without the necessary certainty of future wood supply, there is a lost opportunity to grow and build on the existing industry investment that has been established around the crown forest resource and for any new potential entrants.

- Further development of the **sandalwood industry** for products supporting ceremonial, pharmaceutical and personal care purposes (WA, NT and Qld).

  Indian sandalwood (*Santalum album*) is grown for oil and pharmaceuticals in the Douglas-Daly and Katherine regions of the Northern Territory, in the Ord River Irrigation District in northern WA, and in the Burdekin and Lakeland Downs regions of north Queensland. Sandalwood is the only plantation forestry in Australia that is routinely grown in a mixed species system, and with irrigation.

  WA's sandalwood plantations are currently being harvested and re-planted. Still at the early rotation phase, the NT sandalwood plantations will not be harvested for more than a decade, where they then expect to go into the oils and pharmaceutical markets.

- Increased productivity of future **hardwood pulp fibre plantations** (*e.g. Eucalyptus pellita*) with expected continuation of export market strength (Tiwi Islands, NT).

  Continued growth in global demand for hardwood fibre is expected over the next decade as global populations expand and their living standards increase. Already being harvested, the existing plantations can be re-planted and extended on the Tiwi Islands, the closest Australian location to the main Chinese and Japanese markets and the emerging Indonesian market. These plantations provide an example of targeted suitability plantation forestry, and of opportunities to expand Indigenous-owned forest enterprises.

- Establishment of further **climatically suitable plantation species** (e.g. African mahogany and *Eucalyptus pellita*), and scope for combined co-beneficial agribusiness such as silvopastoralism (Douglas-Daly to Katherine region, NT, and Townsville – Burdekin region, Qld).

  The current African mahogany plantations have an expected rotation of between 18 to 25 years. The NT plantations are mid-rotation and have been independently valued at $100 million standing value (i.e. the current value of trees within the plantation), which will yield saleable timber when

harvested at maturity. They provide an example of targeted suitability plantation forestry and of the financial returns that may be available.

- Extension of Indigenous forestry management and wood products manufacturing and supply (East Arnhem Land, NT and Cape York, Queensland).

  Whether Cape York Timber in eastern Cape York, Wik Timber Holdings in western Cape York, or Gumatj Corporation Limited in East Arnhem Land in Nhulunbuy (NT), the integration of Indigenous business and employment opportunities, with access to native forests and specific (local and international) demand and markets, provides significant scope for future developments.

- Maintenance and expansion of the well-established **softwood plantation estate** and further processing developments (wet tropics regions of north Queensland, and Byfield in central Qld).

  Based on well-established growth in demand for sawn wood products in Australia, planting an additional (approximate) 44,000 hectares of softwood plantations in north Queensland, coupled with some log reallocation from other softwood growing regions, could support a world-scale softwood sawmill in the region, which is currently home to two relatively large sawmills.

  Of all of Australia's fifteen plantation regions, north Queensland has the largest area of land on which softwood plantations may be potentially viable. Stakeholders identified this opportunity, including through initial economic analyses conducted by ABARES, but also pointed to the commercial challenges in establishing new plantations, including in cyclone prone regions, and at a distance from major national markets.

- **Red mahogany** (*Eucalyptus pellita*) was the most widely planted eucalypt in humid, coastal areas of northern Australia and about 4,500 hectares were established in coastal, north Queensland until much of the resource was destroyed by Cyclone Yasi in 2011. The destruction of the red mahogany plantations by cyclone underscores one of the major risks to the further development of the forestry and forest products industries in northern Australia. About 500 hectares of existing small plantings still target timber production.

  Plantation-grown red mahogany generally targets integrated pulp and sawn wood production. Potentially, plantation-grown timber is suitable for solid wood products, veneers and other, appearance grade products, and it can be grown for carbon sequestration, in a range of locations in northern Australia (Harwood et al 1997).

Despite the potential of an extensive land mass, and large forest areas, remoteness and extremes of climate have limited the potential of the region, including the forestry and forest products industry. The northern Australian forestry and forest products industry, at least in terms of wood product processing and value chain activity currently is small scale and fragmented.

In aggregate, northern Australia has 13 million hectares of native forest that is available and suitable for commercial wood production (ABARES 2019, data provided for this project). This represents a significant potential existing resource for future development.

Regarding plantations, there is around 15,000 hectares of softwood plantation in far north Queensland in the vicinity of Hinchinbrook Coast and the Atherton Tablelands, approximately 5,000 hectares of hardwood plantation in north Queensland, approximately 13,000 hectares of African mahogany plantations (NT) and 500 hectares of red mahogany (Qld) intended for high-value products. In addition, there is 32,000 hectares of *Acacia mangium* plantations for pulpwood production on the Tiwi Islands in the Northern Territory. There is also 6,000 hectares of sandalwood plantation in the Northern Territory,

approximately 9,500 hectares of sandalwood in north Western Australia and 1,500 hectares of sandalwood in north Queensland.

Prior to Cyclone Yasi in 2011, the red mahogany plantations in Queensland were reported to be approximately 4,500 hectares. It was the cyclonic conditions that reduced this resource to approximately 500 hectares. This relatively recent example accentuates the challenges of establishing plantations in cyclone prone regions.

Given the extensive forest resources of northern Australia, and the potential to target climatically and otherwise suitable expansion of the plantation forestry assets, the opportunities are equally extensive.

This is especially the case when plantation expansion occurs in proximity to major processing opportunities and existing port facilities, which can assist in addressing major challenges that include the geographic remoteness of some parts of northern Australia and transport distances to wood processing facilities, ports and population centres.

Stakeholder feedback *has also highlighted that key opportunities are consistently constrained by logistical challenges and suggested analysis around the integration of solutions. For example, there might be a single infrastructure investment/solution servicing multiple industry sectors, or port facilities continuously utilised from various sectors.*

Regardless of whether they are in plantations or native forests, trees sequester carbon and store it, long into the future. Policy measures that include ensuring the participation of commercial wood production native forests in carbon pricing schemes and ensuring there is an adequate price on carbon will provide assistance to expansion of the forestry and forest products industries in northern Australia.

In addition to addressing any policy and regulatory impediments to the expansion and establishment of plantation forestry opportunities, there are areas for further consideration by Government, especially as they relate to access to native forests.

The literature and available data demonstrate that in northern Australia, the total area of native forest that is not legally restricted from being harvested is very substantial, amounting to something in excess of 63 million hectares.

Significantly, this includes 22 million hectares of private forest, where specific measures to support forestry activities may assist in addressing some of the barriers to development of this resource. It is noted that the data on the productive capabilities and commercial viability of this resource has not been extensively assessed, but at a national level, the proportion of total forests that is commercially viable was 29% in 2016 and only 8% was of high or very high value. Further modelled information on the area of potentially commercial native forest in northern Australia is presented in section 4.2 of this report.

Security of access and supply is necessary to ensure that commercial viability can be commuted into success at the community, regional and national level. Providing adequate resource security to forest managers/growers, processors and downstream manufacturers is consequently a critical requirement for long-term investment and industry development in northern Australia.

Stakeholder feedback *reiterates the need for both private sector leadership, and for government to take a long-term approach to supporting the opportunities.*

1.0 Introduction

1.1 Objective of the review

This 'situational analysis of northern forestry and forest products industry' literature review:

1. identifies and describes key challenges and opportunities faced by the north Australian forestry and forest products industry;
2. explores potential policy, investment and other solutions to challenges; and
3. assesses sector wide research priorities as well as the most strategic research projects for further investment.

1.2 Study area

The area north of the tropic of Capricorn in Queensland and Western Australia, and including all of the Northern Territory, is the boundary used to define northern Australia in this report.

More broadly, Northern Australia encompasses around 53% of Australia's land mass and contributes 10.7% of Australia's GDP (2016-17). The region's population is 1.3 million, of whom 15% identify as indigenous, or almost 30% of Australia's indigenous population (Commonwealth of Australia 2015, Office of Northern Australia 2018).

2.0 Northern Australian forestry and forest products industry

2.1 Overview

Australia has 134 million hectares of forest, covering 17% of Australia's land area. Australia has approximately 3% of the world's forests, and globally is the country with the seventh largest forest area.

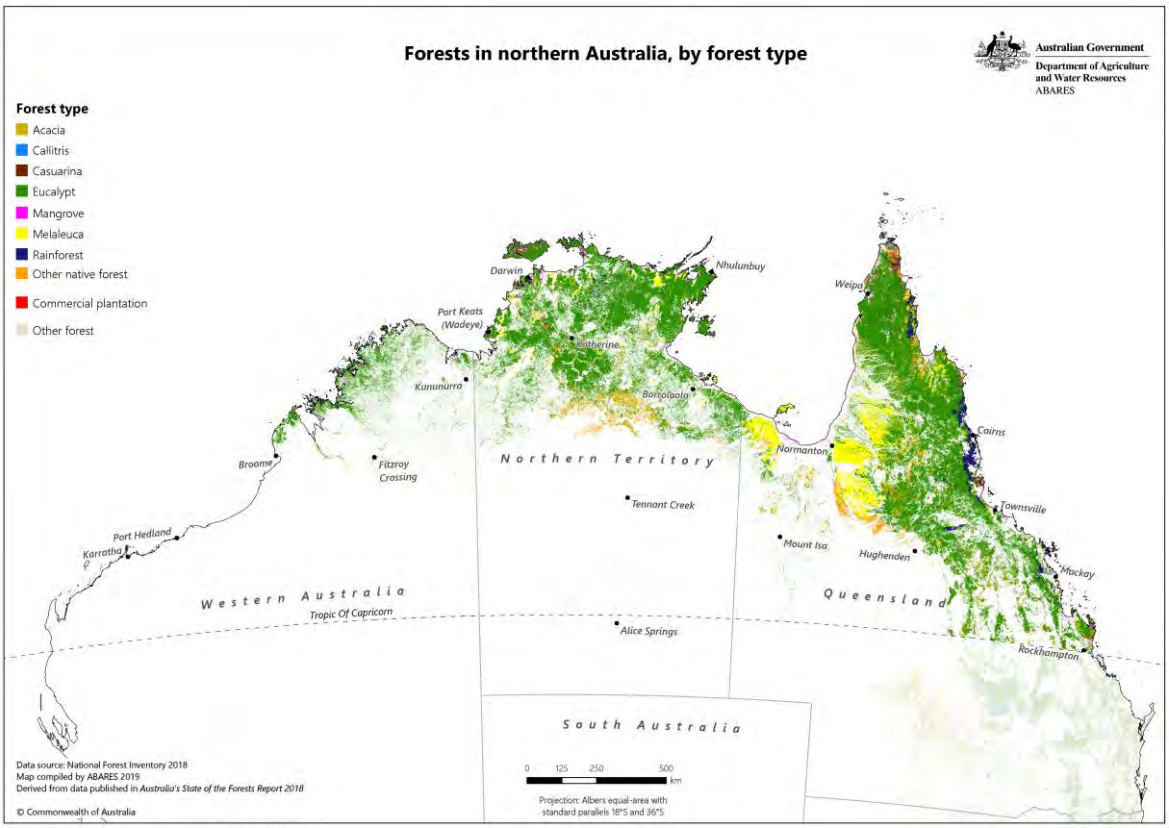


Figure 2. *Source: ABARES* (https://www.agriculture.gov.au/abares/forestsaustralia/forest-data-maps-and-tools/forest-maps)

In northern Australia, there are 63 million hectares of forests, including plantations, accounting for 48% of Australia's total forests. ABARES reports that the Northern Territory has 23.73 million hectares of forests, northern Queensland has 35.78 million hectares and northern Western Australia, 3.66 million hectares.

2.2 Industry development and characteristics

Forestry in northern Australia is small scale and fragmented.

The size and remoteness of northern Australia presents significant challenges for primary industries, including forestry. Distance to wood processing facilities, ports and population centres creates price and competitiveness pressures.

Northern Australia is a vast region, constituting over half of the continent. To date its remoteness, land variability and highly changeable climate have presented barriers to development.

2.2.1 Forest types

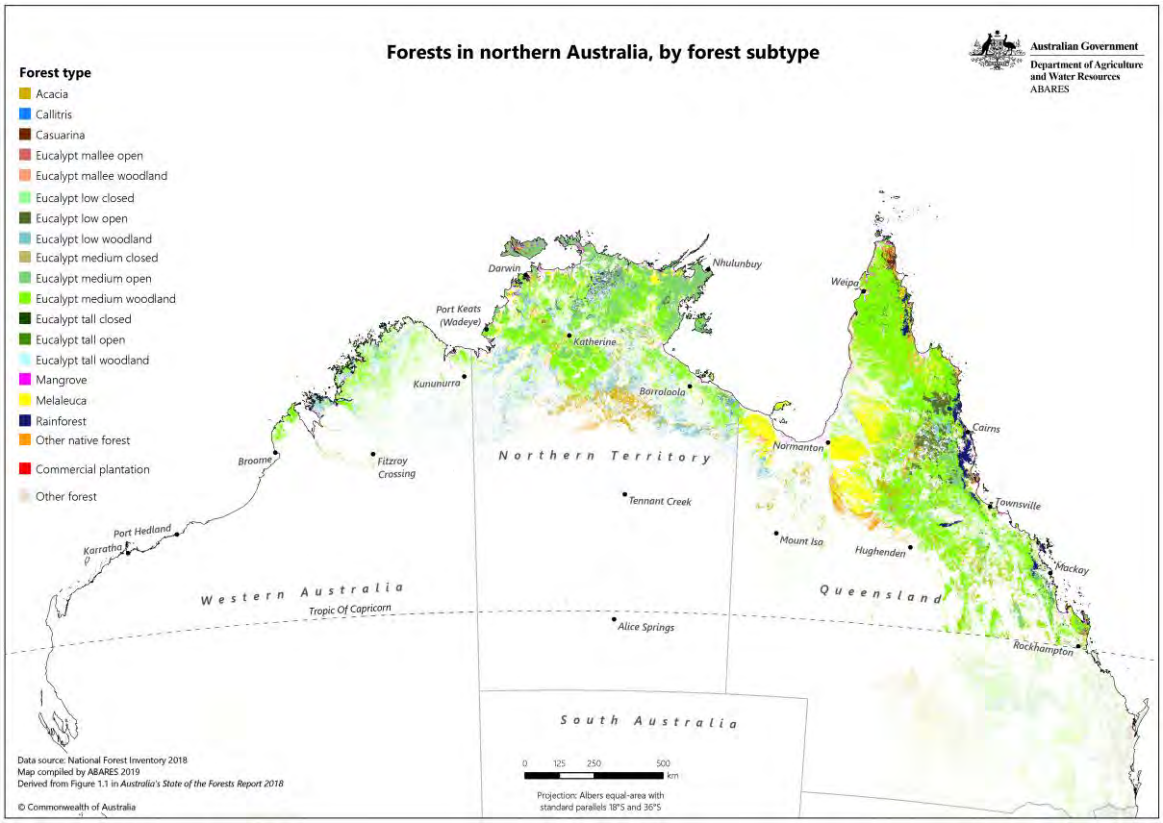


Figure 3. *Source: ABARES* (https://www.agriculture.gov.au/abares/forestsaustralia/forest-data-maps-and-tools/forest-maps)

Resource information on native forests in northern Australia to support commercial decision making is limited in terms of species, volumes and access, as well as with respect to productive capacity. Forest inventory is an area requiring further examination, to inform future decision-making.

The area of native forests available for harvesting in northern Australia was 12.9 million hectares in 2016, of which 96% was commercially low rated according to ABARES (2018).

Whittle et al (2019) reported that nationally, the aggregate plantation estate amounted to 1.97 million hectares in 2015-16, with approximately 930,000 hectares of hardwoods and the remainder being softwoods. The hardwood plantation estate has declined from a peak of about 990,000 ha in 2008-09, and is expected to decline further as commercially marginal plantations are converted to other uses. The softwood plantation estate has remained relatively unchanged in total area for many years.

Within northern Australia, the total area of plantation forest is presently estimated at approximately 100,000 hectares.

Tree plantations include those established for sawn timber production, high value and specialty timbers, pulp, bioenergy, sandalwood, carbon and chemicals. Northern Australia plantation forestry has been undertaken since the 1960s in both Queensland and the Northern Territory mainly for sawn products and pulp. Early plantation programs were government sponsored. While some were developed to a stage where commercial activity could be undertaken, the limited scale of planting was a major limitation (Halkett et al 2012).

African mahogany is being grown in the Douglas-Daly region of the Northern Territory, to produce high-value sawn timber used for flooring, fine furniture or veneers. The 14,000 hectares of dryland plantation is the largest African mahogany plantation in the world, with a predicted rotation of 17 to 22 years (Halkett et al 2012). There is also a small area of several hundred hectares of African mahogany plantations managed by private landowners in the Townsville region.

Black wattle or *Acacia mangium*, is being grown on the Tiwi islands in the Northern Territory, for woodchips to produce pulp, used to manufacture paper. The approximately 32,000 hectares of forest is expected to produce between 200,000 and 400,000 green metric tonnes of wood chips, for export each year.

Indian sandalwood is grown in the Ord River Irrigation Area (ORIA) in Western Australia, in the Douglas-Daly to Katherine regions of the Northern Territory, and in the Burdekin and Lakeland Downs regions of north Queensland. It is a valuable product that has the potential to deliver a high return to growers (Halkett et al 2012).

Sandalwood is grown in irrigated, mixed-species plantations to produce dry heartwood and sandalwood oil for pharmaceutical and ceremonial markets worldwide. The more than 4,000 ha of plantations in the NT, centred around Katherine, are part of the largest area of sandalwood plantations in the world (NT Government 2019).

Future development of tree plantations depends on access to suitable land. In addition to being suitable for the growth of selected species, such land has to be within an acceptable distance of processing or port facilities and preferably be part of an aggregate area to develop a critical mass. General analyses can be undertaken using soils, topography, location, climate and tenure information (Halkett et al 2012). However, the general analysis can only ever be pre-commercial, with private sector investment requiring significantly more detailed and 'granular' land suitability analysis. Investment support mechanisms are required across Australia, to incentivise plantation establishment (de Fegely et al 2011).

A future development opportunity may be the expansion of agroforestry activities, in particular silvopastoral activities, that should be well suited to northern Australia. In particular, grazing of beef cattle may be integrated with tree growing, in land that could be marginal for both activities, without the other.

Stakeholder feedback: *The use of goats is also being trialed to manage weeds in sandalwood plantations in WA and can be considered a form of silvopastoralism.*

This opportunity may be substantial. In 2017-18, the northern beef cattle industry constituted an average 73% of total farm income in northern Australia, as compared with an average 45% for the southern beef cattle farming industry (ABARES, Australian Agricultural & Grazing Systems Survey, 2018).

2.2.2 Contribution to the socio-economics of northern Australia

Nationally, the value added by the Australian forestry and wood products was $8.6 billion in 2015–16 and contributed 0.52% of Australia's gross domestic product (GDP). (SOFR 2018)

Queensland's forest and timber industry makes an important contribution to the economy and to many rural and regional communities. At a state-wide level, the industry had an estimated annual turnover of around $3.8 billion in 2015–16 with diverse activity and investment across the value chain - from forest

growing through the manufacture and sale of new and innovative timber products. (https://www.daf.qld.gov.au/business-priorities/forestry/industry-profile)

Within northern Queensland, the direct value of output generated by the forest industry is estimated at $54 million at the point of primary processed product, and $28 million per annum in gross regional product, drawing on data from Schirmer et al (2018). The direct value of output and gross regional product estimates used here capture data from the Northern region of Queensland and assume half of the value from the Central region, given a large proportion of the central region is below the Tropic of Capricorn.

In Queensland, forestry and the timber industry directly employed more than 10,000 people in 2016, and is a highly-valued employer in many rural and regional areas.

Within northern Queensland, the industry directly employs over 1,052 people which includes growing and harvesting, primary and secondary processing and wholesaling based on the 2016 Census. Applying a multiplier of 1.5 for the northern forest products industry in Queensland, based on the findings from Schirmer at al (2018), total direct and indirect employment from the industry in northern Queensland is estimated at around 1,500 jobs.

For the **Northern Territory**, plantation forestry is the second largest production land use, after beef grazing, with around 51,000 ha of the NT currently growing forest plantations. There are three major types of plantation operations in the NT where companies grow African mahogany (*Khaya senegalensis*), black wattle (*Acacia mangium*) or Indian sandalwood (*Santalum album*). Relevantly, each provides distinct regional employment and income generation opportunities.

In 2017-18, the agriculture, forestry and fishing industry contributed $735 million in real terms to the Northern Territory's economy, and accounted for 1.4% or 1,924 persons of the total resident workforce (Department of Treasury & Finance, NT 2019).

The **Western Australian** forestry and forest products industry delivers a significant contribution to communities, employing more than 6,000 people and generating $1.4 billion for the economy (Forest Products Commission of Western Australia 2019).

2.3 Preliminary evaluation of forestry opportunities

The CSIRO and ABARES (Ash and Gleeson 2014) provided policy makers with a clear indication of the location and scale of medium and longer term opportunities for agricultural production across northern Australia, and critical supply chain and infrastructure investment issues that may help to foster those opportunities. The key messages arising from that research are pertinent for discussions about forestry expansion in northern Australia:

1. Irrigated agriculture in northern Australia has the potential to add considerable value to regional economies;
2. Securing water for irrigated agriculture does not guarantee positive financial returns;
3. Supply chains are a significant constraint in some locations;
4. New markets are critical, especially for high value horticultural production;
5. Processing facilities and supporting infrastructure are needed in most regions;

6. There are opportunities to integrate crop production with the beef industry to create a value-add in both sectors;
7. Infrastructure investment needs differ significantly between regions;
8. Investment plans need to be designed to accommodate unexpected shocks;
9. Labour supply and agribusiness services are important to achieving successful new agricultural initiatives;
10. Successful agricultural development will depend on understanding the entire system, including climate, soils, water resources, pests, agronomy, management, processing, supply chains and markets; and
11. Regional economies are projected to expand (with expansion of irrigated agriculture), but changes to national economic welfare are negligible.

It is encouraging to note that sandalwood is included in the irrigation regional scenarios for the Ord River region, with this crop generating much higher gross margins than any other crop (Ash and Gleeson 2014). However, the report recognizes that sandalwood may not yet be commercially viable, although there has been some assessment of specific opportunities.

At a macroeconomic level, the medium to longer term outlook for the forest products industries will be supported by a number of positive trends (Arup 2019; Stephens and McGavin 2019). These include:

- rising domestic and global demand for building and construction materials to support a growing world population;
- the low embodied energy and carbon sequestration benefits of timber compared with other building materials, with greater recognition of these benefits in public and private policies as part of carbon emissions reduction strategies;
- advances in wood processing technologies with engineered wood products and new applications in commercial and multi-rise construction, and cost-advantages in timber prefabrication systems;
- potential for forest biomass to be utilized for biochemical and bioenergy markets, adding value to waste streams or as a primary product in large global markets; and
- increasing recognition of the biophilic (i.e. nature connected design) aspects of natural materials such as timber used in buildings for health and community well-being benefits.

2.3.1 Native forests

Whittle et al (2019) note that hardwood sawn wood from native forests is predominantly used for high-value appearance applications, including flooring, decking, veneer and furniture, and that domestic consumption is largely influenced by native forest log availability. Whittle et al (2019) also assumed demand for hardwood sawlogs, posts and poles would remain constant at 2015–16 levels until 2050, given uncertainty over future consumer preferences.

At a global scale, the demand for sawnwood is projected to rise in line with other industrial roundwood due to population growth and forecast higher activity in housing and construction, with China typically accounting for a high proportion of consumption (Rhodes and Stephens 2014). Indufor (2012) project the annual demand for global industrial roundwood to quadruple between 2012 and 2050 to 6 billion cubic metres, while global sawnwood consumption is projected to increase from 421 million cubic metres to 594 million cubic metres between 2005 and 2030 (FAO 2009). Australian native hardwood production mainly competes with hardwood sourced from tropical natural forests, and policies aimed toward greater forest sustainability and environmental management in developing countries (World Bank Group 2016), will influence the availability of future global supply. This represents a market opportunity for northern Australia, given the high regulatory standards for sustainable forest management and the proximity of native forest resources to Asia and other major export markets.

2.3.2 Hardwood plantations

Nickles et al (2012) states that African mahogany forestry is potentially an important new industry with capacity to expand in northern Australia producing high-value products and benefitting the whole value chain.

Annual plantings of African mahogany currently constitute approximately 20% of the national yearly increase of Australian hardwood plantations, with the most extensive area in the Douglas-Daly, Northern Territory where over 11,000 ha of plantations have been established since 2006 with annual increments currently around 1,500 ha (Dickinson et al, 2011).

Virtually all these plantings are derived from Africa-sourced wild seed, the rest being from Australian-landrace or locally-improved seed. Many trees have poor stem straightness, short merchantable boles and low diameter. However, the better trees can yield high- value products such as veneers, high-grade boards and furniture.

Red mahogany (*Eucalyptus pellita*) plantations have also demonstrated resilience and both solid wood and pulp wood outputs in volumes and qualities that are equivalent to or better than other eucalyptus species (Harwood et al, 1997 and Herbohn et al, 1999).

Hardwood plantations on the Tiwi Islands (NT) are *Acacia mangium*. They were planted to produce hardwood woodchips to be used primarily in the production of printing and communication papers (and increasingly in products like dissolving pulp, used to make synthetic cloths like rayon).

According to IndustryEdge, (2018 a.) all of the resource on the Tiwi Islands will be exported to pulp producers in Asia. Exports commenced from Melville Island in 2016 and are expected to continue into a second rotation when the first rotation is completed in 2021.

Demand for hardwood chips in China and Japan continues to grow, with mature Japanese markets, maturing Chinese markets and emerging markets in India and Indonesia all adding to aggregate demand. Northern Australia is well situated for supply into Asia.

2.3.3 Softwood plantations

Total demand for plantation softwood sawnwood in Australia is forecast to grow by 30 per cent to 6.6 million cubic metres by 2049–50, with detached house commencements and real GDP growth expected

to be the primary drivers of increased demand. Meeting this increased demand with domestic supplies would require expansion of the softwood estate by 200,000 ha to 490,000 ha (Whittle et al 2019). Using the FORUM model, Whittle and Downham (2019) estimated 495,000 ha of cleared agricultural land is potentially financially viable (NPV > $0/ha at a 7% discount rate) under softwood plantations given continuation of the existing economic environment.

However, softwood plantations may only provide higher returns than the existing land use on about 24,000 ha nation-wide, and this was the estimated area of plantation expansion to 2050 (Whittle et al 2019). At this low rate of additional planting, Australia's imports of softwood sawntimber have been predicted to rise from 560,000 m^3 per year in 2020 to 1,150,000 m^3 per year by 2050 (Whittle et al 2019).

Factors that may drive future plantation investment include carbon market incentives such as the Emissions Reduction Fund and any new carbon reduction policies by Government. Forestry can play an important role in emission reduction strategies due to the sequestration of carbon dioxide from the atmosphere in growing forests and storage in timber and forest products. The Australian Governments National Forest Industries Plan has a goal to plant a billion new trees to produce more timber and wood-fibre.

Although addressed separately at 2.3.6 below, notably Rhodes and Stephens (2014) identify access to carbon markets as important to establishment of additional plantations.

In addition, there are emerging technologies that can convert the volume of smaller diameter or lower quality logs to high performance Engineered Wood Products (EWPs) such as plywood and glue laminated timber products

Due to relatively low land values, there is potential to establish additional plantations in north Queensland for export or domestic sawn timber production (Whittle et al 2019). Whittle and Downham (2019) investigated opportunities for establishment of internationally competitive, world-scale softwood mills throughout Australia. This is essential to maintain an internationally competitive manufacturing base (Ferguson 2014a). Whittle and Downham (2019) projected that planting an additional 44,000 hectares in north Queensland, coupled with some log reallocation from other softwood growing regions, could support a world-scale softwood sawmill in north Queensland.

Prospects for softwood plantation estate expansion in north Queensland appear strong, and have the potential to buffer the region's economy against other shocks, including the risk of Panama disease spread in banana growing regions. Prospects could be further improved if investor discount rates could be lowered, for example, through provision of low interest rate loans similar to those provided from the federal government to the states during the softwood forestry agreements of the 1960s, 1970s and 1980s (Carron 1985).

Whittle et al (2019) found large opportunities for softwood plantation expansion in north Queensland. At a 6% discount rate, about 200,000 ha of existing cleared agricultural land would have its highest value under softwood plantations. At a 5% discount rate, over 500,000 ha in north Queensland would have its highest value under softwood plantations. A 200,000ha estate in north Queensland has the potential to support 10,000 full-time equivalent jobs.

There is presently around 14,000 hectares of high-quality softwood pine plantation in the Mareeba area of North Queensland. These plantations already provide a feedstock for two softwood mills located in Mareeba and Ravenshoe. These mills in turn produce sawn timber for downstream truss and frame

manufacturing and other sawn products for the local Cairns market as well as further east-coast markets. Given the importance of building scale and competitiveness in softwood manufacturing, an industry priority is to increase the area of softwood plantation to enable greater economies of scale and production output.

Stakeholder feedback *concurs with the need for the expansion of softwood plantations in north Queensland (specifically Pinus caribaea), and see a role for Government in encouraging such expansion activities. Stakeholders also identified the need for commercial assessments of risks associated with plantation establishment, including those associated with cyclones and factors and mechanisms that could be introduced to mitigate those risks.*

ABARES did not consider the Northern Territory as providing realistic softwood plantation expansion prospects, because the territory lacks a sufficient softwood estate, existing processing capacity and suitable agricultural land to support an internationally competitive world-scale sawmill. (Whittle and Downham 2019, Whittle et al 2019). The north of Western Australia was not considered in these ABARES assessments.

2.3.4 Silvopastoral systems

Donaghy et al (2010) found there are financial benefits to landholders of adopting silvopastoral systems in northern Australia. Whish (2016) did not account for potential future timber value, but found that a net carbon income (i.e. income after grazing management expenses are removed) of \$2/t CO_2-e to \$4/t CO_2-e was required to offset the financial losses of arising from reduced herd productivity due to retaining regrowth on a moderately productive (8 ha/AE) property in central Queensland. Baker et al (2018) asserted silvopastoral systems have the potential to increase livestock and timber production in Australia, although the many research gaps identified by the authors make it challenging in practice to convince landholders that the benefits of trees outweigh the costs.

AACM (1996) provided a strategic development framework for agroforestry that emphasized the need for pre-assessment of co-benefits, while Polglase et al (2008) described widespread opportunities in Australia from agroforestry activities.

Much of the literature about grazing system management in northern Australia focusses on perceived negative trade-offs between trees and pasture (Scanlan 2002), and how to manage trees (often referred to as woody weeds or regrowth) to maximise pasture production (Hunt et al 2014).

It is generally accepted there is a linear to curvilinear negative relationship between tree density and pasture production in the study area. Competition for site resources means there is a trade-off between trees, and pasture and cattle production. However, numerous studies have reported the benefits of trees on grazing properties (Cameron et al 1989; Bird et al 1993; Gutteridge and Shelton 1994; Lamb and Borschmann 1998; Jackson and Ash 2001; McKeon et al 2008; Stephens and Stunzner 2008; Stephens 2008; Donaghy et al 2010; Maraseni and Cockfield 2011).

These benefits include:

- increased nutrient cycling;
- improved soil condition and structure;
- reduced runoff, erosion and transport of nutrients and agricultural chemicals;
- lowering water tables where salinity is a problem;

- reducing temperature and wind speed;
- higher pasture quality;
- biodiversity conservation; and
- carbon sequestration.

Given these potential benefits, Stephens (2008) identified the need for more applied bioeconomic research into silvopastoral systems in northern Australia, including demonstration sites to promote the benefits to landholders, following an international study tour of similar practices overseas.

The ABARES Australian Agricultural and Grazing Industries Survey indicates that in the grazing of beef cattle in Northern Australia, there has been a reduction of 0.2% per annum in the cost of inputs from 1977-78 to 2017-18, and output growth of 0.9% per annum over the same period. Input cost growth is lower than for the Southern beef cattle region (+0.4% per annum), as is Output growth (1.1% per annum). (ABARES, Australian Agricultural & Grazing Industries Survey, 2018).

The addition of plantation forestry, as set out above, may involve increased costs, increased output productivity and diversified wood products income.

Trees provide microclimate benefits for grazing properties, particularly in relation to reduced temperatures created by shade from the trees. Gutteridge and Shelton (1994) reported that the effect of heat stress on growth and reproductive performance of cows has been well documented, with recordings in Australia of a reduction of 0.9% in calving rate for every 0.1 degrees Celsius increase above 39°C in the rectal temperature of cows. The average depression in calving rate due to heat stress was reported to be 15% to 25% for British breeds and 10% in Brahman-cross herds. Stressed cows also gave birth to lighter calves. In a study by Davison et al (1988, cited in (Gutteridge and Shelton 1994), animals without shade had a mean rectal temperature of 40°C while those with shade had a mean rectal temperature of 39.4°C. Given that the 'best estimate' of climate change across the rangelands of Australia is for a decline in rainfall and an increase in temperature (McKeon et al 2009), the microclimate benefits of trees on grazing properties are likely to increase in the future. This was also considered by Ash and McIvor (1998).

Detailed analysis of *Pinus caribaea* plantations integrated with pasture on the Atherton Tableland in north Queensland demonstrated positive outcomes similar to those set out earlier in this section, but with specific reference to that region (Applegate 1991; Applegate and Nicolson 1988). The economics of a range of agroforestry activities was considered to be generally net positive by Hardman et al (1985).

See also: Bureau of Rural Sciences (2005), Gordon et al (2013), Schirmer et al (2000), Sun et al (1998), Turvey and Lawson (2001).

2.3.5 Processing other wood products

Total demand for wood-based panels (plywood, particleboard and medium-density fibreboard) and hardboard is forecast to grow by 10% to 2050 (Whittle et al 2019). Total demand for paper and paperboard is forecast to grow by around 28 per cent to 4,643 kilotonnes by 2049–50. The estimated availability of pulplogs from existing plantations and the small base case projected increase reported by Whittle et al (2019) is expected to be sufficient to meet domestic demand to 2050, even when taking into account potential exports of roundwood and woodchips. Whittle et al (2019) did not examine

emerging markets for engineered wood products, bioenergy products and other downstream wood products. The counter to that view as IndustryEdge (2018, b.) has reported, is that demand for softwood pulp is growing at a faster rate than previously anticipated, in Australia and globally. Softwood pulp is used to strengthen cement-board products used in housing and as a replacement for asbestos fibres, and is deployed most extensively in the manufacture of corrugated boxes and other packaging, demand for which has increased rapidly.

2.3.6 Carbon sequestration

Significant amounts of carbon are stored in both forests and forest products. In 2016, 4,258 million tonnes of carbon were stored in the forests of northern Australia (refer table below).

Table 4. Carbon stored in forests in northern Australia, 2016 (Mt C)

	NT	northern Qld	northern WA	northern Australia
Forests total	**878**	**3,156**	**224**	**4,258**

Mt C, million tonnes of carbon.

Year is financial year.

Totals may not tally due to rounding.

Figures derived from data shown in Table 5.2 in Australia's State of the Forests Report 2018.

Source: Department of the Environment and Energy

As a co-benefit of harvested wood products, the sequestration of carbon in planted forests has been widely recognized, as Rhodes and Stephens (2013) identify. Notably, they also identify that with the right carbon market policy settings, the value of sequestered carbon in planted forests may provide the required economic incentive to establish new plantations.

Estimates of the potential value of carbon in planted forests vary, over time, based on assumed prices or the prevailing carbon pricing schemes at the time the research was undertaken. Mitchell et al (2012) summarise a range of scenarios where the prevailing price of carbon is approximately \$20/t CO_2-e. They identify that the amount of land that could be viable for plantations ranges widely and potentially up to millions of hectares depending upon price and other key assumptions. Lawson et al (2008) adopt a similar modelling scenario approach.

Neither Rhodes and Stephens (2013) or Mitchell et al (2012) recommend a specific market-based model for the improved recognition of carbon sequestration for commercial wood plantations. In that context, Enters and Durst (2004) describe a range of incentives, including those associated with carbon sequestration, for providing support for the establishment of plantation forestry activities.

Several studies place carbon sequestration in the context of a broader set of ecosystem services, rather than identifying carbon sequestration as the primary emphasis. See ABARES (2011), Bahaus et al (2010), Burns et al (2011), Harrison et al (2003), Kanninen (2010), Kanowski (2010).

Building on the broader benefits of carbon sequestration in a forestry context, both Polglase et al (2011) and Paul et al (2013) assessed the impact of carbon markets on forestry activities, and found that they may provide expansion opportunities and more employment, in a wider range of activities,

than planted forestry operating without access to a carbon market. Schirmer and Bull (2011) also reported divergent views among landowners as to the suitability of plantations for carbon sequestration purposes alone, with considerable concerns where there was no co-related wood outcome.

3.0 Regulatory framework for the forestry and forest products industry in northern Australia

The Federal Government supports tree plantation development and expansion, through the national strategy *Plantations for Australia: The 2020 Vision*. At a state level, there is an absence of a clear forest policy. There is a plantation code of practice in Queensland and the Northern Territory. This lack of high-level policy has created uncertainty for investment in tree plantation development (Halkett et al 2012).

Stakeholder feedback *stated that plantation expansion opportunities rely on more land being cleared however native vegetation rules impose constraints. The Forest Stewardship Council (FSC) was also highlighted as a major challenge to Indigenous decision-making regarding land. For native forestry activities, certainty with respect to existing codes of practice and vegetation management rules is equally important to promote long-term forestry management for commercial wood outcomes.*

3.1 Queensland

3.1.1 Plantation legislation and regulations

New plantation developments require planning approval in Queensland.

These activities are considered a material change of land use which are subject to the *Planning Act 2009* and the relevant local government development assessment requirements.

Plantations that include *Corymbia* and *Eucalyptus* tree species are regulated by the koala conservation plan and management program in some areas of Queensland (koala districts A and B). This regulation complies with the *Nature Conservation Act 1992*. Additional advice on regulatory obligations associated with plantations is provided in the Timber plantation operations code of practice for Queensland (Business Queensland, 2019a).

3.1.2 Private native forestry legislation and regulations

The *Vegetation Management Act 1999* regulates native forestry on private land through an accepted development vegetation clearing code.

The *Vegetation Management Act 1999*, defines native forest in Queensland as being ‘remnant regional ecosystems’ (Category B vegetation), ‘regrowth regional ecosystems’ (Category C or R vegetation) or ‘non remnant’ (Category X vegetation) (Department of Environment and Resource Management 2010). Landholders can request a free property map of assessable vegetation (PMAV) to determine the status of vegetation on their property.

Remnant regional ecosystems in Queensland refer to vegetation that has never been cleared or, if it has been cleared in the past, has regrown to meet particular criteria2. Regrowth regional ecosystems have been cleared in the past and are less mature than remnant vegetation, but often contain many of the biodiversity and habitat values of remnant vegetation. Regrowth regional ecosystems in Category C are high value regrowth vegetation

and in Category R are within 50 m of a watercourse in the Burdekin, Mackay, Whitsunday and Wet Tropics Great Barrier Reef catchments. Category X areas had been cleared of native vegetation in the past, and when a PMAV applying to the area was made, did not contain remnant or regrowth vegetation (Department of Environment and Resource Management 2010). In the years since being categorised as Category X, native vegetation may or may not have re-established on the area.

Due to the importance of private native forests on freehold and Indigenous land for hardwood timber supply, the *Planning Act 2016* (formerly the *Sustainable Planning Act 2009*) provides exemptions, known as exempt clearing work, under Schedule 21 of the *Planning Regulation 2017*, for removing or harvesting vegetation in Category B, C and R areas, provided the activities comply with the requirements of the *Vegetation Management Act 1999*, and the conduct of activities is in accordance with the native forest practice code (Department of Natural Resources and Mines 2014). Under the *Planning Act 2016*, these codes are known as 'Accepted Development Vegetation Clearing Codes'. There are codes applicable to Category B (Department of Natural Resources and Mines 2014), Category C (Department of Natural Resources and Mines 2013a) and Category R vegetation (Department of Natural Resources and Mines 2013b). Forestry activities on Category X land is exempt from requiring management in accordance with a code.

The Department of Natural Resources, Mines and Energy (DNRME) is currently responsible for the regulation of private native forest management for timber production in Queensland. The majority of private native forest within the study area is in remnant regional ecosystems (Category B vegetation), and a brief description of key elements of the relevant *accepted development vegetation clearing code*, *Managing a Native Forest Practice: A Self-Assessable Vegetation Clearing Guide* (Department of Natural Resources and Mines 2014), hereafter referred to as the 'native forest practice code', is provided online (Queensland Government 2019).

The native forest practice code defines a native forest practice as the 'sustainable management of a forest area for timber harvesting within a framework that conserves the natural values of the forest' (p. 6). The native forest practice code defines required outcomes, specifies mandatory practices and provides key definitions with regards to managing native forests for timber production. The private native forest owner must notify the DNRME before commencement of harvesting. The forest practice must produce value-added products (other than woodchips for export) as part of an ongoing forestry business, and landholders must maintain documentary evidence of the sale of products.

Vegetation mapped as 'remnant' has a canopy cover that is at least 50% of the undisturbed predominant canopy cover; averages more than 70% of the vegetation's undisturbed height; and contains species characteristic of the undisturbed predominant canopy.

The native forest practice code lists the regional ecosystems (REs) in which a native forest practice is permitted. These include three coastal wet sclerophyll native hardwood forest REs, 241 other native hardwood forest REs, four cypress forest REs, and 37 rainforest REs. Three permissible silvicultural regimes are described: a rainforest selective harvesting regime; a coastal wet sclerophyll forest group selection regime; and a selective harvesting regime for all other hardwood and cypress pine forests. Clearfelling is not permitted.

The native forest practice code specifies several other restrictions to a native forest practice, including:

- forestry is not permitted where the majority slope (90% of the area) is greater than 25 degrees;
- minimum number of retained trees per hectare;
- minimum number of habitat and recruitment habitat trees per hectare;
- which silvicultural treatment methods, including thinning, planting, fire and weed control, are permissible;
- restrictions on harvesting within buffer zones and filter zones around wetlands and watercourses; and
- the placement and management of snig tracks and landings; and protection measures to minimise soil degradation.

Other regulations concerned with managing protected native plants and animals are also relevant to private native forestry. In some cases, a protected plant flora survey and clearing permit may be required for certain activities (e.g. new road) in high risk areas where endangered, vulnerable or near threatened plants are known to exist or are likely to exist (Business Queensland, 2019b).

3.2 Northern Territory

The Northern Territory has no specific forestry legislation.

The Territory presently lacks any instruments developed specifically for managing forests for wood production, as the Forestry Act 1980 was repealed in 1992. Many existing laws and policies regulate environmental management, none of which specifically refer to plantation forestry operations. All are much more explicit than the voluntary Code (i.e. Northern Territory Codes of Practice for Forestry Plantations) about operating methods for protection of land, water and biodiversity values. The Code currently has no status under relevant environmental or planning laws, and as is a draft voluntary code with no formal status.

Land tenure in the Territory is mostly either pastoral lease, Aboriginal freehold land under the Aboriginal Land Rights Act (Northern Territory) 1976, or vacant Crown land. There are smaller areas of leasehold land (for a variety of development purposes) and non-Aboriginal freehold (largely the residential and surrounding areas of Darwin). There are significant differences in the legislation that regulates the development and management activities across these tenures. Subject to the resolution of native title issues, there is ongoing conversion between different forms of leasehold, and from Crown land to freehold.

The predominant land use in the Territory is grazing, with little clearing of native forests and woodland. The proportion of land cleared has been estimated to be < 1% of the total Territory land area. Because of limited forestry activity, limited pressure for related land clearing, and the desire to treat plantation forestry as an agricultural activity, the Territory Government has not developed regulations specifically for plantation forestry.

Plantation forestry is currently confined to plantation developments on Aboriginal-freehold land of Melville Island (Tiwi Islands), and in the freehold farming areas of the Douglas-Daly to Katherine regions south of Darwin. Early assessments noted the growing development of possible commercially viable wood products (Raison et al, 2012).

3.3 Western Australia

Sustainable timber harvesting in Western Australia's South West native forests is governed by a comprehensive legislative framework and management procedures (see: Forest Products Commission of Western Australia, 2019).

However, there is no regulatory framework that covers northern Western Australia. The Forest Management Regulations 1993 only cover specific requirements relating to sawmills and forest produce licenses (WA Government, 2019).

4.0 Land Tenure and Indigenous Ownership and Management Categories

Across northern Australia, there are a variety of forestry land tenures. The most significant tenures are leasehold forest and private forest. These are also a variety of forms of indigenous land ownership and management.

4.1 Forest by Tenure

In northern Australia, 53% of the forest area is leasehold forest, 34% is private forest and 6.5% is nature conservation reserve. As the figure and table show, there are different forms of tenure that dominate each of the three jurisdictions within northern Australia.

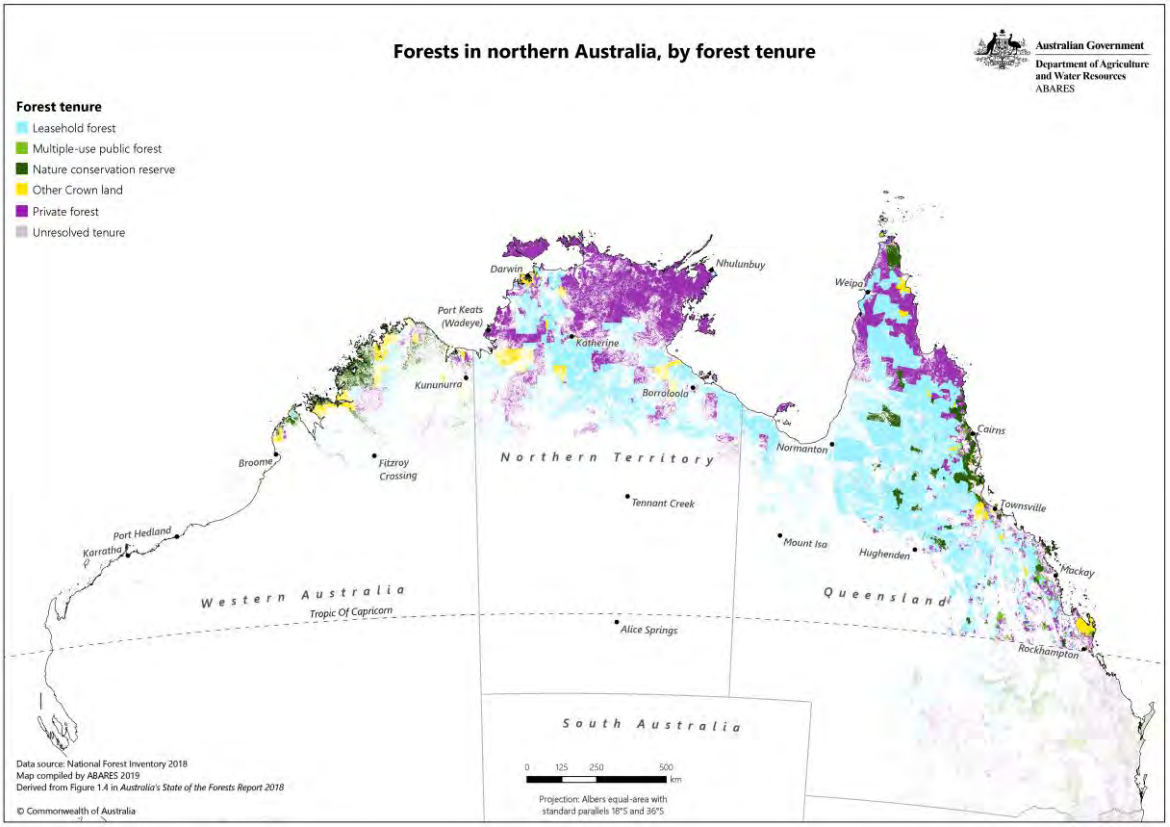


Figure 4. *Source: ABARES* (https://www.agriculture.gov.au/abares/forestsaustralia/forest-data-maps-and-tools/forest-maps)

Table 5. Area of forest in northern Australia, by tenure and jurisdiction					
	Area ('000 hectares)				Proportion of total forest area in northern Australia (%)
Tenure class	NT	northern Qld[a]	northern WA[a]	northern Australia	
Leasehold forest	9,318	23,621	820	33,759	53
Multiple-use public forest	0	440	0	440	0.7
Nature conservation reserve	15	2,703	1,399	4,116	6.5
Other Crown land	889	1,004	950	2,843	4.5
Private forest	13,476	7,713	492	21,682	34
Unresolved tenure	38	302	0	340	0.5
Total forest	**23,735**	**35,783**	**3,662**	**63,180**	**100**

[a] Data for forest north of the Tropic of Capricorn.

Figures derived from data shown in Table 1.6 in *Australia's State of the Forests Report 2018.*

Note: Totals may not tally due to rounding.

Source: ABARES, National Forest Inventory, PSMA Australia Ltd.

4.2 Indigenous ownership and management

About one-half of Australia's forests (69.5 million hectares, 52 per cent of Australia's forest area) is identified as part of the Indigenous forest estate as one of four broad Indigenous ownership and management categories: Indigenous owned and managed; Indigenous managed; Indigenous co-managed; and Other special rights.

The map below shows these broad indigenous land ownership and management categories.

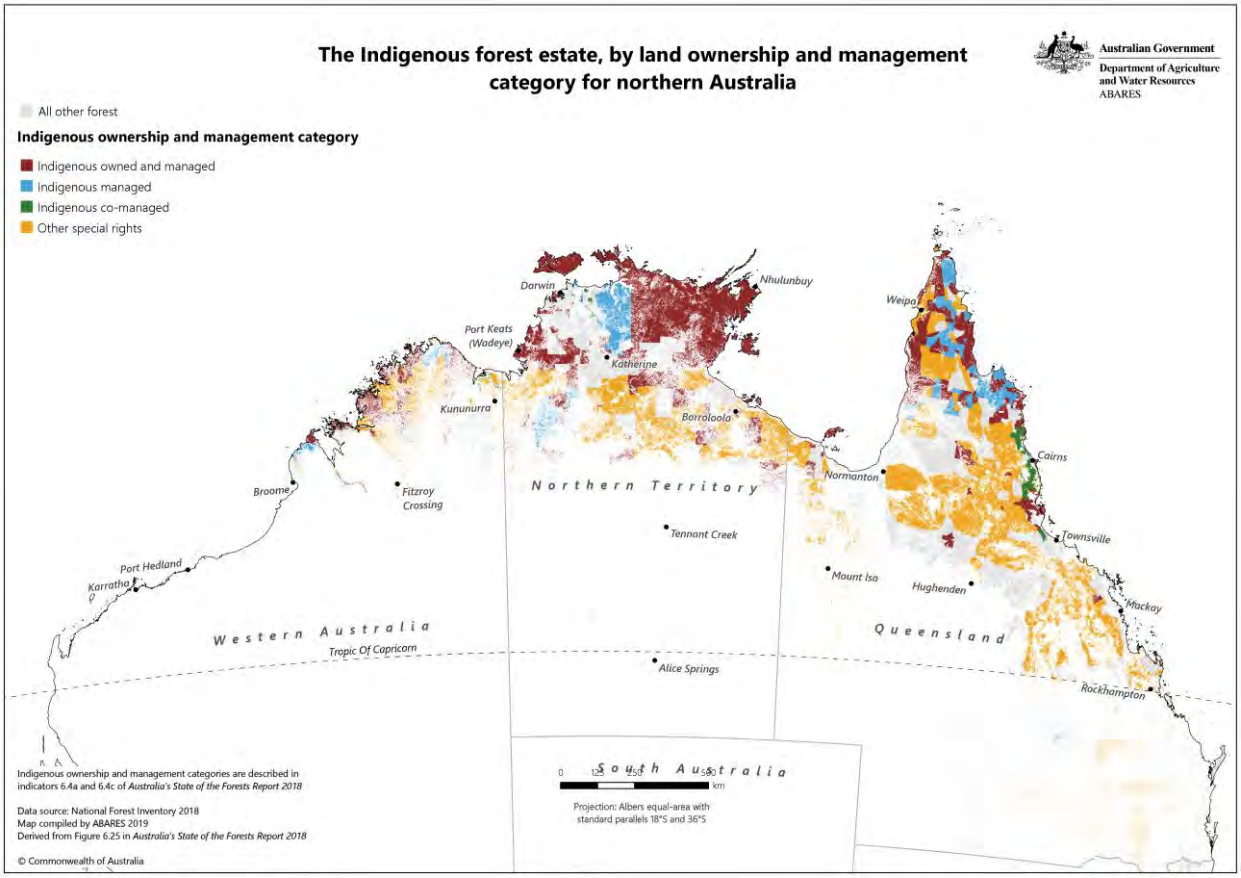


Figure 5. *Source: ABARES* (https://www.agriculture.gov.au/abares/forestsaustralia/forest-data-maps-and-tools/forest-maps)

Table 6. Area of land and forest in the Indigenous estate, by Indigenous land ownership and management categories for northern Australia					
		Area ('000 hectares)			
Management category	Land cover type	NT	northern Qld[a]	northern WA[a]	northern Australia
Indigenous owned and managed	All	61,747	6,124	17,836	85,707
	Forest	11,490	4,747	1,226	17,464
Indigenous managed	All	4,270	3,147	10,504	17,921
	Forest	1,726	2,528	317	4,571
Indigenous co-managed	All	152	1,204	1,644	3,000
	Forest	55	740	57	852
Other special rights	All	37,383	41,410	45,507	124,299
	Forest	5,421	16,224	1,590	23,235
Total Indigenous estate	**All**	**103,551**	**51,885**	**75,491**	**230,927**
	Forest	**18,693**	**24,238**	**3,190**	**46,122**
Total forest in jurisdiction		**23,735**	**35,783**	**3,662**	**63,180**
Proportion of total forest that is forest on the Indigenous estate		**79%**	**68%**	**87%**	**73%**

[a] Data for forest north of the Tropic of Capricorn.

Indigenous ownership and management categories are described in indicators 6.4a and 6.4c of *Australia's State of the Forests Report 2018*

Figures derived from data shown in Table 3.7 in *Australia's State of the Forests Report 2018.*

Note: Totals may not tally due to rounding.

Source: ABARES

Around 60 per cent of the total Indigenous forest estate in Australia is in Queensland and the Northern Territory.

4.3 Native forest

Of the 132 million hectares of native forest in Australia, 63.0 million hectares (48 per cent) are in northern Australia, as described in Table 7 by major forest type.

Table 7. Forest area in northern Australia, by forest type, and jurisdiction

	Area ('000 hectares)			
Forest type	**NT**	**northern Qld[a]**	**northern WA[a]**	**northern Australia**
Acacia	1,522	2,031	11	3,565
Callitris[b]	0	8	0	8
Casuarina	38	218	0	256
Eucalypt	19,764	24,815	3,365	47,943
Mangrove	334	326	115	776
Melaleuca	1,038	5,067	4	6,108
Rainforest	287	1,615	0	1,902
Other native forest	702	1,662	110	2,474
Total native forest	**23,686**	**35,742**	**3,605**	**63,033**

a Data for forest north of the Tropic of Capricorn.

b Stands of Callitris not sufficiently large to map at a 1 hectare scale are present in the NT and WA.

Figures derived from data shown in Table 1.5 in Australia's State of the Forests Report 2018.

Note: Totals may not tally due to rounding.

Source: ABARES, National Forest Inventory, National Plantation Inventory

4.4 Plantations

The Commonwealth National Plantation Inventory (NPI) maintains a database of plantation information based on NPI regions (refer NPI regions for Northern Australia below).

4.4.1 National Plantation Inventory Regions – Northern Australia

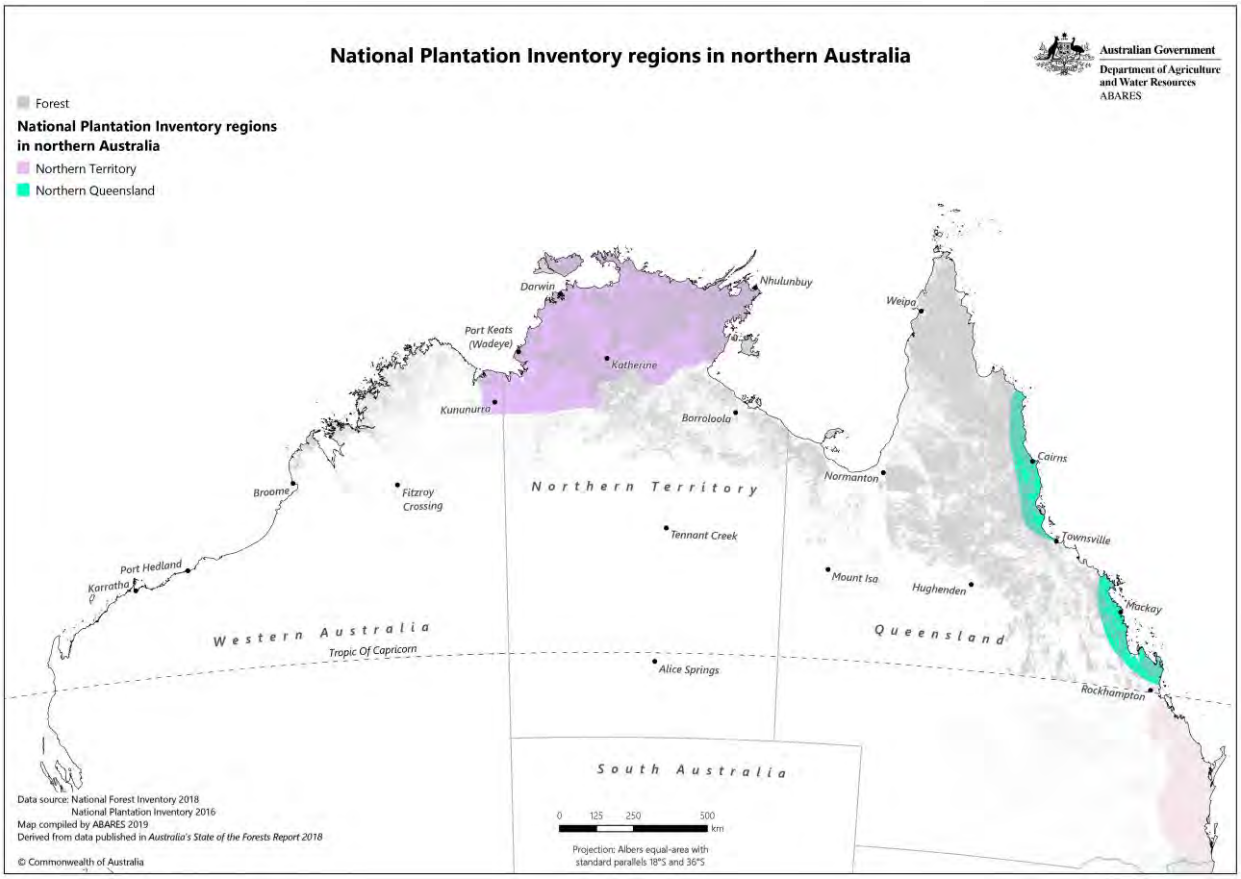


Figure 6. *Source: ABARES* (https://www.agriculture.gov.au/abares/forestsaustralia/forest-data-maps-and-tools/forest-maps)

Based on the NPI, there are approximately 82,000 hectares of commercial plantation forest in northern Australia, noting that these figures do not include sandalwood plantations (i.e. sandalwood plantations are normally categorised in rural statistics as a horticultural land use). The total estimated plantation area of approximately 100,000 hectares for northern Australia used in this study includes the area of sandalwood plantations and other minor species.

Table 8. Plantation forest area in northern Australia, by forest type, and jurisdiction				
	Area ('000 hectares)			
Forest type	NT	northern Qld[a]	northern WA[a]	northern Australia
Softwood	1	32	0	33
Hardwood	44	5	0	49
Unknown or mixed species[b]	0	0	0	0
Total Commercial plantation[c,d]	**45**	**37**	**0**	**82**

[a] Data for forest north of the Tropic of Capricorn.

[b] Plantations of mixed hardwood and softwood species, and plantations where the species type is not reported.

[c] Determined from the National Forest Inventory spatial coverage. Plantation figures in this table do not include sandalwood plantations and so do not match the data reported in Table 1.

[d] Area figures for Queensland plantations reported here differ slightly from the figures reported by Queensland in 2016 – https://www.daf.qld.gov.au/forestry/plantation-forestry/plantation-spatial-data. Area figures for 'Commercial plantations' reported in SOFR 2018 exclude plantations assessed as non-commercial plantations for the National Plantation Inventory, and which are reported in SOFR 2018 in the 'Other forest' category.

Figures derived from data shown in Table 1.5 in *Australia's State of the Forests Report 2018.*

Note: Totals may not tally due to rounding.

Source: ABARES, National Forest Inventory, National Plantation Inventory

4.4.2 Northern Territory

This study has identified approximately 51,000 hectares of plantation forest in the Northern Territory. The majority of the hardwood plantations are Acacia (*Acacia mangium*) (32,00 hectares) on the Tiwi Islands, which are grown for paper pulp, and African mahogany (13,000 hectares) planted in the Douglas-Daly and Katherine regions for high-value timber. Indian sandalwood (6,000 hectares) is also grown in the Douglas-Daly and Katherine regions, and is intended to be used for long-term oil and fragrances markets, and pharmaceuticals as the plantations reach harvest age.

4.4.3 North Queensland

Consistent with the NPI, this study identified approximately 37,000 hectares of plantation forest in Queensland, which is dominated by plantation softwood (32,000 hectares) which is privately owned and used for sawlog production. The total hardwood plantation area is around 5,000 hectares. The hardwood plantations are privately owned or managed to produce a mix of pulplogs and other solid wood products. There is also around 1,500 hectares of Indian sandalwood being grown in the Burdekin and Lakeland Downs regions of north Queensland.

4.4.4 Northern Western Australia

In northern WA there is approximately 10,000 hectares of plantation forest, comprising predominately irrigated Indian sandalwood plantations with an estimated area of 9,500 hectares. The remainder are African Mahogany plantations. Sandalwood is the only plantation forestry in Australia that is routinely grown in a mixed species system and with irrigation (ABARES 2016).

5.0 Productive Condition of Native Forest Resource

The majority of northern Australia's native forests that are available for wood harvesting, are private forests, amounting to 6.6 million hectares (51%). The other major contribution is held in leasehold, totaling 6.0 million hectares (47%).

In terms of the broad commercial productivity of the native forest resource in northern Australia, ABARES (Davey and Dunn 2014) undertook a broad spatial assessment across Australia of wood commerciality taking into account native forest growth rates and yields, and the commercial attributes of forest types and productivity classes. These spatial layers were used to identify broad commerciality classes for producing sawlogs and other high value products (e.g. poles, girders). The commerciality classes were as defined in Table 9.

Table 9. Native forest commerciality classes used in Davey & Dunn (2014)

Productivity class	Sawlog MAI range (m^3/hectare/year)
Limited	0.01-0.07
Very Low	0.08-0.14
Low	0.15-0.29
Moderately low	0.30-0.49
Moderate	0.50-0.99
Moderately high	1.0-1.49
High	1.5-1.9
Very High	2.0-2.9
Extremely high	3.0-5.6

Note: MAI – mean annual increment

The areas of native forest not legally restricted from harvest for northern Australia, by tenure type and commerciality class using this methodology, is described in Table 10.

Table 10. Native forest available and suitable for commercial wood production, by commerciality rating for northern Australia, 2016											
		Area ('000 hectares)								Proportion of total forest that is commercial[e] (%)	Proportion of total forest that is of moderate, high or very high commerciality[f] (%)
				Commercial forest (forest available and suitable for harvesting)							
				Wood commerciality rating							
Reporting year	Tenure[a]	Total forest[b]	Non-commercial forest and forest legally restricted from harvesting[c]	Very low	Low	Moderate	High	Very high	Total[d]		
2016 (SOFR 2018)	Leasehold forest	33,759	22,734	0	5,782	111	131	0	6,024	18	0.7
	Multiple-use public forest	418	143	0	223	30	22	0	275	66	12
	Private forest	21,615	15,000	0	6,442	130	43	0	6,615	31	0.8
	Total	**55,792**	**42,878**	**0**	**12,447**	**271**	**196**	**0**	**12,914**	**23**	**0.8**

[a] The existence of commercial forest on the tenure categories 'other Crown land', nature conservation reserve, and unresolved tenure is not considered in this analysis, even though harvesting is not legally restricted on some areas of 'other Crown land' and unresolved tenure.

[b] Figures for total forest in each tenure category are from Indicator 1.1a for 2016 (SOFR 2018), using the forest coverage available at that time. Areas of forest of various commerciality ratings at that date was obtained by overlaying the coverage and the commercial forest layer described in Davey and Dunn (2014).

[c] 'Non-commercial forest and forest legally restricted from harvesting' includes forest of limited, possible or no commerciality; sandalwood (not associated with other commercial species); forest of unknown floristics and structure; and conservation reserves on private and public land where harvesting is excluded by conservation covenant, regulation or other mechanisms. Forests on formal nature conservation reserves, other Crown land and land of unresolved tenure are not included on this table.

[d] 'Total' Commercial forest is the sum of the areas of forest of very low, low, moderate, high and very high commerciality.

[e] The proportion of the total area of forest in a tenure category that is classified as very low, low, moderate, high or very high commerciality.

[f] The proportion of the total area of forest in a tenure category that is classified as moderate, high or very high commerciality.

The data underpinning this table relates solely to sawlog commerciality, and data accuracy is not necessarily high for some regions of northern Australia. Further, commerciality rankings do not incorporate considerations of access, transport, management intent, market change, or changes in broader economic factors.

Figures derived from data shown in Table 2.2 in *Australia's State of the Forests Report 2018.* Totals may not tally due to rounding.

Source: Davey and Dunn (2014), ABARES

The following map shows the area of northern Australia not legally restricted from harvesting, and that is suitable for wood production by commerciality class, based on the ABARES commerciality modelling (Davey and Dunn 2014).

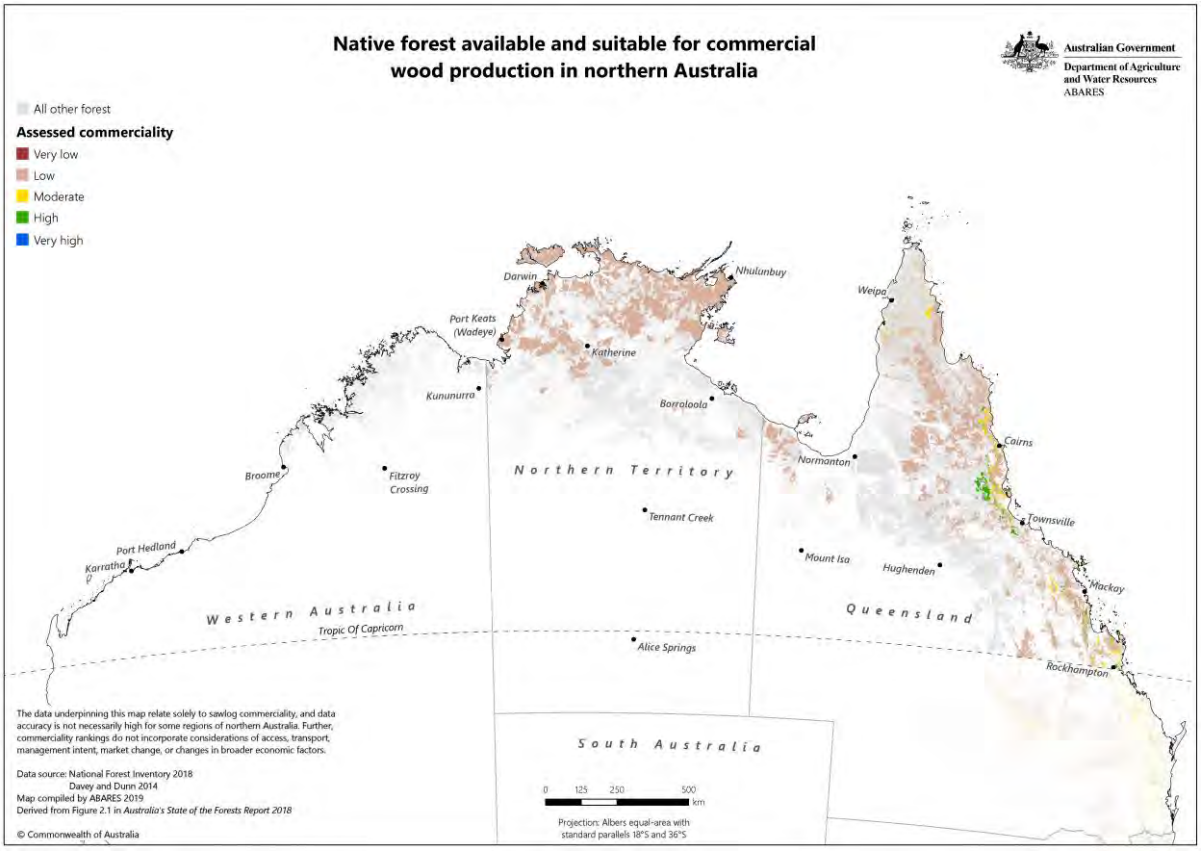


Figure 7. *Source: ABARES*

While this data demonstrates there are large land areas that are available for commercial harvest (totaling 12.9 million hectares), the very significant majority is assessed to be of low commercial value (96%) from the perspective of producing sawlogs. However, there may be scope for other suitable products (e.g. wood fibre and other small log products), noting also that spatial data accuracy is not necessarily high for some regions of northern Australia. This underscores the challenges and opportunities in undertaking commercial forestry and forest products operations in northern Australia.

The native forest resources in the north can be characterised as extensive areas of relatively slow-growing native forest hardwoods outside of the high rainfall wet tropics zone, with large distances to markets and lower average commercial stocking rates per hectare compared to many of the wetter hardwood forest types in southern Australia. Despite these limitations, their productive condition can be improved through targeted silviculture across a sufficiently large area, with scope for a range of sawlog and non-sawlog products.

6.0 Evaluation of Forestry Opportunities by Geography (SWOT)

Each of these SWOT analyses is summarized graphically in the Executive Summary. The main forestry regions in northern Australia presently comprise:

- Cape York (Qld)
- Far North Queensland (Qld)
- Tiwi Islands (NT)
- Douglas Daly and Katherine regions (NT)
- Ord River Irrigation area (Kimberly WA)

6.1 Cape York

Cape York is an area with a high proportion of Indigenous owned and managed forest land with substantial high-quality timber resources. Areas like Cape York have extant native title, particularly the Indigenous owned lands. As stakeholders identified, large areas of Indigenous owned forest resources in Cape York are in conservation tenure.

These communities have a direct interest in economic activity to create business and jobs from regionally based industries such as forestry, including in the context of mine site preparation and rehabilitation (Bell, 2001). For the Cape York forests to be appropriately managed and utilised it is essential that skills development, training and qualifications are available.

Strengths

- Strong desire by traditional owners to manage their land and resources for economic development outcomes, creating economic, social and environmental benefits.
- Proximity to Asian markets.

Weaknesses

- Currently the timber resource occurs on both public and private land holdings. There is very little data on the extent or status of this resource. Investment is needed to better understand this resource and develop appropriate management regimes to ensure its long-term viability and productivity.
- It is acknowledged that greater forestry skills or experience amongst the Indigenous land owners and managers is needed to produce long-term reliable supply from the region.
- The experience from Cape York suggests that a significant barrier to greater levels of investment is the lack of long-term resource security for the industry. While there are large volumes of timber resource on Cape York, some of which is located on privately owned Indigenous land, there is still a poor understanding of this resource and its timber quality and potential end uses.
- Cape York is a very remote location. Lack of adequate infrastructure has been one of the reasons for minimal forest product development from the area. In recent times the road infrastructure has

been improved to some level and this work continues. The remote context continues to limit development in telecommunications facilities. For broader economic activity to emerge in this region there will need to be investment in infrastructure. For the forest products industry, the key areas are road improvement, strategic port facilities and telecommunications services.

- A number of conservation tenures have been applied to large areas of land on Cape York.

Opportunities

- The Cape York region has a large resource of durable hardwood species. While there are some supplies of equivalent timber from international sources, these supplies are dwindling and there are significant questions about sustainability of harvesting and management regimes. These circumstances have created an opportunity for hardwood timber harvesting from Cape York.
- Given the remote locations of forest resources on Cape York it is imperative that opportunities are developed to maximise utilisation and returns from the timber resource. This will involve additional utilisation beyond sawn timber outputs. Possible additional utilisation may involve production of electricity from sawmill by-product, thermal energy pellets, biochar production or other charcoal product, and there are a number of emerging new developments such as gas extraction and rare chemical production.
- New plantation potential as part of the mining land rehabilitation partnership with Rio Tinto Aluminium (refer Wik Timber Case Study below).

Threats

- Lack of collaboration between Government, Traditional Owners, Pastoralists and Miners.
- A perception that Cape York forests are there for the taking - without Traditional Owner involvement.

Case Study

CASE STUDY: WIK TIMBER



Perhaps this is just the tip of the iceberg for mining operational land clearing practices in Australia going forward.
Australian Forests & Timber News December 2017

"Imagine if we can demonstrate that we can collect sawlogs for our sawmills, process some for veneer, utilize some logs for power poles and then utilize the rest as woodchips to generate electricity for Aurukun through Indigenous owned business and replace diesel power generators. And all of this from forest resources that have been traditionally cleared and burnt for over 50 years,"
Gina Castelain, MD of Wik Timber.

- Wik Timber Holdings is an Indigenous business and the timber harvesting, wood chipping and seed collection operations will provide jobs for local Aboriginal people resident in and around Aurukun and Napranum. The Wik Timber project recently purchased two Tigercat machines for its logging operations south of the Embley River, on the Western Cape York Peninsula. They harvest timber, ahead of Rio Tinto Aluminium's land clearing, which allows the mining giant access to the abundant supply of Bauxite.
- With harvesting, transport and port access planning complete, the logging operations are now in their initial stages. When at full scale, the business will produce up to 125,000 tonnes of timber and other forest products annually for international and domestic markets. Annual turnover is expected to be around $6 million. The operations will employ 70 local Aboriginal people.
- Demand for the various products is expected to come from Chinese, Vietnamese and domestic sawmillers and manufacturers of timber- based products. In addition, power transmission poles will be marketed to electricity distributors, Rio Tinto Aluminium will require railway sleepers, and Rio Tinto Aluminium and others will demand chips for mine rehabilitation.

6.2 Far North Queensland (Other than Cape York)

6.2.1 African Mahogany Plantations

Commercial plantations of African mahogany (*Khaya senegalensis*) have been or are being established in five regions in northern Australia. In northern Queensland, these were in Weipa (163 ha), north of Cooktown (355 ha) and Ingham to Bowen (150 ha across many small growers).

Successful establishment generally involves the use of well–conditioned, container–grown stock, intensive site preparation, effective weed control and application of starter fertilizer. In seasonally dry regions where the summer rainfall is erratic, irrigation may widen the planting window.

Strengths

- African mahogany is a species with good potential for commercial plantation development in the northern dry tropics of Australia. Early experience indicates that African mahogany grows on a range of sites, is relatively drought-hardy, and is capable of producing high-grade timber from plantation-grown trees (Underwood 2006).

Weaknesses

- Processing technologies yet to be fully tested with African mahogany plantations.

Opportunities

- Potential for substantial expansion is in the Ingham to Bowen region (including the lower catchment of the Burdekin River, which flows northward to enter the sea some 80 km NW of Bowen) — mainly ongoing, significant plantings by 'small growers', but industrial planting could arise.

Threats

- For commercial production in the dry tropics, either irrigation or a good source of groundwater appears to be essential (Underwood 2006).

See also: Bell (2001), Nikles et al (2014) and Nikles et al (2012).

6.2.2 Softwood Plantations

The Queensland plantation estate comprises around 216 000 hectares—the majority owned and managed by the private company, HQPlantations. Their estate is dominated by softwood species, which are managed on long-term rotations (between 25 and 50 years depending on species) to produce a range of structural and high-value timber products. Their Northern Queensland plantations comprise southern pine on the Hinchinbrook Coast (near Ingham and Cardwell) and Atherton, and *Araucaria cunninghammi* (also known as hoop pine) near Atherton.

There is approximately 13,000 hectares of good quality, well-established softwood plantations owned and managed by HQ Plantations in Far North Queensland that are located close to sawn timber processing facilities and local markets such as Cairns.

Strengths

- Existing pine resource
- Access to two relatively large sawmills
- Industry priority to increase estate and to improve efficiency of growing and processing value chain

Weaknesses

- Highly seasonal rainfall

Opportunities

- Scope for silvopastoral systems for improving the viability of greenfield plantation investments (i.e. can provide supplementary early cash flows and deliver weed and grass control using livestock).
- Expected reductions in the productivity of timber plantations in southern Australia due to climate change (Bush et al 2018) suggests a need to expand the plantation estate, and north Queensland has been identified as a region with high potentially viable agricultural land availability for plantation expansion (refer Figure 8 below).

Current softwood estate and potentially viable agricultural land, by NPI region

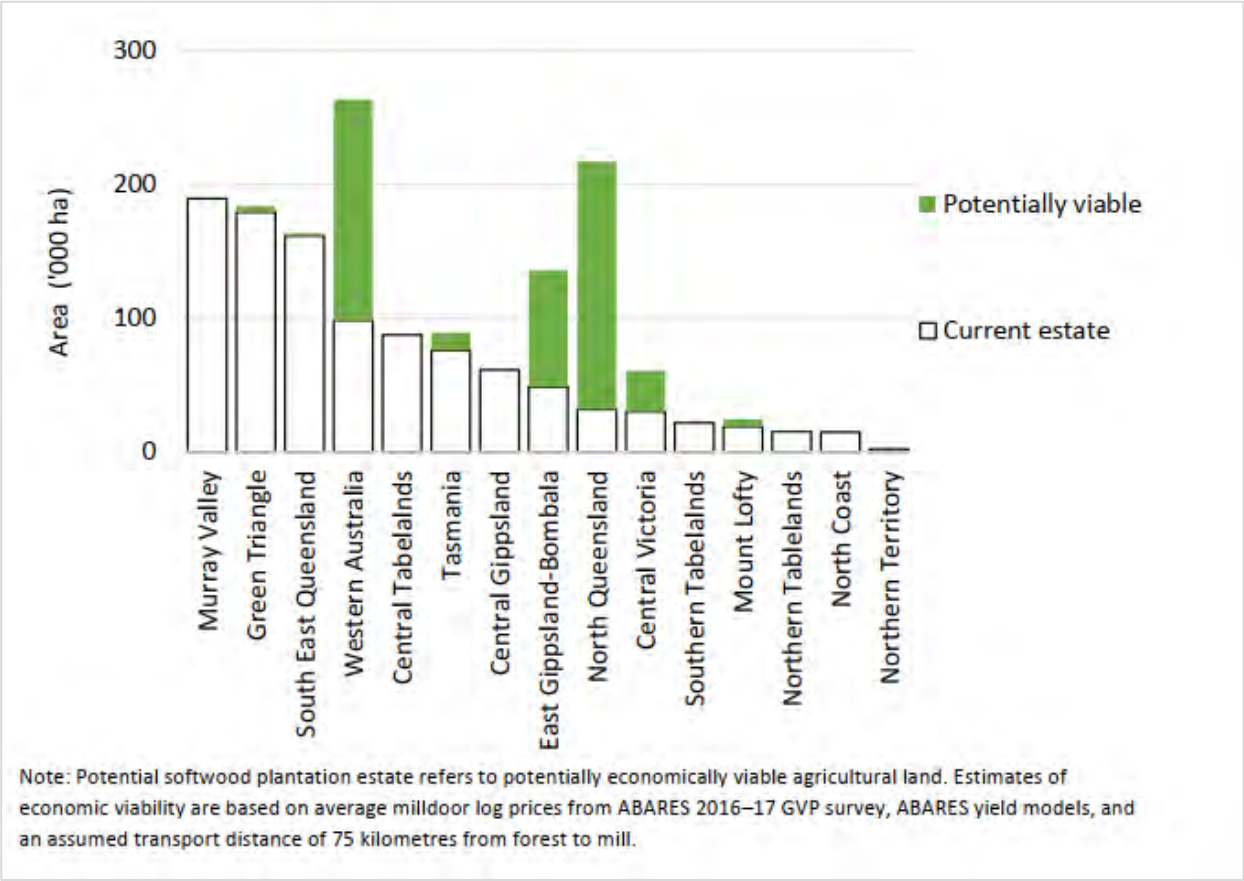


Figure 8. Source: *Whittle and Downham (2019)*

Stakeholder feedback *reiterated there is scope for expansion of the southern pine plantation estate. Potential areas are above the tablelands, including the Lakeland Irrigation Area Project inland from Cape Tribulation. The feedback continues that even though the area has good soils, the land can be expensive in certain locations and required reliable rainfall can be inconsistent.*

- A number of actions have been implemented under the Queensland forest and timber industry plan, providing positive outcomes for plantation investments in Queensland. As a result of these actions, a licence is no longer required to export Queensland unprocessed plantation-sourced timber products, removing a long-standing regulatory burden and offering new market opportunities (Queensland Forest & Timber Industry – An overview, 2016).

Stakeholder feedback *identified silvopastoralism (integrating timber and livestock production) in far north Queensland as a realistic option for improving investment in new plantation development. HQ Plantations also stated they would consider trials on existing softwood plantation to better quantify the costs and benefits of integrating livestock in timber plantations. African Mahogany and Teak were also presented as potential opportunities requiring further research.*

Case Study

CASE STUDY: MAREEBA SOFTWOODS

The region of Far North Queensland has a well-established softwood plantation growing, processing and marketing supply chain, based around the Atherton Tableland and Hinchinbrook Coast.



There is approximately 15,000 hectares of softwood plantation in the region comprising Caribbean pine (Pinus caribaea) and Hoop pine (Araucaria cunninghamii) species. These plantations were mostly developed by the state government for future timber supply and regional development goals, and were subsequently privatised in 2010 with the sale of the estate to HQPlantations.

- This mature resource has facilitated investment in downstream processing with the two integrated mills of Mareeba Softwoods and Ravenshoe Timber producing sawn timber and landscaping products from an intake of around 45,000 cubic metres per annum, for local demand in the Cairns region and broader eastern seaboard markets.
- This is an example of of the largest timber supply chain in northern Australia, with direct timber sector employment of over 200 people in the Cairns local government area alone.
- However, to maintain long-term competitiveness in a global market, there is a need to expand the resource and improve the economies of scale in growing and processing, together with reducing high input costs such as energy.
- The region does have sufficient rainfall, good soils and relatively lower land costs compared to other prospective areas elsewhere in Australia, which can support future plantation expansion. The challenges will be to develop suitable engagement and investment models with relevant stakeholders including local land owners, co-investors and councils. Reducing energy costs, such as better incentives for the utilistion of wood waste for bioenergy, would also improve processing competitiveness and expansion.



Aerial view of Mareeba softwoods sawmill. Image credit: Daryl Killin.

6.3 Northern Western Australia

6.3.1 African Mahogany Plantations

The commercial plantations of African Mahogany (*Khaya senegalensis*) in northern Western Australia are in the ORIA (377 ha).

Refer 6.2.1 African Mahogany Plantations for plantation establishment information and *Strengths*, *Weaknesses* and *Threats* specific to African mahogany plantations.

Opportunities

- Current small-scale industrial planting is in progress in the ORIA, and this region presents an opportunity for expansion.

***Stakeholder feedback** concurs regarding the opportunity for increasing mahogany plantations, especially in the drier regions, but also noting that water allocation is an important issue and needs to be used more efficiently.*

6.3.2 Sandalwood

The Indian Sandalwood (*Santalum album*) resource in the northern part of Western Australia is the world's largest commercial sandalwood plantation, in particular in the Ord River Irrigation Area (ORIA) and nearby Kingston's Rest.

Quintis has sandalwood plantations totaling more than 14,000 hectares in Western Australia, Northern Territory and Queensland, with products, particularly oils, exported primarily for the fragrance and pharmaceutical industries.

Approximately 9,500 hectares of sandalwood plantations are located in northern Western Australia, where commercial harvesting commenced in 2014. For 2018, the interim yield results indicated record levels of heartwood from Quintis managed plantations. The average heartwood per tree was 13.4 kg which was 38% above the previous high of 9.7 kg from the 2016 harvest and double the average heartwood achieved in the 2017 harvest (Quintis, 2018).

In addition to Quintis, Santanol has been growing sandalwood in the Kimberley region of Western Australia since the plantation industry's inception in the late 1990s, and *The Sandalwood Sanctuary*, originally a dairy farm, began its first small harvest in 2014. Santanol manages a sandalwood plantation estate of approximately 2,500 hectares in the Ord River district.

Strengths

- *Stakeholder feedback advises that oil is a key market, along with heartwood sales for carvings and medicines.*

Opportunities

- *Stakeholder feedback advises that in Cape York the University of the Sunshine Coast are trialling a different species of Sandalwood suited to both dry and wetland regions.*
- *The global market value and potential of sandalwood end use markets, such as pharmaceuticals, is significant.*

- *Stakeholder feedback highlights opportunities to further promote the natural and pharmaceutical characteristics of sandalwood, but that significant research is required.*
- *The long-tern supply and sustainability of naturally occurring sandalwood from overseas is uncertain given risks of illegal logging and different regulatory practices.*

Threats

- *Stakeholder feedback raises the risks of fire, disease, fungus and termites (specifically the giant northern termite).*
- *Plantation grown sandalwood is still in its infancy in terms of global market development and acceptance, which is still dominated by naturally occurring sandalwood in regions such as India.*

6.3.3 Teak

Teak (*Tectona grandis)* is a large deciduous tree with a heartwood that has a fine grain, is golden in colour and is a durable timber species. These qualities make it well suited to the manufacturing of high-value timber products, such as furniture, flooring and boats (Pandey and Brown 2000).

Teak tolerates a variety of conditions but prefers deep well-drained soils in warm moist tropical climates with a marked dry season (Pandey and Brown 2000). The soils in the Kununurra region are believed to be well suited to teak growth (Brennan and Radmiljac 1998).

6.4 Northern Territory

6.4.1 African Mahogany Plantations

The plantations of African mahogany (*Khaya senegalensis*) in the Northern Territory are in the Douglas–Daly region and south to Katherine.

A current research project initiated by the mahogany industry aims to understand the optimal resource inputs and management systems (silviculture) on productivity and wood quality. (“Economic diversification through innovative forestry”; Northern Territory Government, Department of Primary Industry and Resources; April, 2018).

The project will examine best practice in silviculture. This includes looking at different fertilising, pruning and thinning techniques as well as researching the optimum practices to grow the NT’s African mahogany for the market specifications, whilst ensuring the profitability of Territory forestry growers. The industry estimates that African mahogany plantations in the NT will have a projected value of $150 million by 2019. (“Funding for forestry research”; Northern Territory Government, Department of Primary Industry and Resources; April, 2017).

Refer 6.2.1 African Mahogany Plantations *for plantation establishment information and Strengths, Weaknesses and Threats specific to African mahogany plantations.*

Opportunities

- Current industrial plantings in the Douglas–Daly to south of Katherine (NT) began in 2006, and present further opportunity for substantial expansion.
- In the Northern Territory, laws now allow a portion of pastoral leases to be developed for other commercial purposes such as agriculture, horticulture, forestry, aquaculture or tourism ventures, so

long as these activities are consistent with the *Native Title Act* where native title has been determined (Australian Government 2015).

6.4.2 Tiwi Islands

The Commonwealth Government initiated plantation forestry on Melville Island in 1960, and about 3,900 hectares of *Pinus caribaea* were planted during the subsequent 20 years. These activities were terminated in the mid-1980s and the ownership of the existing plantations reverted to the Tiwi community, controlled by the Tiwi Land Council. About 900 hectares of these plantations are currently being harvested, with the remainder deemed to have no commercial value and likely to be cleared for re-establishment of other plantation species.

Stakeholder feedback *also highlighted the current harvesting of Pinus caribaea, but contrary to the above, stated this was a good outcome and could be expanded.*

In the mid-1990s, a new forestry project was established as a joint venture between the Tiwi community and *Sylvatech Pty. Ltd*., in which Aboriginal land was leased to *Sylvatech*. The Commonwealth and Northern Territory governments approved the project, which was to establish up to 30,000 hectares of *Acacia mangium*. The venture was declared non-viable in 2009 and abandoned, with the plantations and management responsibility subsequently passing to the Tiwi community, who formed Tiwi Plantations Corporation to manage the plantations with assistance from plantation management consultants.

Midway Limited has now partnered with Tiwi Plantation Corporation to manage about 32,000 hectares of *Acacia mangium* trees on Melville Island, and is shipping to customers in Asia for making paper.

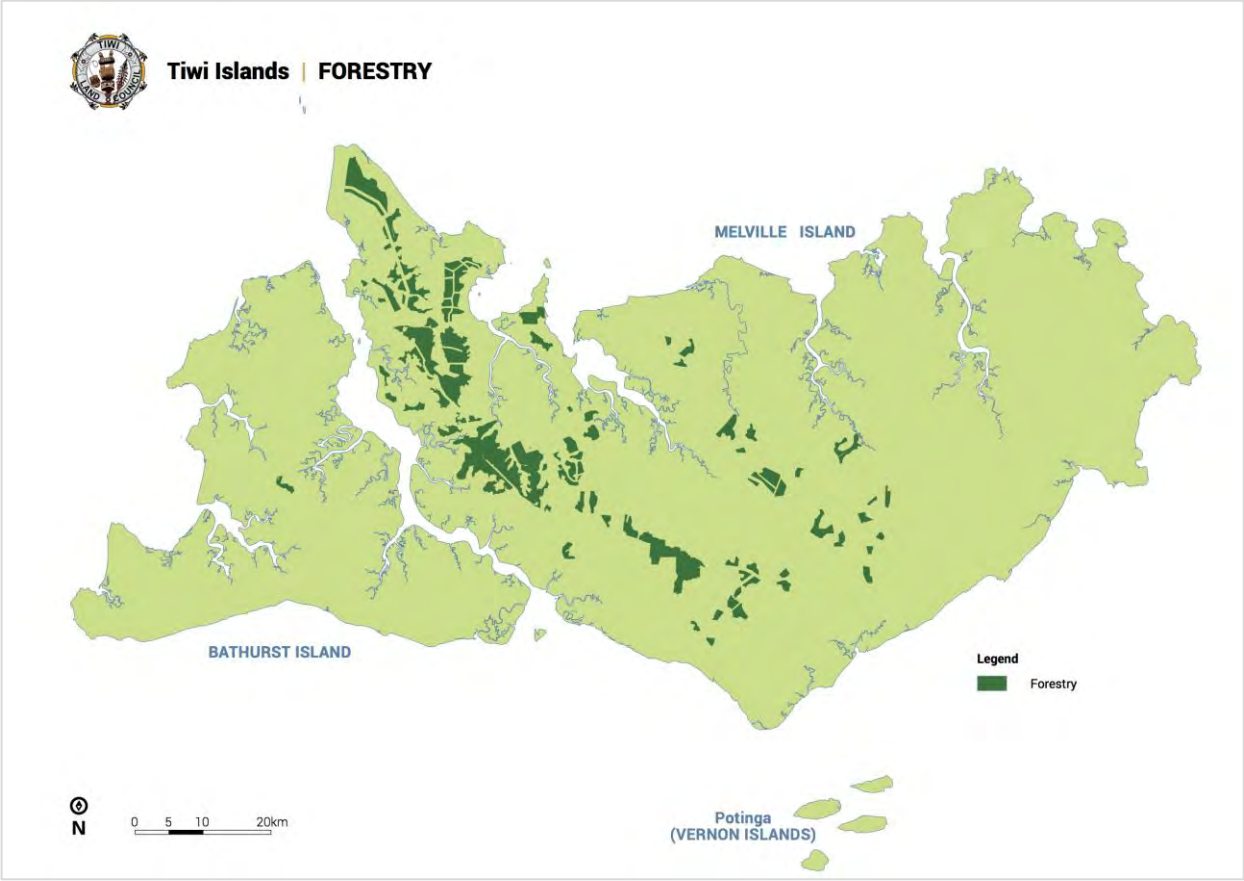


Figure 9. *Source*: http://www.tiwilandcouncil.com/documents/Uploads/Maps/06_Tiwi-Islands-Forestry-Map.pdf

Strengths

- Midway investment in new equipment such as in-field chippers and also new infrastructure at the Melville Port.
- Midway investment will see an increase in loading of woodchip vessels from five to six a year to eight or nine**.** (ABC Rural: Timber company Midway commits $17 million to boost woodchip exports from Tiwi Islands.)

Opportunities

- Eucalypts have been trialled on the Tiwi Islands since the 1980s, but the latest trial of eucalyptus trees are showing significant growing advantages to the acacias that currently dot the landscape of Melville Island. (Ref: ABC Rural - Eucalyptus trees being trialled on Tiwi Islands.)
- There is still an opportunity to conduct a study of future commercial use options for established *Acacia magnum* plantations, including reestablishment options and economic prospects (Halkett et al, 2012.)
- Regional demand for pulpwood is projected to grow as a result of increasing Chinese demand.
- *Stakeholder feedback is that the commercial outlook for the Tiwi plantations has improved with recent new investment and a maturing resource, and underlying demand for the biomass to make either paper or bioenergy in Asian markets including China and Japan.*

Threats

- Due to its proximity to the equator, tropical cyclones are a common occurrence along the Northern Territory coastline (The Senate 2009).
- Incidents of pests and disease with acacia pulp plantations throughout Vietnam and other south-east Asian nations could pose a threat to existing or future species choice.

6.4.3 East Arnhem Land

In East Arnhem Land, the Indigenous owned *Gumatj Corporation Limited's* sawmill (near Nhulunbuy) has been operating since 2014, harvesting and milling timber from land managed by Rio Tinto, prior to mine-site developments. The timber is primarily for local use in the construction sector. This includes supplying the timber required for housing projects in nearby Indigenous communities and for specific projects elsewhere in the Northern Territory (ABC Online 2018).

Some timber, primarily Darwin stringybark, is supplied to local furniture businesses, including Manapan Furniture, whose products are supplied nationwide.

Underscoring the logistical challenges in northern Australia, timber has to be barged from Nhulunbuy to Darwin. In May 2017 sixteen Indigenous people were employed at the mill.

Stakeholder feedback *reiterated that Nhulunbuy has good access to resources, but that infrastructure was less of a challenge with regards to rehabilitating mining areas with plantations than literature might suggest.*

Strengths

- Indigenous community leadership and engagement
- Ability to supply local markets that are distant from other sources of building materials

Weaknesses

- Remoteness (e.g. distance to ports and markets)
- Lack of infrastructure (e.g. roads, telecommunications, etc.)
- Thin local markets
- Limited access to maintenance and other technical support

Opportunities

- Unique timbers and properties
- Branded products for international markets
- Extension of government contract

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APPENDIX TWO – Workshop Reports

Workshops summary

June 2019

The following is a summary of workshops and field visits conducted in June 2019, involving stakeholder, industry and other interested parties. The workshops were conducted to explore forestry opportunities in northern Australia.

While the workshops largely confirmed the input of stakeholders in one-on-one interviews, they added depth to both the opportunities and the actions that need to be taken, for those opportunities to be realised.

Key themes from the workshops

- Security of access to supply is a major constraint on investment in wood processing, including resource availability from crown-owned land (e.g. leasehold in Queensland) and private resources
- Forest inventory and silvicultural information needs to be improved for end-use and investment decisions to be taken in northern Australia
- Re-vegetation opportunities on mine sites are significant, including for regrowth native forests and plantation forestry, but engagement with the mining industry needs to be enhanced to be effective in the future
- Opportunities for meeting local supply are significant, as well as potential national and specific exports markets for some regions
- Market information needs improvement, especially for longer term decision making
- Carbon markets can play a role but more carbon market participation work and accounting work is needed, particularly for native forestry activities, along with the removal of the federal 'water rule' for new plantations

- Forest industry has potential to deliver long-term economic and social benefits to many remote communities

In the text, items referenced in square brackets (e.g. [X]) refer to the likely activity stream of workshop outcomes or major topics arising. In summary these streams are: Research; Regulatory; Development and Market.

Cairns – Tuesday 11th June

Key point ~ regardless of species or source of supply, scale needs to be achieved for a sustainable industry to exist. Fundamental to that, is security of supply across a reasonable forest industries investment timeframe.

Opportunities

- Supply of sawn hardwood to local and specialty markets
- Expansion of supply of sawn softwood to Queensland framing and other softwood product markets
- Hardwood plantation expansion with emphasis on sawlogs
    - Species [Research]

Specific Needs

- Resource security for native forest dependent hardwood mills [Regulatory]
    - Longer-term supply arrangements from Crown leasehold lands (e.g. current contracts in FNQ are due to expire in 12 months for most permit holders)
    - Longer term supply arrangements in partnership with private native forest owners including Indigenous owned lands
- Securing resource available from Private Native Forest (PNF) [Development]
    - Note: this is the industry component of the resource security action
- Expansion of softwood plantations [Development]
    - Land assessments
    - Consideration of access to Federal plantation establishment support mechanisms
- Improved access to mineral resource sites [Development]
    - Salvage prior to mining
    - Rehabilitation for suitable re-vegetation
- Improved coordination across the supply-chain [Development]
    - Regional Hubs a key emphasis

Nhulunbuy – Wednesday 12th June

Key point – sustainable local forest industries can supply local and NT sawn wood markets, with native forests capable of supporting small-scale forestry operations, and plantation establishment options requiring further research and development activities.

Opportunities

- Expand salvage (pre-mining) harvest on mines [Regulatory]
- Economic and social benefits from sustainable (selective) harvesting of traditionally owned native forests
- Alternatives to traditional mine revegetation [Research]
    - Specific plantations

Specific Needs

- Forest inventory [Research] for native forests
- Resource and market information requirements to assist the Northern Land Council assess the most appropriate use
- Plantation species suitable for land [Research]
    - Trial sites of African Mahogany (*Khaya senegalensis*), *Eucalyptus pellita* and other hardwood species for pulp or sawn/peeled wood

Darwin (for NT in general) – Thursday 13th June

Key point – across NT, plantation forestry expansion for sawn wood, peeled wood and for sandalwood outcomes are dependent upon rainfall levels (or irrigation options for sandalwood), unknown value of native trees on crown lease lands with a need for analysis of end-use markets and forestry resource use options.

Opportunities

- Expansion into high-value pharmaceutical and related markets for sandalwood [Market]
- Silvopastoral expansion on a variety of land, building on lessons from plantation African Mahogany estate (Douglas Daly) [Development]
- Sale of thinnings for cash flow purposes – African Mahogany [Research]
- Processing options in NT [Research]
    - Sandalwood
    - African Mahogany and other hardwoods
- Hardwood pulpwood plantations
    - 600 mm water rule and access to carbon markets is relevant

Specific Needs

- Infrastructure
    - Electricity
    - Roads
    - Airfields
    - Water (sandalwood)
    - Telecommunications in the broadest context ~ see RRDC research 'Data to Decision' (available from Forest & Wood Products Australia [FWPA])
- Employment, training and retention strategies – note the link to telecommunications for retention
- End-use market analysis
    - African Mahogany
    - Other sawn hardwoods [Market]
- Research into species and market options for standing forests on Crown land, currently utilized primarily as pasture, as well as for plantation species:
    - Local and international end-use markets and values [Market]
    - Forest inventory (native forests) [Research]
    - Pathways to required land-use approvals (Crown land under lease) [Regulatory]
    - Chip, Biomass, Sawlog, Peeler log [Research]

Tiwi Islands – Friday 14th June

Key point – as it moves to second rotation of its hardwood plantations, traditional owners and their entities and partners on the Tiwi Islands need information on which to base species selection decisions, along with consideration of small-scale native forestry opportunities for self-sufficiency and local markets.

Opportunities

- Second rotation species change [Research]
    - Research to date suggests 60% uplift in productivity from switch from *Acacia mangium* to *Eucalyptus pellita*
    - Note challenge of EPBC Act approval required for change of species [Regulatory]
- Plantations for solid wood outcomes [Research]
    - Sawn wood
    - Peeler
- Plantation income diversification [Research]
    - Horticulture
    - Provision of fuel stations – co-beneficial
- Small-scale native forest harvesting
    - Selective harvesting likely
    - Supply local building materials
    - Sawmill operations previously existed on Melville Island

Specific Needs

- Research support for alternative plantation species
- Market research and development support for sawn wood and peeler wood
- Native forest inventory (may already exist from 1970s)

Kununurra - Workshop Summary

September 2019

The following is a summary of the workshop and field visit conducted on 5 September 2019 in Kununurra, Western Australia. This workshop was focused on the northern Australian sandalwood plantation industry, which is based on the exotic Indian sandalwood species *Santalum album*. This industry has a strong presence in the Ord River Irrigation Area (ORIA) with two main operators involved in the growing and processing of sandalwood products: Santanol and Quintis. The workshop was conducted to explore opportunities and challenges for this particular sector of the industry in northern Australia.

Kununurra – Thursday 5 September

Key point – the sandalwood resource in northern Australia is one of the largest plantation estates of Indian sandalwood on a world scale. There are significant opportunities for this sector in the pharmaceuticals and fragrances market, given its global market value. A key requirement is access to water as an irrigated operation, as well as marketing and product quality to ensure the plantation sourced sandalwood is well-accepted in a global market still dominated by naturally harvested sandalwood (i.e. up to 95% of world supply).

Opportunities

- The global market value and potential of sandalwood end use markets, such as fragrance oils and pharmaceuticals, is significant and worth billions of dollars per annum [Market]
- Promotion of the natural and pharmaceutical characteristics of plantation grown sandalwood, but additional work is required [Development]
- The long-term supply and sustainability of naturally occurring sandalwood from overseas is uncertain, given risks of illegal logging and different regulatory practice [Regulatory, Market]
- Expansion into high-value pharmaceutical markets for sandalwood [Market]
- Diversification of end-products, with a growing interest in solid dry wood exports of sandalwood for processing off-shore [Market]
- Expansion into the Northern Territory (e.g. Katherine, Douglas-Daly) where water availability may be easier to access than in the ORIA [Development]
- Use of silvopastoralism to lower operating costs and reduce use of chemicals (e.g. goats already being trialed to manage weeds) [Development, Research]

Threats

- Risks of fire, disease, fungus, termites (specifically the giant northern termite) and catastrophic loss from cyclones
- Plantation grown sandalwood is still in its infancy in terms of global market development and acceptance, which is still dominated by naturally occurring sandalwood in regions such as India [Development]
- Energy costs with high-tariffs in remote areas [Market, Regulatory]
- Duplication of industry R&D, marketing and investment in processing (i.e. could be greater synergies and economies of scale through greater cooperative activities between the two main companies) [Development]
- New land access, with competing crops and limited availability in the ORIA [Market]
- Inability to access carbon markets given the short-rotation (e.g. up to 15 years), and 25-year rule in the Emissions Reduction Fund for sequestration projects [Regulatory]

Specific Needs

- Infrastructure
    - Water supply (irrigated or groundwater)
    - Energy supply (at an affordable rate)
- Water management rules for land under irrigation (the use it or lose it rule) – NT and WA [Regulatory]
- Processing options in NT for sandalwood given resource is not yet at harvest age [Market, Research]
- Industry collaboration models [Development]
- Pest and disease management (need for termiticides and their efficacy) [Research]
- Silvpastoral systems for weed control and related benefits such as income diversification [Research, Development]
- Processing for solid wood markets – research into drying techniques [Research]
- Market analysis on long-term global feasibility of plantation derived sandalwood products [Development, Market]

General opportunities identified from all of the regional workshops

- Commonwealth concessional loan fund and similar financial support
    - AUD $500 million concession loan fund
    - Further information is required
- Private native forestry (PNF) in all its forms is an under-utilised resource and little understood
    - Tenure differences
        - Traditional Owner freehold
        - Non-Indigenous freehold
    - Adequacy of inventory and therefore opportunity [Research]
    - An extensive resource that can generate economic and social benefits (jobs, skills) and less welfare dependency in remote areas [Development]

<u>General Needs</u>

- Resource security for native hardwood processing and investment [Regulatory for State-Owned land and Development for private native forests]
- Improved/complete forestry inventory [Research]
    - Reference in forest inventory to non-commercial values, on an indicative basis (see appendix)
- Silvicultural knowledge [Research]
- Silvopastoral options
    - Silvopastoral trials and co-benefits analysis [Research]
    - Silvopastoral information for potential partners [Development]
    - Understanding access requirements for Crown lease lands in each jurisdiction [Regulatory]
    - Understanding rules for access to land under other tenures [Regulatory]
- Cross-sector and cross-tenure engagement, especially with Traditional Owners (TOs)
- Commercial assessment of risks and potential mitigants associated with plantation establishment in northern Australia, including but not limited to the risks of cyclones: [Development]
    - Insurance options, including the role of state and federal governments in underwriting or supplying insurance to support plantation expansion and regional economic and employment development

    - Preferred equity options, including options for commercial investment by government on terms that could include differentiation of return hurdles, first-loss, convertibility and similar options typical in infrastructure investing

- Commercial demonstration and trial sites for tree growing [Research]
    - Commercial demonstration for silvopastoral systems (i.e. livestock and trees)
    - Trials for plantation species under different regimes
- Business model options for non-Indigenous investors to co-invest with Traditional Owners and leverage benefits available to TOs [Development]
    - Specific business models
    - Access to CommInsure or other insurance concessions or support
- Sandalwood
    - Water management rules for land under irrigation (the use it or lose it rule) – NT [Regulatory]
    - Pest and disease management (the ongoing need for termiticides and their efficacy) [Research]
- Training and capacity building support [Development]
    - Existing operations
        - Workforce development planning
        - Training and assessment capacity building
        - Emphasis on national objectives including 'Closing the Gap'
    - Prospective operations
        - Workforce needs planning
- Market development planning and support
    - End-use market analysis
    - Market information services

APPENDIX THREE –

Review of indigenous forestry in northern Australia

Review of indigenous forestry in northern Australia

John Meadows*, Mark Annandale* and #Mila Bristow

*University of the Sunshine Coast, #NT Department of Primary Industry and Resources

This review was incorporated into the project as the development of Indigenous forestry enterprises was identified as a key opportunity for developing northern Australia. This Appendix provides a summary of the key findings from a literature review and the project workshop consultations. A more detailed peer-reviewed scientific paper will be produced from the project.

Background

More than 70% of northern Australia's land base is Indigenous land (approximately 230 million hectares out of 321 million hectares), and more than 70% of northern Australia's native forests (around 46 million hectares out of 63 million hectares) are found on Indigenous land (SOFR, 2018). The Indigenous forest estate is defined as forests over which Indigenous peoples and communities (i.e. Aboriginal and Torres Strait Islander peoples) have ownership, management or special rights of access or use (SOFR, 2018). Some of these forests could be available and suitable for commercial wood production. But there is limited knowledge of the commercial values of these parts of the Indigenous forest estate.

Northern Australia's Indigenous forestry industry is small and fragmented (BDO Consulting, 2004), with limited examples of Indigenous owned and managed land being used for commercial forestry (SOFR, 2018). Examples include small-scale sawmills in many communities, integrated forestry enterprises salvage harvesting from native forests ahead of mining developments (and marketing logs, sawn-wood and further value-added products), and the Tiwi Islands plantation estate of around 30,000 ha of mainly *Acacia mangium* that is being chipped for export to international markets. These activities provide opportunities for Indigenous training, employment and direct involvement in forest management (Halkett et al 2012; Loxton et al 2012; SOFR, 2018), but the sector remains far from its potential for increased Indigenous community participation (Feary et al 2010). There remain significant challenges to Indigenous forestry enterprise and industry development in Australia, including resource knowledge and access (remoteness, tenure, resource security), biophysical, supply chain and socio-cultural/community capacity factors (Halkett et al 2012; SOFR, 2018). Lessons from international experiences with Indigenous community forestry and Australian Indigenous forestry enterprises (past and present), and better understanding of local-level opportunities, challenges and needs, will help inform industry development.

Literature review

The study assessed academic and grey literature relevant to the history, current status and growth potential of the Indigenous forestry and forest products industry in northern Australia. For this study, 'Indigenous forestry' refers to the Indigenous forestry and forest products industry, defined as Indigenous community-owned native forests and plantations (including irrigated timber crops and

farm/agroforestry) managed for commercial wood production. The study focuses on types of forestry and forestry enterprises that have or could create income, employment and livelihood development for northern Australian Indigenous communities. It excludes all non-wood forest products (e.g. bushfoods, carbon and other ecosystem services, quarry materials, tourism/recreation).

Review of the academic literature firstly involved systematically searching the Scopus database. The Scopus search was conducted on May 18, 2019, using the following search string of keywords:

*TITLE-ABS-KEY ("*forest*" OR "salvage harvest" OR "plantation" OR "silvopastoral system" OR "agroforestry") AND TITLE-ABS-KEY ("indigenous" OR "aborig*") AND TITLE-ABS-KEY ("Australia" OR "north qld" OR "North queensland" OR "cape york" OR "northern territory" OR "arnhem land" OR "kimberley" OR "tiwi islands").*

The Scopus search retrieved 421 documents. These documents were reviewed and 394 documents not relevant to the study topic or without an author and abstract and/or unable to be obtained as hard or digital copies were removed, leaving 27 relevant academic documents. Relevant grey literature was firstly obtained through google searches using the study title and associated keywords/phrases, searched individually and in various combinations. Project partners from government departments (i.e. Queensland Department of Agriculture & Fisheries, Northern Territory Department of Primary Industry & Resources, Western Australia Forest Products Commission) provided relevant documents uncovered through searches of their internal databases. Additional literature was found through searches of reference lists of retrieved documents. These additional searches yielded a further 14 academic documents and 98 grey literature documents, giving a total of 139 documents considered in the literature review. The reviewed documents included journal articles[1], books, book chapters, theses, reports, discussion papers, conference and workshop papers and presentations, newsletter and magazine articles, media releases, radio broadcast transcripts, business and project update brochures, an industry strategy, a management plan, and an engagement and communications plan.

Analysis of the retrieved literature included identifying publication trends, biases and gaps. Bibliometric data and other data of interest to the study topic were systematically extracted from the reviewed literature based on titles, keywords, abstracts/summaries and full-text review. Key data extracted included geographic location (i.e. jurisdiction and region[2]), forest type[3], and study theme and focal topics[4]. The extracted data were entered in a Microsoft Excel spreadsheet. Key features of the reviewed documents, including their spatial and temporal distributions, were mapped using graphical representations and descriptive statistics. Statistical analyses were undertaken using Microsoft Excel and the SPSS Statistics software (Version 22). The freeware package VOSViewer (van Eck & Waltman, 2010) was used to construct bibliometric maps, and jurisdictional maps were prepared using Microsoft Excel.

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[1] Only two research journals had more than 1 publication - *Australian Forestry* (5) and *Australian Geographer* (2). There were 29 other journals across the forestry, geography, ecology and society, forest policy/economics, rural development, and environmental management disciplines.

[2] Jurisdiction – 'northern QLD', 'Northern Territory', 'northern WA' or 'northern Australia/non-specific'. Region – individual or aggregated IBRA bioregions or 'non-specific'.

[3] 'rainforest', 'woodland', 'sandalwood' (incorporating native & plantation); 'plantation' (incorporating agroforestry & all species except sandalwood); 'all forests/non-specific'.

[4] A thematic analysis of the publication. For details, see the next section and footnotes 5-9.

Results & Discussion

Trends, biases and gaps in the literature

Publications by year, jurisdiction (and region) and forest type

The earliest of the retrieved publications on Indigenous forestry in northern Australia was dated 1973. There was a slow increase in publications since then, culminating in a spike in the early-mid 2000s before tapering back to pre-2000 levels by 2016 (Figure 1a). Much of the pre-2000 literature related to development of the *P. caribaea* plantation estate on the Tiwi Islands (e.g. Cameron et al 1978; Bevege, 1981; Jay, 1983; Eyre, 1987). A driver of the initial post-2000 spike was the work of the Queensland Forest Research Institute (QFRI) to support Indigenous community forestry initiatives on Cape York Peninsula (e.g. Annandale & Crevatin, 2002; Annandale et al 2002; Annandale & Bragg, 2004). These trends were most evident in the grey literature.

By jurisdiction, the highest proportion of publications was for the Northern Territory (~45%), where publications mostly focused on the Tiwi-Coburg and Arnhem Land regions (Figure 1b). This was followed by northern Queensland (~27%), with most publications focused on Cape York Peninsula, which was also the region with the most publications overall. Approximately 24% of the publications had a non-specific regional focus, with general reference to the potential of Indigenous forestry in all parts of northern Australia. Very few publications (~4%) were focused on northern Western Australia and were mostly relevant to the Kimberley region. The dominance of publications focused on the Tiwi-Coburg, Arnhem Land and Cape York Peninsula regions reflects these regions' rich histories of the local Indigenous peoples' participation in the forestry industry (e.g. harvest labour, sawmilling, plantations – see Mack, 1986; Annandale & Taylor, 2007; Pearson & Helms, 2010, 2012), vast areas of native eucalypt forests with commercial potential, high proportions of Indigenous ownership of the total forest area, and extensive mining operations providing opportunities for integrated Indigenous forestry enterprises. Indigenous forestry enterprises are operating in these regions and the regional characteristics suggest a high potential for further enterprise/industry development.

By forest type, publications were mostly plantation-focused, particularly for the Northern Territory (Figure 1c), and mostly related to historical, silvicultural, business development, product (i.e. woodchip) export, and species transition aspects of the Tiwi Islands plantation estate (e.g. Stewart, 2004; Tiwi Land Council & Great Southern Plantations, 2007; Hicks et al 2015). In northern Queensland, plantation-focused publications mostly related to agroforestry, and its potential integration into mine-site rehabilitation (e.g. Bristow et al 2003; Bragg et al 2004; Annandale & Feary, 2009). The small number of publications relevant to northern Western Australia mostly focused on the potential for irrigated eucalypt plantations (e.g. Cameron et al 1980; Barbour et al 2012). Woodland-focused publications were common for the Northern Territory (particularly Arnhem Land) and northern Queensland (particularly Cape York Peninsula), reflecting the large tracts of the most productive eucalypt forests (i.e. woodlands with commercial potential) of northern Australia being found in these regions. Rainforest-focused publications were mostly from the Northern Territory and addressed silvicultural, ecological, sustainability and business aspects of Arnhem Land's woodcarving industry that is largely based on selective harvests of *Bombax ceiba* and *Brachychiton diversifolius* (e.g. Corn, 2003; Koenig et al 2005, 2011, 2012). There were few publications focused on sandalwood and most related to Cape

York Peninsula (e.g. Annandale et al 2008; Wharton, 2009; Lee et al 2018). Most of the publications with a non-specific jurisdictional focus were also not focused on any one forest type.

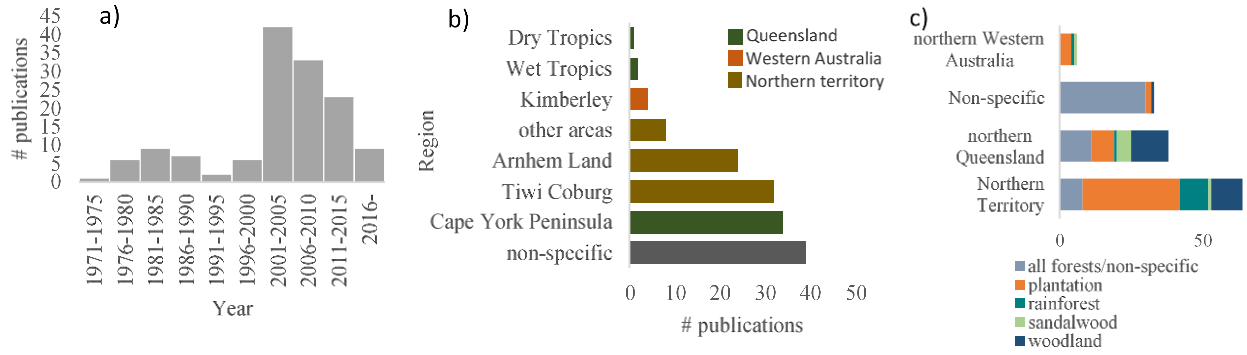


Figure 1. Numbers of publications on Indigenous forestry in northern Australia: a) by year; b) by region of study; and c) by forest type.

3.1.2 Publication themes and focal topics

The most common publication theme was by far Industry Growth & Development[5] (~43% overall, also dominant in all jurisdictions) (Figure 2). By overall publications, the proportional distribution of remaining themes was Harvesting, Processing & Marketing[6] (~22%), Industry History & Current Status[7] (~17%), Indigenous Heritage & Engagement[8] (~13%) and Mine-site Management & Rehabilitation[9] (~5%). By jurisdiction, Harvesting, Processing & Marketing and Industry History & Current Status were also frequent themes of Northern Territory-focused publications, again reflecting the many publications on Arnhem Land's woodcarving industry and the Tiwi Islands plantation estate. Publications under the theme Mine-site Management & Rehabilitation were only focused on northern Queensland and all related to the potential integration of Indigenous community forestry with bauxite mining on Cape York Peninsula (e.g. Annandale, 2003a, 2003b; Bragg, 2008).

[5] Incorporating the topics resource assessment; economic analysis; financial analysis; strategic planning; agroforestry; Indigenous community consultation; Indigenous community development; Indigenous community sawmill; sustainable forest management; regulatory framework; Indigenous business; Indigenous training & employment; Indigenous livelihoods; bioenergy; partnerships; infrastructure; water usage; impact assessment; nursery; seed production; tree breeding; silviculture; irrigation trials; property rights; market development.

[6] Incorporating the topics woodcarving industry; Indigenous livelihoods; supply chain; certification; resource sustainability; didgeridoo; timber qualities; Indigenous community sawmill; Indigenous beliefs and values; salvage harvest; exports; silviculture.

[7] Incorporating the topics resource assessment; Indigenous usage & values; Indigenous forest estate; Indigenous business; Indigenous employment; Indigenous training & employment; Indigenous community sawmill; partnerships; socioeconomic benefits; bibliography; nursery.

[8] Incorporating the topics integrating Indigenous knowledge; cultural heritage preservation; Indigenous participation in forestry industries; Indigenous Land Use Agreements; Indigenous community consultation; partnerships; Indigenous business; Indigenous training & employment; Indigenous governance.

[9] Incorporating the topics Indigenous community development; Indigenous community consultation; Indigenous livelihoods; salvage harvest; agroforestry.

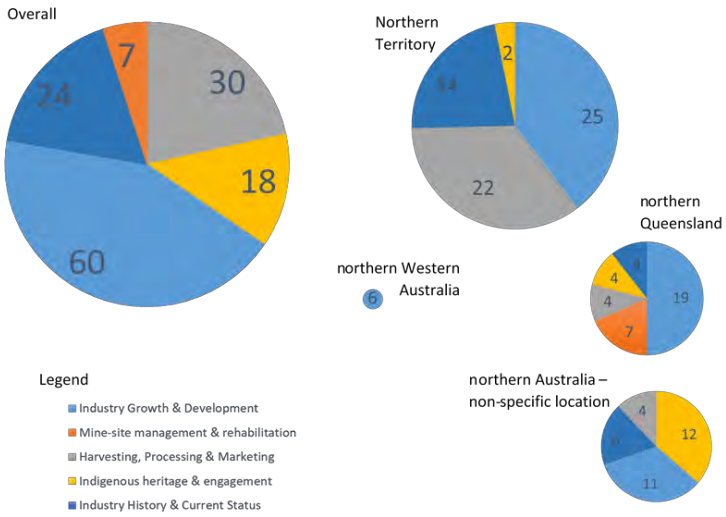


Figure 2. Numbers of theme-based publications on Indigenous forestry in northern Australia, overall and by jurisdiction.

Figure 3 displays the temporal evolution of publication themes and focal topics by region. The above-described trends associated with Tiwi Islands- and Cape York-focused publications are evident. Topics within the Indigenous Heritage & Engagement theme are often of a non-specific regional focus, indicating a need for greater local-level analyses of the potential, processes and outcomes of integrating Indigenous consultation/knowledge/governance/decision-making in industry development, including through partnerships to support Indigenous forestry enterprises. Indigenous employment & training and Indigenous business are prominent topics, but these remain areas of unrealised potential for the forestry industry in northern Australia. Publications focused on the woodcarving industry are only related to the Arnhem Land region and focused on two rainforest species, indicating a lack of published analysis of the history and future potential of the high-value traditional art and craft market in other regions, particularly on western Cape York Peninsula (e.g. Aurukun), or use of lesser-known species from the acacia-dominated shrublands (e.g. Lancewood – *Acacia shirleyi*, Gidgee – *Acacia cambagei*) that are supplying the small but growing high-end furniture market (e.g. see Manapan Furniture).

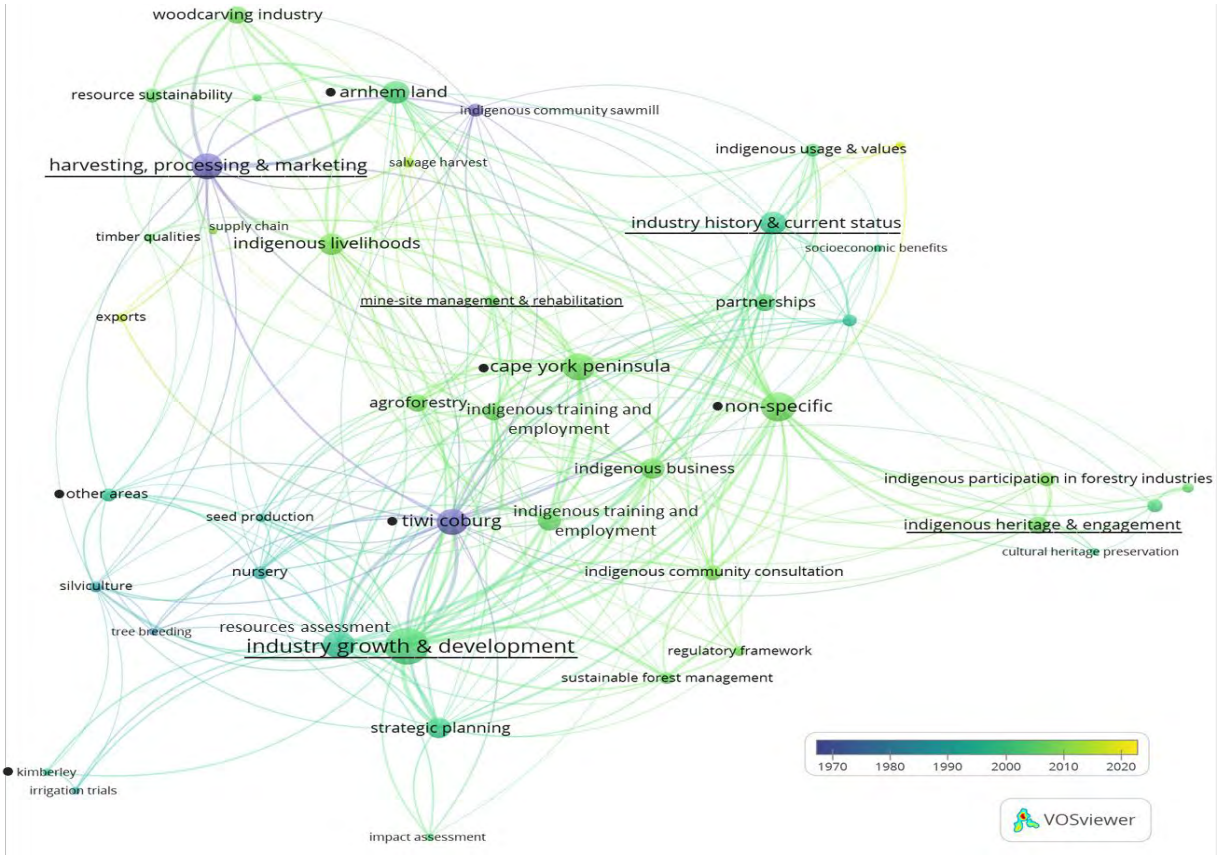


Figure 3. Temporal evolution of publication themes and key topics by region. Note: listed regions, themes and focal topics (i.e. parameters) have 3 or more occurrences in the literature; line thickness represents the number of co-occurrences/connections between parameters; node sizes are relative to the overall frequency of a parameter's mention in the literature.

Priority research and development (R&D) for Indigenous forestry in northern Australia

Key R&D needs to enable Indigenous forestry to realise opportunities can be summarised in four areas:

Native forests

Despite having large forest areas, the lack of data about the commercial value of forest and non-timber forest products is an impediment to Indigenous people and communities realising the opportunities their forests could hold. Fine-scale community-level assessments of both desktop and field-based methods are needed to enable decision-making, and potential use. There are examples of this sort of research now being done or planned in small areas (see Wik case study). There is an urgent need to invest in more of this type of work.

There is lost opportunity for northern Australian native forests that are subject to land conversion which could be used, salvaged, prior to land use change. To realise this opportunity, these forests need to be assessed for their current value in forest products. Currently, salvage harvesting is supporting jobs, regional economic development and timber supplies from mining leases in northern Australia (e.g. Wik Timber, Gumatj timbers). However, there is a need to identify areas beyond mining leases that will be cleared through other approval mechanisms (e.g. development of land for agriculture), where this forest could offer options for forest product in advance of land-use change. Some of these forests are

on Indigenous owned or managed land. There is a need for a more strategic approach to capturing value from these forests.

To use northern Australian native forests, we need more research into the opportunity for sustainable selective harvesting, and to understand products and optimal management regimes for these forests. This would need to include value-adding opportunities. We recommend that permanent growth plots and silvicultural trials are established throughout Indigenous community forests across northern Australia, along with research into new product development and optimisation suited to this resource.

Plantation forestry

There are two separate opportunities for plantation R&D in Indigenous forestry: 1) research and consideration of policy implications on where plantations could be established on rehabilitated mine sites, and 2) research to support plantation forestry on other land, including on previously cleared land, or second rotation sites.

For both situations, research needs include species selection, genetic improvement, and plantation silviculture and pest and disease, as well as product development, utilisation and optimisation research to support sustainable forest products. There is currently very limited forest biosecurity R&D presence across northern Australia. This is a key threat to plantation forestry in very remote, Indigenous forestry operations.

Mine rehabilitation

Current Indigenous forestry in northern Australia has stemmed from salvage harvest of timber ahead of mining. This has regularly raised the opportunity to access the rehabilitated mine land at the other end of mining operations. Indigenous people and communities in northern Australia are interested in research to underpin use of this rehabilitated land including salvage harvesting, product development and use of residues, and potentially establishment of plantations (rather than other end options post-mining). This includes research to support multiple-use community forestry within landscape rehabilitation. This sort of forestry has strong support from Indigenous people and communities, where R&D is needed to ensure they are a part of developing their long-term livelihoods beyond mining.

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APPENDIX FOUR

Image library of key forest resources and processing activities

Image credits: Timber Queensland, except where indicated.

List of images

Acacia mangium plantation, Tiwi Islands, NT 3

Eucalyptus pellita plantation, Tiwi Islands, NT 4

African Mahogany (*Khaya senegalensis*) plantation, Douglas-Daly, NT 5

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Cape York Timber sawn product using Darwin stringybark (*Eucalyptus tetrodonta*), Cape York, Queensland 19



Acacia mangium plantation, Tiwi Islands, NT



Eucalyptus pellita plantation, Tiwi Islands, NT



African Mahogany (*Khaya senegalensis*) plantation, Douglas-Daly, NT



African Mahogany plantation with cattle being trialed for weed control and silvopastoral potential, Douglas-Daly, NT



Indian sandalwood (*Santalum album*) plantation, Douglas Daly, NT

Sandalwood tree second stem from the left adjacent mixed host species.



Young Indian sandalwood plantation, Kununurra, WA

Sandalwood stem is in the foreground, first from the right.



Goats being trialed for weed control in Indian sandalwood plantation, Kununurra, WA



Young softwood pine (*Pinus caribaea*) plantation, Far North Queensland

Image credit: HQPlantations



Mixed species native forest with Darwin Stringybark *(Eucalyptus tetrodonta*), Cape York, Queensland

The rough-barked Darwin stringybark trees are in the foreground.



Woodchip processing and ship loading facilities, Tiwi Islands (Melville Island), NT



Mareeba Softwoods sawmill, Mareeba, Far North Queensland

Image credit: Daryl Killin



Pine processing residues (e.g. bark) being transported for other market uses, Mareeba, Far North Queensland



Water infrastructure for sandalwood plantations, Kununurra (Ord River), WA



Harvested sandalwood for further processing, Kununurra, WA



Gumatj sawmilling operations, Nhulunbuy, East Arnhem, NT



Gumatj hardwood truss being used for local housing, Nhulunbuy, East Arnhem, NT



Cape York Timber sawn product using Darwin stringybark (*Eucalyptus tetrodonta*), Cape York, Queensland

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