REPORT: ASSESSING THE NET BENEFITS OF MULTIPLE USE NATIVE FOREST MANAGEMENT IN QUEENSLAND

1 November 2022

Native Forest Management

This report was commissioned by the South & Central Queensland Regional Forestry Hub with funding from the Australian Government, Department of Agriculture, Fisheries and Forestry.

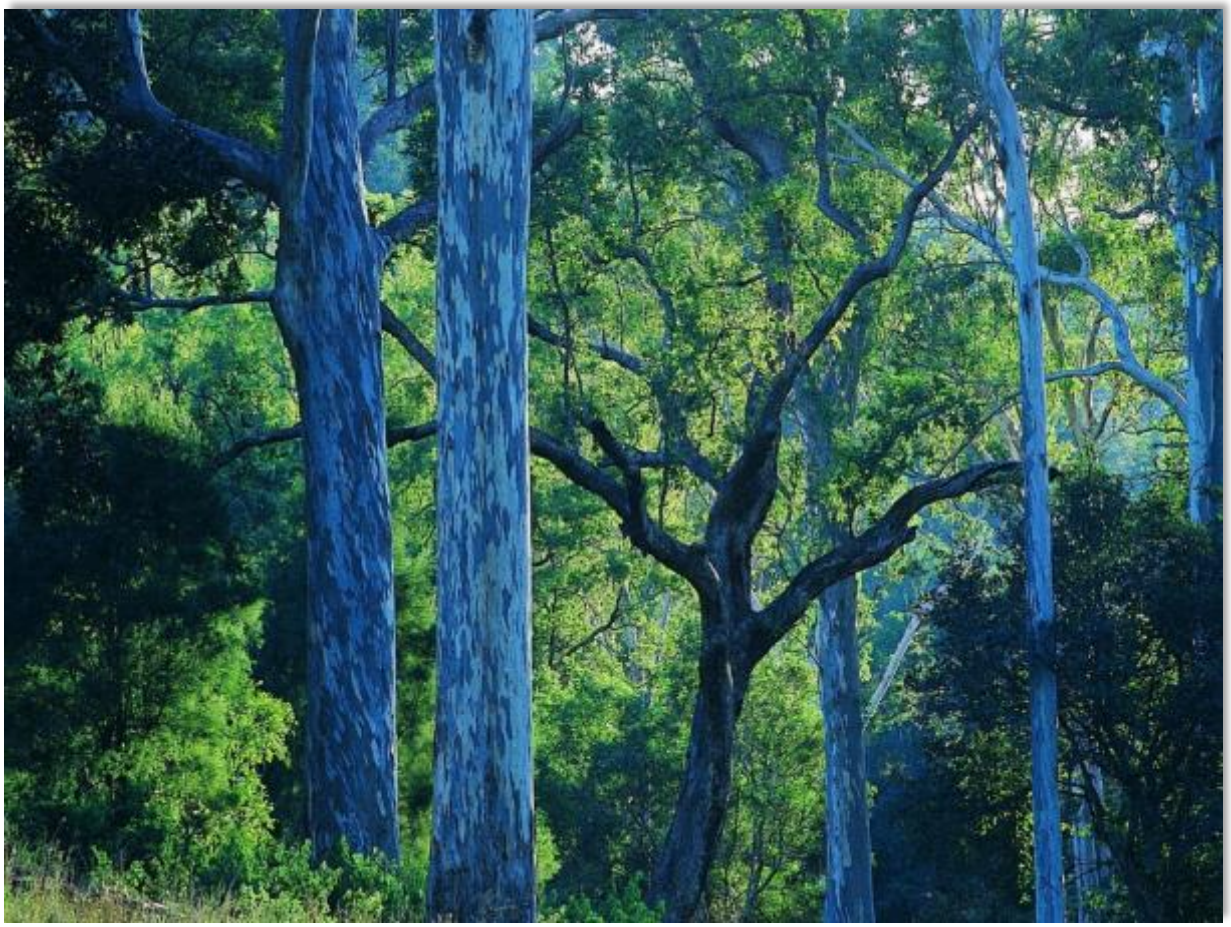
Assessing the net benefits of multiple use native forest management in Queensland

Project report prepared for

South & Central Queensland Regional Forestry Hub

by

Indufor & Natural Capital Economics



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Indufor Asia Pacific (Australia) Pty Limited ('Indufor') and Natural Capital Economics Pty Ltd ('NCE') worked in partnership to prepare this report for the Regional Forestry Hub.

Indufor and NCE acknowledge the funding provided by the Australian Government Department of Agriculture, Fisheries and Forestry, and the coordination and support from the Regional Forestry Hub, to enable this assessment and the report on the assessment outcomes.

LIMITATIONS

The purpose for this report is to provide relevant information and inform policy considerations in relation to the management of Queensland's public native forests into the future. The report should only be used for the purpose for which it was prepared, and its use is restricted to consideration of its entire contents. The conclusions presented are subject to the assumptions and limiting conditions noted within.

Andrew Morton
Managing Director
Indufor Asia Pacific (Australia) Pty Ltd

Jim Binney
Director
Natural Capital Economics

For information on this report, corresponding author details are set out below:

Blair Freeman
Indufor Asia Pacific (Australia) Pty Ltd
Level 8, 276 Flinders Street
Melbourne VIC 3000 Australia

blair.freeman@indufor-ap.com
www.induforgroup.com

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EXECUTIVE SUMMARY

This study, prepared for the South & Central Queensland Regional Forestry Hub (SCQ Hub), presents a detailed assessment of costs and benefits associated with the management of public forests into the future. The primary focus is an assessment of the net benefits of managing native forests for multiple uses, including timber harvesting and non-consumptive uses such as tourism and recreation, and comparing this to formally protected forests encompassing national parks and conservation reserves, which have a more limited range of uses and management objectives and interventions.

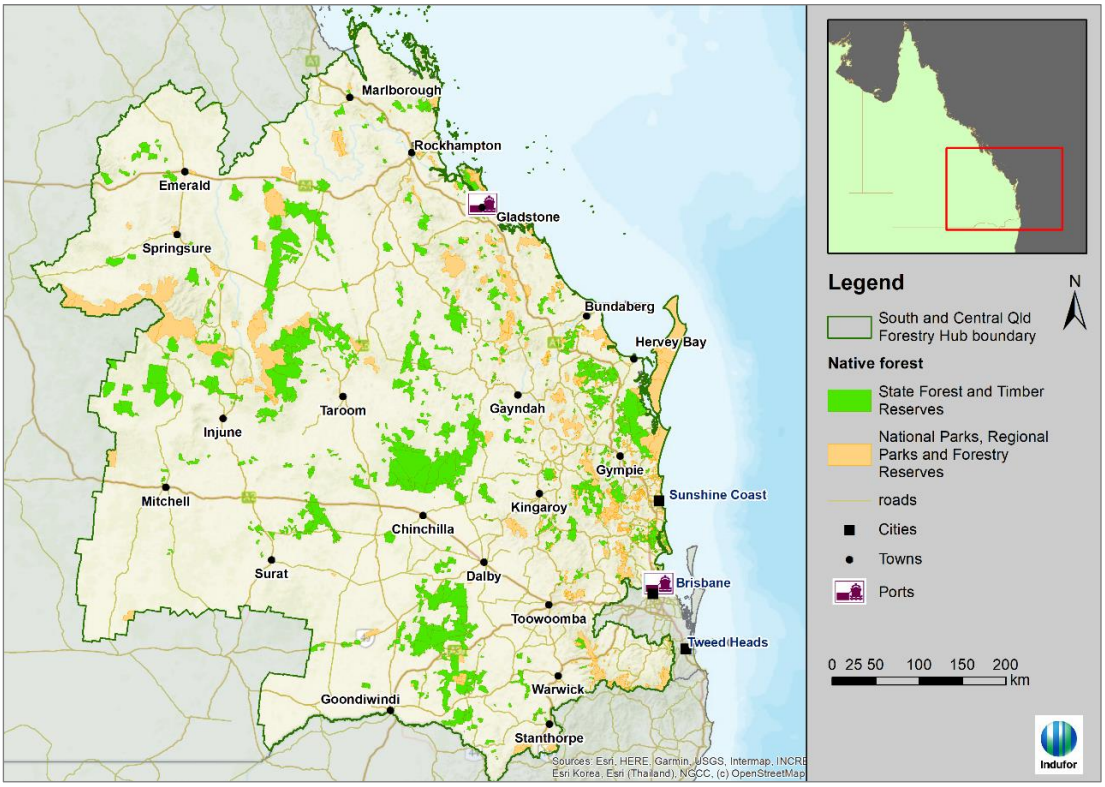
Context

The Queensland Government's Native Timber Action Plan, launched in November 2019, was developed to refresh the South East Queensland Forests Agreement (SEQFA), which was signed by the State government, the timber industry and the conservation sector in 1999. A key aim of the plan is to build a sustainable future for the timber industry and regional employment that also ensures conservation outcomes.

The renewed plan specifies that state-owned native timber production will end in the South East Queensland (SEQ) Regional Plan area on 31 December 2024. Across the remainder of the SEQ supply region, i.e., the Eastern Hardwoods region, timber production from state-owned native forests will continue through to 31 December 2026. The Eastern Hardwood region includes areas around Wide Bay such as Gympie, the Fraser Coast, Bundaberg, Gladstone, and most of the South Burnett area. The geographic boundary for the SCQ Hub encompasses both the SEQ Regional Plan area and the Eastern Hardwoods region (ES Figure 1).

The renewed timeframe for timber harvesting in the Eastern Hardwoods region has been set to provide time to undertake the work needed to make informed longer-term decisions, with a view to achieving an appropriate balance between wood production, economic development and environmental values.

ES Figure 1 Study area for forest management analysis in South & Central Queensland



Source: Queensland Regional Forestry Hubs (2022); Queensland Department of Environment and Science (2022).

The SCQ Hub has observed that a range of recent policy decisions in other Australian states have resulted in or will result in the cessation of timber harvesting in certain public native forests, and this will likely result in tenure changes or forest management zoning changes that transfer multiple use production forests to protection forests. These policy decisions to cease timber harvesting in public native forests have raised several key issues in relation to the net benefits and the longer-term implications for the management of public land.

Within this context, the SCQ Hub has identified that a fundamental issue confronting the native hardwood industry in the region is long-term resource security. This is partly due to a gap in knowledge in terms of the amount of information available on the net benefits from state-owned native timber production forests compared to formally protected forests. This lack of information creates uncertainty and can lead to sub-optimal policy options or outcomes where decisions are made to transfer multiple-use native production forests to protection forests. A key policy risk is that land-use decisions may not account for the full range of costs and benefits from shifting areas from multiple-use timber production forests to protection forests and could unnecessarily restrict the supply of wood resources to industry and forgo other higher total net benefits to society.

This assessment of the net benefits from multiple use forests has been prepared to better inform these issues and to provide guidance on relevant best practice cost benefit methodologies.

Assessing net benefits from multiple forest values and ecosystem services

This assessment has focused on two main types of forest land tenure in Queensland:

- State forests and timber reserves (i.e., multiple-use tenures), which provide for selective timber harvesting plus a broad range of other activities, including recreational use and biodiversity conservation (the "*multiple use*" option); and
- National parks and conservation reserves (i.e., formally protected forests), which place primacy on biodiversity conservation and protection of natural and cultural values, and forest uses are largely limited to some recreation and tourism (the "*protection*" option).

As directed under relevant legislation and regulations, these land tenures have different management objectives, and they aim to deliver different ecosystem services. The suite of services provided by public forests include *regulating services* such as biodiversity conservation, carbon sequestration and water filtration; *provisioning services* such as timber production and beekeeping for honey production and pollination services; and *cultural services* including recreation and tourism[1]. A summary of the general intent of the management objectives and permitted activities for these public forest lands is set out below (ES Figure 2).

[1] Haines-Young R. and Potschin MB (2018): *Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure*. Online, accessed 1 April 2022: www.cices.eu

ES Figure 2 Comparison of key services provided under public forest land tenures

Natural capital services	Multiple use State forest 'Production forest'	Formally protected forest 'Protection forest'
Provisioning services:		
Timber and wood products	✓	×
Fuelwood production	✓	×
Extractive industries - gravel / stone / minerals	✓	×
Non-wood forest products – e.g. honey	✓	Exclusion with transitions
Non-wood forest products - grazing & livestock feed	✓	×
Pollination services – beekeeping in native forests	✓	Exclusion with transitions
Clean water supply	✓	✓
Genetic resources – e.g. seed of forest species	✓	✓
Regulation services:		
Biological control – e.g. pests and diseases	✓	✓
Water regulation	✓	✓
Water purification	✓	✓
Air quality regulation	✓	✓
Climate regulation – e.g. carbon sequestration	✓	✓
Soil protection	✓	✓
Biodiversity repository	✓	✓
Hazard regulation	✓	✓
Cultural services:		
Spiritual & cultural	✓	✓
Historical	✓	✓
Education	✓	✓
Tourism	✓	✓
Recreation, e.g. hiking, picnicking, camping	✓	✓
Sport, e.g. fishing, mountain biking, motor sports etc.	✓	×
Hunting – e.g. feral animals	×	×

Source: based on the Common International Classification of Ecosystem Services (CICES).

The total area of public native forests in this study region is close to 4.3 million hectares (ha). State forests, timber reserves and other multiple use forests currently account for around 64% of this area. National parks and conservation reserves comprise around 36% of the public native forests in the region. This is significantly higher than the state-wide proportion of forest in the National Reserve System (encompassed in the International Union for Conservation of Nature (IUCN) protected area categories), which was around 17% in 2018[2]. For comparison at the national level, the proportion of forest in all IUCN categories across Australia was 25% in the same year.

It is important to note that up until the mid-1970s, most of these public native forests, including areas that are now protected forests, were managed for over 120 years by the Queensland Department of Forestry (and predecessor agencies); and were managed under regimes that had evolved towards or effectively become multiple use production forests or forest reserves. An implication of this is that important biodiversity values and ecosystem services were being managed and generally maintained under a 'forestry' regime, of predominantly multiple use management, up until the formation of Queensland's National Parks & Wildlife Service in 1975.

[2] Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee (2018) *Australia's State of the Forests Report 2018*, ABARES, Canberra, December. CC BY 4.0. Refer Table 1.18.

Cost benefit analysis

This assessment incorporated a cost benefit analysis (CBA), in which the benefits and costs associated with the alternative forest management options in SCQ were estimated in monetary terms. In accordance with best practice, the development of the CBA aimed to incorporate values for a broad range of ecosystem services, to recognise a forest's capacity to deliver multiple benefits regardless of the management model's primary objectives (ES Figure 3).

ES Figure 3 Key design features for CBA relating to managing forest resources

Key design features	This CBA study for SCQ
Incorporates a broad scope of ecosystem services	✓ Identifies and values a broad suite of benefits where quantitative data is available. Note, however, the robustness of current estimates for some services is quite low due to data availability and quality.
Recognises that native forests can be managed to provide for a broad range of values, with many complementary uses	✓ Recognises that multiple use State forests can be managed for selective timber harvesting as well as maintaining recreation values, such as mountain bike trails, while also providing conservation values.
	✓ Recognises in the commentary that sustainable timber harvesting can support and effectively subsidise fire-fighting capability and capacity by providing access to heavy machinery and maintaining roads and fire tracks for fire protection; but does not quantify this cross-subsidisation in the CBA.
Recognises both the costs and benefits arising from managing specified values	✓ Incorporates costs and benefits, including for example, costs associated with the scenario of seeking to maximise carbon sequestration and storage in-forest by excluding sustainable timber harvesting.
Recognises downstream impacts and benefits arising	✓ Recognises the benefits of CO_2 emissions avoided through substitution of wood products for non-wood products (with higher emissions intensity). Note the current study does not incorporate socio-economic impacts from downstream processing of wood products, to avoid the complexity of ensuring indirect benefits are treated consistently across the options.
Recognises the market dynamics for wood products	✓ Adopts a simple premise that current markets for Queensland wood products will continue to demand wood, and the value of timber harvesting and wood products from public native forests can be maintained, provided it is conducted on a sustainable basis.
Recognises the carbon dynamics in native forests and in harvested wood products	✓ Recognises and quantifies emission reduction benefits based on an extensive life cycle analysis, and "what the atmosphere" sees, in contrast to only what can be credited in current carbon markets. ✓ Recognises that sustainable timber harvesting can facilitate faster sequestration rates in regrowth forests, with carbon in harvested products reallocated to harvested wood products.

Source: Key design features specified by Natural Capital Economics

Assessment outcomes

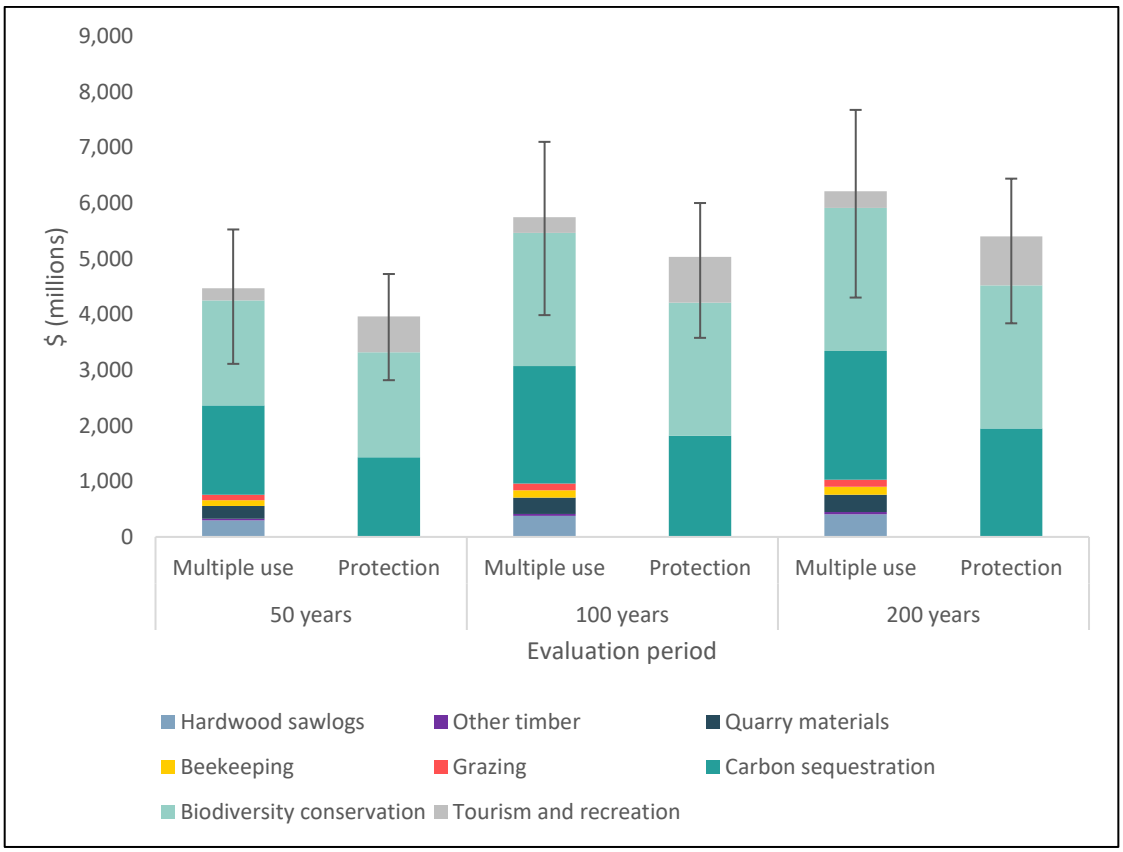
This assessment was conducted to present various outcomes from the comparison of the multiple use option with the protection option for existing State forests in Queensland, across a range of evaluation periods (50, 100 and 200 years) and discount rates (1.35%, 2.65% and 7%) (all in real terms).

Focussing initially on the present value of benefits (excluding costs), a summary of the outcomes across different evaluation periods, discounted at 2.65%, is shown below (ES Figure 4). This illustrates that the present value of benefits would be expected to rise under both models of management (multiple use and protection) with longer evaluation periods, given forest values and related benefits commonly are ongoing and incremental. While both management regimes display increases in the total present value of benefits, the marginal difference between each scenario remains relative consistent.

The assessment found the present value of benefits (excluding costs in this case) to be relatively similar across both models. However, the multiple-use forest scenarios resulted in consistently higher benefits across all evaluation periods and discount rates, due to a higher suite of likely outcomes.

This finding can be attributed to the significant benefits derived from provisioning services from multiple use forests (including hardwood sawlogs, other timber, quarry materials, honey from beekeeping, and grazing), which would not be realised if these forests areas were converted to protection forests. While the protection forest option may provide higher values of tourism and recreation, multiple use management provides a wider range of benefits including gains arising from carbon sequestration and product substitution over time as well as maintaining biodiversity conservation. This assessment has assumed the values for biodiversity conservation under the multiple use option and the protection option would be similar, based on the premise the cessation of selective timber harvesting and rezoning multiple use forests to formally protected forests will not directly (with no further resources or interventions) increase biodiversity values. Further resourcing and management interventions may be required, across both tenures, to mitigate the most threatening processes to biodiversity in public native forests.

ES Figure 4 Present value of benefits under alternative evaluation periods (discount rate of 2.65%)

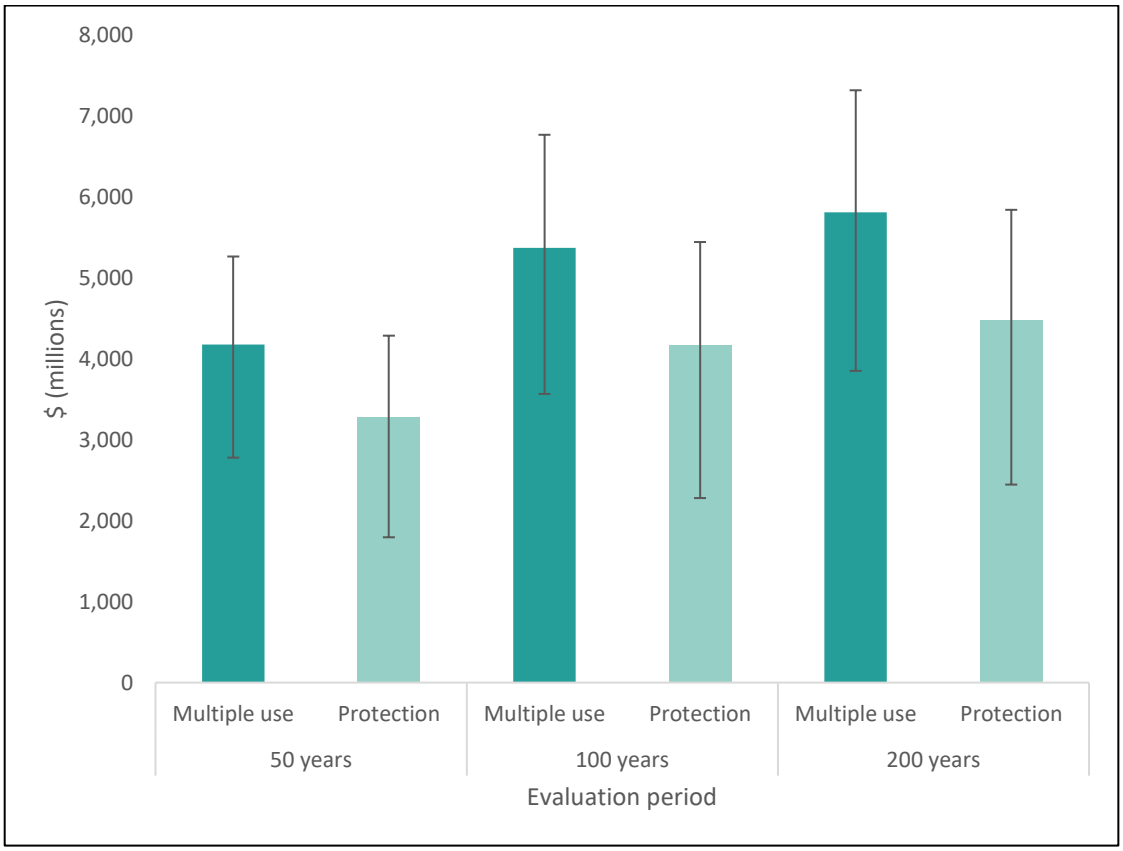


The CBA applied through this assessment excludes the full economic value of pollination services provided by honeybees accommodated in multiple use forests as distinct from national parks in SCQ; largely because beekeepers have been granted further access to certain national parks until 2044. However, it should be noted the economic value of pollination services may be a significant differentiator if commercial beekeeping were to be excluded from formally protected forests (as might occur post 2044); in which case, the net economic benefits of multiple use forests could be significantly higher.

Turning to net present values (NPV) (incorporating benefits and management costs), the assessment found that across each evaluation period, the multiple use option has a higher median NPV than the protection option (ES Figure 5). This indicates that multiple use forests are more likely to have a higher NPV than protection forests, based on the model assumptions. The large range in possible NPVs across both models reflects the level of uncertainty associated with the model inputs.

Furthermore, it should be noted there is considerable overlap of the error bars between each model, which indicates there are scenarios in which protection forests may have a higher NPV than multiple use forests. The CBA and associated stochastic analysis show it is more likely that multiple use forests will have a higher NPV than protection forests; however, this cannot be stated as a certain outcome across all settings and circumstances.

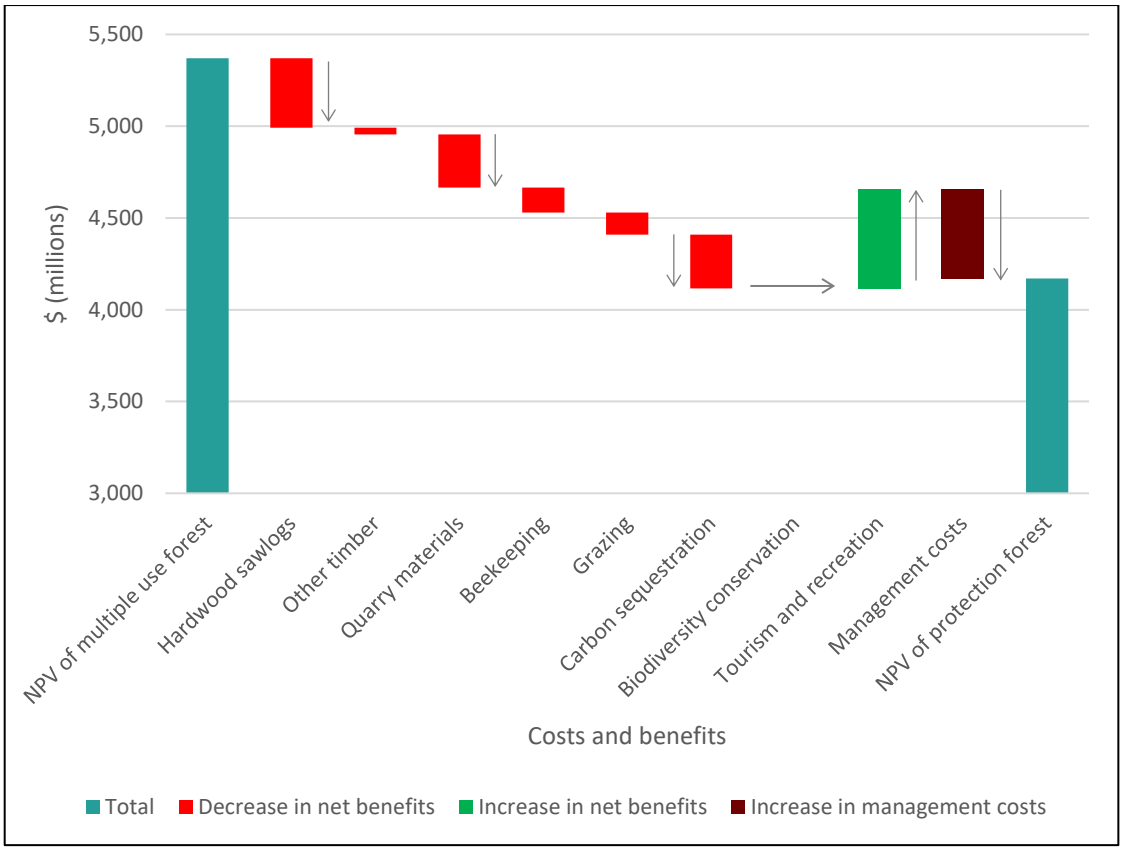
ES Figure 5 Net present values of each scenario across alternative evaluation periods (discount rate of 2.65%)



This assessment also found that increased management costs would be the biggest driver in the decline of NPV when moving from multiple use to protection forests (ES Figure 6). Management cost assumptions were drawn largely from an analysis of historical expenditure information from the Queensland Treasury Corporation in 2018, which indicated that management resources are generally concentrated towards highly valued recreational areas, notably in protection forests.

The same analysis by the Queensland Treasury Corporation highlighted that funding allocations to protected areas in Queensland are relatively low compared to other Australian states. An implication of this is that management expenditure may need to be increased further to ensure the maintenance of conservation values in formally protected areas, especially in the context of climate change and the increasing threats posed by more intense and frequent natural disturbances, and ongoing marked increases in societal expectations regarding physical use activities and rights.

ES Figure 6 Change in NPV between multiple use and protection forests (over a period of 100 years, discount rate of 2.65%)



Key findings

Based on an extensive literature review and development of a CBA specifically for application to SCQ, this assessment has observed the following in relation to managing public native forests within this region, and potentially other regions of Australia:

1. ***Multiple use forests support and maintain a broad range of ecosystem services***, including biodiversity conservation, extensive recreation opportunities, and carbon sequestration and storage, as well as provisioning services; and the scope for ecosystem services is broader than under existing protected forest tenures.

   There is a substantial range of provisioning services provided by multiple use forests – including sustainable timber harvesting, quarry materials, beekeeping for honey production and pollination services to the horticulture and agriculture industry, and cultural services in the form of more intensive recreational pursuits that are not supported in national parks and reserves.

   Furthermore, some of the management activities for provisioning services are highly complementary.

2. ***Timber harvesting currently occurs in a small proportion of public native forest estate in Queensland***, and forestry practices can be modified further to accommodate the conservation of specific threatened species in space and time.

   The current footprint of timber harvesting in public native forests of SCQ (in terms of the actual net area of harvesting each year) is less than 0.3% of the total area of multiple use forests, and less than 0.2% of public native forests overall.

Furthermore, timber harvesting in public native forests in SEQ is conducted using selective harvesting practices with a significantly lower intensity than state-managed timber harvesting practices elsewhere, which results in harvested areas continuing to provide a wide range of benefits; and there is full regeneration of these areas post-harvesting operations.

3. Timber harvesting is not considered one of the common or significant threats to forest biodiversity or the environment in Australia

Sustainable timber harvesting, conducted within multiple use forests, is not one of the common threats to forest dwelling flora and fauna species listed as threatened species, nor is it considered by Australia's *State of the Forests* report or *State of the Environment* report to be one of the major pressures or threatening processes.

The primary threats to native forests are the same across public land tenures: these are forest and habitat loss predominantly from clearing for agriculture and urban and industrial development; invasive pest species; small population sizes; and altered fire regimes.

Most multiple use public forests in Australia maintain accredited, third-party certification for their forest management, based on standards with annual auditing and reporting. There are very few examples of equivalent programs for national parks or other formally protected forests in Australia, at least to the same level of stakeholder scrutiny and international review. Transferring multiple use public forest to formally protected forest could potentially result in less transparency and reporting under current settings.

4. Sustainable timber harvesting supports a broad range of socio-economic benefits

Timber harvesting in multiple use forests supports the State's capacity to supply a proportion of its own timber, enhancing the resilience to supply chain shocks and disruptions to timber availability in the wake of pandemics, geopolitical tensions and/or increasing costs of imports.

This study has used a welfare economics approach to assess benefits. This enables the results of this assessment to be incorporated directly into future CBAs and business cases. It should be noted that the socio-economic benefits associated with timber harvesting in public native forests also include rural and regional employment, as well as downstream manufacturing, value adding and product innovation. The latter benefits are identified but not quantified in the CBA, to avoid the complexity of ensuring indirect benefits are treated consistently across the options.

5. The cessation of timber harvesting, and transfer from multiple use forests to national parks and conservation reserves, is unlikely to result in any climate change mitigation (emission reduction) benefits

This assessment of forest management models has reviewed peer reviewed research and relevant published (grey) literature and data to derive estimates of carbon stocks and the carbon flux in multiple use forests and formally protected forests in Australia.

These estimates, based on life cycle carbon dynamics for native forests in SCQ, indicate that multiple use management of existing State forests in the region would have a slightly superior outcome in terms of carbon sequestration and storage in forest and offsite storage and substitution impacts, in comparison to formally protected forests, over the longer term.

6. The cessation of timber harvesting, and transfer from multiple use forests to national parks and conservation reserves, may result in lower net social benefits over the longer term

The CBA developed and applied through this assessment indicates there may be a material net benefit to the State from maintaining multiple use production forests with the current level of provisioning services, in contrast to ceasing timber harvesting and transferring these forests to formally protected forests.

The median net benefit of the multiple use model across the full extent of multiple use forests in SCQ is in the order of $5.4 billion (in 2022 dollars) when benefits and costs are assessed over a 100-year evaluation period and discounted at a rate of 2.65%. By comparison, the median net benefit of the protection model is about $4.2 billion, when using the same parameters.

The CBA applied through this assessment excludes the full economic value of pollination services provided by honeybees accommodated in multiple use forests as distinct from national parks in SCQ. While the value of beekeeping services is captured through an assessment of the willingness to pay for apiary sites, the value to other sectors has been excluded largely because beekeepers have been provided further access to certain national parks until 2044. If commercial beekeeping were to be excluded from formally protected forests, the net economic benefits of multiple use forests could be significantly higher.

7. Multiple use forests and formally protected forests provide a complementary set of ecosystem services for Queensland

This assessment has observed public native forests provide a broad range of forest values and ecosystem services, across multiple tenures and forest management models, including multiple use forests and formally protected forests. Therefore, there is no-one preferred forest management model. Multiple use forests and formally protected forests are complementary models, which can both provide a sustainable and broad range of ecosystem services for Queensland.

This complementarity is dependent upon the effective management across all public forest tenures, with adequate resourcing to support the planning and implementation requirements to realise both the differing and complementary management objectives. Queensland's capacity to manage State forests for multiple uses is underpinned by the primacy of its focus on biodiversity conservation and maintaining natural conditions in national parks; and conversely, Queensland can afford to focus on biodiversity conservation and maintaining natural conditions in national parks when it is providing opportunities for a broader range of forest uses in other areas.

8. There will be distributional consequences and impacts (benefits and costs) from changes to forest land uses that are not fully reflected in this regional level analysis

This assessment has focussed on the aggregate value of all benefits and costs to the people of Queensland. However, there are distributional consequences and issues relating to who would benefit most and who would be adversely impacted by the costs. The scope and extent of these potential benefits and costs have not been explored or quantified in this study.

Further considerations

This assessment provides the basis for a range of further considerations for the SCQ Hub and its stakeholders. In the first instance, the key findings from this assessment suggest a basis for further consideration of policy directions under the Native Timber Action Plan, specifically in relation to the future management of State forests and the scope and capacity to maintain a broad range of provisioning services, based on the outcomes of this assessment.

Other considerations relate to supporting further work to address key data limitations in this assessment, particularly in respect to quantifying biodiversity values on public forests and associated management costs, supporting assessments of regionally specific carbon stocks and carbon flux rates, and determining the value of tourism and recreation within State forests.

In addition, this assessment has observed the importance of ongoing engagement with Traditional Owners and Aboriginal and Torres Strait Islander peoples on the management of public native forests. These and related initiatives would strengthen the knowledge base to further inform policy decisions on the future management of Queensland's multiple use forests.

GLOSSARY

ACCU	Australian Carbon Credit Units
BCR	Benefit-cost ratio
CBA	Cost benefit analysis
DAF	Department of Agriculture and Fisheries
DCF	Discounted cash flow
DPI	NSW Department of Primary Industries
EPBC	Environmental Protection & Biodiversity Conservation Act 1999 (Cwlth)
FAO	Food and Agriculture Organization of the United Nations
Formally protected (non-production) forest (protection forest)	For the purposes of this study, a public native forest managed primarily but not exclusively for the conservation of biodiversity values. Other values may include some levels of recreation and tourism, but specifically the management excludes timber harvesting and extractive uses such as quarry materials; and may exclude use for honey production.
GHG	Greenhouse Gas
GRP	Gross regional Product
m^3	Cubic metres
Multiple use production forest (production forest)	For the purposes of this study, a public native forest managed for multiple uses and values, including commercial timber harvesting and the production of wood products, as well as other products (quarrying, grazing apiary) and a suite of services such as recreation activities.
Natural capital accounting	An umbrella term covering efforts to use an accounting framework to provide a systematic way to measure and report on stocks and flows of natural capital (United Nations, n.d.)
NCE	Natural Capital Economics, an Alluvium Group company
NPV	Net present value
NSW	New South Wales
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
LCA	Life Cycle Analysis
NPV	Net present value
QPWS	Queensland Parks and Wildlife Service
QSFUA	Queensland State Forest User Alliance
RFA	Regional Forest Agreement
SCQ	South & Central Queensland
SEQ	South East Queensland
SEQFA	South East Queensland Forests Agreement (1999)
SGP	Stock grazing permits
SOFR	Australia's State of the Forests Report
UNECE	United Nations Economic Commission for Europe
Welfare Economics	A branch of economics that is concerned with wellbeing at an aggregate / economy level. Within welfare economics, wellbeing is expressed in terms of the sum of consumer and producer surplus.
WTP	Willingness to pay
WTWHA	Wet Tropics World Heritage Area

1. INTRODUCTION

1.1 Purpose of study

Indufor and Natural Capital Economics (NCE) have prepared this study for the South & Central Queensland Regional Forestry Hub (SCQ Hub), to provide relevant information regarding the management of the State's natural forests into the future.

The primary focus is a comprehensive cost benefit analysis (CBA) methodology, and best-practice approach to assessing the net benefits of managing native forests for multiple-uses, including timber harvesting and non-consumptive uses such as tourism and recreation, compared to protected natural forests with a more limited range of uses and interventions.

This assessment estimates the costs and benefits that can be gained from public native forests under two alternative scenarios:

- The status quo in terms of continuing with State forests and timber reserves (i.e., multi-use tenures) that provides for selective timber harvesting plus a broad range of other activities, including recreational use and biodiversity conservation ("*multiple use*" option); and
- An alternative scenario in which all harvesting of hardwood timber from the public native forest estate has ceased, and areas of State forest and timber reserves are managed with the objectives of national parks and conservation reserves ("*protection*" option).

1.2 Background

The Queensland Government's Native Timber Action Plan[3], launched in November 2019, was developed to refresh the South East Queensland Forests Agreement (SEQFA), which was signed by the State government, the timber industry and the conservation sector in 1999. The SEQFA aimed to phase out timber production in State forests in the region to allow tenure change of these areas to the conservation estate.

The refreshed Native Timber Action Plan acknowledges the timber industry faces new and unexpected challenges, including the unsuccessful hardwood plantation program (established during the 2000s) that has not delivered an alternative resource, while also highlighting the conservation outcomes sought through the SEQFA continue to remain important.

In this context, the plan specifies that state-owned native timber production will end in the SEQ Regional Plan area (Figure 1-1) on 31 December 2024. The SEQ Regional Plan area includes Brisbane, Moreton Bay, Lockyer Valley, Scenic Rim, Gold Coast, Logan, Redlands, Sunshine Coast and Noosa.

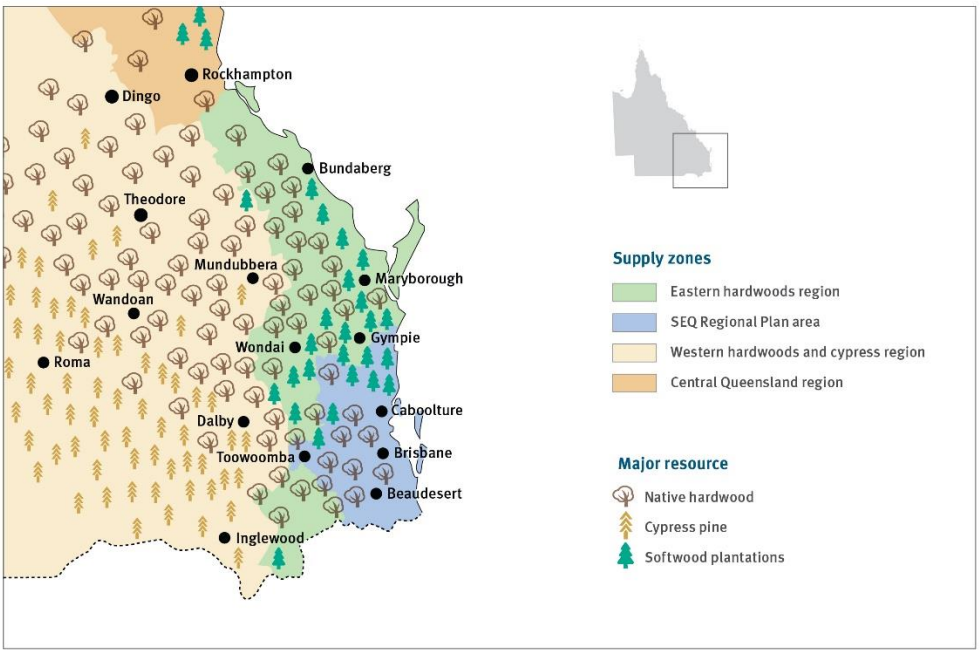
Across the remainder of the SEQ supply region, i.e. the Eastern Hardwoods region, state-owned native timber production will continue through to 31 December 2026. The Eastern Hardwoods region includes areas around Wide Bay, the Fraser Coast, Bundaberg, Gladstone and most of South Burnett, as well as small areas to the east of Toowoomba and Southern Downs.

The renewed timeframe for timber harvesting in the Eastern Hardwoods region provides time to undertake the work required to make informed longer-term decisions, with a view to achieving an appropriate balance between wood production, economic development and environmental values.

The State government has also reconfirmed its plan to transfer high-value conservation areas to the protected area estate. Reflecting this, a commitment has been made to progressively transfer up to 20,000 hectares (ha) of State forest land in the SEQ Regional Plan area to the conservation estate before 2024.

[3] Queensland Department of Agriculture and Fisheries (2022) *Native timber action plan*. Online: https://www.daf.qld.gov.au/business-priorities/forestry/native-timber-action-plan

Figure 1-1 South East Queensland Regional Plan area



Source: Department of Agriculture and Fisheries

The SCQ Hub has observed that a range of recent policy decisions in other Australian states have resulted in or will result in the cessation of timber harvesting in certain public native forests, and this will likely result in tenure changes or forest management zoning changes that transfer multiple-use production forests into protection forests.

Across Australia, between 1996 and 2016, the net harvestable area[4] of public native forest decreased from about 10 million ha to around 5 million ha; due largely to the "*transfer of areas of multiple-use public native forest to nature conservation reserves, as well as increases in areas to which harvesting restrictions apply*"[5]. Over this same period, Queensland's net harvestable area of public native forest decreased from 3.2 million ha to around 1.9 million ha[6].

Many of these transfers of native forest land tenure across Australia were undertaken as part of the Regional Forest Agreement (RFA) process between the Commonwealth and State Governments to identify and establish a mix of protection forests and multiple-use production forests.

In the context of Queensland, the SCQ Hub has engaged this assessment to provide a broad-based and robust economic assessment of the net benefits from multiple-use forests in the region, to support further informed discussion about the implications of alternative options.

Through this assessment, the SCQ Hub is looking to address the full range of ecosystem services and benefits to be considered and provide guidance on relevant best practice cost benefit methodologies.

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[4] The net harvestable area refers to available and suitable for commercial wood production after taking account of additional exclusions and restrictions imposed to manage non-wood values (ABARES, 2018).

[5] Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee (2018) *Australia's State of the Forests Report 2018*. ABARES, Canberra, December. CC BY 4.0

[6] *Ibid*. Refer Table 2.3.

1.3 Study scope

This assessment of net benefits from multiple-use forests has encompassed consideration of a broad range of forest values, including biodiversity conservation and ecosystem services comprising *regulating services* such as carbon sequestration and water filtration, *provisioning services* such as timber production and beekeeping for honey production and pollination services, and *cultural services* including recreation and tourism.

This assessment is based on an expert desktop study, which draws principally on an expert review of relevant published literature and data; with only limited scope for consultation to identify and access relevant information. In addition to setting out a best practice cost-benefit methodology, this study has encompassed:

- a review of academic and grey literature of benefit valuations as well as limitations of fire management research;
- commentary on the application of cost-benefit principles and findings to the future management of multiple-use forests in the SCQ region; and
- quantification and valuation of the net benefits from multiple-use forest management, through a CBA, where data was readily available and could be cited.

This assessment has considered risks to natural forests posed by climate change and associated threats, including bushfires and cyclones, droughts and floods, feral pests, invasive plant species and diseases – and importantly, has factored this into the costs and benefits of mitigation actions and investments in forest protection programs across landscapes.

The data used for this assessment is predominantly secondary data, collected through desktop research of existing studies and reports. In some cases, the data was non-specific to the study region and was limited in scope. These factors, combined with the age of some data used, impact the robustness of the CBA results.

The use of imperfect data is relatively common in CBAs for natural resource management in Australia and many other countries, due to the level of resources required to perform primary data collection. Furthermore, primary data collection, which involves gathering data through methods such as interviews and surveys, seldomly provides perfect information. It is for these reasons that sensitivity analysis is a critical part of performing a CBA. Along with providing an understanding of how results will alter with changes in input values, sensitivity analysis provides insight into which inputs have the most impact on the CBA results, and therefore, for which inputs further work on enhancing data is most worthwhile.

However, the limitations of the data used do affect the precision of the CBA results. In this context, the findings are intended to inform policy deliberations based on robust consideration of key factors, rather than purport to be a definitive quantitative assessment of forest values.

1.4 Report structure

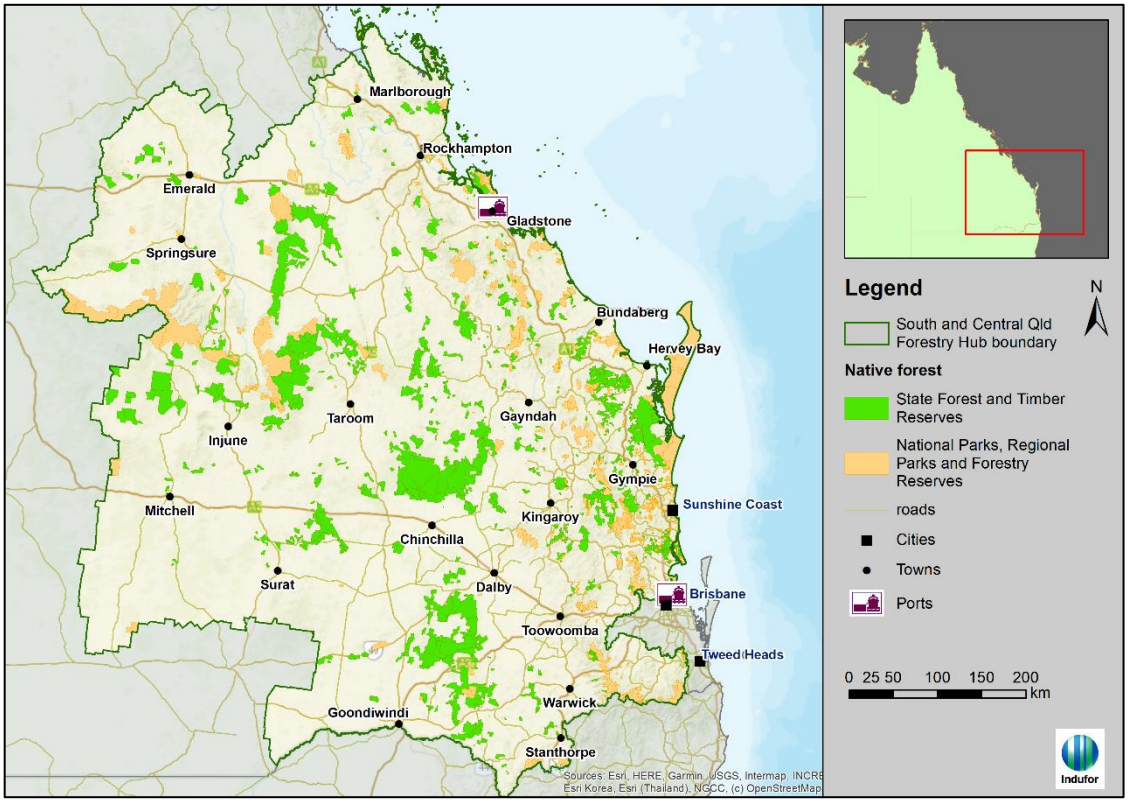
The following report is structured as follows:

- Section 2 sets out the geographic scope of the state-owned native forest areas that is considered in this assessment;
- Section 3 describes the current regulatory instruments and management of public native forests within this study region;
- Section 4 presents a literature review of relevant studies, across a range of key themes;
- Section 5 describes the methodology used to conduct a CBA for this region;
- Section 6 sets out the assessment outcomes with a discussion of the implications, including the results of a sensitivity analysis; and
- Section 7 sets out conclusions arising from this study.

2. THE STUDY REGION

The study area for this assessment is the boundary of the Southeast and Central Queensland Forestry Hub, which is set out below (Figure 2-1). This boundary encompasses public native forests within 23 regional council areas, extending from the NSW border up north of Rockhampton, and west from the coast to Injune and Emerald in Central Queensland[7].

Figure 2-1 Study area for forest management analysis in South & Central Queensland



Source: Queensland Regional Forestry Hubs (2022); Spatial data: Department of Environment and Science (2022).

The total area of public native forests in this study region is close to 4.3 million ha (Table 2-1). State forests, timber reserves and other multiple use forests, which are managed for multiple uses that include selective timber harvesting as well as recreation and a broad range of other activities, currently account for around 64% of this area.

National parks and conservation reserves now comprise around 36% of this area, i.e., over a third of public native forests in the region are formally protected for conservation and a limited range of recreation activities. This is significantly higher than the state-wide proportion of forest in the National Reserve System (encompassed in the International Union for Conservation of Nature (IUCN) protected area categories), which was around 17% in 2018[8].

It is important to note that up until the mid-1970s, most of these public native forests, including areas that are now protected forests, were managed by the Queensland Department of Forestry (noting its predecessors and subsequent name changes since the establishment of a Forestry Branch within the Department of Public Lands in 1900); and were managed under regimes that had evolved towards or effectively become multiple use production forests or forest reserves.

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[7] The Regional Forestry Hub encompasses Banana Shire; Bundaberg; Central Highlands; Cherbourg Aboriginal Shire; Fraser Coast; Gladstone; Goondiwindi; Gympie; Livingstone Shire; Lockyer Valley; Maranoa; Moreton Bay; Noosa Shire; North Burnett; Rockhampton; Scenic Rim; Somerset; South Burnett; Southern Downs; Sunshine Coast; Toowoomba; Western Downs; and Woorabinda Aboriginal Shire.

[8] ABARES (2018) *Australia's State of the Forests Report 2018*. Refer Table 1.18.

Table 2-1 Study area by land tenure, 2022

Land tenure	Forested area (million ha)	Forested area (%)
State forests (multiple use forests)	2.74	64%
National Parks and conservation reserves	1.54	36%
Public forest land	4.28	100%

Source: Indufor analysis; Queensland Regional Forestry Hubs (2022)[9]; Queensland Department of Environment & Science (2022)[10]

Queensland's National Parks & Wildlife Service (QPWS) was established in 1975, through the enactment of the *National Parks & Wildlife Act 1975*. The first national park in Queensland, Witches Falls (in today's Tamborine National Park), was gazetted in 1908; followed by Bunya Mountains National Park in July 1908, and then Lamington National Park in 1915[11].

The establishment of the earliest national parks was driven in large part by concerns about the extent of forest 'clearing', for timber, grazing and residential development[12] – in contrast to more selective and sustainable timber harvesting that aligns with contemporary forestry principles and practices. Professional forestry principles and practices were introduced, promoted and increasingly regulated through the first half of the last century. During this period, national parks were managed by a small branch within the Department of Forestry. More national parks were added and progressively expanded over time. Since the formation of QPWS, this expansion of formally protected parks and reserves has continued; and Queensland's Protected Area Strategy 2020-2030 clearly states the intent to sustainably 'grow' the extent of national parks across the State, including forested areas[13].

An implication of this relatively recent history is that important biodiversity values and ecosystem services were being managed and generally maintained under a 'forestry' regime, of predominantly multiple use management, up until the 1970s. Since that time, some of these areas that had been managed as multiple use forests, have been deemed to be of sufficiently high conservation value to establish national parks and other formal conservation reserves. This indicates that the management of these areas for 50-80 years as multiple use production forests did not greatly diminish their conservation values.

[9] Queensland Regional Forestry Hubs (2022) *South & Central Queensland: Our Region*. Online, accessed 1 April 2022: https://www.qldforestryhubs.com.au/our-region-s-cq

[10] Queensland Department of Environment and Science (2022) Protected areas of Queensland v6.13 [*Shapefile geospatial data]*. Published 16 February 2022. Modified using ArcMap 10.8 as a subset of the original dataset accessed online via the Queensland Spatial Catalogue on 1 April 2022: https://qldspatial.information.qld.gov.au/catalogue/custom/detail.page?fid={07E360E3-A191-4C24-9671 1471362F0B1B}.

[11] Queensland Government (2022a) *Parks and forests - Nature, culture and history*. Online, accessed 2 May 2022: https://parks.des.qld.gov.au/parks/tamborine/about/culture

[12] *Ibid*.

[13] Queensland Government (2020a) *Queensland's Protected Area Strategy 2020-2030*. Online, accessed 2 May 2022: https://parks.des.qld.gov.au/__data/assets/pdf_file/0016/212524/qld-protected-area-strategy-2020-30.pdf

3. MANAGING PUBLIC FOREST LANDS IN SOUTHEAST QUEENSLAND

3.1 Management objectives across tenures

This study is focused on comparing two main types of public forest land tenure in Queensland:

- State forests and timber reserves (i.e., multiple-use tenures) that provides for selective timber harvesting plus a broad range of other activities, including recreational use and biodiversity conservation under existing protection measures ("multiple use" option);
- National parks and conservation reserves (i.e., formally protected forests), which place primacy on biodiversity conservation and protection of natural and cultural values, and forest uses are largely limited to recreation and tourism ("protection" option).

As directed under relevant legislation and regulations, these land tenures have different management objectives and they aim to deliver different ecosystem services. A summary of the general intent of the management objectives and permitted activities for these public forest lands in Queensland is set out in Table 3-1, in the context of defined ecosystem service categories[14]. Further descriptions of the primary management objectives and permitted activities are set out below.

Table 3-1 Comparison of key services provided under public forest land tenures

Natural capital services	Multiple use State forest 'Production forest'	Formally protected forest 'Protection forest'
Provisioning services:		
Timber and wood products	✓	×
Fuelwood production	✓	×
Extractive industries - gravel / stone / minerals	✓	×
Non-wood forest products – e.g. honey	✓	Exclusion with transitions
Non-wood forest products - grazing & livestock feed	✓	×
Pollination services – beekeeping in native forests	✓	Exclusion with transitions
Clean water supply	✓	✓
Genetic resources – e.g. seed of forest species	✓	✓
Regulation services:		
Biological control – e.g. pests and diseases	✓	✓
Water regulation	✓	✓
Water purification	✓	✓
Air quality regulation	✓	✓
Climate regulation – e.g. carbon sequestration	✓	✓
Soil protection	✓	✓
Biodiversity repository	✓	✓
Hazard regulation	✓	✓
Cultural services:		
Spiritual & cultural	✓	✓
Historical	✓	✓
Education	✓	✓
Tourism	✓	✓
Recreation, e.g. hiking, picnicking, camping	✓	✓
Sport, e.g. fishing, mountain biking, motor sports	✓	×
Hunting – e.g. feral animals	×	×

Source: based on the Common International Classification of Ecosystem Services (CICES); primary management objectives and permitted activities populated by Indufor & Natural Capital Economics.

[14] Haines-Young R. and Potschin MB (2018): *Common International Classification of Ecosystem Services (CICES) V5.1 and Guidance on the Application of the Revised Structure*. Online, accessed 1 April 2022: www.cices.eu

Importantly, this comparison shows the choice of forest land tenure and the subsequent uses of native forests has a profound impact on the values that are derived from the forest natural capital. Economic analysis enables the trade-offs between forest land tenure decisions to be made in an informed way.

It is important to highlight there is a broad range of public land tenures on which there may be native forest, and the management intent and services can vary, although within the bounds of regulatory requirements. Furthermore, there are internationally recognised categories that reflect varying objectives. For example, the IUCN classifies six different types of protected areas, including *Category VI: Protected area with sustainable use of natural resources*, which provide for low-level non-industrial use of natural resources[15]. These are generally large areas, with most of the area in a natural condition, where a proportion is under sustainable natural resource management and where low-level non-industrial use of natural resources compatible with nature conservation is seen as one of the main aims of the area. This is an example of an internationally recognised tenure or management in which low level production activity can be integrated with nature conservation objectives.

The two main groupings set out above encompass most of public native forests in SCQ that are managed specifically for their forest values. Key features of the current regulatory directives and management are outlined below.

3.2 Management of multiple use production forests

3.2.1 Regulatory framework and the Cardinal Principle

Queensland's *Forestry Act 1959* provides for forest reservations, and the management, silvicultural treatment and protection of State forests, including the sale of state-owned forest products and quarry material. The Forestry Act applies to State forests, timber reserves, leasehold lands, reserves, public lands and certain freehold lands.

The Act also sets out the ***cardinal principle*** to be observed in the management of State forests, being *the permanent reservation of such areas for the purpose of producing timber and associated products in perpetuity and of protecting a watershed therein*[16]. Forest products includes timber and non-wood products such as honey, seeds and flowers.

Under the Forestry Act, the chief executive of the responsible agency must ensure State forest is managed in ways considered appropriate to achieve the Act's purposes, having regard to:

- the benefits of permitting grazing in the area;
- the desirability of conservation of soil and the environment and protection of water quality; and
- the possibility of applying the area to recreational purposes.

Furthermore, under Section 34 (j) of the Act, the chief executive may from time to time, for the purposes of the use and management of State forests, *promote and encourage the use of a State forest or any part or parts thereof for recreational purposes*. Therefore, the current legislation in Queensland makes it clear the intent in classifying public lands as State forest was, and remains, to ensure:

- permanent reservation of such areas for producing timber and associated products;
- these lands can be used for grazing enterprises where complementary;
- these lands can be used for a range of recreational purposes;
- management decisions incorporate consideration of the desirability of conservation, of soils, water resources, and conservation of soil and the environment more broadly.

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[15] IUCN (2008) *Guidelines for Applying Protected Area Management Categories*. Online, accessed 1 April 2022: https://portals.iucn.org/library/efiles/documents/pag-021.pdf

[16] *Forestry Act* 1959 (Queensland), section 33 - *Cardinal principle of management of State forests*.

In addition, there is other State legislation in Queensland that sets out regulatory requirements for the management of multiple use forests that extend beyond timber production, watershed protection and enabling use for recreational purposes. These include, for example:

- the *Environmental Protection Act 1994*, which has requirements aimed at protecting Queensland's environment while allowing for development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends ('ecologically sustainable development');
- the *Queensland Heritage Act 1992*, which has regulatory requirements that provide for the conservation of Queensland's cultural heritage for the benefit of the community and future generations; and
- the *Aboriginal Cultural Heritage Act 2003* and *Torres Strait Islander Cultural Heritage Act 2003*, which seek to provide effective recognition, protection and conservation of Aboriginal and Torres Strait Islander cultural heritage, by providing blanket protection of areas and objects of traditional, customary, and archaeological significance, and recognising the key role of Traditional Owners in cultural heritage matters.

These statutes apply across public land that includes State forests. Therefore, while the Forestry Act and its cardinal principle recognises permanent reservation of State forests and timber reserves for the purpose of producing timber and associated products in perpetuity, the regulatory framework in Queensland clearly recognises a broader range of values that need to be managed through stewardship and conservation of multiple use forests.

3.2.2 Voluntary certification schemes

In addition to regulatory mechanisms that prescribe forest management, the Department of Agriculture and Fisheries' (DAF) forest management system for native forest harvesting in multiple use forests is independently certified to the Australian standard® for sustainable forest management (AS 4708) under the Responsible Wood Certification Scheme[17], which requires DAF to, among other things, ensure the maintenance of biodiversity, forest health, soil, water, cultural heritage and other values. This voluntary certification program provides a framework for regular (annual) monitoring and reporting on the management of State forests and assessing the extent to which they are conserved and managed responsibly to ensure they deliver social, environmental and economic benefits.

There are very few examples of equivalent or similar programs for national parks or other formally protected forests in Australia, at least to the same level of stakeholder scrutiny and international review.

3.2.3 Government agency responsibilities

The QPWS, which is part of the Department of Environment and Science, has overarching responsibility for the overall management and day-to-day administration of State forests (encompassing multiple use production forests), including any non-commercial activities.

Under the custodianship of the QPWS, the DAF – and its Forest Products unit - is responsible for activities related to the supply of native forest timber and other forest products from State forests. Other forest products include seeds and foliage, and quarry material, as well as managing access for beekeeping. These activities can occur on State forests, timber reserves, leasehold lands, reserves, public roads and certain freehold lands where the State has retained ownership of the forest products or quarry material. These activities are subject to legislation that protects environmental and cultural heritage values, recognises native title rights, and requires a safe and healthy work environment.

[17] Responsible Wood (2022) *Forest Products – DAF*. Online: https://www.responsiblewood.org.au/certificate_holder/forest-products-daf/

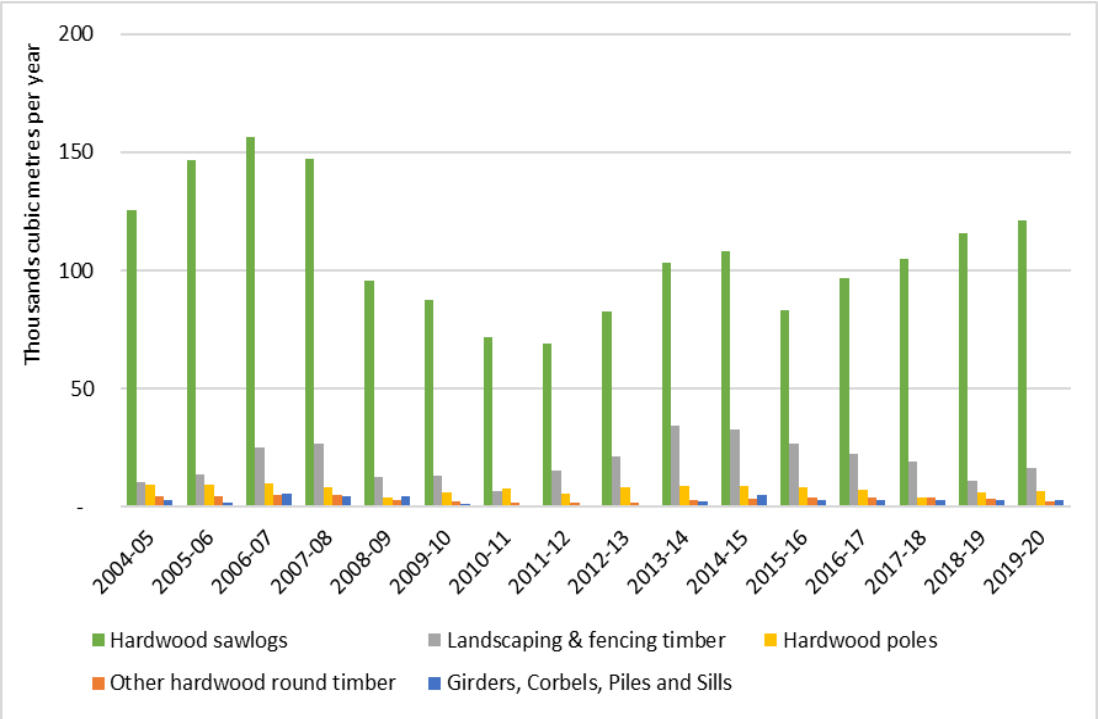
Beyond these functions managed and administered by the DAF Forest Products unit, QPWS' focus on provisioning services from multiple use forests is limited, largely to clean water supply.

3.2.4 Forest uses in State forests and timber reserves

Sustainable timber production

As outlined above, one of the primary intended uses of State forests is sustainable timber harvesting for a range of hardwood products. Over the past three years, Queensland's total annual hardwood log harvest from public native forests (excluding native cypress pine) has totalled around 140,000 cubic metres (m^3) per year (Figure 3-1); of which sawlogs constitute around 80+%, reflecting highly selective single tree harvesting practices, with no pulpwood production from Queensland native forest, unlike other states of Australia.

Figure 3-1 Hardwood log removals from Queensland State forests, 2004-05 to 2019-20

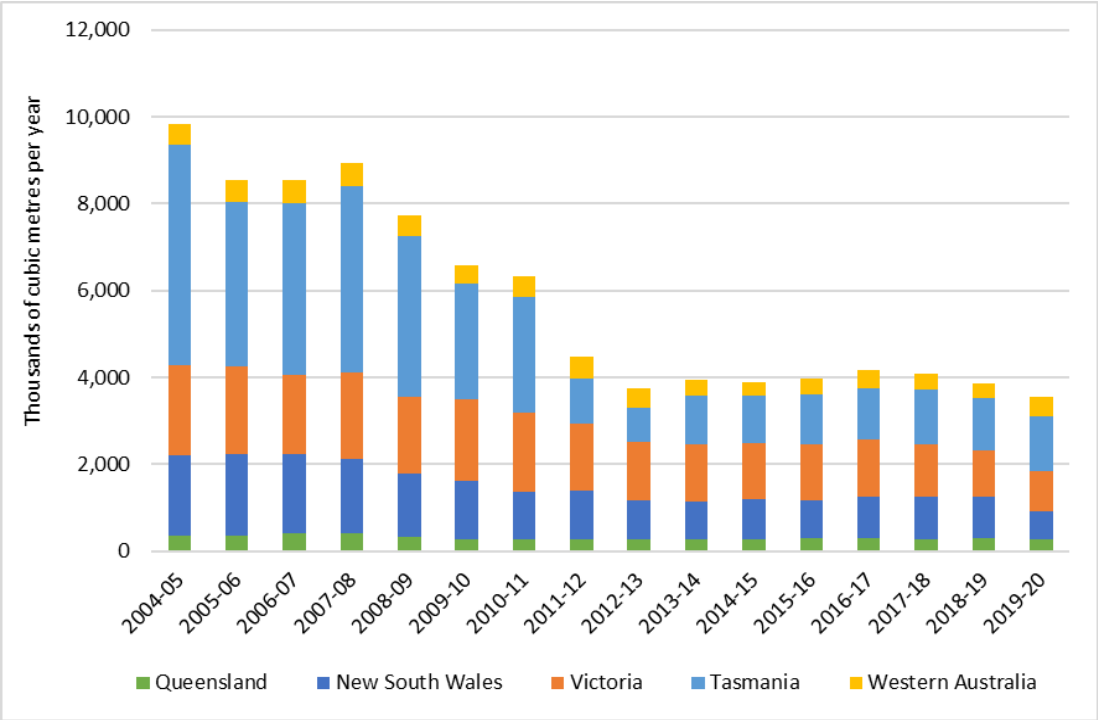


Source: Queensland Department of Agriculture and Fisheries

Queensland's hardwood native forest log production (from public and private forests) is relatively small compared to most other states of Australia (excluding South Australia); accounting for around 6% on average of total hardwood native forest logs in Australia (Figure 3-2). Over the decade 2010 – 2020, private native forests supplied approximately 55% of the hardwood resource to industry in Queensland[18] – i.e., the major share of supply to industry. This means the total supply from Queensland's public native forests (State forests) is smaller again when compared to other states of Australia where the State forest supply is the primary source of native forest hardwood log production (e.g. NSW, Victoria and Tasmania). However, the productive condition of Queensland's private native forest resource is highly variable[19], and the State forest supply provides a very important underpinning of forest industry development.

[18] Lewis T, Venn T, Francis B, Ryan S, Brawner J, Cameron N, Kelly A, Menzies T, Schulke B (2020) I*mproving productivity of the private native forest resource in southern Queensland and northern New South Wales*. Report prepared for FWPA, Project number: PNC379-1516, April 2020.
[19] *Ibid*.

Figure 3-2 Hardwood native forest log production for selected states, 2004-05 to 2019-20



Source: ABARES Australian Forest & Wood Products Statistics

In 2020/21, direct timber revenues from public native forests in SEQ totalled in the order of $11 million (Table 3-2). These log products are directed to downstream processing and value adding; and a socioeconomic assessment in 2018 determined forest industry business activities dependent on eucalypt native forests directly contributed around $181 million to Gross Regional Product (GRP) in 2015-16 (once flow-on effects through the entire economy were included)[20].

Table 3-2 State revenues from forest product removals from Queensland public native forests (excluding cypress pine), 2020-21

Forest products from public native forests	State revenue ($)
Hardwood sawlogs	$ 8,633,082
Poles	$ 1,526,704
Girders, Corbels & Piles	$ 414,732
Logs for landscaping and fencing timber	$ 507,224
Logs for other hardwood timber	$ 88,584
Other logs (includes some firewood)	$ 156,278
Misc. foliage/seed	$ 50,813

Source: Queensland Department of Agriculture and Fisheries.

Across the State (i.e., SEQ *plus* northern regions), a total of 22 larger primary processors (employing more than 10 people) were engaged in sawmilling or other processing of logs from publicly and privately owned native eucalypt forests, of which all but five are dedicated solely to processing native eucalypt logs. About 37 additional mills (employing up to 10 people) process small amounts of logs harvested from a mix of publicly and privately owned native forest[21].

[20] Schirmer J, Mylek M, Magnusson A, Peel D, and Morison J (2018) *Socioeconomic impacts of the forest industry – Queensland*. 2nd edition, May 2018. Report prepared for FWPA.
[21] *Ibid.*

Quarry material

State forests and timber reserves also provide quarry material to support the construction and maintenance of roads and other infrastructure. A summary of state-owned quarry material revenues and expenses attributable to public multiple use native forests is outlined in Table 3-3. DAF has attributed the significant uplift in revenues in 2020-21 royalties to infrastructure and mining projects[22]. These extractive activities are not permitted in formally protected forest areas.

Table 3-3 State revenues and expenses from state-owned quarries in multiple use forests, 2016-17 to 2020-21

Quarry materials	2016-17	2017-18	2018-19	2019-20	2020-21
Actual royalties' revenue	$7,938,951	$10,404,108	$9,977,652	$10,953,755	$25,880,257
Actual total expenses	$2,705,864	$2,860,501	$2,900,290	$2,743,006	$2,976,335

Source: Queensland Department of Agriculture and Fisheries.

Recreation and tourism

Queensland's multiple use native forests are used extensively for recreation and tourism. Permitted activities include those that are enjoyed in national parks, plus others that are generally excluded from or restricted in national parks - such as four-wheel driving, motorcycle riding, fossicking and recreational prospecting, mountain bike riding and horse riding.

There is no published data currently available on total visitor numbers or revenues for recreation and tourism specifically within State forests in Queensland. The Queensland State Forest User Alliance (QSFUA) has asserted in a submission to the State's Tourism Industry Reference Panel, the total value of potential recreational forest uses in Queensland, could generate up to $500 million per year[23]; however, this is an estimate of potential value rather than current actual values (or empirical data), and the QSFUA has asserted that realising these revenues would be dependent on some significant changes to the way in which State forests are managed for recreation and tourism, e.g.

- Expanding the number and range of areas in which camping is permitted;
- Extending access for four-wheel driving and trail bike riding, beyond gazetted roads;
- Expanding the range of areas for recreational prospecting and fossicking.

It should be noted that these types of activities and forest uses already occur in State forests at a level - and the QSFUA has not suggested they replace sustainable timber harvesting, but rather there should be further investment in these complementary activities. The QSFUA advocates that sustainably managed State forests can in many cases preserve habitat and mitigate carbon better than national parks, because the management of these forests can be funded from the sustainable harvesting of timber; with the revenue spent on, amongst other things, the infrastructure in the forest which is able to be used by forest-based tourists[24].

Two other important provisioning services from Queensland's multiple use State forests include livestock grazing and beekeeping.

Grazing in State forests

Under the Forestry Act, stock grazing for cattle and horses is supported in State forests, through the administration of stock grazing permits (SGP), on the basis it increases the flexibility of cattle management in Queensland and allows graziers to feed their livestock with food sources

[22] Queensland Department of Agriculture and Fisheries (2021) *Annual Report 2020-2021*, p64.
[23] Queensland State Forest User Alliance (2020) *Submission to Tourism Industry Reference Panel, "Designing Our Tourism Future" consultation*. Online: https://www.dtis.qld.gov.au/__data/assets/pdf_file/0004/1583563/queensland-state-forest-user-alliance.pdf
[24] *Ibid.*

growing on state-owned land[25]. The value of this grazing in SEQ State forests, in terms of livestock production and permit revenues to the State, is estimated to be in the order of around $3-4 million per year, excluding downstream processing and sales[26].

Beekeeping for honey production and pollination services

Like grazing, beekeeping is permitted in State forests, whereas under State policy there is the intent to exclude it from national parks. This has been a contentious issue in Queensland, as beekeeping had traditionally been conducted on State forests and forest reserves for over 100 years until the introduction of the SEQ Forests Agreement consigned some State forests and forest reserves, containing over 1,000 apiary sites into 49 national parks[27]. Under the *Nature Conservation Act 1992*, apiarists were required to transition out of national parks, by the end of 2024; however, successive Queensland governments and the industry have been unable to find suitable alternative honey sites for beekeeping.

State government concerns about beekeeping in national parks relate mainly to supporting commercial operations that are based on using European honeybees ('invasive bees'), which compete to an extent with native bees. The Australian Government Department of Agriculture has stated that feral European honeybees can outcompete native fauna for floral resources, disrupt natural pollination processes and displace endemic wildlife from tree hollows[28]. However, the Department has also observed there is insufficient research about interactions between European honeybees and Australian biota to fully describe their impacts.

Relatedly, a study by Curtin University on the evidence for and against competition between the European honeybee and Australian native bees found the data on whether honeybees outcompete native bees is equivocal: there were no associations found in relation to native bee abundance, species richness, or reproductive output in most cases[29]. The study concluded the effects of honeybees are species-specific, and more detailed investigations regarding how different species and life-history traits affect interactions with honeybees is needed.

Meanwhile, Queensland beekeepers have highlighted the State's horticultural and agricultural industries are underpinned by abundance of healthy bee colonies for pollination, resulting in contributions up to $2.8 billion to the Queensland economy through managed honeybee pollination services[30],[31]. Beekeepers contend their ability to supply these colonies is underpinned by maintaining access to Queensland nutrient rich native forests. Commercial beekeeping has a migratory nature and beehives are transported between different floral resources to meet the nutrition needs of the bees. Commercial beehives from Queensland provide pollination services across the state and in New South Wales, Victoria and South Australia. Queensland beekeepers have reported that in 2021, approximately 30,000 hives travelled to southern NSW, Victoria and South Australia to provide vital pollination services to the Australian almond industry[32].

In November 2021, the State government formally extended beekeeping permits for a further 20 years in certain national parks created as part of the SEQ Forests Agreement, while noting

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[25] Queensland Government (2022b) *Stock grazing in state-owned forest.* Online: https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/grazing-pasture/grazing-state-forest

[26] Unpublished data: NCE & Indufor's indicative estimates of the grazing permit revenues to the state, based on indicative grazing areas, stocking rates and current beef prices.

[27] Queensland Government (2021a) *Beekeeping allowed to continue in Queensland national parks for now*. Media release by Mark Furner MP, 11 October 2021.

[28] Australian Government Department of Agriculture (2022) *Invasive bees*. Accessed on 27 May 2022: https://www.awe.gov.au/biosecurity-trade/invasive-species/insects-and-other-invertebrates/invasive-bees

[29] Prendergast K, Dixon K, Bateman P (2022) The evidence for and against competition between the European honeybee and Australian native bees. *Pacific Conservation Biology*, doi:10.1071/PC21064.

[30] Queensland Beekeepers Association Inc. (2022) *Submission to the State Development and Regional Industries Committee - The Nature Conservation and Other Legislation Amendment Bill 2022*. Accessed on 1 September 2022: https://documents.parliament.qld.gov.au/com/SDRIC-F506/NCOLAB2022-216E/submissions/00000021.pdf

[31] Karasiński J (2018) *The Economic Valuation of Australian Managed and Wild Honey Bee Pollinators in 2014 – 2015*. Accessed on 1 September 2022: www.aussiepollination.com.au/pdf/Karasinski JM 2018 The Economic Valuation of Aust Managed and Wild Honey Bee Pollinators in 2014-2015.pdf.

[32] Queensland Beekeepers Association Inc. (2022) *op cit*.

its intent to continue working with industry and other key stakeholders to identify alternative sites for the future relocation of beekeeping off national parks. Queensland beekeepers have welcomed this extension of access until 2044, noting it provides the industry confidence to invest in the future[33].

In relation to this cost benefit analysis for public native forests, the extension to 2044 means that for the next 20 years, the economic value of pollination services provided by (beekeepers access to) multiple use forests and certain national parks in Queensland will not differ significantly. Principally for this reason, this assessment of the net benefit of multiple use native forest management does not include a specific economic value for pollination services. The value of honeybees in public native forests is captured through the willingness to pay of beekeepers for apiary site permits in these forests. This is a partial valuation only, based on the benefit derived from honey production and recreational beekeeping. A robust estimation of the value of pollination services from multiple use forests specifically would require development of a sophisticated economic model integrating contributions made by honeybee pollinators, farm gate prices of pollinated agriculture crops and the elasticity of demand, to determine the values. The model would also need to be developed at a national level to account from demand and supply dynamics in agricultural markets across state borders.

Therefore, this assessment addresses the value of pollination services in largely qualitative terms. However, it should be noted that the economic value is considerable and would be a significant differentiator if commercial beekeeping were to be excluded from formally protected forests (as might occur post 2044); in which case, the net economic benefits of multiple use forests would be significantly higher.

3.2.5 Managing biodiversity and other values

While multiple use State forests provide a range of provisioning services, they are also managed in accordance with the *Forestry Act* 1959 for the conservation of soil and the environment and protection of water quality. Timber harvesting is excluded from reserves within State forests, and areas such as steep areas, riparian zones and special habitat zones where harvesting is restricted by the Code of Practice for Native Forest Timber Production on Queensland's State Forest Estate (the Code of Practice)[34]. The proportion of multiple use production forest selectively harvested each year is currently in the order of 0.3%; with the balance managed for a broad range of environmental and social values.

Importantly, Queensland's Code of Practice provides a suite of environmental protection measures within selectively harvested areas to maintain biodiversity and other environmental values. These measures include (noting this is not an exhaustive list): retention and recruitment of specified numbers of habitat trees; minimum basal areas (i.e., permanent forest cover); maintaining ecological processes; minimal compaction of soil resources; watercourse setbacks; wetland protection; roading design and drainage; and weed and pest management. These measures provide a further basis to support the assumption of the relatively low impact of harvesting operations on biodiversity values across State forests.

Furthermore, monitoring and compliance systems are in place for native forest harvesting under the Forestry Act. The DAF, and QPWS, as the custodians of State forests and timber reserves in Queensland, audit native forest harvesting on State forests and timber reserves. *State of the Forests* reporting to date has observed there were no significant non-compliances or breaches reported for native forest activities authorised under the Act[35].

State of the Forests reporting has also observed during the last decade that Queensland's regeneration of State forests post-timber harvesting has been 100% effective (full regeneration). This is the leading result in Australia, with effective regeneration rates across other states being 95% for Tasmania, 92% for Victoria, 79% in NSW, and Western Australia's effective

[33] Queensland Government (2021a) *op cit.*
[34] Queensland Government (2020b) *Code of practice for native forest timber production on Queensland's State forest estate*. Prepared by the Queensland Parks and Wildlife Service.
[35] Montreal Process Implementation Group for Australia & National Forest Inventory Steering Committee, (2018) *op cit*.

regeneration reported simply as adequate[36]. This is largely attributable to the low intensity, single tree selection harvesting practices in Queensland, incorporating natural regeneration.

3.2.6 Fire management

Fire is a common land management tool in SCQ; and broadly, fire management in public native forests is conducted in similar ways across State forests (multiple use forests) and national parks and reserves (formally protected forests). The QPWS is the main land management agency responsible for planned burning on state–government-managed public land.

On public land in the SEQ region, planned burns (also described as prescribed burns) is mostly used to reduce the risk of unplanned fire (bushfires), through reducing fuel loads and modifying fuel structure, and for encouraging biodiversity through the potential ecological benefits for flora and fauna in specific ecosystems[37]. Despite known benefits of planned burning in certain ecosystems, fire is not applied to all ecosystems equally, mainly owing to the lack of resources available for planned burning over large areas, and to the varying fire requirements or sensitivities to fire of different vegetation types.

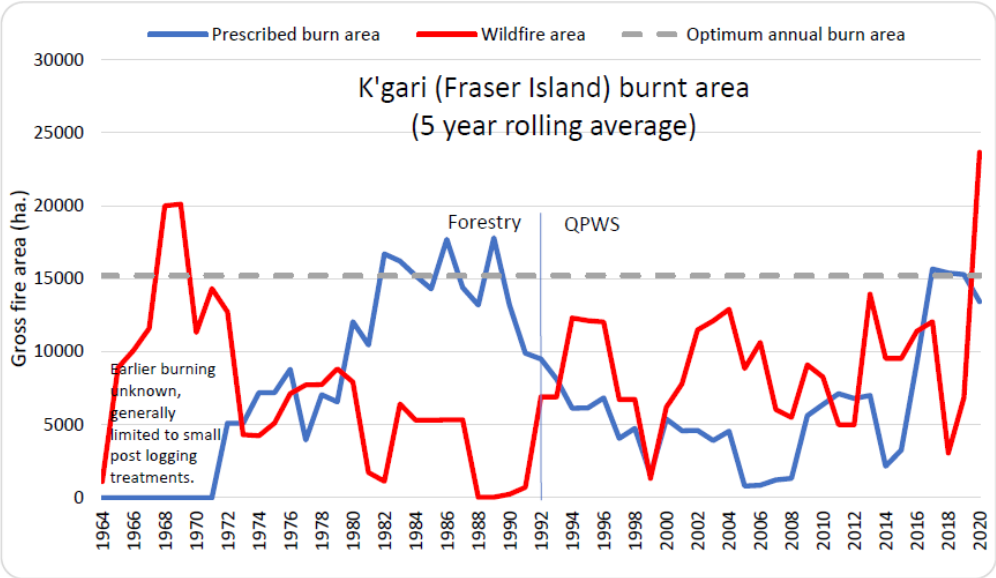
There is some empirical data to support anecdotal information that points to the observation that, historically, there was more planned burning conducted on State forests (multiple use management); both in Queensland and across other states of Australia. For example, in relation to the fire management history on K'gari (Fraser Island), the Institute of Foresters of Australia reported that from the early 1960s, the Queensland Department of Forestry changed from its fire exclusion policy and reintroduced a pattern of prescribed burning with extensive mosaic burning over large blocks. Between 1972 and the end of Department of Forestry management on the island in 1992, planned burning in forests averaged about 12,000 ha per year, and bushfires significantly reduced to an average of about 5,000 ha per year (in contrast to the 85,000 ha burnt in the most recent bushfires on K'gari in late 2020)[38]. After 1992, when State forests were transferred from the Department of Forestry to QPWS, the annual area of planned burning declined; which was followed by an upward trend in the area of unplanned fire (bushfires). This trend incorporating a five-year rolling average is shown in Figure 3-3. The spike in 2020 represents the increase in the rolling average following the most recent bushfires that burnt on K'gari for a period of two months.

[36] *Ibid*.

[37] Eliott M, Lewis T, Venn T, and Srivastava SK (2019) Planned and unplanned fire regimes on public land in south-east Queensland. *International Journal of Wildland Fire*, https://doi.org/10.1071/WF18213

[38] Institute of Foresters of Australia (2021) *Submission to IGEM K'gari Bushfire Review*, January 2021.

Figure 3-3 Fire history on K'gari, based on 5-year rolling average estimates, 1964-2020



Source: Institute of Foresters of Australia submission to IGEM K'gari Bushfire Review. Note these are 5-year rolling average estimates based on QPWS fire records, old management plan data and Landsat fire scar mapping.

Recent reporting by QPWS indicates there has been concerted efforts to increase planned burning across QPWS-managed state public land, encompassing State forests as well as national parks and conservation reserves in SCQ. These initiatives are discussed further in relation to the management of formally protected forests (refer section 3.3.5). However, there is at present no publicly reported regional breakdown of this performance, or a breakdown by tenure to compare activity on State forests with national parks and reserves. This reflects the ongoing issues of limited resources available for government agencies to ensure an appropriate level of planned burning, to achieve risk-reduction objectives and ecological objectives[39].

3.3 Management of formally protected forests

3.3.1 Regulatory framework and the Cardinal Principle

Formally protected forests (protected areas) in Queensland are managed in accordance with the *Nature Conservation Act 1992*, which makes provisions for a broad range of protected areas and forest reserves. This range of protected areas includes national parks (of varying types including special management areas), conservation parks, resources reserves, special wildlife reserves, nature refuges and coordinated conservation areas.

The scope for this assessment limits the focus on protected areas largely to national parks, which under the Nature Conservation Act, must be managed to[40]:

- provide, to the greatest possible extent, for permanent preservation of the area's natural condition and the protection of the area's cultural resources and values;
- present the area's cultural and natural resources and their values;
- ensure that the only use of the area is nature-based and ecologically sustainable;
- provide opportunities for educational and recreational activities in a way consistent with the area's natural and cultural resources and values; and
- provide opportunities for ecotourism in a way consistent with the area's natural and cultural resources and values.

[39] Eliott et al. (2019) *op cit*.
[40] *Nature Conservation Act 1992*, section 17.

Section 17(2) of the Act specifies the ***cardinal principle*** for management of national parks is to provide, to the greatest possible extent, for permanent preservation of the area's natural condition and the protection of the area's cultural resources and values.

In general, the regulatory requirements outlined above apply to most other protected areas, noting that some protected areas such as national parks that are managed for scientific purposes may exclude opportunities for ecotourism, and the management of national parks on Aboriginal and Torres Strait Islander land and Cape York Peninsula Aboriginal land is to be directed by or in consultation with the Traditional Owners of those lands.

The Act notes scope for some forest reserves to provide for the continuation of any lawful existing use of that land, e.g. beekeeping, foliage harvesting, recreation and salvage timber harvesting under the Forestry Act 1959 and grazing under the same Act and the *Land Act 1994*; but otherwise, these forest uses are excluded from national parks and other protected areas.

3.3.2 Government agency responsibilities

The QPWS carries responsibility for the overall management and day-to-day administration of national parks and other formally protected forest reserves. This includes responsibility under the *Nature Conservation Act 1992* to produce management statements or plans for all protected areas that provide strategic management direction about the management of key park values.

3.3.3 Forest uses in national parks

In respect to ecosystem services that have market or monetary values, the main forest uses in national parks are recreation and tourism (i.e., 'ecotourism' as specified in the Act). In contrast to State forests, Queensland has granular time series information on the value (i.e., net benefits) from tourism and recreation in national parks. In 2020, a University of Queensland study provided updated estimates of the value of national parks to the State economy[41]; building on a methodology developed in 2008. These studies have focussed on the value derived from tourism and recreation assets specifically, they have not attempted to quantify other non-monetary benefits such as conservation, health, and other environmental and social benefits.

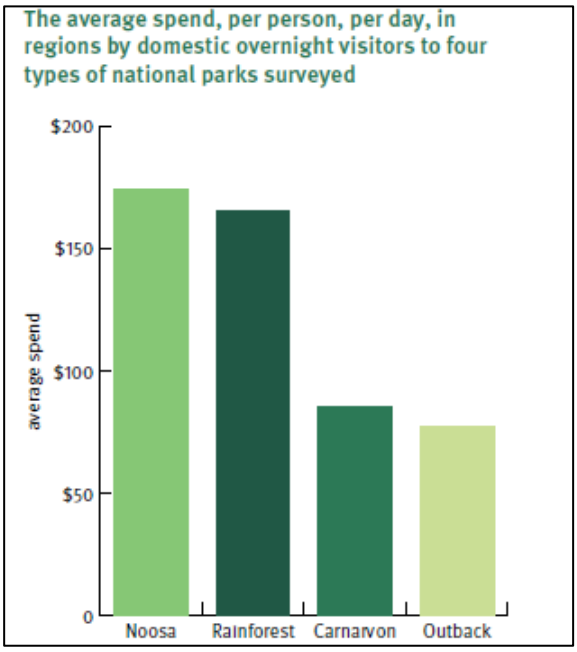
These studies provide data for and insights into a range of economic benefits and costs associated with the usage of national parks, with some regional breakdowns. As entry to national parks in Queensland is free and visitors usually provide their own transport and accommodation arrangements, the studies calculated the economic benefits of national parks based on spending that visitors make in the surrounding region, in association with their visits to national parks. Visitors spend money in the vicinity of national parks on accommodation, transport, tours, food and beverage etc. in addition to any in-park costs such as for camping.

The University of Queensland's study in 2020 also found the highest spenders are domestic overnight visitors, who usually stay in the region surrounding the national parks. International visitors generally spend a little less per day, while daytrip visitors spend 25% to 40% of what overnight visitors spend. On average, overnight visitors to parks in SEQ spend as much or more than visitors to the Wet Tropics and other regions (Figure 3-4).

The 2020 study provides total estimates of economic benefits, using multiple methodologies. Using an economic contribution analysis, the unambiguous component of national park generated spending in the regions comprising SCQ totalled around $165 million in 2018; and the contribution to Gross Regional Product (taking account of regional impacts) was around $123 million (Table 3-4). This economic activity supported approximately 1,100 jobs across the study area in 2018. In total, these contributions from SCQ are comparable to the economic contribution of recreation and tourism associated with national parks in the Wet Tropics.

[41] Driml S, Brown RPC, Moreno Silva C (2020) *Estimating the Value of National Parks to the Queensland Economy*. School of Economics Discussion Paper Series 636. School of Economics, The University of Queensland. http://www.uq.edu.au/economics/abstract/636.pdf.

Figure 3-4 Survey response on the economic benefits of national parks - visitor spend



Source: Driml et al. 2020

Table 3-4 Economic contribution of national park generated spending - unambiguous component, to Gross Regional Product and Gross State Product, 2018

SCQ regions	NPGS – UC* ($m)	Contribution to GRP/GSP ($m)			Employment ($m)		
		Direct	*Indirect*	***Total***	*Direct*	*Indirect*	***Total***
Gold Coast	$22	$9	$7	$16	98	44	143
Brisbane	$60	$30	$22	$52	266	141	407
Sunshine Coast	$30	$11	$9	$20	127	56	184
Fraser Coast	$22	$9	$6	$15	118	38	156
Bundaberg	$11	$4	$3	$7	55	20	75
Gladstone	$12	$4	$4	$8	57	23	81
Capricorn	$8	$3	$2	$5	38	16	54
Total	**$165**	**$70**	**$53**	**$123**	**759**	**338**	**1,100**

Source: Driml et al. 2020. National Parks Generated Spending (NPGS) Unambiguous component (UC), for selected regions.

This type of data is not available for recreation and tourism in State forests, which limits capacity for comparisons of how these results would differ with a change of tenure. Furthermore, direct comparisons of recreation and tourism values in State forests with national parks, would be problematic, as they will generally not be a fair, like-with-like comparison.

For example, the economic contribution of recreation and tourism could be considerably higher in a national park when compared with a State forest – not because of the different land tenure or 'the sign at the front gate'; but because the sites in national parks had much higher natural or cultural values to begin with (hence why there were designated as national parks); and may also have received considerable investment already in infrastructure (including good access roads, signage and facilities) along with high level promotions to attract recreation and tourism to national parks, and the same or equivalent investment has not been afforded to the comparable State forest.

For these and related reasons, a more reasonable comparison of recreation and tourism values generated by national parks and State forests respectively, would be based on assessments on the *same* sites – conducted *prior to* and *after* a change of land tenure (with infrastructure spend considered also). This type of data was not available for the current study in SCQ; but could be sought for future assessments of the net benefits of managing public native forests as multiple use forests compared to formally protected forests.

In the University of Queensland's study in 2020, visitation estimates to national parks are based on responses in the annual surveys of domestic and international visitors conducted by Tourism Research Australia, where participants are asked to nominate if they visited a 'national/state park' on their trips[42]. These visitation estimates are then used as an input to estimate the economic contribution of national parks. The approach detailed for estimating economic contribution does not describe any adjustment being made to visitation estimates to account for the proportion of visitors visiting state parks instead of national parks; nor is there any economic contribution attributed to state parks in the study.

3.3.4 Managing biodiversity and other values

In 2020, the Queensland Government released its *Protected Area Strategy 2020–2030*, which is a plan for supporting the growth, management and sustainability of national parks and other protected areas. A key component of the strategy is expanding the extent of the estate, with initial investments directed to initiatives comprising the strategic acquisition of properties across the state for dedication as protected areas; expanding the private protected areas program that supports landholders to establish nature refuges and special wildlife reserves on their land; and funding to support the work of Indigenous Land and Sea Rangers across the State[43].

This focus on expanding the protected areas is reflected in the first key theme of the *2021 Report Card,* which is *'Grow'*[44]; notably the expansion of national parks and new nature refuges in SEQ and elsewhere across the state. The second and third themes, '*Care*' and '*Connect*', reflect a broad range of initiatives across protected areas to secure good conservation outcomes, developing and implementing values-based management frameworks, and strengthening visitor experiences in selected locations.

Analysis by the Queensland Treasury Corporation in 2018 suggested that funding for the management of Queensland public protected area estate is relatively modest by comparison to other Australian states and funding has not increased at the same rate as expansion of the estate[45]. Furthermore, the Corporation observed biodiversity and conservation outcomes were in decline across the State. These factors make it difficult to assess how the value of biodiversity will be impacted by a change in management regime from multiple use to a protection model.

For this project, due to a lack of region-specific information, biodiversity values have been determined using information from a study into the value of ecosystem services in the Wet Tropics World Heritage Area (WTWHA) of Queensland[46]. In this study, biodiversity values were estimated across forest tenures of national parks, State forests and timber reserves. This approach provides a point of reference as to the relative difference in the value of biodiversity across forest tenures. However, the value of biodiversity in the WTWHA is expected to be higher than for the study region. Therefore, the use of these values may overestimate the value of biodiversity across both scenarios. These factors, combined with the limited extent of reliable data, constrain a robust contemporary estimate of the value of biodiversity in the study region. Furthermore, they highlight the need for further work to support well informed policy decisions.

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[42] Driml et al. (2020) *ibid*.
[43] Queensland Government (2020a) *ibid*.
[44] Queensland Government (2021b) *Queensland's Protected Area Strategy 2020-2030: 2021 Report Card*.
[45] Queensland Treasury Corporation (2018) Queensland protected areas financial sustainability strategy. https://documents.parliament.qld.gov.au/TableOffice/TabledPapers/2020/5620T1524.pdf
[46] Curtis I (2004) Valuing ecosystem goods and services: A new approach using a surrogate market and the combination of a multiple criteria analysis and a Delphi panel to assign weights to the attributes. *Ecological Economics*. 50. 163-194. 10.1016/j.ecolecon.2004.02.003.

3.3.5 Fire management

As noted above in relation to fire management across multiple-use forests (refer section 3.2.6), fire is a common land management tool in SCQ; and in general terms, fire management in public native forests is conducted in similar ways across State forests (multiple use forests) and national parks and reserves (formally protected forests), most notably through the use of planned burning. The QPWS is the main land management agency responsible for planned burning across public land including protected forests.

Historically, it is apparent that there was more planned burning conducted on State forests, as illustrated in the K'gari case study. More recent reporting indicates there has been concerted efforts to increase planned burning across QPWS-managed state public land, including national parks and conservation reserves in SEQ. Queensland's *Protected Area Strategy 2020-2030 Report Card 2021* states the Fire Management Program met its targets for the management of fire on parks and forests in 2020–21. Planned burns and other bushfire mitigation works treated 27% of the protection zone area on park and forest boundaries to minimise bushfire risk to life and property; and QPWS delivered over 430 planned burns and other bushfire mitigation works on around 650,000 ha or 5.3% (target >5%) of the park and forest estate to maintain environmental values and reduce impacts of bushfires[47].

It is important to note the *Protected Area Strategy 2020-2030 Report Card* does not present a regional breakdown of this performance, and there is no reporting on planned burning in SEQ forests specifically; or a breakdown by tenure to compare activity on State forests with national parks and reserves. However, this reporting does indicate increased focus on fire management objectives for formally protected forests.

3.4 Impacts on Aboriginal cultural values and customary uses

Looking beyond existing tenures, a key issue for consideration is determining what impact there would there be on Traditional Owners and Aboriginal and Torres Strait Islander peoples within the study region, from changing the land tenure from multiple use forests with provisioning services to formally protected forests, with less provisioning services, especially timber production.

No published studies or data was found to quantify this specific impact on Traditional Owners in SCQ; and it was beyond the scope of this study to consult with Traditional Owners or representatives of Aboriginal and Torres Strait Islander peoples on this matter. Therefore, the impacts on Aboriginal cultural values and spiritual values have not been quantified in this CBA comparing the alternative forest land uses.

It may be that a change from multiple use management to formally protected forests could have some adverse effects on Aboriginal groups that may be hoping to establish sole or joint management over forests, to continue or re-establish customary and cultural practices; particularly if provisioning services are to be curtailed from 2024. Conversely, there may be scope for net benefits from areas that have high potential to secure revenue from tourism or recreation However, the scope and extent of these potential benefits and costs have not been explored or quantified in this study.

More broadly, there are questions to address in relation to how well the western concepts of conservation, as enshrined in current legislation and embedded in institutions, with the values and views of Aboriginal and Torres Strait Islander peoples within the study region. Further consideration should be given to these specific aspects, in the context of the Queensland Government's Reconciliation Action Plan and related reconciliation processes.

In this context it is unclear, without further consultation, what the impact of a more substantial change in forest land use could be on Aboriginal clans and Indigenous traditional practices. The scope and extent of these potential benefits and costs have not been explored or quantified in this study.

[47] Queensland Government (2021b) *Ibid*.

4. REVIEW OF RELEVANT STUDIES

This assessment is focussed specifically on assessing the net benefits of managing native forests for multiple uses, including timber harvesting, compared to protected natural forests with a more limited range of uses and interventions.

While there are few recent studies with this specific focus, there are numerous studies on forest management in Australia and studies on specific aspects areas that relate to the net benefits of differing management objectives across multiple tenures. Below we briefly discuss a selection of those studies, with particular focus on those that are authoritative and have been more widely quoted in discussions around options for the management of public native forests.

4.1 State of the Forests

Australia's State of the Forests Report (SOFR) presents a comprehensive national synthesis of information describing Australia's forests and the condition of these forests. The information is presented systematically against sustainable forest management criteria and indicators that are based on the framework of the international Montreal Process Working Group. This framework provides a common basis to describe, monitor, assess and report on forests, and to assess performance against the principles of sustainable forest management.

Australia's State of the Forests reports are compiled and published every five years, with the most recent report published in 2018[48]. A selection of relevant observations from the latest report is set out below in Table 4-1, with implications for the assessment of net benefits of managing native forests for multiple uses, including timber harvesting, compared to protected natural forests.

Key points arising specifically in relation to the status of multiple use production forests in comparison to formally protected forests comprise the following:

- At a national level, Australia's forest reserve system already significantly exceeds international targets for protection of terrestrial areas (17+%). Australia's forest reserve system incorporates formally protected forests and is complemented by both formal and informal protection measures that extend across multiple use production forests.
- Sustainable timber harvesting (conducted within multiple use forests) is *not* one of the common threats to forest dwelling flora and fauna species listed as threatened species under the *Environmental Protection & Biodiversity Conservation (EPBC) Act* 1999. The threats of far more concern are forest loss from clearing for agriculture and urban and industrial development; the impacts of predators (invasive pest species); small population sizes; and unsuitable fire regimes.
- Introduced vertebrate pests and weed species are adversely impacting on both conservation reserves and multiple-use public forests; with no reported differentiation in impacts between tenures.
- There is a lack of comprehensive knowledge and monitoring of the occurrence of representative species across land tenures and forest types, but this observation extends across formally protected forests and multiple use forests; and long-term ecological research in multiple use forests is providing valuable insights to address these gaps.
- Queensland has been leading all states on regeneration performance (with 100% effective regeneration) following timber harvesting in multiple use production forests over the past two decades, in large part due to its use of single-tree selection silvicultural systems. This means that sustainable timber harvesting can be carried out in Queensland with minimal risk of the forest not regrowing in accordance with compliance standards monitored by QPWS.

[48] Montreal Process Implementation Group for Australia & National Forest Inventory Steering Committee (2018) *op cit*.

- Transferring multiple use public forest to formally protected forest will not directly reduce the risk of negative bushfire impacts; and may possibly increase the risk of fire impacts, subject to policy decisions on planned burning programs and other interventions.
- Most multiple use public forests in Australia maintain accredited, third-party certification for their forest management, based on standards with annual auditing and reporting. There are very few examples of equivalent or similar programs for national parks or other formally protected forests in Australia, at least to the same level of stakeholder scrutiny and international review. One example is the IUCN Green List initiative, which is a globally applicable Standard for the assessment of protected areas. It provides an international benchmark for quality that motivates improved performance and achievement of conservation objectives[49]. The representation of protected forests in South & Central Queensland on the IUCN Green List is currently limited to Lamington National Parks. This means there are additional levels of independent auditing and reporting for operations and forest condition across most areas of State forest than there is for national parks and conservation reserves; and transferring multiple use public forest to formally protected forest may result in less transparency and reporting under current settings.

Table 4-1 Selected observations in national trends on forest condition across tenures

Key relevant observations from *SOFR 2018*[1]	Implications for land use decisions
Area of forest in protected area categories (1.1c) The United Nations Strategic Plan for Biodiversity 2011–2020 under the international Convention on Biological Diversity, specify Aichi Biodiversity Targets, which include the target that at least 17% of terrestrial areas are protected. With 35% of Australia's native forest area managed for the protection of biodiversity, Australia has therefore met this Aichi Biodiversity Target with respect to native forests.	• Australia has met the internationally recognised biodiversity targets (Aichi Biodiversity Target) for forest reservation in protected area categories, principally through the establishment of a National Reserve System that encompasses formal and informal processes that are used to protect areas of forest for the conservation of biodiversity.
Threats to forest dwelling species (1.2b) The most common threats to nationally listed forest-dwelling fauna and flora include forest loss from clearing for agriculture and urban and industrial development; impacts of predators; small population sizes; and unsuitable fire regimes. - For listed forest-dwelling fauna, the most common threat categories are forest loss from clearing for agriculture and urban and industrial development, as well as predation by introduced predators - For listed forest-dwelling flora, the most common threat categories are small population sizes, mortality agents and unsuitable fire regimes - For threatened forest ecological communities, the most common threat categories are weeds, and forest loss due to clearing for agriculture Based on the emphasis given in listing advice documents in regard to their impacts, forestry operations pose a less significant threat to nationally listed forest-dwelling fauna and flora species compared with other threat categories.	• Timber harvesting is not listed as one the most common threats to flora and fauna listed as threatened species under the *Environmental Protection & Biodiversity Conservation Act 1999*. • The most common threats to fauna comprise historical land-use change and forest loss caused by clearing for agriculture, grazing, and urban and industrial development, followed by predation from introduced predators. • The most common threats to flora comprise small population size and localised distribution; mortality agents including illegal collection, recreational pressure, pressures from peri-urban development, genetic issues; and unsuitable fire regimes. • Based on the emphasis given in listing advice documents in regard to their impacts, forestry operations pose a less significant threat to nationally listed forest-dwelling fauna and flora species compared with other threat categories.

[49] IUCN *Green List of Protected and Conserved Areas*. Online, accessed 1 August 2022: https://iucngreenlist.org/

Key relevant observations from *SOFR 2018*[1]	Implications for land use decisions
Representative species monitored at scales (1.2c) There continues to be a lack of comprehensive knowledge and monitoring of the occurrence of representative species across land tenures and forest types, which limits the conclusions that can be drawn from available data. Long-term monitoring programs such as the *FORESTCHECK* program in Western Australia and the Warra Long-term Ecological Research site in Tasmania contribute monitoring information supportive of continuous improvement of sustainable forest management in those states.	• The lack of comprehensive knowledge and monitoring of the occurrence of representative species is a significant issue *across* land tenures - i.e., in conservation reserves and multiple-use production forests. • *SOFR 2018* highlights two long-term ecological research sites that are providing valuable information about changes and trends in key elements of forest biodiversity in eucalypt forest associated with management activities, *including* wood harvesting and silvicultural treatments.
Productive capacity of forest ecosystems (2.1c) The sustainable annual yield of high-quality sawlogs from multiple-use public native forests declined across Australia by 53% from 1992–93 to 2015–16. Reasons for the decline in sustainable yield from multiple-use public native forests include the transfer of multiple-use native forests into nature conservation reserves, increased restrictions on harvesting, revised estimates of growth & yield, and impacts of occasional, intense broad-scale bushfires.	• Over the 5-years between 2011/12 and 2016/17, the total net harvestable area in Australia reduced by around 10%, due to transfers of areas of multiple-use public native forest to nature conservation reserves, as well as increases in areas to which harvesting restrictions apply.
Effective regeneration (2.1e) Effective regeneration of harvested multiple-use public native forest was reported for NSW, Queensland, Tasmania, Victoria and Western Australia for extended time periods. Across the period 2011–12 to 2015–16, the annual average proportion of harvested multiple-use public native forest that was effectively regenerated, as assessed against stocking standards, was reported as 79% in NSW, 100% for Queensland, 95% for Tasmania and 92% for Victoria. In Queensland, effective regeneration is monitored on harvested areas of multiple-use public native forests through the post-harvest audit process conducted by QPWS. Effective regeneration has been reported as being 100% since 2000–01 for three periods.	• Queensland has led all states on regeneration performance in multiple use production forests over the past two decades, in large part due to its use of single-tree selection silvicultural systems. • Ensuring effective regeneration of native forest after timber harvesting is a fundamental requirement of sustainable forest management in Australia, across all States.
Forest health and vitality (3.1a) In most jurisdictions, vertebrate and weed species were reported as damaging to native forest in conservation reserves and multiple-use public forests. - Introduced vertebrate pests with widespread adverse impacts on forests in one or more jurisdictions were deer, cats, rabbits, pigs, foxes and cane toads. - Weed species with widespread adverse impacts on forests in one or more jurisdictions include Mission grass, lantana and prickly pear.	• Introduced vertebrate pests and weed species are adversely impacting on both conservation reserves *and* multiple-use public forests; with no reported differentiation in impacts between tenures.

Key relevant observations from *SOFR 2018*[1]	Implications for land use decisions
Impacts of planned and unplanned fire (3.1b) Of the cumulative area of forest fire across Australia over the reporting period of five years (106 million ha), the largest areas nationally were in leasehold forest (42 million ha) and private forest (46 million ha). The ratio of planned fire to unplanned fire in this period varied by tenure and jurisdiction. In nature conservation reserves, 55% of the cumulative forest fire area for 2011–12 to 2015–16 was planned fire, whereas in leasehold and private forests 26% and 24% respectively of the cumulative forest fire area was planned fire. The area proportions of fire that was planned in multiple-use public forest in Victoria and in southern WA were substantially higher than the national average for that tenure, at 64% and 69% respectively. The largest area of forest burnt by fire in southern Australia in this period was in nature conservation reserves (2.4 million ha); this was also the case in each jurisdiction in southern Australia except for Tasmania, where the largest forest area burnt was in multiple-use public forests. In Queensland the largest area of forest burnt by fire was on leasehold land (17 million ha) then private land (7.1 million ha).	• Fire is an important part of many forest ecosystems in Australia and may have either positive or negative impacts on forest health and vitality. • The extent of these impacts depends on multiple inter-dependent factors, and the *SOFR* 2018 shows variation across jurisdictions and tenures. • In relation to public native forests, there are examples of data showing the area of forest burnt in nature conservation reserves *exceeds* multiple use production forests (e.g. evident in southern Australia between 2011-12 to 2015-16), and that there was a greater proportion of planned fire than unplanned fire in multiple use public forests. • These findings are not absolute, and will vary over time, but they highlight that transferring multiple use public forest to formally protected forest will not directly reduce the risk of negative bushfire impacts; and may possibly increase the risk, subject to policy decisions on planned burning programs and other interventions.
Forest contribution to global carbon cycle (5.1a) Over the most recent five years (2011–16), forest carbon stocks increased by 129 million tonnes of carbon (Mt C), due to a combination of recovery from past clearing, additional growth of plantations, reduced clearing of native forest, expansion of the area of native forests, and continued recovery from bushfire and drought. In addition to carbon in forests, 94 Mt C was present in wood products in use, and 50 Mt C in wood products in landfill. Carbon stocks in both these pools increased steadily over the period 2001–16.	• Forest carbon stocks have increased over time, and timber harvesting for wood products has resulted in a material contribution to removing carbon dioxide from the atmosphere, which significant carbon stocks in wood products in use and in landfill (end of life contributions). • Carbon stock in wood and wood products in use and in landfill increased by 25 Mt over the period 2001–16, which was greater than the 12 Mt decrease in carbon stocks in forests over this period.
Institutional frameworks (7.1b) Forest management certification is the voluntary, independent assessment of forest management activities and operations in a particular area of forest against a credible standard that has criteria, requirements and indicators encompassing environmental, economic, social and cultural values. Forest management standards establish thresholds for sustainable forest management through a range of economic, social, environmental and cultural criteria and requirements for wood production in native forests and plantation forests. Two forest certification schemes operate in Australia: the Responsible Wood Certification Scheme (RWCS), and the Forest Stewardship Council (FSC) scheme. In addition to forest certification, most multiple-use public forests and some private forests are managed in accordance with codes of forest practice.	• Most multiple use public forests maintain accredited, third-party certification for their forest management, based on standards set out by internationally recognised forest certification schemes. These standards incorporate provisions for sustainable timber harvesting, within broader frameworks for sustainable forest management. • This type of certification is maintained in addition to regulatory requirements administered by national, state and local governments, including State-based codes of forest practice. • *SOFR 2018* does not refer to equivalent third party certification programs for national parks or other formally protected forests; and there are few examples of protected forests with independent auditing against a global standard currently in Australia.

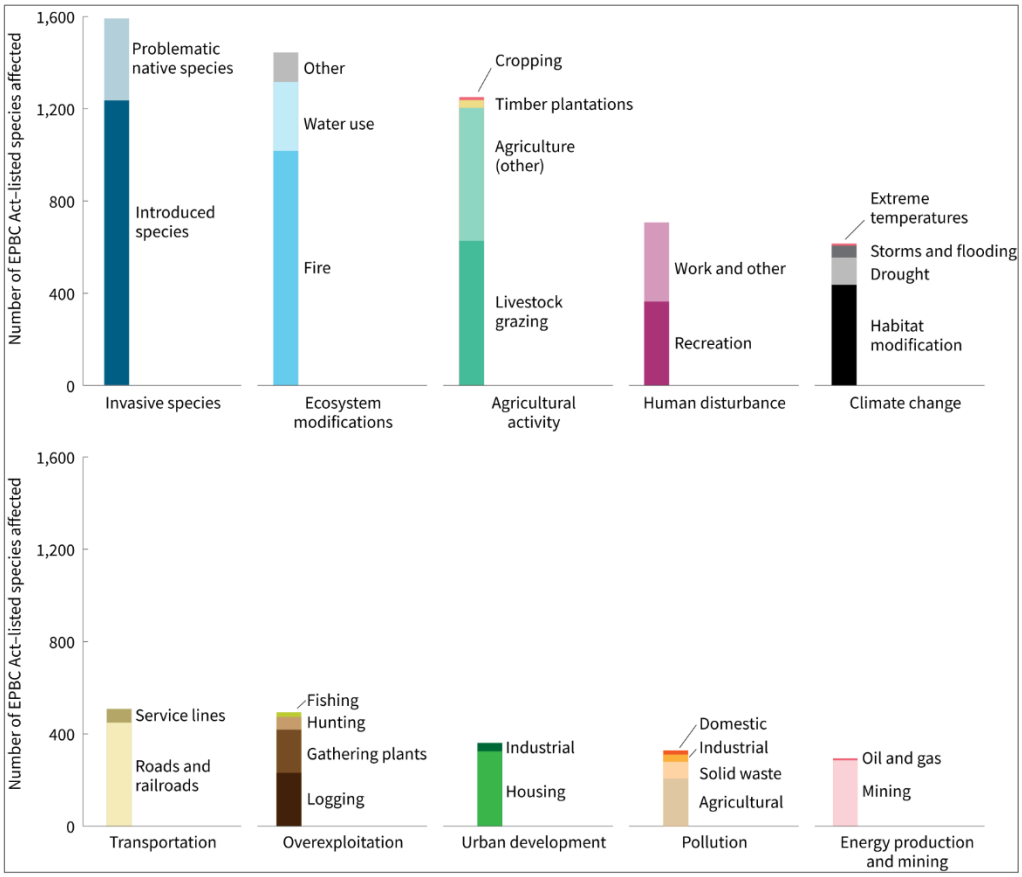
Source: *Australia's State of the Forests Report 2018* for the observations; Indufor for the implications.

Australia's State of the Environment Report (which is also prepared on a five-yearly basis) provides regular reporting on a broader range of environmental considerations than the SOFR; and in relation to aspects such as biodiversity and forest biodiversity, there is considerable overlap. The most recent report (2021) identifies invasive species, ecosystem modifications (notably changed fire regimes) and agricultural activity as the threats identified in listing criteria of the EPBC Act affecting the largest numbers of Australian threatened species (Figure 4-1)[50].

'Logging' is referred to in the *State of the Environment* Report as a threatening process for some species and regions. However, it is not one the major impacts overall - and Kearney (2018) has observed that while the impacts of 'overexploitation' threats (including logging, bushmeat hunting and overfishing) are having an increased impact on species that are already under pressure, overexploitation threatens a higher proportion of species globally than in Australia[51]. Furthermore, for SCQ, the selective timber harvesting practices have a relatively low intensity impact in space and time, compared to more intensive clear-felling-based logging practices.

More broadly, the latest *State of the Environment* report shows pressures on Australian biodiversity have not improved since the previous report (2016), and outcomes for species and ecosystems are generally poor. This conclusion generally applies across tenures, including public native forests.

Figure 4-1 Prevalence of threats to Australian threatened taxa, 2018



Source: Murphy & van Leeuwen (2021); derived from Kearney et al. (2018). Note each chart is scaled according to the number of EPBC Act–listed taxa listed as being affected by each threat category.

[50] Murphy H & van Leeuwen S (2021) *Australia State of the Environment 2021: Biodiversity*. Available online: https://soe.dcceew.gov.au/biodiversity/key-findings

[51] Kearney SG, Carwardine J, Reside AE, Fisher DO, Maron M, Doherty TS, Legge S, Silcock J, Woinarski JCZ, Garnett ST, Wintle BA & Watson JEM (2018) The threats to Australia's imperilled species and implications for a national conservation response. *Pacific Conservation Biology*, 25(3):231–244.

Key points:

- Sustainable timber harvesting, conducted within multiple use forests, is not one of the common threats to forest dwelling flora and fauna species listed as threatened species, nor is it considered a major threatening process or pressure on Queensland's biodiversity.
- The primary threats to native forests are the same across public land tenures - these are forest and habitat loss from clearing for agriculture and urban and industrial development; invasive pest species; small population sizes; and altered fire regimes.
- The extent to which there is more active management of multiple-use public forests provides a basis for evidence of a greater proportion of planned fire than unplanned fire in multiple use forests, and higher levels of transparency on operations and forest condition through third party certification and related programs.

4.2 Active and adaptive forest management

Within the published literature on the management of native forests in Australia and overseas, there is an increasingly prominent call for more active and adaptive management, across tenures, to address to future land management threats and opportunities.

Jackson et al. (2021) posited there is a need for the more active and adaptive management of forests to maintain or enhance ecological functionality and improve forest resilience to shocks such as landscape-scale severe bushfires and the impact of climate change[52]. Humanity has altered forest landscapes to such an extent that they now require active management to ensure ecosystem health and build resilience to bushfires and climate change.

One of the most compelling arguments for this view currently is the devastating impact of recent wildfires, in Australia and across a range of other countries in recent years; and substantive evidence that one of the primary causes of the destructive impacts of those and previous bushfires has been a 'lack' of active and adaptive land management over past decades[53] - specifically, a lack of fuel reduction and limited development of forest mosaics and strategic fire breaks to slow or halt the spread of fires. International wildfire experts have noted that mitigating bushfire disasters will require greater use of planned burning in suitable forest types to reduce bushfire risks and impacts,[54], while recognising it is not a panacea for major bushfires and can have limited impact on slowing major bushfires under extreme conditions[55].

Another compelling argument is biodiversity conservation and the need to address the decline in flora and fauna species across landscapes, through more active and adaptive management of the threats, as outlined above in the *State of the Forests* reporting.

Studies show that simply establishing formally protected reserves is not enough to arrest this decline. As an example, Woniarski et al (2011) assessed declines over the last decades in the mammal fauna of Kakadu National Park, and concluded they are a delayed reverberation of the wholesale shift in land management in Australia following European colonization in 1788, and imposition in northern Australia mostly during the 1850s to 1890s. Many mammal species have declined gradually but extensively, and the outlook for their persistence looks dire. The study concluded that while necessary, the establishment of conservation reserves alone is clearly

[52] Jackson W, Freeman M, Freeman B & Parry-Husbands H (2021) Reshaping forest management in Australia to provide nature-based solutions to global challenges, *Australian Forestry*, 84:2, 50-58.

[53] Morgan GW, Tolhurst KG, Poynter MW, Cooper N, McGuffoge T, Ryan R, Wouters MA, Stephens N, Black P, Sheehan D, et al. (2020) Prescribed burning in south-eastern Australia: history and future directions. *Australian Forestry*. 83:4–28. doi:10.1080/00049158.2020.1739883

[54] Moreira F, Ascoli D, Safford H, Adams M, Moreno J, Pereira J, Catry F, Armesto JJ, Bond W, González M, et al. (2020) Wildfire management in Mediterranean-type regions: paradigm change needed. *Environmental Research Letters*. 15:011001. doi:10.1088/1748-9326/ab541e.

[55] Hislop S, Stone C, Haywood A, Skidmore A (2020) The effectiveness of fuel reduction burning for wildfire mitigation in sclerophyll forests. *Australian Forestry*. 83(4):255–264. doi:10.1080/00049158.2020.1835032

insufficient to maintain biodiversity; and there is a need to manage reserves (and their threats, and their surrounds) far more intensively, purposefully, and effectively[56].

Jackson et al. provided the following definitions of active and adaptive management of forests:

- *active management*: the preparedness to conduct interventions that will conserve and restore biological diversity, ecological functions and evolutionary processes at multiple spatial and temporal scales
- *adaptive management*: the ongoing process of regularly setting and reviewing management objectives based on credible evidence, consulting with stakeholders, implementing forest management and conservation actions to achieve the planned objectives, and monitoring and evaluating the effectiveness of forest management as well as changes in forest health.

These calls for ongoing active and adaptive management of forests are generally supported by literature reflecting Indigenous knowledge of land management in Australia; and concerns expressed about concerted efforts to uphold the notion of pristine forest landscapes as wilderness in conservation ideals and practices. Fletcher et al. (2021) highlighted dominant global conservation policy and public perceptions still fail to recognize that Indigenous and local peoples have long valued, used, and shaped "high-value" biodiverse landscapes:

> "*…moreover, the exclusion of people from many of these places under the guise of wilderness protection has degraded their ecological condition and is hastening the demise of a number of highly valued systems*"[57].

Indigenous perspectives of the critical use of fire and cultural burning as part of the active management of forest landscapes is discussed further in the following section of this review.

In Europe, the need for adaptive forest management has been recognised as a prerequisite for sustainable forestry in the face of climate change; and an integral part of an overall strategy of "*avoiding the unmanageable and managing the unavoidable*"[58] – that is, avoiding climate change becoming a global catastrophe.

Due to climate change, Europe has already warmed more than the global average; and particularly, the number of warm extremes has increased, whereas cold extremes have become less frequent. The shift towards noticeably warmer and dryer site conditions observed in many parts of Europe has begun to change the disturbance regime in forests. Thus, the development of adaptive forest management strategies in the face of climate change is a key challenge for future resource management in Europe and worldwide[59].

Similarly, in North America, in recognition of an uncertain world, Canadian researchers have highlighted the need to replace the sustained single good or objective-yield paradigm with a new paradigm that integrates risk, flexibility and adaptability into scenarios of sustained provision of various goods and services[60]. This research has led to proposals for a set of broad principles and changes to increase the adaptive capacity of forests in the face of future uncertainties.

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[56] Woinarski J, Legge S, Fitzsimons J, Traill B, Burbidge A, Fisher A, Firth R, Gordon I, Griffiths A, Johnson C, McKenzie N, Palmer C, Radford I, Rankmore B, Ritchie E, Ward S, Ziembicki M (2011) The disappearing mammal fauna of northern Australia: Context, cause, and response. *Conservation Letters*. 4. 192 - 201. 10.1111/j.1755-263X.2011.00164.x.

[57] Fletcher MS, Hamilton R, Dressler W, Palmer L (2021) Indigenous knowledge and the shackles of wilderness. *Proc Natl Acad Sci* U S A. 2021 Oct 5;118(40):e2022218118. doi: 10.1073/pnas.2022218118.

[58] Bolte A, Ammer C, Löf M, Nabuurs GJ, Schall P, Spathelf P (2010) Adaptive forest management: a prerequisite for sustainable forestry in the face of climate change. In: Spathelf P, editor. *Sustainable forest management in a changing world – a European perspective*. Managing forest ecosystems. Vol. 19. Chapter 8. Dordrecht (Netherlands): Springer; p.115–139. doi:10.1007/978-90-481-3301-7-8 p. 116.

[59] *Ibid*.

[60] Messier C, Puettmann K, Chazdon R, Andersson KP, Angers VA, Brotons L, Filotas E, Tittler R, Parrott L, Levin SA (2014) From management to stewardship: viewing forests as complex adaptive systems in an uncertain world. *Conservation Letters*. 8:368–377. doi:10.1111/conl.12156.

In broad terms, this research supports the concept of 'multiple use' forest management, rather than a singular focus on either production or conservation, with emphasis on increase the adaptive capacity of forests to sustain provision of various goods and services.

In a synthesis of the 'contested past', 'tenure-driven present', and 'uncertain future' for Australian forests, Kanowski (2017) observed that the need for governance models accommodating uncertainty, allowing adaptive management, and building adaptive capacity have been recognised in various policy settings; however, the national government and State governments have repeatedly demonstrated their unwillingness to cede control to more pluralistic forms of policy development and implementation[61]. Therefore, while there is acknowledgement and stated aspirations for more adaptive management across both multiple use forests and formally protected forests in Australia, the implementation of these principles and processes are not yet deeply embedded in forest management governance and operating systems.

In this context, Queensland's Native Timber Action Plan provides a timely opportunity for the State to review and consider the extent to which native forest management, across tenures, can accommodate uncertainty, allow adaptive management, and build adaptive capacity.

Most importantly, the management paradigms should be set up to recognise forests as complex systems and to actively manage forests for their health, to maintain their full range of values and to build resilience. Active management includes reducing the threats to forests, preparing forests for future threats, maintaining the capacity of forests to recover after disturbances, and restoring forests that have been degraded.

Key points:

- There is generally strong support for more active and adaptive management of forests, to address a range of threatening processes.
- Active management is not limited to multiple use forests; and does not necessarily need to incorporate commercial timber harvesting or ecological thinning; but there is a body of evidence that shows that active management can including timber harvesting, which is not one of the primary threats to native forests in Australia.
- There are calls for more pluralistic forms of policy development and implementation, specifically in relation to the management of native forests.

4.3 Biodiversity conservation

Australia's *State of the Forests* and *State of the Environment* reporting provides context for consideration of biodiversity conservation challenges across tenures, and the extent to which the value of biodiversity would change if the tenure or management regime for multiple use forests were changed to exclude timber harvesting and establish formally protected conservation reserves.

The most recent 5-yearly reports, which build on trends reported over time, indicate the major threats to biodiversity are forest loss from clearing for agriculture and urban and industrial development; the impacts of predators (invasive pest species); small population sizes; and unsuitable fire regimes[62,63]. Ward et al. (2021) pointed to habitat as the most fundamental need of species, and that habitat loss is primarily driven by agriculture and urban development; while invasive species are also severely affecting Australian threatened taxa, despite many initiatives aimed at reducing their impacts[64].

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[61] Kanowski P (2017) Australia's forests: Contested past, tenure-driven present, uncertain future. *Forest Policy and Economics*. Volume 77, 2017, Pages 56-68, ISSN 1389-9341.
[62] Montreal Process Implementation Group for Australia & National Forest Inventory Steering Committee (2018) *op cit*.
[63] Murphy H & van Leeuwen S (2021) *op cit*.
[64] Ward et al. (2021) A national-scale dataset for threats impacting Australia's imperiled flora and fauna. *Ecology and Evolution,* 11 (17) ece3.7920 1-13. https://doi.org/10.1002/ece3.7920

Most significantly for this assessment, these primary threats do not include timber harvesting, particularly when conducted on a low intensity, highly selective basis as is the current policy and practice in Queensland's State forests. This means the primary threats to biodiversity are essentially the same across tenures; and excluding the scope for selective timber harvesting and potentially some other related consumptive uses (when managed on a sustainable basis) will not have a significant impact on biodiversity values compared to the primary threats.

This finding is evident in relevant studies focusing on some of Australia's most iconic forest dwelling species, e.g. koalas and the Leadbeater's possum. An extensive assessment of the effects of regulated timber harvesting on koala density in the public native forests of north-east NSW between 2019 and 2021 concluded that native forestry regulations provided sufficient habitat for koalas to maintain their density, both immediately after selective harvesting and 5–10 years after heavy harvesting[65].

Concurrently, an assessment of the spatial and temporal dynamics of habitat availability and stability for the Leadbeater's possum, a critically endangered arboreal marsupial in Victoria, found that bushfire, not logging, was the biggest threat to habitat availability for Leadbeater's possum in the Central Highlands[66]. Furthermore, the study found that less than half of the area within the current parks, reserves, and timber harvest exclusion zones in Victoria provided stable long-term habitat for Leadbeater's possum over the next century. The study recommended providing conservation planners with a spatially and temporally explicit framework for incorporating the key dynamic processes that are typically omitted in conservation planning.

Therefore, this review of published studies provides a basis for applying the same average biodiversity values to the same forest types across managed public native forest tenures, as the cessation of selective timber harvesting and rezoning of multiple use forests to formally protected forests will not directly (on its own) increase biodiversity values. Further resourcing and management interventions may be required, but across both tenures, to mitigate the more threatening processes to biodiversity.

In applying this premise, it is important to recognise that *existing* national parks and conservation reserves may have higher biodiversity values than *existing* multiple use forests. Existing national parks and formally protected forests have been established to protect the best sites, or 'world-class natural and cultural values'[67], with a primary focus on the management of biodiversity conservation and the natural condition (while recognising that landscapes are dynamic and will change over time in response to multiple factors including climate trends and natural disturbances).

In Queensland and across other states, national parks and formally protected conservation reserves comprise a 'forest reserve system' that has been established to ensure that, at a minimum, a representative extent of forest values (including but not limited to ecological, geological, cultural and landscape amenity values) are protected from any harmful or cumulative impacts of uses for other values. Within this construct, the formally protected forest reserve system provides for the primacy of protecting those world class natural and cultural values. Conversely, this means that not all sites and forest values need to be protected within national parks and conservation reserves.

This assessment is looking principally at how the monetised value of an area of multiple use forest would change if the same area were to be transferred to protected forest. Therefore, in this construct, the underlying forest type and forest condition remains the same, and the comparison is based on different tenures or management regimes.

With this perspective, it is proposed the CBA for this assessment can apply the same biodiversity values across the two scenarios – i.e., the same value for forest that may be zoned

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[65] Law B, Gonsalves L, Burgar J. et al. (2022) Regulated timber harvesting does not reduce koala density in north-east forests of New South Wales. *Scientific Reports*, 12, 3968. https://doi.org/10.1038/s41598-022-08013-6

[66] Nitschke C, Trouvé R, Lumsden L, Bennett L, Fedrigo M, Robinson A, Baker P (2020) Spatial and temporal dynamics of habitat availability and stability for a critically endangered arboreal marsupial: implications for conservation planning in a fire-prone landscape. *Landscape Ecology*. 35. 10.1007/s10980-020-01036-2.

[67] Queensland Government (2020a) *ibid.*

as either multiple use forests or formally protected forests. This proposition assumes that the consumptive uses in multiple use forests, notably selective timber harvesting and some forms of recreation and tourism not permitted in national parks, would be conducted in accordance with State-based regulatory compliance requirements and industry practice standards and controls to ensure they do not unduly impact on biodiversity and other values, over time and across any given forested landscape.

This premise is strengthened further by published studies that point towards benefits for biodiversity conservation from active management and sustaining diverse disturbance regimes across forested landscapes (refer section 4.2). In addition, studies have reported that, unlike other threatening processes, there are substantial opportunities to modify forest management systems and practices to accommodate the conservation of specific threatened species over space and time. Munks et al. (2020) have described an "off-reserve" management system for the conservation of biodiversity in Tasmania, through complementing the reserve system and other conservation mechanisms[68]. The Tasmanian system has evolved over the past 30 years into a targeted risk- and outcomes-based approach; and key elements include a policy to maintain a permanent native forest estate, a code of practice, planning tools, scientific advice, training, research, monitoring, and continual improvement in an adaptive management manner. Standards and guidelines applied at multiple spatial scales have aimed to reduce impacts on a diverse range of forest biodiversity values ranging from vegetation communities and broad habitat features to individual fauna and flora species and focal habitats.

In international agricultural and forestry settings, a mix of 'land sharing' and 'land sparing' at the landscape scale[69] has frequently been found to generate relatively high regional biodiversity values, through facilitating heterogeneity at the landscape-scale by managing harvest intensity, retained structural elements, types and intensity of silvicultural treatments, and the spatial configuration of forests with different times since disturbance at multiple scales on the landscape. Runting et al. (2019), focused on forest managed in Indonesia, found that improved management strategies, including reduced-impact logging, provided larger conservation gains than altering the balance between sparing and sharing, particularly for threatened species (including endangered species). They concluded ultimately, debating sparing versus sharing has limited value while larger gains remain from improving forest management practices[70].

On this basis, active and adaptive management of multiple use forests in SCQ, with selective timber harvesting and thinning operations contributing to the diversity of disturbance regimes, can clearly provide an off-reserve management system that complements the formally protected conservation reserve system.

Determining reasonable monetary values to apply to biodiversity in Queensland's native forests is constrained by limited published research and data that is relevant to this assessment. One relevant study is a comprehensive valuation of ecosystem services (described as ecosystem goods and services in their study) for the Wet Tropics World Heritage Area (WTWHA) in far north Queensland. This study was conducted in 2003 and provided a detailed breakdown of multiple ecosystem services including biodiversity, across tenures within the WTWHA. The total value of ecosystem services was found to be in the range of $188 to $211 million per year, or $210 to $236/ha/year (in 2002 dollar terms). Biodiversity and refugia were the two attributes ranked most highly, at $19 to $21 million per year and $17 - $18 million per year respectively. This suggests biodiversity values in the order of $20 - 23/ha across tenures, in 2003 dollars (Table 4-2); which would approximate $28-$32/ha in 2021.

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[68] Munks S, Chuter AE & Koch A (2020) 'Off-reserve' management in practice: Contributing to conservation of biodiversity over 30 years of Tasmania's forest practices system. *Forest Ecology and Management*. 465. 117941. 10.1016/j.foreco.2020.117941.

[69] The land '*sharing*' and '*sparing*' concepts relate to biodiversity conservation-agricultural production trade-offsets. They represent two contrasting approaches to land use allocations: one partitions forests (sparing), the other integrates both objectives in the same location (sharing). In the forestry context, extensive management in native forests with selection harvesting systems is an example of land-*sharing*. Designating areas of land for intensive plantation-based production is an example of land *sparing*.

[70] Runting et al. (2019) Larger gains from improved management over sparing–sharing for tropical forests. *Nature Sustainability*. 2. 53-61. 10.1038/s41893-018-0203-0

Table 4-2 Summary of annual values or shadow prices for biodiversity for selected tenure categories in the WTWHA (2003)

Wet Tropics WHA	National Park	State Forest	Timber Reserves
Area	285,744	347,300	74,163
Biodiversity value (2002$/year)	$6,690,500	$8,069,500	$1,573,500
Biodiversity value (2002$/ha/year)	$23	$23	$21

Source: Curtis (2004)

Noting the lack of other relevant published data on monetising a biodiversity value for ecosystem services from public native forests in Australia, it is proposed that a CBA on the net benefits of multiple use forests compared to formally protected forests in SCQ could use an average annual biodiversity value for public native forests in the order of $30/ha (in 2021 dollars).

Key points:

- Published studies indicate the cessation of selective timber harvesting and transfer of existing multiple use forests to formally protected forests will not directly increase biodiversity values, without additional resourcing and mitigation of major threats (such as invasive species) that could equally be applied in multiple use forests.
- This provides a basis for applying the same biodiversity value to public native forests managed under the tenure of multiple use forests or as formally protected forests.
- Further resourcing and management interventions are required, across both tenures, to mitigate the more threatening processes to biodiversity.

4.4 Fire management across tenures

The primary focus of this assessment is the differences in management regimes across tenures, specifically across multiple use forests and formally protected forests, and the net benefits associated with managing forests for multiple uses including timber harvesting.

In Australia, forest governance models are predominantly tenure-based, and in broad terms, there is limited integration across institutions, landscapes, and tenures[71].This has significant implications for fire management across forest landscapes.

With a particular focus on southern Australia, Stephens observed in 2010 that forest fires in southern Australia were increasing in scale and intensity, and this disturbing trend was attributed in no small part to the lack of a comprehensive landscape approach to fire risk management[72]. Based on trends observed during the 2000s, the review concluded that effective bushfire management appeared to be a problem of social and political commitment to preventative land management rather than a case of scientific complexity.

More broadly across Australia, the transfer of public production forest (i.e., State forest) to national parks and reserves across multiple states, over the past 40 years, has reportedly seen significant reductions in the public land management workforce, heavy equipment and skills available for forest firefighting and fire management[73]. The downsizing of the forestry industry brought about by this transfer of large tracts of State forest to conservation reserves has also been associated in many instances with a more passive approach to fuel reduction on public forest land. Native forest timber harvesting requires a workforce with heavy equipment and skills that can be made available for forest firefighting and fire management, and maintaining a road and fire access track network, which may not otherwise be maintained to the same level.

[71] Kanowski P (2017) *op cit*.
[72] Stephens M (2010) Bushfire, Forests and Land Management Policy Under a Changing Climate. *Farm Policy Journal*, 7(1): 11-19.
[73] Morgan et al (2020) *op cit*.

The extent of planned burning across tenures

These perspectives are supported by a comprehensive review in 2015 of the use of planned (prescribed) fire in Australia, which observed the redesignation of many areas of State forest as national parks has left management agencies largely dependent on the 'public purse' to finance their management activities[74]. The *National Burning Project* study (an Australian Government Initiative) cited evidence tendered in various recent bushfire related inquiries which claimed that changes in public land tenure has typically been accompanied by reduced public funding of natural areas which, of themselves, can generate little regular income. This in turn has resulted in a shift in focus away from broad-scale land management activities (such as the use of planned fire) to a park visitor-focus targeting only a small proportion of the areas under public management. These trends have seen a significant loss of agency workforce expertise in many areas and a shift in the fire management emphasis on public lands.

The National Burning Project study also noted the value of planned fire in improving bushfire management was illustrated by NSW experience over the 10-year period from 1993–94 to 2002–03 (Table 4-3). The study cited research by Jurskis et al. (2003)[75], which attributed the stark difference in the success of bushfire management between NSW State forests and national parks over this period to their respective land management philosophies. In national parks at that time, the use of planned fire was primarily focused on community protection and restricted to boundary areas in proximity or adjacent to urban and rural communities. Conversely, in State forests, planned fire was being used for a broader range of values and was both more extensive and more widespread across the landscape.

It must be noted these data and observations extend back 20 years, and there has been changes to State government policies and program funding allocations across jurisdictions since then, which will have resulted in some significant changes in the average area that has been subject to planned burning each year and the ratio of planned fire to unplanned bushfire.

Table 4-3 Comparative success of bushfire management in NSW State Forests and National Parks during the 10-year period from 1993–94 to 2002–03

Public lands in NSW	National parks	State Forests
Average % of land tenure burnt by planned fire per year	0.4%	3%
Average area burnt by planned fire per year	20,500 ha/year	73,000 ha/year
Average area burnt by bushfire per year	250,000 ha/year	70,000 ha/year
Planned fire: unplanned bushfire ratio	8 : 92 [0.09]	51 : 49 [1.04]

Source: AFAC (2015), derived from Jurskis et al. (2003)

For example, as noted above specifically in relation to Queensland, more recent reporting indicates there has been concerted efforts to increase the use of planned fire across QPWS-managed state public land, including national parks and conservation reserves in SEQ. Queensland's *Protected Area Strategy 2020-2030 Report Card 2021* states the Fire Management Program met its targets for the management of fire on parks and forests in 2020–21[76].

Whether this QPWS program is meeting ecological thresholds during its planned burn activities is not clear in the reporting to date. For example, Eliott et al. (2021), in a study of planned and unplanned fire regimes on public lands in Queensland, observed it is difficult to accurately determine whether areas have been burnt within their recommended interval due to the short

[74] AFAC (2015) *Overview of prescribed burning in Australasia*. Report for the National Burning Project – Subproject 1. Australasian Fire and Emergency Service Authorities Council Limited. March 2015.
[75] Jurskis V, Bridges B, de Mar P (2003) Fire management in Australia: the lessons of 200 years. In: '*Proceedings of the joint Australia and New Zealand Institute of Forestry conference*'. 27 April – 1 May 2003. pp. 353 – 368. Ministry of Agriculture and Forestry: Wellington/Queenstown.
[76] Queensland Government (2021b) *Ibid.*

period of data collection. They identified a general indication regarding ecological requirements, with large areas (over 26%) of eucalypt forest not burnt in the 12 years covered by the present study, which suggested a bias towards the longer unburnt end of fire guidelines[77].

Australia's *State of the Forests 2018* report shows the area proportion of planned fire to total cumulative fire in Queensland, between 2011–12 to 2015–16, was around 23% for multiple use public forests and 33% for nature conservation reserves[78]. In contrast, data from southern states shows the area proportions of fire that was planned in multiple-use public forest in Victoria and in southern Western Australia between 2011–12 to 2015–16 were substantially higher than the national average for that tenure, at 64% and 69% respectively.

In relation to cost-benefit analyses, Eliott et al. (2021) observed that while planned burning is widely practised, the economic efficiency of planned fire is poorly understood. This led to development of a generalized linear planned fire cost model for south-east Queensland, based on a dataset of over 500 planned burns on public land over the period 2004 to 2015, to estimate planned burning costs per hectare as a function of environmental predictors[79]. This study generated a range of average (mean) unit costs for reference, such as approximately $700/ha for planned fire in open forests and woodlands, and closer to $1,000/ha for wet tall open forests. However, the study also highlighted the wide range of observed values, with planned fire costs per hectare negatively related to planned fire burned area, distances to the nearest building and nearest freshwater body and the forest fire danger index (FFDI); while positively related to fuel quantity and distance to the nearest QPWS (operations) base. Planned fire costs also varied significantly between some fire vegetation groups.

This study made no distinction between tenure, e.g. multiple use forests and formally protected reserves, but provides a model that can support the estimation and justification of annual operational budgets for planned fire, notably for south-east Queensland.

The impact of timber harvesting on bushfire extent and severity

Another relevant aspect of fire management is the extent to which timber harvesting activity in native forests may impact on the extent or severity of bushfires. This is a contentious issue, with published research presenting conflicting views. Some have argued that the historical and contemporary 'logging' of forests has had profound effects on the severity and frequency of recent bushfires in Australia[80]. These profound effects have been attributed to a rise in fuel loads (immediately following the harvesting operations), as well as increases in the potential drying of wet or moist forests, and creating habitat loss, fragmentation, and disturbance for many species.

Other studies have presented findings that recent logging resulted in higher probability of crown fire in a range of forest types, including Ash forest, during the 2009 Victorian fires[81]. With a Southeast Queensland perspective, it should be noted these arguments have mostly related to a focus on relatively intensive timber harvesting practices in wet and moist forests in southern Australia; less so sub-tropical areas with highly selective harvesting practices.

However, more recent research has contended that there is no evidence for this argument. An extensive review conducted during 2020/21 concluded the proportion of forested conservation reserves burnt in these fires was similar to that for public forests where timber

[77] Eliott M, Lewis T, Venn T, Srivastava S (2019) Planned and unplanned fire regimes on public land in south-east Queensland. *International Journal of Wildland Fire*, 29. 10.1071/WF18213.
[78] Montreal Process Implementation Group for Australia and National Forest Inventory Steering Committee (2018) *op cit*.
[79] Eliott, M, Venn T, Lewis T, Farrar M, Srivastava SK (2021) A prescribed fire cost model for public lands in south-east Queensland. *Forest Policy and Economics*, Volume 132, November 2021, 102579.
[80] Lindenmayer DB, Kooyman RM, Taylor C. et al. (2020) Recent Australian wildfires made worse by logging and associated forest management. *Nat Ecol Evol,* 4, 898–900 (2020).
[81] Bradstock R. and Price O (2014) Logging and Fire in Australian Forests: errors by Attiwill et al. (2014) *Conservation Letters*, 7: 419-420. https://doi.org/10.1111/conl.12086

harvesting is permitted, and the proportion of forest burnt with different levels of fire severity was similar across tenures and over time since timber harvest[82].

Furthermore, an analysis of the areas burnt in 2019/20 indicated that the extent and severity of the fires was determined almost entirely by three years of well-below-average rainfall (leading to dry fuels across all vegetation types), extreme fire weather conditions and local topography - and past timber harvesting had negligible or no impact on fire severity. This research also pointed to the significant observation that three major inquiries into the Black Summer bushfires had made no recommendations regarding the impact of timber harvesting on fire risk.

Given these findings, and that timber harvesting in public native forests in SCQ is conducted using selective harvesting practices with a significantly lower intensity than state-managed timber harvesting practices elsewhere, there is a reasonable basis for concluding the impact of timber harvesting on bushfire extent and severity would be small to negligible in SCQ.

Key points:

- Historically, it is apparent there has been more planned burning conducted on State forests. The transfer of State forest to national parks and reserves across multiple states, over the past 40 years, has reportedly seen significant reductions in the public land management workforce, heavy equipment and skills available for forest firefighting and fire management.
- Fire management regimes in public native forests in SEQ are now broadly comparable across national parks and State forests; however, multiple use forests will generally provide more synergies, given the workforce requirements with equipment and skills.
- While governments acknowledge and support the use of planned fire, there are still limited resources available for government agencies to ensure an appropriate level of planned burning to achieve not only risk-reduction objectives, but also ecological objectives.
- In relation to timber harvesting, there is a reasonable basis for concluding the impact of timber harvesting on bushfire extent and severity would be small to negligible in SCQ.

4.5 Carbon dynamics in managed forests

The carbon balance associated with the management of native forests under differing tenures has been investigated to a significant degree, both in Australia and internationally.

In a broad literature review conducted in 2021, the NSW Department of Primary Industries (DPI) observed that there are studies pointing to the climate benefits associated with the management of native forests for multiple uses including timber production, compared to a conservation only approach; while there are others that have arrived at different results.

Contrary arguments in other studies have included, for example, the proposition that changing forest management policy to avoid emissions from logging will contribute to the global objective of reducing atmospheric carbon dioxide emissions and to national targets for reducing emissions[83].

Following their broad literature review, DPI countered these arguments, and concluded '*there is significant evidence from studies in Australia and internationally that the sustainable management of native forests – including sustainable timber harvesting - can lead to superior climate outcomes when a full life cycle approach (LCA) is adopted in assessments*'[84].

[82] Keenan RJ, Kanowski P, Baker PJ, Brack C, Bartlett T & Tolhurst K (2021) No evidence that timber harvesting increased the scale or severity of the 2019/20 bushfires in south-eastern Australia. *Australian Forestry*, 84:3, 133-138, DOI: 10.1080/00049158.2021.1953741.

[83] Keith, H., D. Lindenmayer, B. Mackey, D. Blair, L. Carter, L. McBurney, S. Okada, and T. Konishi-Nagano. 2014.Managing temperate forests for carbon storage: impacts of logging versus forest protection on carbon stocks. *Ecosphere*, 5(6):75. http://dx.doi.org/10.1890/ES14-00051.1

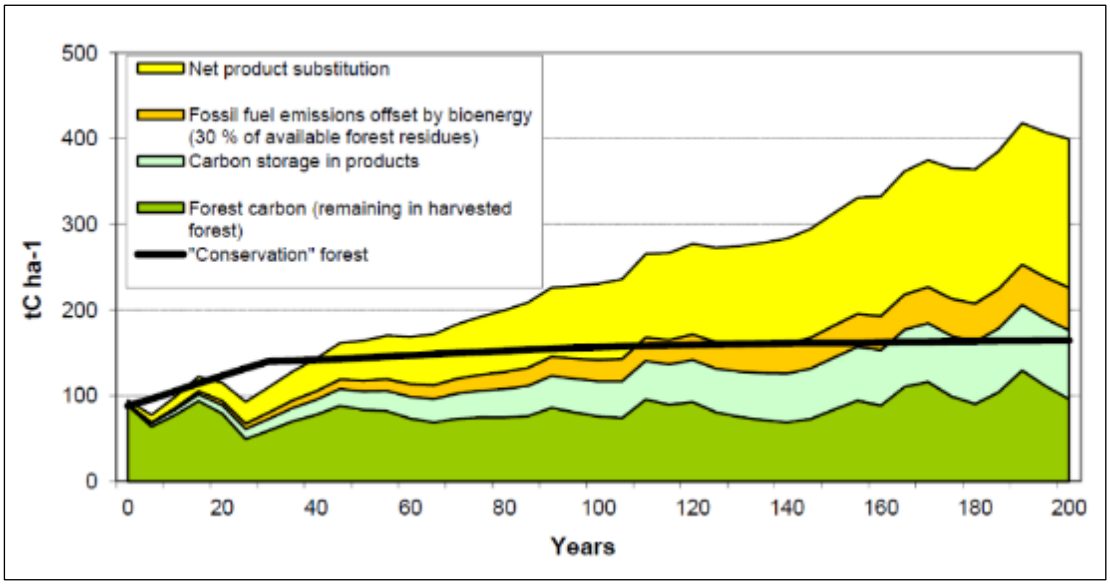
[84] NSW Department of Primary Industries (2021) *Carbon dynamics in native forests – a brief review*. Report published September 2021. This research was financially supported by Timber Queensland.

Their review findings were aligned with the stated positions of multiple respected international agencies including the Intergovernmental Panel on Climate Change (IPCC), the Food and Agriculture Organization of the United Nations (FAO) and United Nations Economic Commission for Europe (UNECE), which have consistently released statements supporting the principle that sustainable management of forests for production is an important climate change mitigation tool[85]. In relation to its assessment of Climate Change and Land in 2019, and greenhouse gas fluxes in terrestrial ecosystems, the IPCC concluded:

> '*Sustainable forest management can maintain or enhance forest carbon stocks, and can maintain forest carbon sinks, including by transferring carbon to wood products, thus addressing the issue of sink saturation. Where wood carbon is transferred to harvested wood products, these can store carbon over the long-term and can substitute for emissions-intensive materials reducing emissions in other sectors*'.[86]

An earlier assessment by DPI researchers in 2012 looking at the greenhouse gas (GHG) balance in native forests in NSW concluded that forests managed for production (one of multiple uses) provide the greatest ongoing GHG benefits; with long-term carbon storage in products and product substitution benefits critical to the outcome[87]. The product substitution benefits arising from using wood products or biomass to replace more emissions intensive non-wood products will generally gradually increase over time, as shown in the modelling of carbon stocks for NSW north coast forests over 200 years (Figure 4-2).

Figure 4-2 GHG implications of the "conservation" and "production" scenarios for carbon stocks in North Coast NSW forests modelled over a 200-year period



Source: Ximenes et al 2012

Over this period, the average mitigation benefit from production over conservation was found (through modelling) to be 195 tonnes carbon per ha (or 715 tonnes of CO_{2e} per ha). This net benefit is likely to be significantly higher than the potential for mitigation in SEQ forests, given the considerably higher carbon stocks and higher harvest yields (and therefore higher rates of conversion to harvested wood products and product substitution) in North Coast NSW forests. However, the results highlight that a production forest scenario can provide superior GHG mitigation benefits compared to conservation scenario. Through subsequent studies,

[85] *Ibid*.
[86] IPCC (2019) Climate Change and Land | Summary for Policymakers. https://www.ipcc.ch/srccl/chapter/summary-for-policymakers/
[87] Ximenes F de A, George B, Cowie A, Williams J, Kelly G (2012) Greenhouse Gas Balance of Native Forests in NSW, Australia. *Forests*, 2012, 3, 653-683; doi:10.3390/f3030653

NSW DPI has reported the role for sustainably managed forests will likely be strengthened over time as more of the currently under-utilised forestry biomass is used to manufacture novel bio-products that will displace fossil-fuel based products[88].

Note that these analyses are largely focussed on carbon *stocks* rather than *rates* of carbon sequestration in forests; although rates of carbon sequestration are embedded in the favourable outcome for production forests shown above. Following disturbance events such as bushfire, or timber harvesting, carbon can be sequestered more quickly in actively growing forests areas, prior to a slowing in the rate of carbon sequestration as the forest patch matures and ultimately begins to senesce. A multiple use production forest that features use of selective harvesting can be managed to realise uneven aged forests for more structural diversity, and a mix of young actively growing forests within mature stands, sequestering carbon at different rates over time.

Other studies in Australia have similarly asserted that substantial reductions in national carbon emissions could be achieved by having the construction sector (which accounts for approximately 18% of national emissions due to reliance on carbon-intensive construction materials) increase its use of engineered wood products[89]. This finding reinforces the body of evidence relating to the long-term storage of carbon in wood products, which will generally endure for many years or decades, beyond the carbon flux in the forest dynamics over time.

Key points:

- Sustainable forest management for various outcomes, including timber products, can lead to superior GHG mitigation outcomes compared to conservation only approaches, with long-term carbon storage in products and substitution benefits critical to the outcomes.
- Cost benefit analyses of the carbon balance for alternative forest management models need to ensure the various parameters used are underpinned by robust, defendable data.
- There is compelling evidence from full life cycle assessments in Australia and overseas that, over the long-term, carbon balance under multiple use production forests will not inherently be any worse or lesser than formally protected forests.

4.6 Cost benefit analyses for forest management options

There is a limited range of relevant studies specifically focussed on a conducting a CBA to compare the net benefits of multiple use management in Australia. Following is an outline of other relevant studies and their findings to date.

Economic impacts assessments

Over time the forestry sector has conducted economic impact assessments for specific regions or state-wide enterprises. As examples, in Victoria, Deloitte Access Economics has calculated the economic impact of the native timber harvesting sector in the Central Highlands RFA area and its impact on the Central Highlands and Victorian economies (2015); and two years later, calculated the economic benefits and costs (both direct and indirect) of the native timber industry in Victoria (2017)[90].

These studies incorporated the use of a Computable General Equilibrium framework to capture the interdependencies between VicForests, its contractors and customers and other segments of the economy, and the extent to which economic activity would be impacted across all sectors of the Victorian economy, including the native timber industry, if VicForests did not exist. This is a different construct to the current assessment for SCQ, which is not focussed on a state-wide enterprise, but instead, the net benefits associated with multiple use management of public forests in SCQ.

[88] NSW Department of Primary Industries (2021) op cit.

[89] Yu M, Wiedmann T, Crawford R. & Tait C (2017) The carbon footprint of Australia's construction sector. *Procedia engineering,* 180: 211-220.

[90] VicForests & Deloitte Access Economics (2017) *The economic impact of VicForests on the Victorian community*. Report published September 2017. Available from: https://www.vicforests.com.au/

The Deloitte & VicForests study concluded the cumulative value-added impact attributable to the native forestry industry was estimated at $2.2 billion in net present value terms over the 10-year modelling period, or around $223 million a year. The economy-wide impact over the modelling period was $5.2 billion, including native forestry and accounting for its interactions and impacts with other industry sectors.

The scale of these impacts reflects the relatively large scale of the native forest timber industry in Victoria compared to SCQ; noting VicForests harvested around 1.3 million m^3 of logs in 2015-16, generating $112 million in annual revenue via the sale of native timber; which represents indicatively a ten-fold increase on SCQ production levels. However, the study does highlight the significant positive net economic contribution from sustainable timber production, while maintaining a range of other ecological and social values in multiple use forests.

One significant feature of the Deloitte & VicForests study is its approach to comparing the Victorian economy with native forestry as the base case to a world where the native forestry industry and the sub-sectors strongly dependent on it do not exist – that is, there is no redirection of capital in the current Victorian native forestry to alternative industries.

This approach differs from the scope of the current assessment for SCQ (discussed further in the next section), which is based on the alternative would be formally protected forests such as national parks or nature conservation reserves with a different suite of economic activity. However, Deloitte considered its approach was consistent with the highly specialised nature of the inputs used by the native forestry industry to produce output; and consistent with sector-specific socio-economic studies that have highlighted the ability of capital and labour currently used in native forestry to physically migrate to other sectors may be limited, should the industry not exist.

Cost benefit analyses

More recently, Frontier Economics (2021) compared the value of alternative uses of native forests in southern NSW, with a focus on testing whether the economic value of the native hardwood forest is higher when it is harvested and used to make processed timber products or when it is left in its natural state to provide environmental and recreational services, including carbon abatement. The study reached the conclusion that there would be an economic benefit from ceasing native forest harvesting in the Southern and Eden forest regions, with the incremental benefits of ceasing native forest harvesting calculated to be higher than the incremental costs by around $62 million[91]. This calculation was based on an analysis measuring the stream of costs and benefits over a 30-year period to 2051.

The study in southern NSW had a similar scope to the current assessment for SCQ and is therefore directly relevant for consideration. The study comprised a cost benefit analysis comparing a status quo model, which was for NSW to continue harvesting the native forest estate in the Southern and Eden RFA regions; and compare this with ceasing harvesting and capturing the values associated with the standing forest. It also considered the values associated with carbon sequestration services, tourism, and recreation services.

However, a review of the Frontier Economics study for this assessment has identified a range of issues relating to the design of the analysis, which should be considered in relation to the applicability of the findings to SCQ and other regions. These design issues include the following:

1. The alternative options present a simple, binary delineation of activities under the options: with the *Status quo* comprising logging (timber harvesting), but no mountain biking, and relatively large levels of greenhouse gas emissions associated with timber harvesting; and the a*lternative option* of ceasing timber harvesting, being replaced by mountain bike trails and related economic activity, and relatively low levels of greenhouse gas emissions.

   This represents a false dichotomy in land management, as there is considerable scope for recreation and tourism values in multiple-use forests (the status quo model), as is already

[91] Frontier Economics & Macintosh A (2021) *Comparing the value of alternative uses of native forests in Southern NSW*. Report published 30 November 2021.

apparent today in NSW, SCQ, and other regions, which have extensive mountain bike trails and other tourism and recreation facilities in State forests.

2. The report assumes there would be substantial economic benefit arising each year from avoided harvest, haulage, and processing costs – totalling more than $1.2 billion over the 30-year study period. This amount was accounted for in the cost-benefit analysis as a saving to taxpayers, i.e. as a benefit. The issue arising is that this 'cost saving' represents what is actual income for regional businesses, and related economic activity, with operations paid for by timber processors, from the total revenue that flows from the sale of forest products. Therefore, the cessation of timber harvesting would see regional businesses and communities forego that revenue and income. Furthermore, the study excludes the net value to society of wood products by assuming it is no more than the sum of cash expenditures to create those products.
3. The report assumes higher net carbon dioxide emissions associated with timber harvesting compared to the alternative option. However, as outlined in this report (refer Section 4.5 – Carbon dynamics in managed forests), there is relevant published research and recognition from multiple respected international agencies, including the IPCC, FAO and UNECE, that the sustainable management of forests for production is an important mitigation tool. Furthermore, sustainably managed production forests are most likely to produce a superior long-term outcome when the multiple carbon sequestration and abatement pathways are considered. The underlying assumptions regarding the valuation of carbon sequestration benefits and methodology used would need to be further investigated to assess their robustness and validity.
4. Based on sensitivity testing, the study concluded that the finding of realising net benefits when native forest logging ceases held up under all scenarios, except where there is a 10% increase in the value of wood products. The study then noted that as the supply of native logs has been shifting to smaller logs that produce lower value wood products, this scenario is considered unlikely. This assumption is not supported, and the opposite could be argued, particularly in the current market settings, which have seen significant increases in prices for wood products due to increasing demand and supply chain constraints. Furthermore, with the ongoing evolution of technologies it is now possible to produce high value timber products from logs that were previously considered too small to be usable commercially.
5. The report notes there are credible, alternative employment opportunities in the area for displaced workers. As noted above, the Deloitte and VicForests study in Victoria highlighted the observation that only a small proportion of people who have lost their jobs in forestry, logging and wood processing have found re-employment readily, on comparable terms – and there is no evidence of a strong migration into tourism and hospitality jobs.
6. Furthermore, the study appears to overlook the fact that in the absence of timber harvesting practices, there will be substantial additional costs required to maintain fire-fighting capability and capacity, access to heavy machinery requirements, and road and fire track maintenance – which are currently maintained through economic activity and private sector investment, rather than entirely through the public purse.

Key points:

- There are few CBA studies in Australia that relate directly to assessing the net benefits of multiple use forests incorporating sustainable timber harvesting.
- Further consideration should be given to the methodologies ahead of the implications of these studies and the application of findings to Queensland and other regions.

5. COST BENEFIT ANALYSIS

5.1 Definitions

This section provides guidance on how the CBA has been conducted within the context of the Project and includes discussion on important considerations when conducting CBA in relation to the forestry sector which may have significant implications for results. Further guidance on the method and these key considerations is provided in **Annex 1**.

What is cost-benefit analysis?

CBA is a common economic technique used to systematically assess and compare the net benefit of alternative projects/options. In a CBA, benefits and costs are estimated in monetary terms across an evaluation period and discounted to account for the 'time value of money'. The evaluation period is the period over which benefits and costs are expected to accrue while discounting accounts for the fact there is a preference to receive benefits early and delay costs.

A CBA is based on two decision rules, which can both be used as a basis for comparison of options, and that reflect a net benefit to society:

- A net present value (NPV) > 0; where NPV is the net benefit (i.e., the total discounted benefit less costs) over the appraisal period;
- A benefit-cost ratio (BCR) > 1; where BCR is the ratio of discounted benefits over costs.

CBAs are the Queensland Government's preferred approach for assessing the costs and benefits of investments as part of business cases[92]

5.2 Best practice methodologies

Economic analysis such as CBA is commonly used to understand the trade-offs between different land use types and/or to justify decisions to cease or continue timber production. However, there are several issues that arise that can make conducting a robust CBA involving the forestry sector challenging.

A CBA focused on the forestry sector should aim to incorporate values for a broad range of ecosystem services, to recognise a forest's capacity to deliver multiple benefits regardless of the management model's primary objectives. This includes incorporating non-market benefits which are provided at zero direct cost to beneficiaries or at price which is below an efficient market value. When incorporating benefits, it is critical that the costs of realising those benefits are also considered. Where possible, the downstream impacts of changes should also be factored into the analysis. The degree to which this occurs will be influenced by the spatial boundaries of the assessment, and the complexity of capturing those impacts consistently across multiple options.

A summary of key features of the CBA undertaken for this assessment, as they relate to these issues, is set out in Table 5-1. These features are contrasted with other recent economic assessments of native forestry assets and management, notably:

- Forico's *Natural Capital Report* (2021), which uses an environmental accounting approach to value natural capital within its native forests and plantation forest interests in Tasmania[93];
- Frontier Economics & Professor Andrew Macintosh's (2021) study on *comparing the value of alternative uses of native forests in Southern NSW*[94]. Their report considered tenure decisions within a narrower scope of economic analysis.

Further information on common approaches and issues in addressing these issues is presented in **Annex 1**.

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[92] Queensland Government (2021) *Cost Benefit Analysis Guide - Business Case Development Framework*.
[93] Forico (2021) *Natural Capital Report of the Tasmanian Forest Trust for the year ended 30 June 2021.*
[94] Frontier Economics & Macintosh A (2021) *op cit*.

Table 5-1 Key design features for CBA relating to managing forest resources

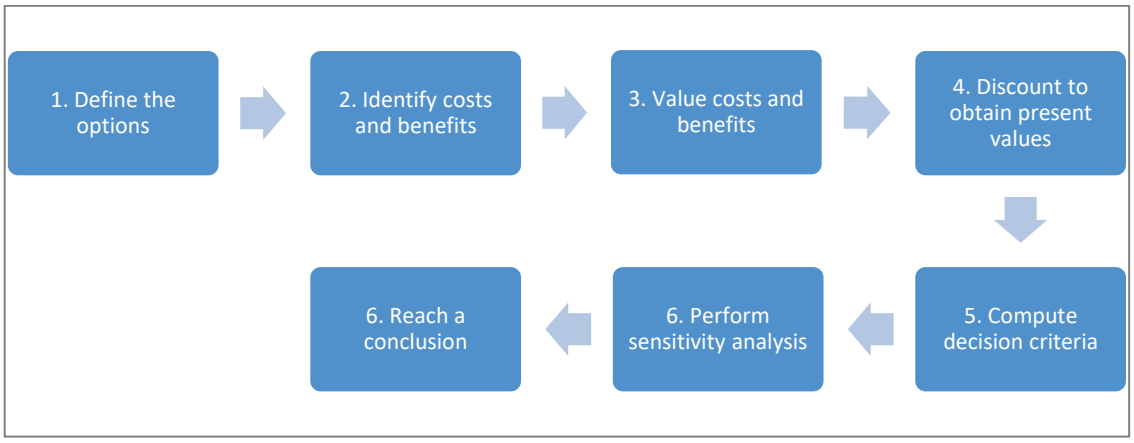
Key design features	This CBA study for SCQ	Examples of limitations of other CBAs
Incorporates a broad scope of ecosystem services into the assessment	✓A broad suite of benefits is identified and valued where quantitative data is available. Note, however, the robustness of current estimates for various services is quite low.	× Only benefits that potentially create market transactions are valued[1]. × Many ecosystem services are excluded or simply identified qualitatively[2].
Recognises that native forests can be managed to provide for a broad range of values, with many complementary uses	✓ Recognises multiple use State forests can be managed for timber harvesting as well as maintaining recreation values, such as mountain bike trails, and supporting conservation values.	× Presents a more binary comparison, in which State forests are managed almost solely for timber production and no other values, i.e. excludes scope for recreation values and conservation values[2].
	✓ Recognises in the commentary that sustainable timber harvesting can support and effectively subsidise fire-fighting capability and capacity, access to heavy machinery requirements, and road and fire track maintenance requirements for fire protection; but does not quantify this cross-subsidisation in the CBA.	× Overlooks the likely outcome that in the absence of timber harvesting, there may be substantial costs required to maintain firefighting capability and capacity, access to heavy machinery requirements, and road and fire track maintenance[2].
Recognises both the costs and benefits arising from the management for specified values	✓ Incorporates costs and benefits, including for example, costs associated with the scenario of seeking to maximise carbon sequestration and storage in-forest by excluding sustainable timber harvesting.	× Only a small scope of costs and benefits valued[1]. × Excludes consideration of the full cost of managing public native forest, for scenarios that seeks to maximise carbon sequestration and storage in-forest by excluding sustainable timber harvesting[2].
Recognises downstream impacts and benefits arising	✓ Recognises benefits of CO_2 emissions avoided through substitution of wood products for non-wood products (with higher emissions intensity). Note study does not incorporate socio-economic impacts from downstream processing of wood products.	× No downstream impacts or benefits incorporated in the analysis[1]. × Excludes the value to society of wood products by assuming it is only the sum of cash expenditures to create those products[2].
Recognises the market dynamics for wood products	✓ Adopted simple premise that current markets for Queensland wood products will continue to demand wood, and the value of harvested wood products from public native forests will be maintained, if not increased, provided it is conducted on a sustainable basis. Note this is considered conservative given the declining supply in hardwood timbers across Australia.	× Assumes the trend towards harvesting smaller logs (i.e. average log diameters and lengths are decreasing) means that timber production is becoming commercially infeasible[2].
Recognises the carbon dynamics in native forests and in harvested wood products	✓ Recognises emission reduction benefits based on extensive life cycle analysis ("what the atmosphere sees"), in contrast to only what can be credited in current carbon markets. ✓ Recognises sustainable timber harvesting can facilitate faster sequestration rates in regrowth forests, with carbon reallocated from forests to harvested wood products.	× Only recognises ACCU accreditable carbon included[1]. × Assumes carbon stocks in forests are generally static, and sustainable timber harvesting results simply in a reduction in carbon stocks compared to non-harvest regimes[2].

Relevant studies for comparison: 1. Forico Natural Capital Report 2021; 2. Frontier Economics & Macintosh A (2021) Comparing the value of alternative uses of native forests in Southern NSW.

5.3 Method overview

Our method for performing the CBA is broadly consistent with the Queensland Government guidelines[95]. The CBA is broken down into seven steps as shown in Figure 5-1 and described below.

Figure 5-1 Key steps for assessing the net-benefit of a public native production forest compared to a protection forest



Source: Natural Capital Economics' standard approach to developing cost-benefit analysis.

Step 1: Define the options

To begin the analysis, the options (in this case, management models) being assessed must be defined. This includes defining the base case and the alternative management model to be assessed. The models are compared to determine the incremental benefits or costs which occur under alternative types of management.

Th CBA method described is designed to compare the net benefits arising from managing public native forests under two alternative models:

- *Status quo*: multiple use forests (base case); and
- *Alternative model*: formally protected forests.

Step 2: Identify costs and benefits

To perform a comprehensive assessment, the differences in costs and benefits must be identified for each option. In this analysis, we rely predominantly on an assessment of ecosystem services[96] to identify incremental (or marginal) costs and benefits. Identifying ecosystem services typically begins by first identifying the ecosystem assets, in this case the native forest, and then identifying the ecosystem services which flow from this asset.

Step 3: Value costs and benefits

Once benefits have been identified, the next step is to quantify their value, in monetary terms. Due to limitations on public data and resources, it is typically not possible to quantify the value of all costs and benefits identified.

A range of economic techniques are available to value costs and benefits. These are predominantly categorised as either market or non-market valuation approaches. Market

[95] Queensland Department of Treasury (2015) *Project Assessment Framework - Cost-benefit analysis*. Online, accessed 1 April 2022: https://s3.treasury.qld.gov.au/files/paf-cost-benefit-analysis.pdf
[96] Ecosystem services are the benefits (goods and services) derived by humans from the environment.

approaches to valuation are used when market prices exist, while non-market approaches are used when they do not.

Step 4 Discount to allow future values to be compared

Within a CBA, discounted cashflow (DCF) analysis is used to convert future benefits and costs into present values. This process, known as discounting, enables a fair comparison of cost and benefits by taking account of the 'time value of money' or the fact that there is a preference to receive benefits early and delay costs. Discussion of appropriate discount rates is included in section *Discount rate*.

Step 5: Compute decision criteria

Once present values have been estimated, the net present value (NPV) and the benefit-cost ratio (BCR) of alternative options can be determined (or in this case models). These are the two primary decision criteria used to evaluate the net benefits of options. A NPV above zero and a BCR above 1 indicates an option has a net benefit, with a higher value indicating a higher benefit to society and a more preferred option.

Step 6: Perform sensitivity analysis

Sensitivity analysis is the process used to understand which inputs and assumptions have the most significant effect on the overall results. For this analysis, sensitivity analysis was performed using a Monte Carlo simulation which is a statistical technique used to model the probability of different outcomes. This process identifies which input parameters or assumptions have the most influence on outputs and establish confidence intervals around the findings.

Step 7: Reach a conclusion

The last step is to draw conclusions from the outputs of the analysis. This includes considering the values of the decision criteria, the results of the sensitivity analysis, any qualitative descriptions of benefits or costs not valued, and other contextual information. The results of this analysis enable conclusions to be drawn as to the net benefit to the region or state from converting multiple use forest to protection forest, as proposed under current policies.

5.4 Model inputs and assumptions

The costs and benefits included in the CBA model are set out in Table 5-2, with a description of the valuation approach used to determine these costs and benefit values. This summary also includes a confidence rating to show the relative confidence in the accuracy of the final valuation. The input data used for each valuation is included in **Annex 2**.

Table 5-2 Benefits and costs included within the CBA and valuation approaches used

Assessed costs & benefits	Valuation approach: Multiple use forests	Valuation approach: Protection forests	Valuation confidence
Forest management	• Historic expenditure	• Historic expenditure	Medium
Hardwood sawlogs	• Market values • Based on the market value of native forest log timber removals in the SCQ Hub each year less harvest and haulage costs	• Not quantified • Under the protection model, most provisioning services are assumed to cease, including timber production	High
Other hardwood timber products			High
Quarry materials	• Royalty value • Based on the value of royalties from the SCQ Hub region to the State less expenses to authorise removal		High
Beekeeping	• Market value • Based on the willingness to pay for beekeeping permits in the SCQ Hub		Medium
Grazing	• Producer gains • Based on market value of liveweight gain to producers from grazing in forests in the SCQ Hub		Medium
Carbon sequestration	• Consumer surplus • Based on the amount of carbon storage (change in carbon stocks) valued at market rates		High
Biodiversity conservation	• Consumer surplus • Valued using a benefit transfer approach	• Consumer surplus • Valued using a benefit transfer approach	Low
Tourism and recreation	• Consumer surplus • Valued based on the willingness to pay (WTP) of visitors per visit. adjusted to account for the relative difference in WTP for tourism and recreation between forest tenures.	• Consumer surplus • Valued based on the WTP of visitors per visit adjusted to account for the relative difference in visitation between forest tenures	Low

The valuation approaches described in Table 5-2 have been developed based on the best data currently available. Limitations of these approaches are further discussed in section 5.5. Improvements in the underlying data will improve the confidence in these valuation approaches and in some case may lead to more sophisticated valuation methods becoming available.

Key point:

- This study, while using the best data currently available, does rely on data of highly variable quality. This impacts on the robustness of the findings from the CBA.

Discount rate

There is significant commentary on what is appropriate for a social discount rate for projects with significant public good characteristics, or intergenerational aspects. There is an argument that a failure to discount, or the use of high discount rates, can lead to decisions which adversely affect the wellbeing of future generations[97].

Therefore, we have set up a model to run using different discount rates (consistent with Treasury guidelines and lower rates previously used in intergenerational projects, like the Garnaut Climate Change Review in 2008[98]) to compare how discount rates influence the results of the CBA.

Three discount rates are illustrated (real, net of inflation):

- 1.35% - This rate was adopted from the Garnaut Climate Change Review in 2008[98]; and it is used to reflect the argument that lower discount rates are more appropriate over long periods.
- 2.65% - This rate was also adopted from the Garnaut Climate Change Review 2008; and is used to reflect the argument that lower discount rates are more appropriate over long periods.
- 7.00% - is the recommended discount rate of the Queensland Government[92] (and other State Governments[99]) for use in business cases for infrastructure proposal. It also represents the recommended social discount rate of the Australian Government[100].

Evaluation period

A typical CBA might be run over an evaluation period of no more than 30 years[92]. However, the relevant evaluation period should be based on the period for which benefits and costs are expected to accrue[101].This model is set up to run over longer periods to recognise the long life of forest assets, the long-term ability of forests to deliver benefits and to compare how the evaluation period influences CBA results. The evaluation periods used are:

- 50 years – conservative estimate of the period over which benefits and costs are expected to accrue;
- 100 years – midpoint estimate of the period over which benefits and costs are expected to accrue; and
- 200 years – upper bound estimate of the period over which benefits and costs are expected to accrue and is a modelling period that is consistent with notable greenhouse gas balance modelling in key native forest areas[87].

These longer periods for CBA evaluations are more reflective of the growth cycle of native forests, including the continued growth in many of the benefits derived.

5.5 Limitations of estimated values

The data used for the project was collected through desktop research. In some cases, the data was non-specific to the study region and was limited in scope. These factors, combined with the age of some data used, impact the robustness of the CBA results.

The use of imperfect data is relatively common in CBAs for natural resource management in Australia, and in other countries, due to the level of resources required to perform primary data

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[97]Scarborough H (2011) Intergenerational equity and the social discount rate. *Australian Journal of Agricultural and Resource Economics*, 55: 145-158. https://doi.org/10.1111/j.1467-8489.2011.00532.x

[98] Garnaut R (2008) *The Garnaut Climate Change Review*. Cambridge University Press, Cambridge.

[99] Department of Treasury and Finance (2013) *Economic Evaluation for Business Cases Technical guidelines*.

[100] Australian Government (2007) *Best Practice Regulation Handbook*, Canberra.

[101] Dobes L, Leung J & Argyrous G (2016) *Social cost benefit analysis in Australia and New Zealand - The state of current practice and what needs to be done*. ANU Press.

collection. Furthermore, primary data collection, which involves gathering data through methods such as interviews and surveys, seldomly provides perfect information. It is for these reasons that sensitivity analysis is a critical part of performing a CBA. Along with providing an understanding of how results will alter with changes in input values, sensitivity analysis provides insight into which inputs have the most impact on the CBA results, and therefore, for which inputs further work on enhancing data is most worthwhile.

This quality of the data used has affected the reliability of the CBA results through:

- **Limiting the ecosystem services which could be valued.** For example, we have estimated the value from carbon sequestration across both models but have not been able to estimate the value provided through improvements to water quality;
- **Limiting the extent of benefits reflected in estimated values.** For example, we have valued the benefits of quarry material based on royalties to the State. This reflects only a small proportion of the total benefit the use of these goods provide;
- **Limiting the accuracy of estimates.** For example, we have estimated the value of biodiversity conservation across both scenarios, but the accuracy of these estimates is limited due to a lack of detailed data on the economic value of biodiversity in the study region and how this will change under different management regimes.

Some of the key values for which there is a significant level of uncertainty are management costs, biodiversity values, and recreation and tourism values. The uncertainty relating to these values and limitation around incorporating fire risk is discussed below.

Management costs

The management cost information used for this assessment is based largely on an analysis by the Queensland Treasury Corporation[102]. Their analysis in 2018 suggests that operational funding across Queensland's public protected area estate averaged around $16.50/ha in 2018. However, spending varied considerably, with $45.60/ha being spent in coastal and island regions and $1.60/ha being spent in central regions of Queensland. By comparison, at around the same time, NSW and Victoria were spending on average around $58/ha and $42/ha respectively to manage public protected estates.

This analysis from 2018 suggests that operational spending can vary significantly across the protected areas, which makes it hard to predict changes in management costs due to a change in management regime. In addition, without a good understanding of management costs, it is also hard to predict subsequent changes in other outcomes. For example, Queensland Treasury Corporation suggest that *'state-wide biodiversity and conservation outcomes appear to be declining*', which may be related to the "modest" level of funding which limits what environmental and other outcomes are achievable[103].

Biodiversity

For this project, due to a lack of region-specific information, biodiversity values have been informed by a study into the value of ecosystem services in the Wet Tropics World Heritage Area (WTWHA)[104]. In this study, biodiversity values are estimated across the forest tenures of national parks, State forests and timber reserves. In this study, biodiversity values were found to be similar in national parks and State Forests, but lower in timber reserves.

Tourism and recreation

The value of recreation and tourism under each scenario is based on the number of visitors and the benefit obtained per visit, where the benefit per visit is based on the willingness to pay (WTP)

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[102] Queensland Treasury Corporation (2018) *Queensland protected areas financial sustainability strategy*. Online: https://documents.parliament.qld.gov.au/TableOffice/TabledPapers/2020/5620T1524.pdf
[103] *Ibid*.
[104] Curtis, I (2004) Valuing ecosystem goods and services: a new approach using a surrogate market and the combination of a multiple criteria analysis and a Delphi panel to assign weights to the attributes, *Ecological Economics*, Volume 50, Issues 3–4, Pages 163-194, ISSN 0921-8009.

of visitors obtained from the University of Queensland's estimated values of national parks to the Queensland economy (2020)[41] The WTP is adjusted under the multiple use scenario to account for a potentially lower WTP associated with visiting a multiple use forest versus a protection forest. This adjustment is based on the relative difference between the value per visit obtained from visiting a national park in Victoria by comparison to the value per visit obtained from visiting State forest, with data obtained from Parks Victoria and the Victorian Government Department of Environment, Land, Water and Planning (DELWP)[105]. This approach may overestimate the difference in the value per visit between both models, as this study compares the value per visit of different parks rather than the same park which has undergone a change of tenure.

Visitation data is also drawn from the same study, which is based on data from Tourism Research Australia on domestic and international visitors to "national/state parks". This data may underestimate visitors under both models as it does not consider any visitors who make a round trip of less than 50 km.

Limiting the robustness of the estimated tourism and recreation benefit is a lack of recent data that disaggregates visitation by forest tenure in the study region. This type of data would improve estimates of visitation under each scenario, including what the potential uplift may be with a change in management regime from multiple use to protection. Conversely, there may be a decline in tourism and recreation benefits, as some recreational pursuits such as four-wheel driving and motorcycle riding may be discouraged under the protected forest scenario.

As described earlier, increased visitation may occur in conjunction with increases in operating costs associated with more visitor activity. However, without more granular data it is hard to predict what uplift in both these factors is likely.

[105] Parks Victoria (2015) *Valuing Victoria's Parks Accounting for ecosystems and valuing their benefits: Report of first phase findings*.

6. ASSESSMENT OUTCOMES

The CBA results are presented in this section, with a breakdown of results by ecosystem service and summary results provided for each of the two scenarios. Further results are presented in **Annex 3**.

6.1 Estimated present values for costs and benefits

The present value of management costs and ecosystem services for multiple use and protected forest options, when discounted at a rate of 2.65% over 100 years, are shown in Table 6-1. The present values are shown across a range to illustrate the values that are possible based on the range of input values used. The values for ecosystem services are all positive illustrating that they are providing a net benefit, while management costs are negative to represent a net cost.

Biodiversity conservation or carbon sequestration have the highest values among all ecosystem services across each option. The values associated with each of these ecosystem services all have a large range. For biodiversity conservation, this reflects the low level of confidence associated with the inputs used in valuing this benefit. For carbon sequestration, this range is primarily a reflection of uncertainty associated with the future price of ACCUs which has been used to provide a shadow price for valuation. No method currently exists to monetise this carbon sequestration benefit in the form of carbon credits for either assessed scenario.

Table 6-1 Estimated present value of management costs and ecosystem services (100 years, discount rate 2.65%)

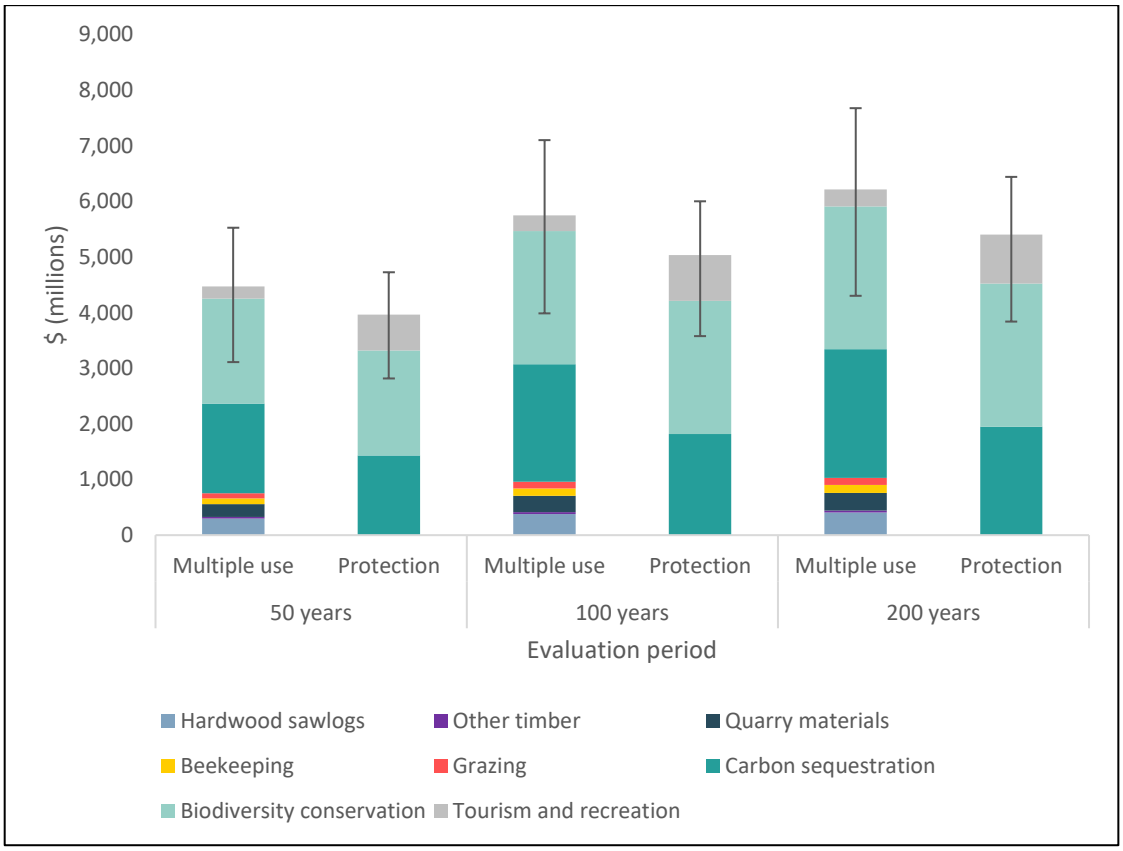
	Estimated annual value ($M)					
	Multiple use forests			Protection forests		
Management costs & ecosystem services	Low	Mid	High	Low	Mid	High
Management costs	(422)	(377)	(335)	(1,299)	(865)	(560)
Hardwood sawlogs	280	379	501	0	0	0
Other timber	19	35	55	0	0	0
Quarry materials	204	291	429	0	0	0
Beekeeping[106]	36	135	300	0	0	0
Grazing	48	120	220	0	0	0
Carbon sequestration[106,107]	1,101	2,111	2,533	948	1,817	2,181
Biodiversity conservation[106,107]	2,131	2,396	2,660	2,131	2,396	2,660
Tourism and recreational[106]	169	281	404	499	822	1,161
Total ($M)	**3,566**	**5,371**	**6,767**	**2,279**	**4,170**	**5,422**

Relative to biodiversity conservation and carbon sequestration, the values for the provisioning services of hardwood sawlogs, other timber, and quarry material under multiple use forests are lower and have smaller ranges due to a higher level of confidence surrounding the input values and valuation approach used.

[106] Non-market valuation approaches have been used to estimate the values of these ecosystem services noting that this is only the case for the upper bound estimate of beekeeping.
[107] No established markets currently exist to capture the value of biodiversity conservation or carbon sequestration under the multiple use or protection scenarios in the study region.

The present value of benefits (excluding costs) across different evaluation periods, discounted at 2.65%, are shown in Figure 6-1. This illustrates that the present value of benefits will increase under both models of management with longer evaluation periods as the longer period provides increased recognition of forests being able to deliver benefits over a long period. Despite increases in the total present value of benefits, the marginal difference between each scenario remains relative consistent. In part, this reflects the static nature of the annual benefits incorporated into the CBA across most ecosystem services (except carbon sequestration). The values of benefits and costs may fluctuate from year to year. This limitation of the analysis is not expected to significantly change the outcomes.

Figure 6-1 Present value of benefits for each scenario across alternative evaluation periods (discount rate of 2.65%)



The assessment found the present value of benefits (excluding costs in this case) to be relatively similar across both models. However, the multiple-use forest scenarios resulted in consistently higher benefits across all evaluation periods and discount rates, based on most likely outcomes.

This finding can be attributed to the significant benefits derived from provisioning services from multiple use forests (including hardwood sawlogs, other timber, quarry materials, honey from beekeeping, and grazing), which would not be realised if these forests areas were converted to protection forests. While the protection forest option may provide higher values of tourism and recreation, multiple use management provides a wider range of benefits including gains arising from carbon sequestration and product substitution over time as well as maintaining biodiversity conservation. This assessment has assumed the values for biodiversity conservation under the multiple use option and the protection option would be similar, based on the premise that the cessation of selective timber harvesting and rezoning multiple use forests to formally protected forests will not directly (with no further resources or interventions) increase biodiversity values. Further resourcing and management interventions may be required, but across both tenures, to mitigate the more threatening processes to biodiversity in public native forests.

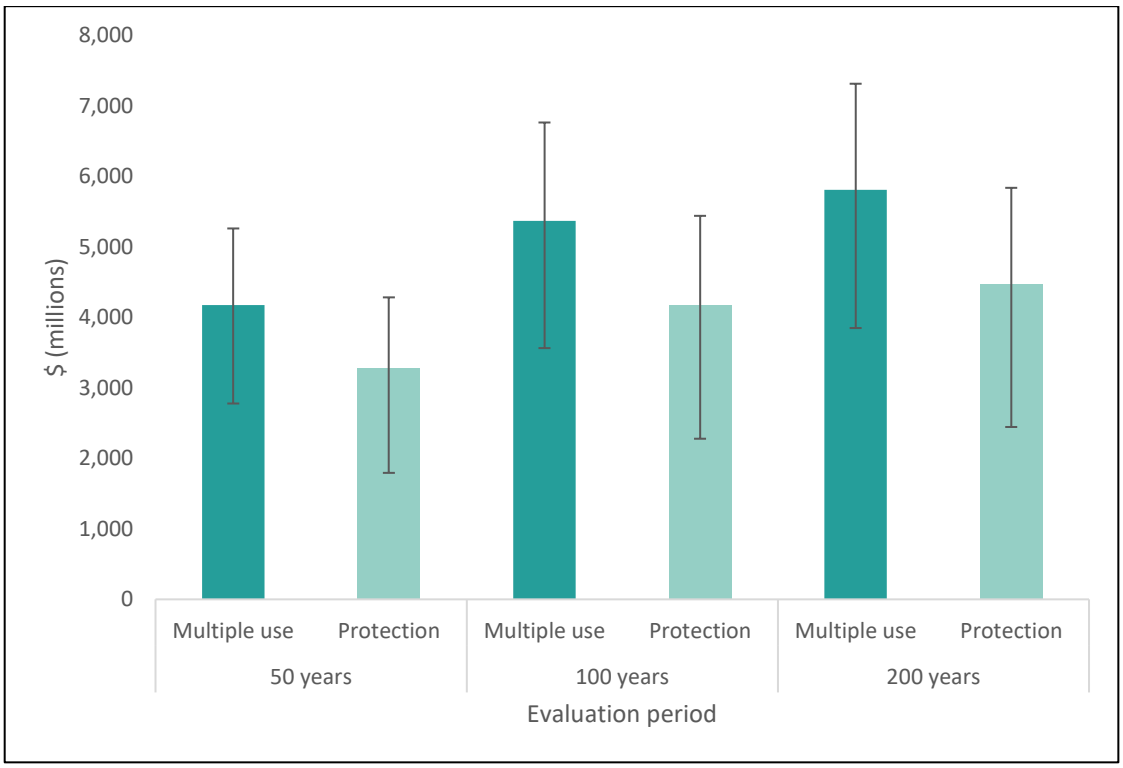
6.2 Net present values

Median net present values (NPVs) of the multiple use option and the protection option across each evaluation period, discounted at 2.65%, are shown in Figure 6-2. The NPVs represent the value of benefits being provided by the forest ecosystem services, net of management cost.

This summary incorporates error bars to show the range of possible NPV outcomes. The error bars are determined using the stochastic (Monte Carlo) simulation analysis.

Across each evaluation period, the multiple use forest management option has the highest median NPV. This indicates that multiple use forests are more likely to have a higher NPV than protection forests, based on the model assumptions.

Figure 6-2 Net present values of each scenario across alternative evaluation periods (discount rate of 2.65%)



As shown in Figure 6-2, there is considerable overlap of the error bars between each model; and across the array of potential outcomes and values that may be attributed to ecosystem services under each model, there are scenarios in which protection forests may have a higher NPV than multiple use forests. Therefore, although the CBA and associated stochastic analysis shows it is more likely that multiple use forests will have a higher NPV than protection forests, this cannot be stated as a certain outcome across all settings and circumstances.

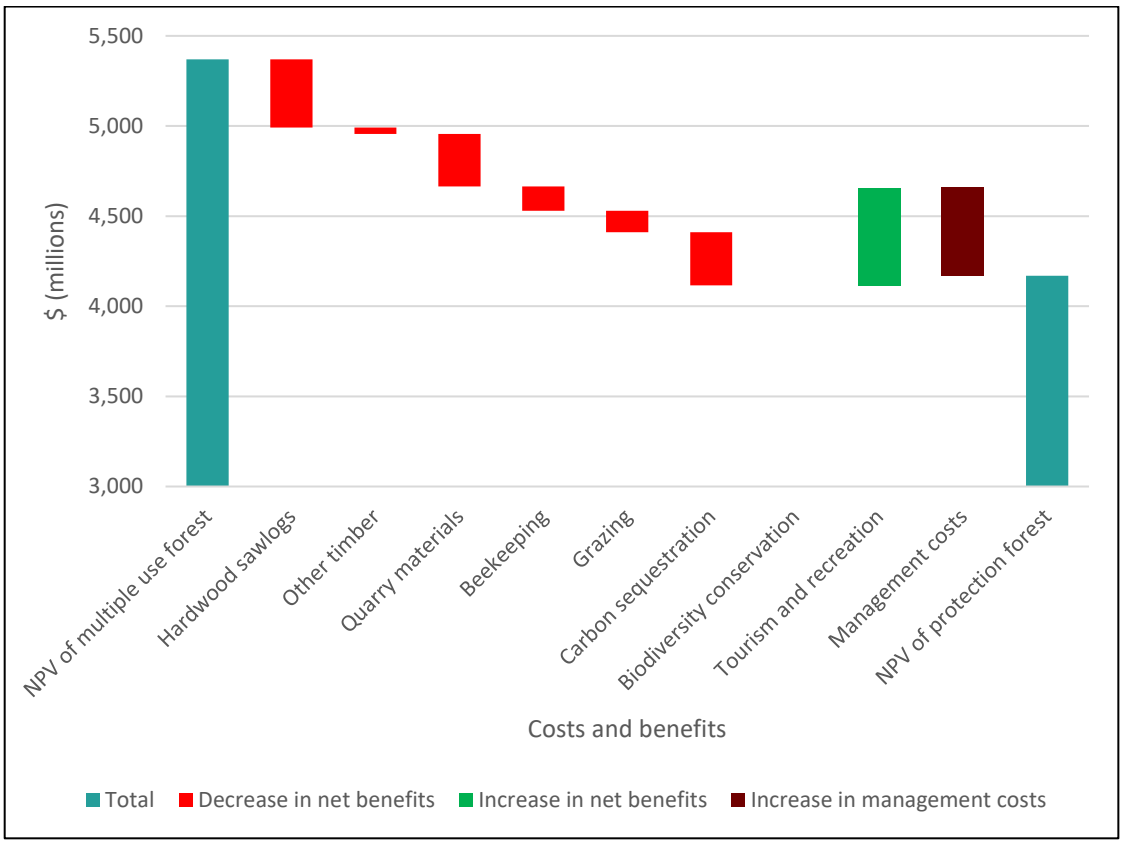
The large range in possible NPVs across both models reflects the level of uncertainty associated with the model inputs. Further work to refine these input values would be expected to reduce the range in NPVs and provide greater certainty as to which model will more consistently provide the best outcomes.

The midpoint estimate of the NPV of the multiple use option is $5.4 billion, with a range from $3.6 to $6.8 billion. The midpoint NPV of the protection option is $4.2 billion, with a range from $2.3 to $5.4 billion. The ranges reflect the potential NPV for each model. They have been informed by the input values used which also incorporate a range to reflect uncertainty with knowing an inputs exact value. Due to considerable overlap of the ranges, this analysis is unable to demonstrate that these models are significantly different from a statistical point of view.

The key values contributing most to the variance in NPV estimates are shown in Figure 6-3. Increased management costs are the biggest driver in the decline of NPV between multiple use and protection forests. Analysis by the Queensland Treasury Corporation (2018) suggest that management resources are generally concentrated towards highly valued recreational areas. There is a high level of uncertainty associated with how management resources would be reallocated with a change in the management regime from multiple use to protection.

Figure 6-3 also shows a decline in the value of all other ecosystem services, except biodiversity conservation and tourism and recreation between multiple use and protection forests. Biodiversity conservation remains the same, while tourism and recreation increase under the protection option, which partially offset the losses from provisioning services and carbon sequestration.

Figure 6-3 Change in NPV between multiple use and protection forests (100 years, discount rate of 2.65%)



Key points:

- The aggregate estimates of benefits between the multiple use and protection tenures are relatively similar, although the distribution of benefits by type is significantly different for each tenure option.
- The results indicate that significant gains in tourism and recreation benefits would be required from a protection tenure model to offset the losses in other ecosystem services (particularly provisioning services).
- When the net changes across all benefit streams and changes in costs are incorporated into the analysis, the results indicate the multiple use tenure option will likely be superior to the protection tenure option in terms of net benefits.

6.3 Sensitivity testing

Sensitivity analysis is an important component of any CBA, particularly when there are high levels of uncertainty around key inputs, and/or where there are limitations on the quality of the data available. Performing sensitivity analysis can significantly improve the robustness of the CBA results by providing an understanding of how the results of the analysis change with changes in the input parameters and by identifying which inputs have the most significant influence on the results.

For this project, a sensitivity analysis was performed using a stochastic (Monte Carlo) simulation[108], with 50,000 iterations, for two purposes:

- To establish confidence intervals around the values of annual costs and benefits related to management costs and individual ecosystem services which then fed into the CBA to provide low, mid-point and high result estimates[109]; and
- To test the effect of the full range of input parameters on the model results to identify which inputs have the most significantly influence.

The results of this analysis are shown in Figure 6-4 and Figure 6-5.

Figure 6-4 Top five inputs contributing to the variance in NPV of multiple use forests (100 years, discount rate of 2.65%)

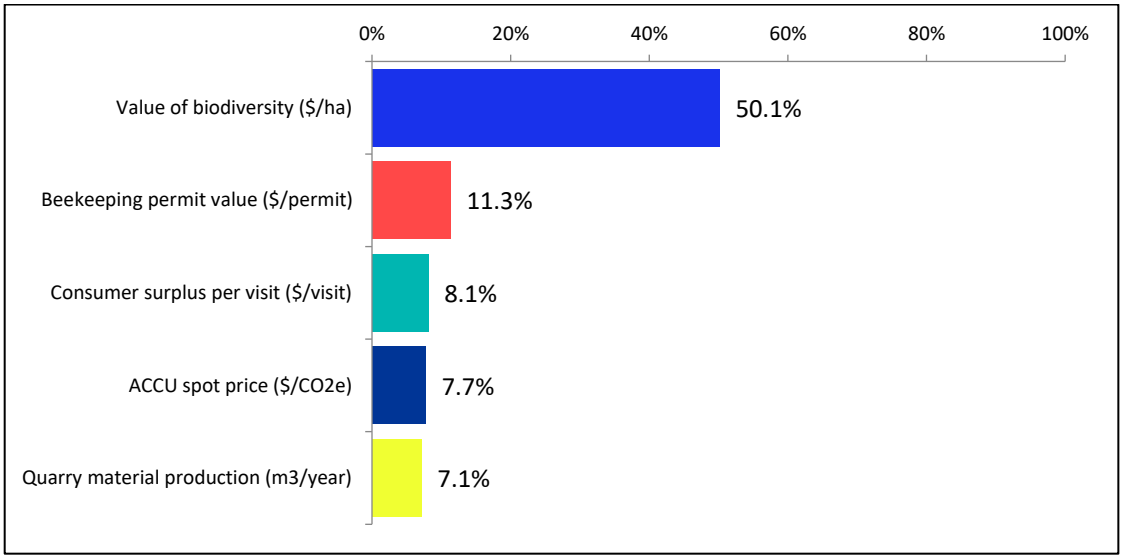


Figure 6-4 indicates the five inputs that contribute most significantly to the variance in the NPV of multiple use forests. The input which contributes the most is value of biodiversity, which represents the value of biodiversity on a per hectare basis. The inputs used to value beekeeping, tourism and recreation, and carbon sequestration also all significantly contribute to the variance in NPV as does the volume of quarry materials produced each year. When the top five inputs are excluded, all remaining inputs account for about 15% of the overall variance.

[108] Monte Carlo simulations are statistical techniques used to model the probability of different outcomes in a process that cannot easily be predicted due to the variability in multiple input variables used in the analysis.

[109] This approach was designed based on the need to provide a model which could be easily updated without the use of Monte Carlo simulations if more reliable data becomes available. Without Monte Carlo simulation, the low, medium, and high estimates of annual values would not take into account the probability of different outcomes and be based on the low, mid and high input values.

Figure 6-5 Top five inputs contributing to the variance in NPV of protection forests (100 years, discount rate of 2.65%)

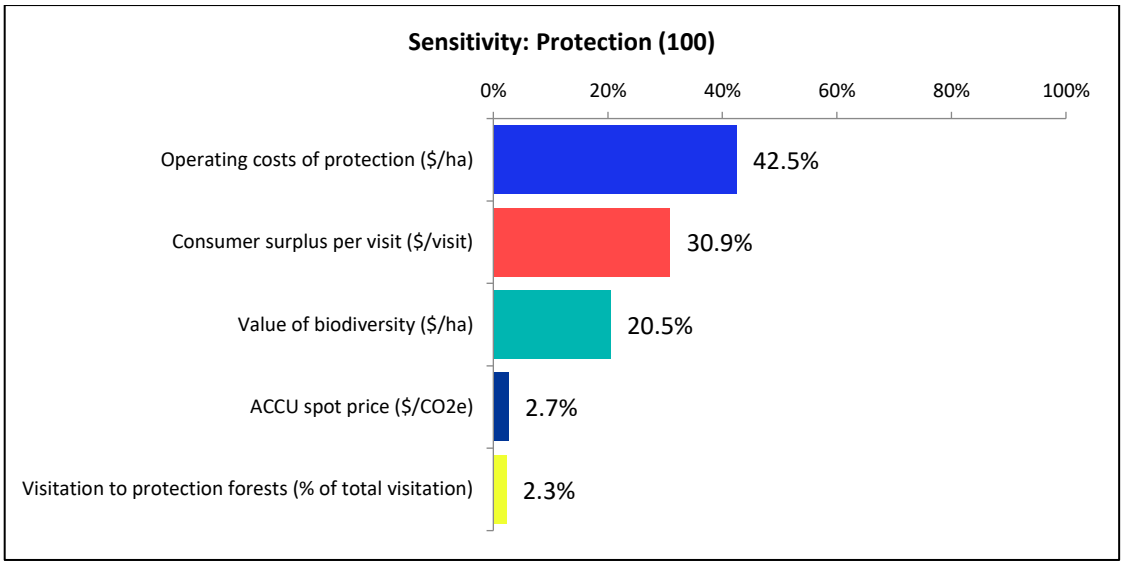


Figure 6-5 indicates that the operating costs of a protection forest is the primary driver of the variance in NPV for the protection option. The input range for this input suggests that management costs in a protection forest will be between $3 and $17 per hectare. The next most significant drivers of the variance in NPV of protection forests is the value of consumer surplus per visit which informs the value of tourism and recreation and the value of biodiversity per hectare which informs the value of biodiversity.

Further work to improve understanding of the most likely values for the inputs identified as being significant drivers of the NPV results should be prioritised as this will have contribute most significantly to improving the robustness of the results.

Key points:

- The sensitivity analysis found that the overall results are particularly sensitive to the unit values for inputs used.
- It would be prudent to address this uncertainty in the analysis before this analysis could be used to reliably inform tenure change decisions.

6.3.1 Unplanned fire risk

Unplanned fires reduce the delivery of ecosystems services from multiple use and protection forests[110]. Unplanned fires can also cause damage to built infrastructure, human health, and agriculture[111]. This makes unplanned fire risk an important consideration for this study and for future land use decisions.

Climate change is increasing unplanned fire risk in southeast Queensland. This is occurring through increased lengths and severity of fire weather conditions and reduced opportunities for

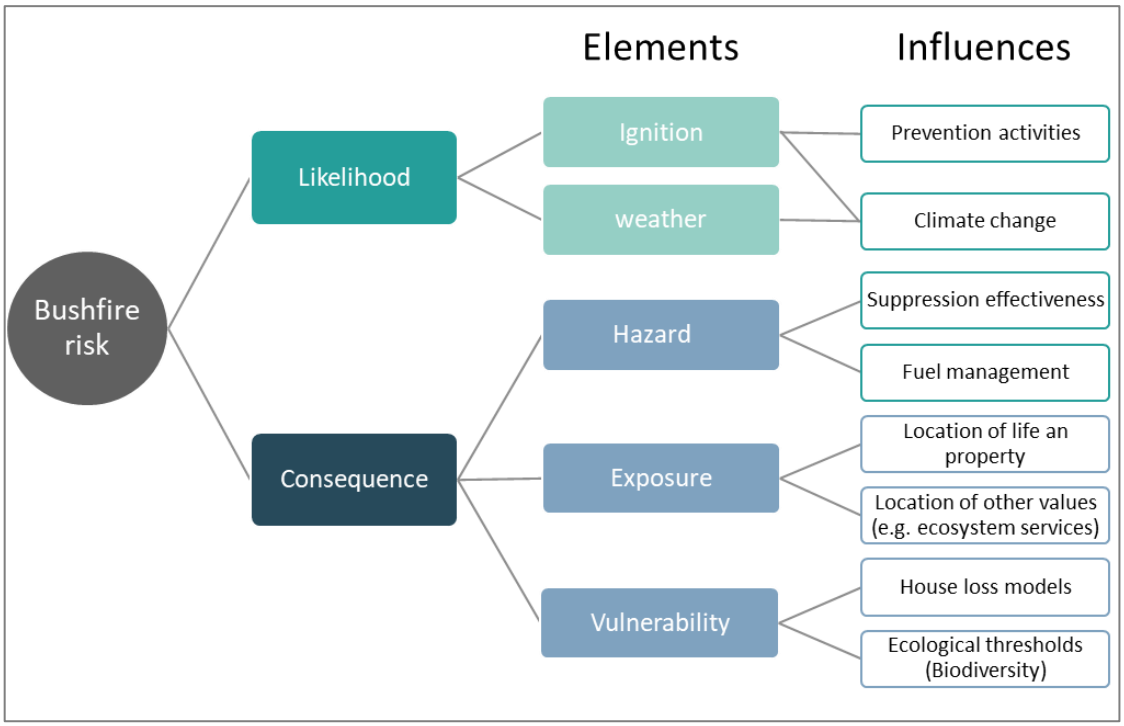
[110] Department of Environment, Land, Water and Planning (2020) *Ecosystem services from forests in Victoria Impact of the 2019-20 bushfires*. Online, accessed 30 June 2022 : https://www.environment.vic.gov.au/__data/assets/pdf_file/0023/555116/Ecosystem-services-from-forests-in-Victoria-Impact-of-the-2019-20-bushfires.pdf

[111] Deloitte Access Economics (2014) *op cit*.

planned burning[112]. The effects of climate change make considering fire risk in decision making even more important.

Unplanned fire risk is a function of likelihood and consequence, where likelihood is the probability that a fire will start and spread, and consequence is the impact if such an event occurs. Likelihood is based on ignition likelihood and weather, whereas consequence is based on the biophysical properties of the fire (including its footprint), exposure of assets and values, and their vulnerability to fire[113]. While a number of these variable are exogenous (external to management control), a number can be actively managed. A set of key elements that contribute to bushfire risk are shown in Figure 6-6, based on a risk management framework developed in Victoria.

Figure 6-6 Victorian perspectives on key elements and influences for unplanned fire risk



Source: adapted from DELWP, as cited by the Victorian Auditor-General's Office, 2020

As shown in Figure 6-6, unplanned fire risk can be influenced by a range of factors including management activities. This means unplanned fire risk may vary under different forest management approaches. This study has found limited evidence available to understand how each of these factors change across different forest tenures in south-east Queensland.

Planned burning is one approach used to reduce unplanned fire risk by reducing fuel loads. It can also be used to restore biodiversity values, particularly where fire has been a historical influence on the landscape. Historical evidence suggests that in some cases across Australia, the proportionate level of planned burning in multiple use forests has been higher than in protection forests[114]. All else being equal, this may indicate a lower level of unplanned fire risk in multiple use forests than protection forests.

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[112] Climate Council (2019) *'This is Not Normal': Climate change and escalating bushfire risk*. Online, accessed 6 July 2022: https://apo.org.au/sites/default/files/resource-files/2019-11/apo-nid267541.pdf
[113] Victorian Auditor-General's Office (2020) *Reducing Bushfire Risks*. Online, accessed 6 July 2022: https://www.audit.vic.gov.au/report/reducing-bushfire-risks?section=#33655--2-assessing-and-planning-to-address-bushfire-risk
[114] AFAC (2015) *op cit*.

Suppression effectiveness is another factor which contributes to unplanned fire risk[115]. It is generally influenced by fire detection times, on ground access to fight outbreaks, and aerial assistance as well as the weather and fire simultaneity[116]. The presence of a more extensive road network, developed to support timber extraction, in multiple use forests may facilitate improved on ground access to fires and response times[117,118]. This may also reduce the level of unplanned fire risk in multiple use forests relative to protection forests.

The cessation of timber harvesting is, on its own, not expected to reduce unplanned fire risk in multiple use forests. Timber harvesting, when used appropriately, may support a reduction in unplanned fire risk through maintaining roads, thinning to improve timber quality, creating more variable stand structures, and by maintaining adequate seed stocks and technical capacity to regenerate forests[119].

6.3.2 Fire risk modelling

Using a basic economic model, we have run several hypothetical scenarios to evaluate the potential additional economic cost of an increased risk of unplanned fire in a protection forest relative to a multiple use forest. This analysis is undertaken to illustrate the importance of considering fire risk in decision making and to illustrate how higher fire risk can significantly reduce the value of ecosystem services delivered.

The analysis focuses on the additional consequences of unplanned fire only and assumes that the likelihood of unplanned fires is consistent across protection and multiple use options. Consequences are based on the loss of ecosystem services attributable to a larger extent of damage from unplanned fires.

This analysis uses four scenarios to consider the impact of fire severity (*low*, *moderate*, *high* and *mixed*), where severity is represented by the length of time a forest's ecosystem services take to recover from fire (in years). The mixed severity scenario is based on the severity of fire which occurred in Lamington National Park in 2019-20[120].

The assumptions and inputs for this analysis are shown in Table 6-2. Results are estimated over 100 years and discounted at a rate of 2.65% to consistent with the primary analysis in this study.

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[115] Victorian Auditor-General's Office (2020) *op cit*.

[116] Relevant international research on this includes, Rodrigues M, Alcasena F, Vega-García C (2019) Modeling initial attack success of wildfire suppression in Catalonia, Spain. *Science of The Total Environment*, 666, 915–927.

[117] Powell J (1998) *Travel routes, forest towns and settlements*. Queensland CRA/RFA Steering Committee. Online, accessed 6 June 2022: https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/rfa/regions/qld-south-east/cultural-heriatage/forest-industry-places/qld_se_travel.pdf

[118] Relevant international research on this includes, Zhang F, Dong Y, Xu S, Yang X & Lin H (2020) An approach for improving firefighting ability of forest road network. *Scandinavian Journal of Forest Research*, 1–15.

[119] Keenan R, Kanowski P, Baker P, Brack C, Bartlett T & Tolhurst K (2021) No evidence that timber harvesting increased the scale or severity of the 2019/20 bushfires in south-eastern Australia. *Australian Forestry*, 84:3, 133-138, DOI: 10.1080/00049158.2021.1953741.

[120] Queensland Government (2021d) *Gondwana—Post-fire ecological assessment*. Online, accessed 7 July 2022: https://www.qld.gov.au/environment/plants-animals/conservation/bushfires-threatened-species-recovery/gondwana-wha/post-fire-ecological-assessment

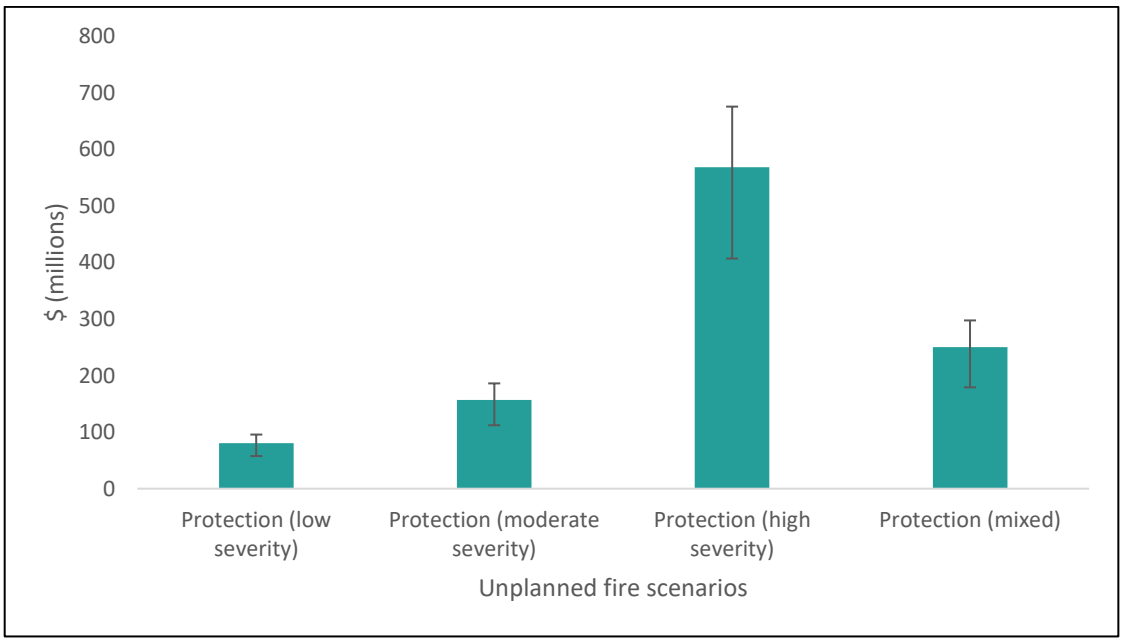
Table 6-2 Inputs into fire risk analysis for sensitivity testing of the CBA

Inputs	Values	Units	Source	Confidence rating
Existing area of production forest	2.74	million ha		H
Additional annual extent of unplanned fires in protection forest	1% - 5%	Proportion (%) of total study area	NCE assumption	L
Regeneration period for low severity fire	2	No. of years (regeneration is assumed to occur at a linear rate)	Based on DELWP, 2020	L
Regeneration period for moderate severity fire	5			L
Regeneration period for high severity fire	25			L
Proportion low severity fire	23	Proportion (%) of total unplanned fire	Queensland Government, 2021b	L
Proportion moderate severity fire	50			L
Proportion high severity fire	27			L
Value ecosystem services in protection forest	38 to 64	$/ha	NCE estimate	L

Source: Natural Capital Economics estimates, unless otherwise stated.

The results of this analysis are shown in Figure 6-7 for the forest estate of 2.74 million ha. Based on the results of the moderate severity scenario, if the extent of unplanned fires is 1% larger each year in protection forests relative to multiple use forests the additional cost over 100 years is estimate to between $105 and $177 million through lost ecosystem services. The range in this estimate reflects the range in estimated ecosystem service values. The results also show that as the severity of fire increase so does the economic cost of unplanned fire.

Figure 6-7 Estimated present value of the additional cost over 100 years from an indicative 1% increase in the annual extent of unplanned fire in protection forests relative to multiple use forests

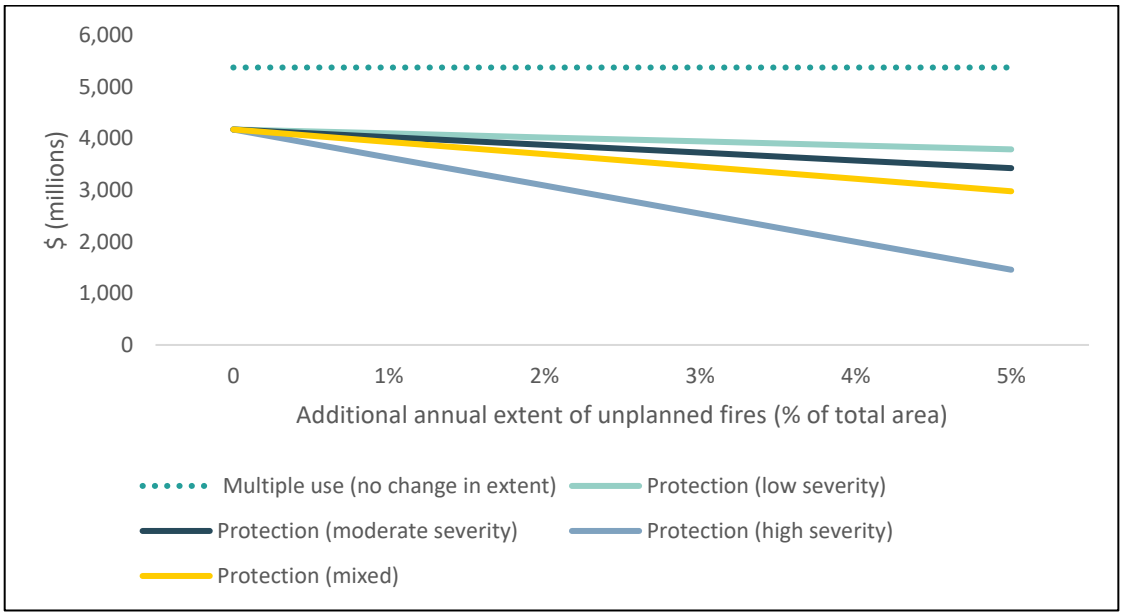


Source: Natural Capital Economics modelling, based on estimates over 100 years and discounted at 2.65%.

Based on the model used for this analysis, a single low severity unplanned fire which covers 1% of the study area will result in a total estimated cost to the State of between $1.6 and $2.6 million spread over two years, or a present value cost of between $1.5 and $2.6 million when discounted at a rate of 2.65%. The two-year period reflects the assumed period for recovery and regeneration after a low severity unplanned fire. Costs will decrease over time as more of the forest ecosystem services recover. A single high severity fire with the same extent will have a total estimated cost of between $13.5 and $22.8 million occurring over 25 years, or a present value cost of around $11.1 million and $18.7 million when discounted at a rate of 2.65%.

The effect on the estimated NPV of a protection forest from increasing the additional annual extent of unplanned fire, relative to multiple use forests, for each of the severity scenarios is shown in Figure 6-8. It illustrates that an increased level of fire risk can significantly reduce the value of net benefits received from a forest over 100 years. The results also show that a higher level of fire risk (e.g. due to climate change) will increase the marginal difference in net benefits between management options. Therefore, it is important to consider unplanned fire risk in management approach decisions to ensure benefits are maximised over the long term.

Figure 6-8 Effect on estimated NPV for protection forests from a range of increases in the additional annual extent of unplanned fire relative to multiple use forests (mid estimates)



Source: NCE estimate. Note NPVs are estimated over 100 years and discounted at 2.65%.

6.3.3 Limitations of fire modelling

This analysis assumes that unplanned fire risk is higher in protection forests than in multiple use forests largely because of fuel loads and the capacity to fight fires due to enhanced access. This is based on limited evidence and may not reflect the unplanned fire risk in the study area. It also does not consider all evidence to the contrary such as the fact that higher levels of human activity may increase the likelihood of fire[121].

[121] Tolhurst K (2018) *Bushfire Risk Analysis in the Yellingbo Area*. A report for Forest Fire Management, Department of Environment, Land, Water & Planning, Victoria. Online, accessed 6 July 2022: https://s3.ap-southeast-2.amazonaws.com/hdp.au.prod.app.vic-engage.files/5315/3413/5876/Kevin_Tolhurst_Bushfire_Risk_Analysis_in_the_Yellingbo_Conservation_Area_5_July_2018_FINAL.pdf

This analysis does not consider the cost to assets and values in addition to ecosystem services (e.g. life and property). The value of ecosystem service losses is based on values estimated in earlier analysis in this study. These estimates do not capture the value of every ecosystem service expected to be affected by unplanned fire.

The cost of performing planned burning to reduce the risk of unplanned fire is not considered in this analysis, although by area, this is likely to be lower in multiple use forests due to easier access. Likewise, it does not consider any benefits to biodiversity from planned burning.

This analysis uses hypothetical scenarios to investigate the impact of different levels of fire severity. A more robust approach would consider the vulnerability of each individual ecosystem service to fire. The extent to which the delivery of ecosystem service is reduced and for how long will depend on factors including the type of ecosystem service affected, the frequency of fire, as well as severity, all requiring a more robust understanding of cause-effect relationships[122].

Due to the limitations of the analysis, the impact of unplanned fire has not been included within the main CBA results and instead forms part of the sensitivity testing. Therefore, there is a need for further research to understand which elements contribute most to unplanned fire risk in southeast Queensland and how they are influenced by existing management approaches being used in the study area. This will provide insight into how effectively unplanned fire risk is being managed and how it differs across forest tenures in the study area.

[122] DELWP (2020) *op cit*.

7. CONCLUSIONS

7.1 Key findings

This assessment has focused on the net benefits of multiple use management of public native forests, in the context of the options under consideration for management of SCQ State forests. This assessment has contemplated the potential impacts of ceasing timber harvesting in multiple use State forests and transferring these forests across to the conservation estate. The following observations are made in relation to managing public native forests in SCQ, and potentially other regions of Australia:

1. ***Multiple use forests can support and maintain a broad range of ecosystem services, including biodiversity conservation, extensive recreation opportunities, and carbon sequestration and storage, as well as provisioning services; and the scope for ecosystem services is broader than under existing protected forest tenures***

   a. There is a substantial range of provisioning services provided by multiple use forests – including sustainable timber harvesting, quarry materials, beekeeping for honey production and pollination services, and cultural services in the form of more intensive community recreation that are not supported in national parks and reserves.

   b. Some of the management activities for provisioning services are highly complementary. For example:

      i. selective timber harvesting can further promote and enhance structural diversity of both wet and dry sclerophyll forests, and provide road and trail infrastructure for beekeepers to access hives and for fire management;

      ii. the operational capacity requirements for sustainable timber harvesting (including trained forestry staff and contractors and their machinery) are well aligned with providing the skillsets and machinery required for forest fire management, including planned burns and mitigating the increasing risks associated with unplanned fires and climate change impacts;

      iii. commercial beekeepers require access to Queensland nutrient rich native forests and their floral resources to provide both honey production and vital pollination services to other sectors (notably the agriculture and horticulture industries); and

      iv. many costs of managing the public native forest estate (e.g. maintenance of fire breaks and access roads) would be borne by the State budget if harvesting ceased.

2. ***Timber harvesting currently occurs in a small proportion of public native forest estate in Queensland, and forestry practices can be modified further to accommodate the conservation of specific threatened species in space and time***

   a. The current footprint of timber harvesting in public native forests of SCQ is less than 0.3% of the total area of multiple use forests, and less than 0.2% of public native forests.

   b. Timber harvesting in public native forests in SEQ is conducted using selective harvesting practices with a significantly lower intensity than state-managed timber harvesting practices elsewhere, e.g. indicatively, less than 10% and 20% of the average timber harvesting yields in some regions of NSW and Victoria, respectively.

   c. Australia's State of the Forests report (every five years) shows Queensland is maintaining full regeneration (100%) of its harvest areas within public native forests.

3. ***Timber harvesting is not considered one of the common or significant threats to forest biodiversity or the environment in Australia***

   a. Sustainable timber harvesting, conducted within multiple use forests, is not one of the common threats to forest dwelling flora and fauna species listed as threatened species, nor is it considered by Australia's State of the Forests report or State of the Environment report to be a significant pressure on biodiversity compared to the major pressures.

b. The primary threats to native forests are the same across public land tenures: these are forest and habitat loss from clearing for agriculture and urban and industrial development; invasive pest species; small population sizes; and altered fire regimes.

c. Most multiple use public forests in Australia maintain accredited, third party certification for their forest management, based on standards with annual auditing and reporting. There are very few examples of equivalent programs for national parks or other formally protected forests in Australia, at least to the same level of stakeholder scrutiny and international review. Transferring multiple use public forest to formally protected forest could potentially result in less transparency and reporting under current settings.

4. Sustainable timber harvesting supports a broad range of socio-economic benefits

a. Timber harvesting in multiple use forests directly supports the State's capacity to supply a proportion of its own timber, enhancing the resilience to supply chain shocks and disruptions to timber availability in the wake of pandemics, geopolitical tensions and/or increasing costs of imports.

b. Socio-economic benefits associated with timber harvesting in public native forests also include rural and regional employment, as well as downstream manufacturing, value adding and product innovation. The latter benefits are identified but not quantified in the CBA, to avoid the complexity of ensuring indirect benefits are treated consistently across the options.

5. The cessation of timber harvesting, and transfer from multiple use forests to national parks and conservation reserves, is unlikely to result in any climate change mitigation (emission reduction) benefits

a. This assessment of forest management models has reviewed peer reviewed research and relevant published literature and data to derive estimates of carbon stocks and the carbon flux in multiple use forests and formally protected forests in Australia.

b. These estimates based on life cycle carbon dynamics for native forests in SCQ indicate that multiple use management of existing State forests in the region would have a slightly superior outcome in terms of carbon sequestration and storage in forest and offsite storage and substitution impacts, over a 30-year period to 2050, in comparison to formally protected ('conservation') forests.

c. This outcome is largely attributable to the relatively low intensity, selective harvesting practices, in which emissions associated with harvesting are offset by forest regeneration in subsequent years, as well as carbon storage in wood products and the positive substitution factors associated with using those products instead of non-wood product alternatives with higher levels of emissions intensity in their manufacturing.

d. The estimated variance in carbon stocks and carbon flux between the two management models over a 30-year period is not large, as the main difference between the models being the timber harvesting activity in multiple use forests, which has a small footprint relative to the total estate. Furthermore, as noted above, the selective harvesting practices in Queensland are of relatively low intensity. However, this assessment indicates there is no apparent benefit from a carbon perspective in further transfers of multiple use forests to the formally protected conservation estate.

e. This assessment is based largely on derivations from published research on carbon dynamics for public native forests in NSW, and associated assumptions for southeast Queensland – and there are notable limitations to the application of this data to this CBA. Current research studies are addressing regionally specific parameters for southeast Queensland, including forest yield data and substitution factors for wood products. This research will lead to more sophisticated modelling of carbon dynamics for SEQ, and publications over the next 12 months that will improve the accuracy and robustness of carbon stock estimates for a comparative assessment of forest management models in Queensland.

Furthermore, this assessment, based on a CBA methodology and analysis of available data on forest values in SCQ, indicates the following key findings:

6. The cessation of timber harvesting, and transfer from multiple use forests to national parks and conservation reserves, may result in lower net social benefits over the longer term

a. The CBA developed and applied through this assessment indicates there may be a material net benefit to the State from maintaining multiple use production forests with the current level of provisioning services, in contrast to ceasing timber harvesting and transferring these forests to formally protected forests (which would further limit other provisioning services). However, due to overlap in the range of potential estimated values, it cannot be stated with certainty that either tenure option definitively delivers the best option for society.

b. The median net benefit of the multiple use model across the full extent of multiple use forests in SCQ was found to be in the order of $5.4 billion (in 2022 dollars) when benefits and costs are assessed over a 100-year evaluation period and discounted at a rate of 2.65%. By comparison, the median net benefit of the protection model was about $4.2 billion, when using the same parameters.

c. The CBA applied through this assessment excludes the full economic value of pollination services provided by honeybees accommodated in multiple use forests as distinct from national parks in SCQ. While the value of beekeeping services is captured through an assessment of the willingness to pay for apiary sites, the value to other sectors has been excluded largely because beekeepers have been provided further access to certain national parks until 2044. However, it should be noted the economic value of pollination services would be a significant differentiator if commercial beekeeping were to be excluded from formally protected forests; in which case, the net economic benefits of multiple use forests could be significantly higher.

d. Sensitivity analysis found that the overall results are particularly sensitive to the unit values used as inputs. Key inputs which drive the results include the value of biodiversity per hectare and the factor used to account for how biodiversity values changes between models. The operating costs and the distribution of visitors to forest under each model also have significant influence on the overall results.

e. It is recommended that the uncertainty associated with key input values are addressed to improve the robustness of the CBA results before this analysis is used to inform tenure change decisions.

7. Multiple use forests and formally protected forests can provide a complementary set of forest values and ecosystem services for Queensland

a. This assessment has observed public native forests provide a broad range of forest values and ecosystem services, across multiple tenures and forest management models, including multiple use management and formally protected parks and reserves.

b. National parks and other conservation reserves have been established to protect the best sites, or 'world-class natural and cultural values', with primacy on the management of biodiversity conservation and the 'natural condition' (while recognising that landscapes are dynamic and will change over time in response to multiple factors including climate trends and natural disturbances).

c. In Queensland and across other states, national parks and conservation reserves comprise a 'forest reserve system' that has been established to ensure that, at a minimum, a representative extent of forest values (including but not limited to ecological, geological, cultural and landscape amenity values) are protected from any harmful or cumulative impacts of uses for other values. Within this construct, the formally protected forest reserve system provides for the primacy of protecting those world class natural and cultural values.

d. Conversely, this means that not all sites and forest values need to be protected within national parks and conservation reserves. For other forested areas, outside the best 'world class' sites, State forests and other multiple use land tenures enable management for multiple values, including for example, biodiversity conservation, *and* potentially other values such as selective timber harvesting, beekeeping and honey production, as well as more active recreation and tourism, including camping, horse riding or use of motorised vehicles.

e. Furthermore, there are forest values and ecosystem services that can only be provided in multiple use State forests, as specified under state legislation and regulation. These values and ecosystem services include the provisioning services referred to above. In terms of cultural services, Queensland's State forests already provide for all the recreational activities provided by national parks, and an additional suite of recreational values. This assessment has found that foregoing the full range of provisioning and cultural services currently provided by State forests and timber reserves would represent a significant net cost to the state – with minimal if any additional benefit in terms of conservation outcomes.

f. Through application of the principles of active and adaptive management, the management of State forests and other multiple use forest areas can be adjusted progressively over time to align with specified objectives for multiple values. This may include for example, maintaining a primary focus or emphasis on biodiversity conservation in particular areas, supported by compatible forest uses in adjacent or surrounding areas (e.g. modified selective timber harvesting, or thinning operations) that may complement and certainly do not compromise the other multiple uses.

g. Therefore, there is no-one preferred forest management model. Multiple use management and formally protected forests are complementary models, which can provide for a broad range of ecosystem services for Queensland.

h. This complementarity is dependent upon the effective management across all public forest tenures, with adequate resourcing to support the planning and implementation requirements to realise the differing management objectives. Queensland's capacity to manage State forests for multiple uses is underpinned by the primacy of focus on biodiversity conservation and maintaining natural condition in national parks; and conversely, Queensland can afford to balance primacy to those values in national parks, when providing opportunities for a broad range of forest uses in other areas.

8. There will be distributional consequences and impacts (benefits and costs) from changes to forest land uses that are not fully reflected in this regional level analysis

a. This analysis has focussed on the aggregate value of all benefits and costs to the people of Queensland. However, there will also be distributional consequences, i.e., issues relating to who would benefit most and who would be adversely impacted by the costs.

b. The major beneficiaries of a change from multiple use forests to formally protected forests are those who attach very high values to biodiversity conservation and wilderness values (e.g. very low intensity activities like hiking in remote or difficult terrain); and may not be active users of the forests, or products from the forests. These groups may live in urban areas or regional areas.

c. Those who will be disadvantaged by such a change will include those who are employed in timber harvesting or processing forest products (predominantly in regional areas), or beekeeping for honey production or pollination services to the horticulture and agriculture industry over the longer term, or those who engage in recreational pursuits allowable in multiple use State forests but not in national parks.

d. It is unclear, without further consultation, what impact such a change would have on Aboriginal clans and cultural practices in SCQ. The scope and extent of these potential benefits and costs have not been explored or quantified in this study.

7.2 Further considerations

This assessment has presented a CBA methodology with the intent to provide a transparent, balanced, and robust framework for consideration of the net benefits of alternative land use models of managing public native forests. This CBA framework is based on the data currently available, and the quality of these datasets varies considerably. Improvements in the underlying data – both in extent and quality - will improve the confidence in these valuation approaches and in some case may lead to more sophisticated valuation methods becoming available.

The following areas are proposed for further consideration, based on the assessment outcomes:

1. **Review the policy directions and options under the Native Timber Action Plan, specifically in relation to the future management of State forests** and the scope and capacity to maintain a broad range of provisioning services, based on these outcomes.
2. **Support further work to address key data limitations in this assessment**, specifically:
   a. Support the Queensland Government, principally the Department of Environment and Science, to conduct further work on **quantifying biodiversity values** across public native forests and develop metrics to inform monetary values that can be used in a CBA – e.g. through building on the State's *Bio-Condition* program to determine and compare values across land use tenures as well as vegetation classes.
   b. Support ongoing research on **assessments of regionally specific carbon stocks and carbon flux rates** for native forests across SCQ, with appropriate substitution factors for Queensland wood products, to determine the life cycle impacts of timber harvesting and using harvested wood products compared to non-wood products.
   c. Determine the **extent and value of tourism and recreation within State forests**, which is reportedly significant, but has not been assessed and quantified in published literature in the same way as addressed for national parks.
   d. Support a comprehensive assessment of the **economic value of pollination services** provided by commercial beekeepers in Queensland, with a specific focus on the value associated with accommodating honeybees within multiple use production forests in contrast to national parks and other formally protected forests.
3. **Enhance the understanding and engagement of Traditional Owners and Aboriginal and Torres Strait Islander peoples in the management of Queensland's public native forests**; and specifically, the impact of substantive changes in forest land use and management on Aboriginal clans and Indigenous culture and traditional practices.
4. **Review and adjust timber harvesting prescriptions, as needed**, following the further work on quantifying biodiversity values and developing metrics for biodiversity condition.
5. Concurrently, **consider and specify where Queensland would source hardwood timber products from over the next 20-30 years to 2050 – and how much more it may cost to obtain these wood products -** without hardwood plantation resources in the state and constraints on the development of hardwood plantations grown for sawlogs and roundwood products around Australia.
6. Concurrently, **consider and specify how the existing multiple use State forests would be funded and managed into the future to address the following key challenges**:
   a. maintaining road and firebreak networks to enable forest fire management;
   b. maintaining contractor capacity for forest fire management including suppression;
   c. controlling invasive pests and diseases across the estate; and
   d. monitoring forest condition and ecological values over time.

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Annex 1

CBA Methodology

KEY CONSIDERATIONS

This annex provides further guidance on the method for using cost-benefit analysis (CBA) to compare the net benefits arising from managing public native forests under two alternative models:

- *Status quo*: multiple use production forests (base case); and
- *Alternative model*: formally protected forests.

Along with a CBA method, this annex includes discussion of common CBA pitfalls which can have significant implications for results.

This project uses a traditional CBA framework as this is the approach commonly used to inform public policy decision making and business case development. CBA differs from other forms of economic analysis in important ways. This is explored further in **Box 1**.

Box 1 Comparing cost-benefits analysis to economic impact assessment

CBA is a robust technique for understanding the net benefit of a project or policy. In CBA, benefits and costs are estimated and compared in monetary terms to determine the overall change in welfare for the community. CBAs are the Queensland Government's preferred approach for assessing the costs and benefits of an investments as part of business cases (DSDILGP, 2021).

Economic Impact Assessments (EIAs) estimate the amount of economic activity generated from a project or policy based on national accounting principles. They are not a form of efficiency analysis and do not determine net benefit. Due to modelling limitations, the Queensland Government does not use EIAs, which rely on the use of input-output modelling and multipliers as part of project evaluation (DSDILGP, 2021).

CBA can be applied to projects which affect the natural environment. A key aspect of its application in this context is the valuation of ecosystem services, which involves quantifying the contribution of ecosystems and biodiversity to human-wellbeing (OECD, 2018). This is like the emerging approach of environmental or natural capital accounting, which uses accounting principles to value ecosystems and ecosystem services.

A CBA will provide a more comprehensive account of ecosystem services values than is currently possible using natural capital accounting, as natural capital accounting is based on exchange values, which prevent the inclusion of non-use values (United Nations, 2021).

Key considerations

Economic analysis such as CBA is commonly used to understand the trade-offs between different land use types and/or to justify decisions to cease or continue timber production. However, there are multiple issues that arise that can make conducting a robust CBA involving the forestry sector challenging. App Figure 1 contains a selection of common issues that can occur, and the recommended approach to addressing these to enhance the quality of forestry sector CBAs.

App Figure 1 Considerations when conducting forestry sector CBAs

Issue	Common pitfall	Recommended approach
1. Options selection and unrealistic assumptions	There is a wide range of management options for native forests, which extend beyond harvesting decisions. By only evaluating a limited subset of options or by choosing an option which is based on unrealistic assumptions, the most beneficial action may be misrepresented.	Use CBA to compare multiple options and transparently report inputs and results of the analysis so the components which are driving the results can be understood and evaluated. Seek feedback from informed and impartial stakeholders.
2. Management effectiveness	The forest management model alone will not determine the benefits a forest provides. Benefits will also be influenced by how effectively the model is implemented and managed into the future. This includes resourcing. CBA of forestry projects or policy must incorporate realistic assumptions about the effectiveness of management when determining expected benefits.	Draw on historical information and expert advice to incorporate realistic assumptions about the effectiveness of management when determining expected benefits. Perform sensitivity analysis of results to understand how the results of the CBA might change if benefits are lower than under the most likely outcome.
3. Spatial boundaries of the assessment and which costs and benefits are included	The defined spatial boundary of an assessment will determine which costs and benefits are included. The spatial boundary can be at a local, regional, state, national or global level. Limiting the boundary of an assessment, and/or inclusion of relevant costs and benefits, may result in project's net benefit being misrepresented. This will also occur if project costs or benefits are counted more than once. Any benefits attributable to not harvesting timber cannot be fairly considered without also examining the benefits lost from the loss of timber products.	Clearly define the spatial boundaries of the CBA and include all relevant costs and benefits. Consultation with key stakeholder will assist with identifying relevant costs and benefits. Queensland Government projects are typically assessed within State boundaries.
4. Evaluation period and discount rates	The period and discount rate used to evaluate costs and benefits will have an impact on the overall results of the CBA. For example, short analysis time frames which consider minimal harvests will limit the inclusion of the long-term benefit provided by harvested wood products (HWP) storing carbon (Ximenes, 2021).	Use a range of discount rates including those consistent with Treasury department guidelines, lower rates associated with intergenerational projects or a hybrid approach to discounting. Perform sensitivity testing to understand how an alternative discount rate will alter the results of the analysis. Select an evaluation period which allows a range of costs and benefits to be considered. Consider evaluating options over differing periods to draw out the significance.
5. Additionality of costs and benefits	Timber harvesting in native forest typically occupies a proportion of the total estate at any one time. As such, non-timber benefits are likely to be realised on those areas that are not being harvested.	Clearly define the base case and only consider additional benefits and costs, relative to the base case.

Issue	Common pitfall	Recommended approach
6. Public goods and absent price signals	Many native forest goods and services exhibit public good characteristics[1] and are provided at zero direct cost to beneficiaries or at price which is below an efficient market value. Similarly, many native forest goods and services are non-market in nature, meaning they cannot be traded in traditional markets. These factors restrict effective valuation and can result in CBAs underestimating some benefits.	Use the best available data and a range of evaluation approaches to value ecosystem services derived from forests and include within sensitivity analysis. Seek feedback from informed and impartial stakeholders. Qualitatively rate the completeness of each valuation.
7. Distribution of benefits	A project or policy may have a net benefit but that doesn't mean an improvement in welfare for all members of a community. Instead, some members may be made better off while others are made worse off. A large number of stakeholders with wide ranging preferences can make analysing the distribution of costs and benefits of forestry projects or policies difficult. How costs and benefits are distributed across the community may impact decisions about implementing a project or policy.	Identify the key stakeholders affected and perform high level quantitative distributional analysis to understand how benefits and costs are distributed.
8. Carbon sequestration benefits and carbon credits	Carbon sequestration has a benefit to society. However, not all carbon sequestration can earn carbon credits under current additionality eligibility requirements. In Australia, native forests and existing plantations are not currently eligible to earn ACCUs. Similarly, the benefit of carbon sequestration may not be fully reflected in the market price of carbon credits.	Specify assumptions used within the CBA regarding the treatment of carbon credit eligibility requirements. Use a range of market prices to value the benefit of carbon sequestration. (e.g. ACCU, European Emission Allowance [EEA]). When reporting, differentiate between income from carbon sequestration and total benefits.
9. Carbon storage and sequestration rates	Unrealistic carbon stock estimates can be calculated if unreasonable assumptions (e.g. age, size and decay rates) about trees are used and extrapolated over large areas (Ximenes, 2021). The use of different accounting frameworks can also lead to different estimates of carbon benefits due the varying scopes and system boundaries (Ximenes, 2021). The period over which carbon sequestration and storage is evaluated will influence the results of any analysis.	Provide a list of inputs and assumptions used in estimating carbon storage and sequestration and describe limitation of estimates. Seek feedback from informed and impartial stakeholders.

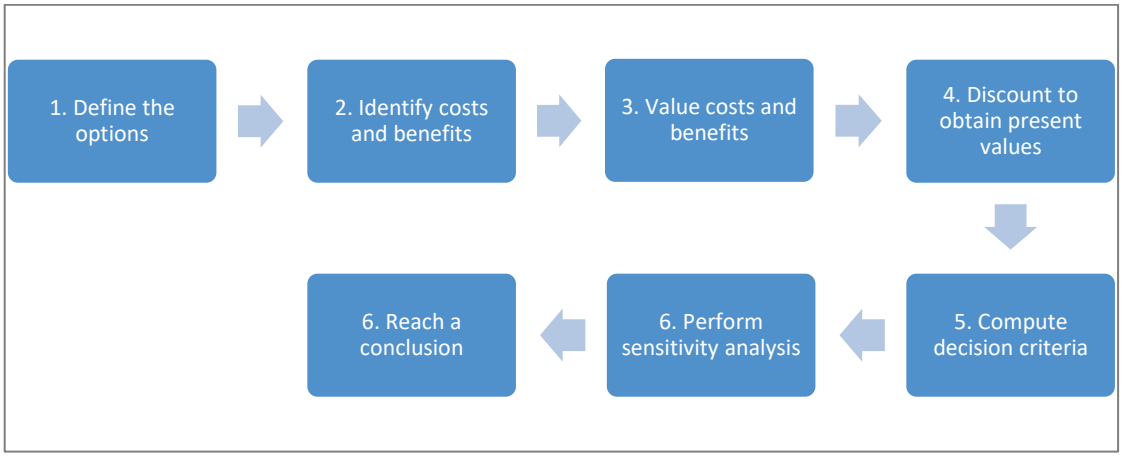
[1] Goods and services for which, users cannot be barred from accessing or using them for failing to pay for them. e.g., carbon sequestration.

Issue	Common pitfall	Recommended approach
10. Carbon stored in HWP	When trees are harvested, a portion of the carbon they store is released into the atmosphere. The remaining carbon is stored in HWP. HWP can continue to store carbon throughout their lifetime and after they are disposed of in landfill. Failure to account for carbon stored in HWP, will lead to carbon sequestration benefits being underestimated.	Adopt an approach to estimating carbon sequestration and storage which captures the long-term benefits of carbon stored in HWP. If not included specify basis for exclusion (e.g. because evaluation period is shorter) and acknowledge likely underestimation.
11. Product substitution	The use of HWP can offset carbon emissions by replacing the use of more carbon intensive products or materials. This has a carbon benefit. Sustainably HWP can be replaced by unsustainably HWP. This has a carbon cost. Plantations typically require a smaller area to produce the same volume of timber. However, plantations are also typically less biologically diverse (Venn, not published).	Quantitatively describe the limitations of the analysis and any costs and benefits which have not been quantified.
12. Forests benefits and costs over time	Forests are dynamic and the range of benefits (and costs) that will be realised will change over time as trees grow and die or are harvested and regenerated. For example, water use and habitat provision change as trees mature. Furthermore, climate change continues to influence the range of benefits and costs associated with native forest management. There is a need to appropriately reflect the dynamic nature of costs and benefits within CBA.	Provide a list of inputs and assumptions used in estimating benefits and costs that are dependent on forest age and whether future climate change has been explicitly included. Seek feedback from informed and impartial stakeholders.
13. Economic activity and the use of EIAs	Economic activity, which is underpinned by economic output and jobs, can be viewed as a benefit when evaluating projects using EIAs. Similarly, a loss of economic activity can be viewed as a cost. Such changes in economic activity do not represent changes in the net benefit of a given forest management/policy decision and therefore does not affect overall changes in welfare that are the focus of CBA.	Use CBA to compare total costs and total benefits to determine the overall change in welfare within an economy. As part of the CBA, use distributional analysis to understand and consider how key groups are affected by project and policy decisions.

METHOD

Our method for performing the CBA is broadly consistent with the Queensland Treasury (2015) and DSDILGP (2021) CBA guidelines and is broken down into seven steps. These steps are shown in App Figure 2 and described in the following sections of this report.

App Figure 2 Key steps for assessing the net-benefit of a public native production forest compared to a protection forest



Step 1. Define the options

To begin the analysis, the options (in this case, management models) being assessed must be defined. This includes defining the base case and the alternative management model to be assessed. The models are compared to determine the incremental benefits or costs which occur under alternative types of management.

For this project, the options will be based on existing management in Southeast Queensland of:

- Status quo: multiple use forests (base case)
- Alternative model: formally protected forests.

Step 2. Identify the costs and benefits

To perform a comprehensive assessment, the differences in costs and benefits must be identified for each option. In this analysis, we will rely predominantly on an assessment of ecosystem services to identify incremental (or marginal) costs and benefits. Identifying ecosystem services typically begins by first identifying the ecosystem assets, in this case the native forest, and then identifying the ecosystem services which flow from this asset.

What are ecosystem services

Ecosystem services are the benefits (goods and services) derived by humans from the environment. The current best practice approach for identifying and classifying ecosystem services is outlined in the Common International Classification of Ecosystem Services (CICES). This provides a robust and widely accepted means of collating and presenting data to decision makers and potential co-investors.

Ecosystem services are often categorised into four types which are described below:

- *Social and cultural services*: services directly experienced by humans
- *Provisioning services*: services describing the material or energy outputs from ecosystems
- *Regulating services*: services that ecosystems provide by acting as regulators
- *Supporting services (ecological functions)*: services that underpin other ecosystem services categories.

Supporting or intermediate services may be better described as "structures, processes and functions that give rise to services" rather than being a final service[2]. These functions are not classified under the CICES.

App Figure 3 Examples of ecosystem services by type

Provisioning services	Regulating services	Cultural services
Products obtained from ecosystems	*Benefits obtained from regulation of ecosystems*	*Non-material benefits obtained from ecosystems*
• Food • Fresh water • Fuelwood • Fibre / Wood • Biochemical • Genetic resource • Livestock production • Honey	• Climate regulation • Disease regulation • Water regulation • Water purification • Pollination	• Spiritual and religious • Recreation and ecotourism • Aesthetics • Inspirational • Educational • Cultural heritage

Ecological functions (often termed supporting services)

Services necessary to produce all other services

• Soil formation • Nutrient cycling • Primary production

Scoping of costs and benefits

Based on an understanding of their differences, potential costs and benefits associated with each forest management model have been scoped and presented in App Figure 4. This table also highlights the expected data required to value the identified costs and benefits.

In addition to identifying the range of costs and benefits associated with each model it is important to consider their timing and the period over which costs and benefits will be assessed (also known as the assessment or evaluation period). Qld government guidelines (DSDILGP, 2021) suggests that the assessment period should be no greater than 30 years. However, this guidance is aimed principally at infrastructure projects, and 30 years is considered too short for the forestry sector, when it is necessary to take, for example, tree growth rates and carbon sequestration into consideration. Given this, a 50, 100, and 200-year assessment period will be used and compared.

[2] Fabis Consulting (2018).

App Figure 4 High level scoping of potential costs and benefits associated the two forest management models

Potential costs and benefits	Considered as part of CBA	Expected valuation method	Data required
Costs			
Management costs	Yes	Historical costs	Historical cost of management activities
Benefits (additional ecosystem services)			
Industrial wood (raw materials)	Yes	Market value	Annual sales revenue from timber Operational cost of sales Market price for timber
Food (non-wood products) – e.g. honey, game meat	Yes	Market value	Annual permit revenue
Fuelwood (raw materials)	Yes	Market value	Annual volume of firewood collected Annual permit revenue Market price of firewood
Feed (non-wood product)	Yes	Market value	Annual permit revenue Value of grazing for producers
Gravel / stone / minerals (raw materials)	Yes	Market value	Annual royalties
Pollination (of agricultural crops from hives in native forests)	Yes	Market value	Annual permit data Area of agricultural crops in vicinity of forests
Benefits (improved delivery of ecosystem services)			
Recreation	Yes	Market value	Annual revenue generated from recreational activities
Tourism	Yes	Market value	Annual revenue generated from commercial activities
Climate regulation – e.g. carbon sequestration	Yes	Market value	Carbon price values (e.g. ACCU) Annual rate of net carbon sequestration (carbon sequestration less emissions from management and decay) for both management options
Hazard regulation	Yes	Avoided damages	Estimated incremental reduction in bushfires associated with public native production forest management combined with estimated damages from bushfires.

Step 3. Value costs and benefits

Once benefits have been identified, the next step is to quantify their value, in monetary terms. Due to limitations on public data and resources, it is typically not possible to quantify the value of all costs and benefits identified. For this analysis, the value of costs and benefits that are expected to be the most material will be quantified. Benefits (or costs) that are not readily quantified in monetary terms (e.g., cultural and heritage values), can be described qualitatively.

A range of economic techniques are available to value costs and benefits. These are predominantly categorised as either market or non-market valuation approaches. Market approaches to valuation are used when market prices exist, while non-market approaches are used when they do not. The choice of the most appropriate valuation method depends on the type of benefit or cost being quantified and available data. Examples of potential valuation approaches that will be used in this analysis are shown in App Figure 5.

App Figure 5 Approaches for valuing costs and benefits

Method	Based on…	Examples of use…
Market approaches		
Market values	Actual market transactions	• Value of timber production based on sale price • Value of bee keeping assessed through permit prices • Value of carbon sequestration using ACCUs
Productivity-based	Inputs to production of commercial goods	• Value of grazing using gross margins
Replacement cost	Costs of replacing a service or avoiding replacement costs	• Value of firewood collection through avoided cost of buying firewood • Value water filtering through avoided cost of water treatment
Non-market approaches		
Travel cost method	Expenditure and frequency of visiting a site	• Value of four-wheel driving
Benefit transfer	Studies undertaken in similar locations	• Value of bushwalking through willingness to pay • Value of biodiversity through willingness to pay

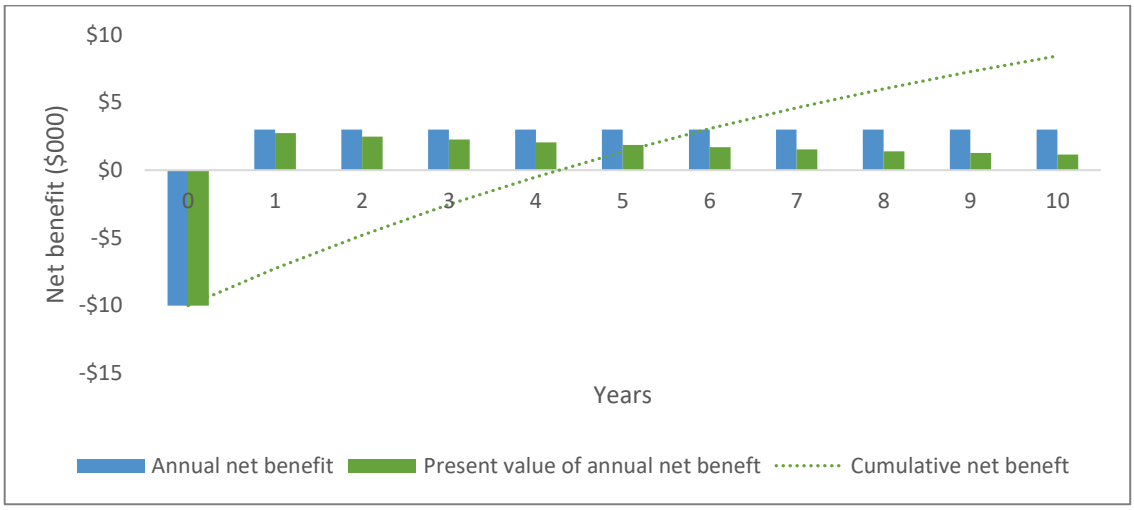
Step 4. Discount to allow future values to be compared

Within a CBA, discounted cash flow (DCF) analysis is used to convert future benefits and costs into present values. This process, known as discounting, enables a fair comparison of cost and benefits by taking account of the 'time value of money' or the fact that there is a preference to receive benefits early and delay costs. A visual representation of a DCF analysis is shown in App Figure 6.

The DSDILGP (2021) guidance for undertaking CBA suggests using of a real discount rate of 7% for business cases, with sensitivity testing using discount rates of 4% and 10%[3].

[3] State and Commonwealth government agencies across Australia tend to recommend similar ranges. However, the Garnaut Climate Change Review (2008) used a discount rate between 1.4 and 2.7 % when considering the long-term costs and benefits of climate change.

App Figure 6 Visual representation of a discounted cash flow analysis



Step 5. Compute decision criteria

Once present values have been estimated, the net present value (NPV) and the benefit-cost ratio (BCR) of alternative options can be determined (or in this case models). These are the two primary decision criteria used to evaluate the net benefits of options. A NPV above zero and a BCR above 1 indicates an option has a net benefit, with a higher value indicating a higher benefit to society and a more preferred option. They are calculated using the following formulas:

$$Net\ Present\ Value\ (NPV) = Present\ value\ of\ benefits\ (PVB) - Present\ value\ of\ cost\ (PVC)$$

$$Benefit\ Cost\ Ratio\ (BCR) = \frac{Present\ value\ of\ benefits\ (PVB)}{Present\ value\ of\ costs\ (PVC)}$$

It is also important to consider that there are cases when using one decision rule over the other may result in different outcomes. For example, there may be cases where the option with the highest BCR may not have the highest NPV. In this case, one of the decision rules must be chosen to select the preferred option. App Figure 7 illustrates how these different decision rules can be used in decision-making, with reference to the extent to which the options are mutually exclusive and the extent to which budgets are constrained. NPV is preferred if options are mutually exclusive; except when multiple, non-exclusive projects can be funded with a limited budget.

For the purposes of this study, we are assuming the models are mutually exclusive, which means NPV is the preferred decision criteria.

App Figure 7 Decision rule selection matrix

		Exclusivity	
		Options mutually exclusive	Options not mutually exclusive
Budget	Limited	**NPV preferred** Choose the project with the largest NPV within the budget constraint.	**BCR preferred** Rank all projects by BCR and fund all projects in order of their BCRs (highest to lowest) until the budget constraint is reached.
	Unlimited	**NPV preferred** Choose the project with the largest NPV.	**NPV or BCR** Fund all projects with NPV greater than 0 (or BCR greater than 1).

Step 6. Perform sensitivity analysis

Within CBA, it is common to have to make assumptions where data is not available or poor quality. To account for this, sensitivity analysis is used to understand the extent to which such assumptions effect the overall results.

For this analysis, we will perform sensitivity analysis using a Monte Carlo simulation. Monte Carlo simulations are a statistical technique used to model the probability of different outcomes. This process will identify which input parameters or assumption have the most influence on outputs and establish confidence intervals around the findings. This approach is particularly useful when considering what issues to focus on if attempting to improve estimates in the future.

To enable sensitivity analysis using Monte Carlo simulations, each of the selected data inputs (i.e., the most influential input parameters) will be represented by a range of values (e.g., low, most-likely, high), informed by available data on each input's possible values. Where data is not available to inform low and high estimates, a range of ±20% will be used.

Incorporating risk

Sensitivity analysis is one approach to incorporating risk and uncertainty into CBA. In addition, as part of step 6, risk and uncertainty will also be considered through a semi-quantitative description of the risks associated with different management models. For example, more active management models may reduce the risk of fire or the spread of pests and disease.

Step 7. Reach a conclusion

The last step involves drawing conclusions from the outputs of the analysis. In drawing conclusions, we will consider the values of the decision criteria, the results of the sensitivity analysis, any qualitative descriptions of benefits or costs not valued and other contextual information.

The results of this analysis will enable conclusions to be drawn as to the net benefit to the region and State from converting a protection forest to public native production forest, and vice versa. It will also assist Timber Queensland in formulating future management models which provide incremental benefits.

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Annex 2

CBA Model inputs

COST BENEFIT ANALYSIS (CBA) MODEL INPUTS

The following tables present the input data used in the cost-benefit analysis model, with each table showing the inputs used for valuing management costs or an ecosystem service.

Inputs have been compiled through desktop research and are presented across a range of values to recognise the uncertainty associated with each value. Where possible, the range in values is informed by available information. In the absence of any such information, a default ±20% range is used. Inputs are presented to ensure that the assumption which underpin the model are clear. A confidence rating for each input is provided to illustrate confidence in the accuracy of the input used.

App Figure 8 Management cost inputs

Input	Low	Mid	High	Units	Source	Confidence rating
Operating costs of protection forests	(17)	(8)	(3)	$/ha	Queensland Treasury Corporation, 2018	H
Operating costs of production forests	(2.9)	(2.4)	(1.9)	$/ha	Queensland Treasury Corporation, 2018	M
Expense to authorise timber removal	(48)	(37)	(29)	$/m^3	DAF, 2020a	H

App Figure 9 Hardwood sawlog inputs

Input	Low	Mid	High	Units	Source	Confidence rating
Native forest hardwood sawlog production	68,957	107,189	156,459	m3/year	DAF, 2020b	H
Hardwood sawlog price	134	168	201	$/m^3	ABARES, 2021	H
Harvest and haulage costs	63	79	95	$/m^3	Independent Pricing and Regulatory Tribunal, 2017	H
State to Hub conversion factor		87%		%	Department of Natural Resources and Mines, 2021	M

App Figure 10 Other timber inputs

Input	Low	Mid	High	Units	Source	Confidence rating
Native forest Girders, Corbels, Piles and Sills production	707	2,791	5,409	m^3/year	DAF, 2020b	H
Native forest Hardwood Poles production	3,926	7,505	10,107	m^3/year	DAF, 2020b	H
Native forest Landscaping and Fencing Timber production	6,714	19,302	34,394	m^3/year	DAF, 2020b	H
Native forest Mining Timber production	0	73	494	m^3/year	DAF, 2020b	H
Native forest Hardwood Round Timber production	1,779	3,480	5,214	m^3/year	DAF, 2020b	H
Native forest Other Log Timber production	106	666	1,888	m^3/year	DAF, 2020b	H
Native forest other pine sawlogs production	0	1,054	5,567	m^3/year	DAF, 2020b	H
Native forest Sandalwood production	69	200	378	m^3/year	DAF, 2020b	H
Other timber average price	73	91	110	$/$m^3$	ABARES, 2021	M
Cost of production	40	59	79	$/$m^3$	Independent Pricing and Regulatory Tribunal, 2017; Murdoch University 2022	M
State to Hub conversion factor		87%		%	Department of Natural Resources and Mines, 2021	M

App Figure 11 Quarry material inputs

Input	Low	Mid	High	Units	Source	Confidence rating
Quarry material production quantities	3,372,117	4,517,322	10,522,865	m3/year	DAF, 2020c	H
Royalty rate	1.7	2.1	2.5	$/ m^3	DAF, 2020c; DAF, 2020a	H
Average expense necessary to authorise the removal of a cubic metre of forest product	0.2	0.3	0.6	$/ m^3	DAF, 2020a	H
State to Hub conversion factor		87%		%	Department of Natural Resources and Mines, 2021	M

App Figure 12 Beekeeping inputs

Input	Low	Mid	High	Units	Source	Confidence rating
No of approved apiary sites with in SCQ Hub	2386	2982	4359	No. of sites	DAF2019	H
Permit value	119	148	37746	$/site	Business Queensland, 2022; Unpublished source	M

App Figure 13 Grazing inputs

Input	Low	Mid	High	Units	Source	Confidence rating
Stocking rate in production forest	0.00	0.05	0.10	Cattle / ha	Queensland CRA/RFA Steering Committee, 1998	M
Grazing days	146	183	219	Days	Hassall and Associates, 1998	M
Cattle weight gain	0.25	0.30	0.35	Kg / day / head	Hassall and Associates, 1998	H
Beef price	1.6	2.1	2.5	$ / kg	ABARES, 2016	H
Cost of production	47	59	71	$ / head	Hassall and Associates, 1998	H
Grazable land adjustment factor	0.4	0.5	0.6	%	Queensland CRA/RFA Steering Committee, 1998	M

App Figure 14 Carbon sequestrating inputs

Input	Low	Mid	High	Units	Source	Confidence rating
ACCU spot price	27	51	61	$/$CO_{2e}$	Clean Energy Regulator, 2021	H

App Figure 15 Biodiversity inputs

Input	Low	Mid	High	Units	Source	Confidence rating
Value of biodiversity	20	25	30	$/ha	Based on Curtis, 2004	L

App Figure 16 Tourism and recreation inputs

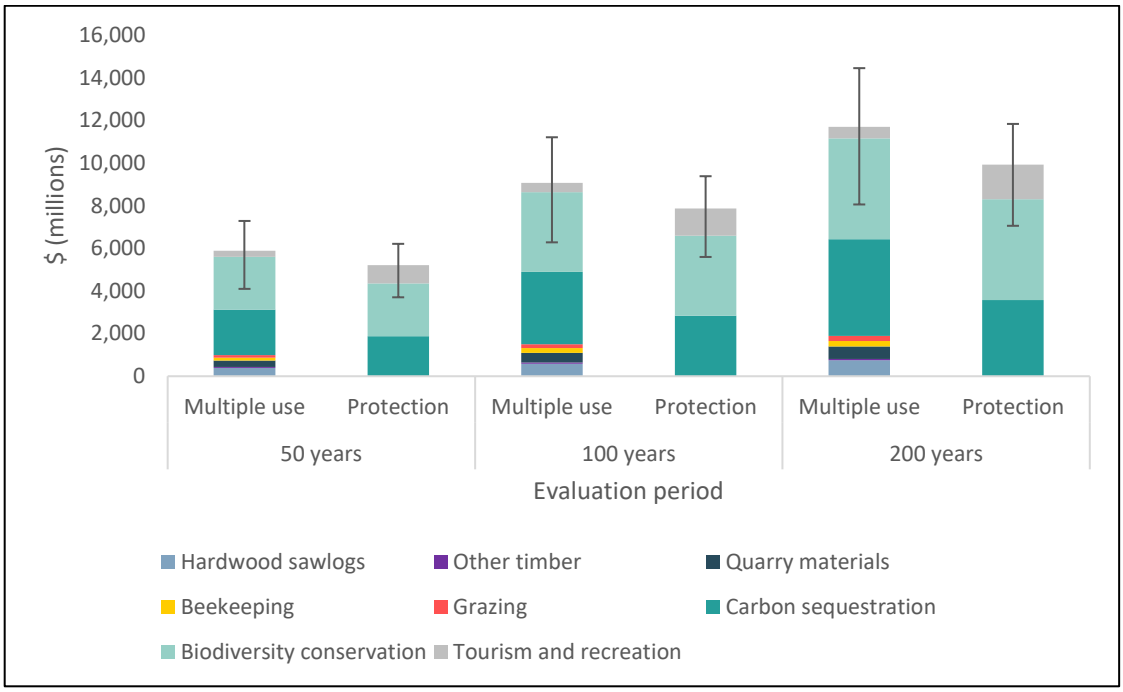
Input	Low	Mid	High	Units	Source	Confidence rating
International visits	414	518	621	No. (000)	Driml et al. 2020	L
Overnight visits	998	1,248	1,497	No. (000)	Driml et al. 2020	L
Day visits	1,526	1,908	2,289	No. (000)	Driml et al. 2020	L
Consumer surplus of visit (National Park)	8	27	45	$/visit	Driml et al. 2020	M
Adjustment factor to convert National Park consumer surplus to State Park consumer surplus	0.28	0.34	0.41	ratio	DELWP, 2015	L
Adjustment factor to split visitation between state parks and national parks	0.19	0.24	0.29	ratio	Kinhill Economics, 1998	L

Annex 3

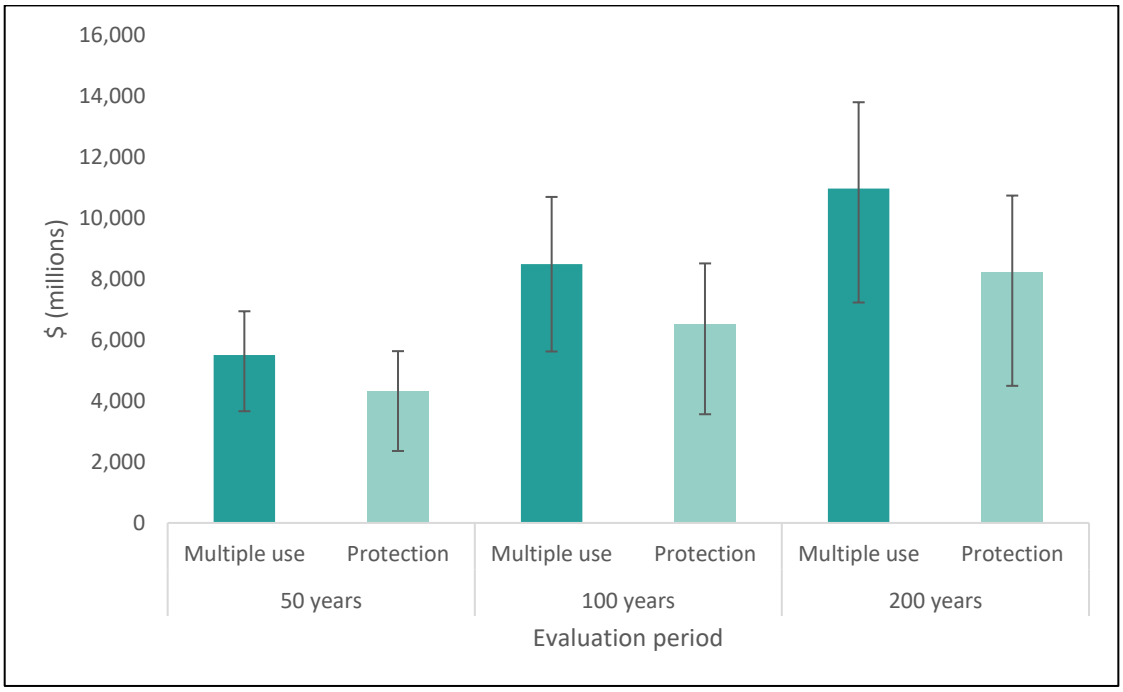
Extended results

EXTENDED RESULTS

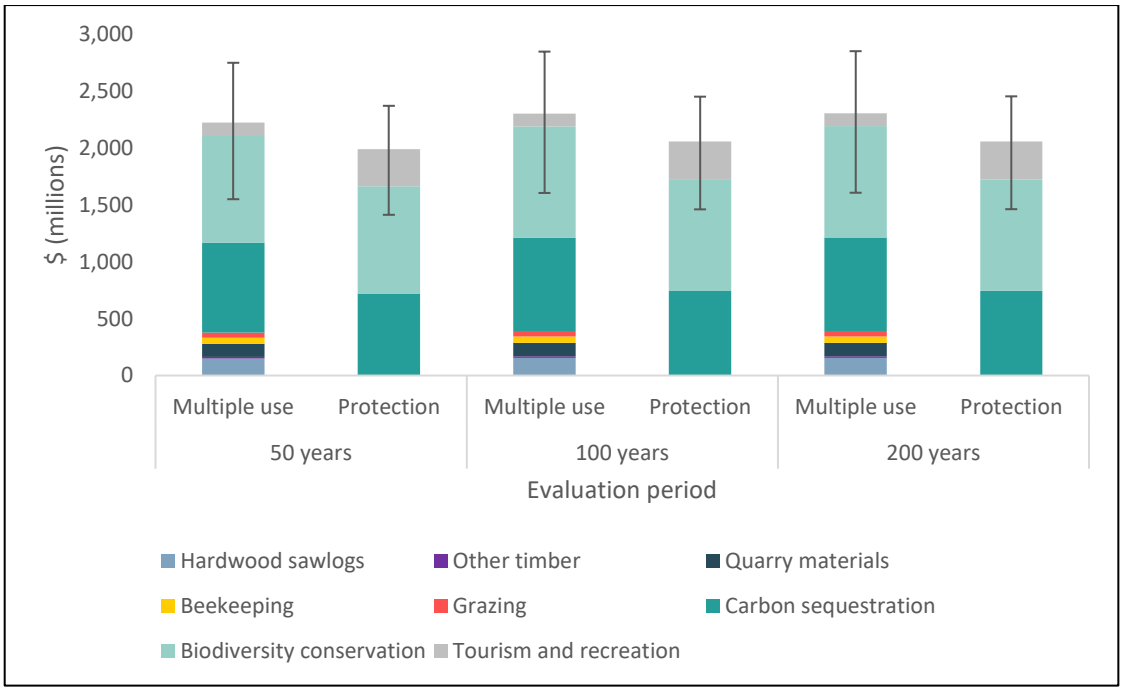
App Figure 17 Present value of benefits for each scenario across alternative evaluation periods, discounted at 1.35%



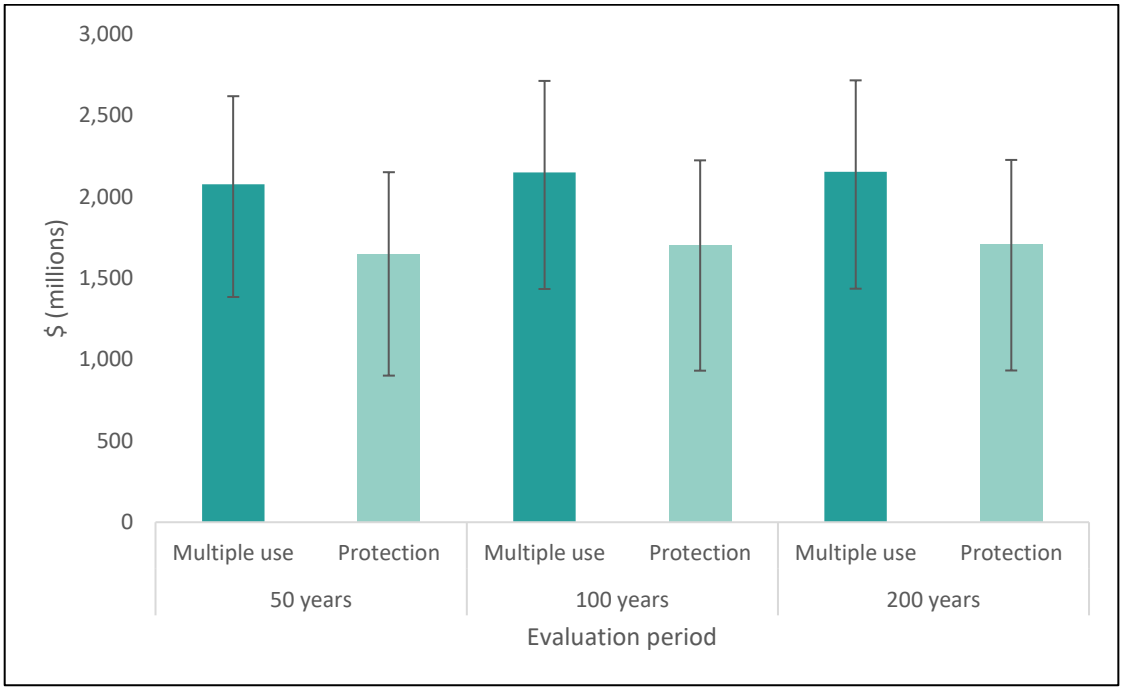
App Figure 18 Net present values of each scenario across alternative evaluation periods, discounted at 1.35%



App Figure 19 Present value of benefits for each scenario across alternative evaluation periods, discounted at 7.00%



App Figure 20 Net present values of each scenario across alternative evaluation periods, discounted at 7.00%



Indufor Oy
Helsinki, Finland

Indufor Asia Pacific Ltd
Auckland, New Zealand

Indufor Asia Pacific (Australia) Pty Ltd
Melbourne, Australia

Indufor North America LLC
Washington DC, USA

Indufor Oy
Shanghai, China

indufor@induforgroup.com
www.induforgroup.com