REDUCING CARBON EMISSIONS BY PROTECTING A NATIVE FOREST IN TASMANIA

PROJECT DESIGN DOCUMENT (PDD)

For validation at:
CLIMATE, COMMUNITY & BIODIVERSITY ALLIANCE (CCBA)

REPORT PREPARED BY: MGM INTERNATIONAL

General Information

Location of the Project
Country: Australia
Nearest City: Launceston, north Tasmania.
Precise Location of Project Activities: Coordinates 146° 59’ 40” E, 41° 50’ 11’’ S, REDD Forests Project Area (RFPA), northern Tasmania.

Implementing Organizations

REDD Forests: REDD Forests is a leading forestry carbon project developer in Australia.

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Executive Summary

The REDD Forests Tasmania Project is located within the Australian Midlands Region in the state of Tasmania. This is one of the most complex bioregions in Tasmania. The region has a large diversity of native vegetation which is related to climatic gradients operating at a regional and local scale and to variations in altitude, rock types and landforms.

However, the region has a history of logging with drier forests. This project site historically was logged for pulpwood and firewood. Additionally, the Midlands region has a significantly lower proportion of public land preserved compared to other Tasmanian bioregions.

The Redd Forests Tasmania Project is a pilot Improved Forestry Management project designed to prove the commercial viability of using the carbon market to generate a viable alternative income to landowners to traditional logging income.

Furthermore, the project will protect native and old growth forests for a 25-year period from deforestation and/or degradation. By the year 2035, the project activities will have protected an old growth forest that, if cleared (without project, business as usual) would emit 179,050 tonnes of CO_2e. Also, if replaced by a monoculture plantation of non-native exotic eucalypts (also the alternative) the project demonstrates that 73,824 tonnes of CO_2e sequestration would be lost. Therefore the project will provide improved income earning potential for the landowner and surrounding communities by substituting income from carbon sequestration for income from logging while abating carbon emissions.

Success of this pilot will result in an extension to the project to include much larger areas and many more landowners in Tasmania.

GENERAL SECTION

G1. Original Conditions in the Project Area

G1.1. Project Area Location and Physical Parameters

The REDD Forests Project ("the Project") is located in the state of Tasmania, about 150 km north of the city of Hobart. The nearest urban area is Launceston, found about 20 km from the RFPA boundary. The REDD Forests Project Area (RFPA) includes 1433.9 ha of which 790 ha are available for logging according to the Forests Practices Plan of Tasmania in the absence of finance from any carbon trade scheme (Figure No. 01).

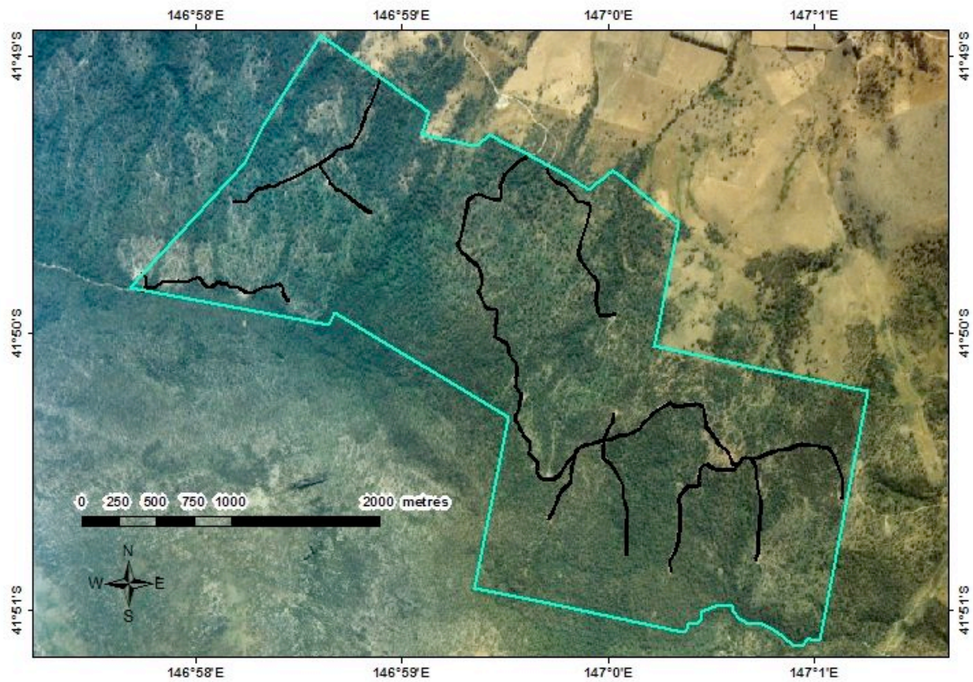

Figure No. 01. REDD Forests Project Area (Source: REDD Forests aerial photography 2007).

The project boundaries are defined by other selective logged forests, sheep grazing on previously forested land, oat cropping and exotic *Pinus radiata* plantations.

The project is located within the Australian state of Tasmania (Figure No. 02). Tasmania is an island located 240 km south of the eastern side of the continent, being separated from it by Bass Strait. The state has an estimated population of 500,000 (as of December 2008) with almost half located in the Greater Hobart area, and an area of 68,401 square km, of which the main island covers 62,409 square km.

Tasmania is promoted as the *Natural State* owing to its significant natural environment. Formally, almost 37% of Tasmania is in reserves, national parks and World Heritage sites. The island is 364 km long from the northernmost point to the southernmost point and 306 km from west to east.

The state capital and largest city is Hobart, which encompasses the local government areas of the City of Hobart, City of Glenorchy, and City of Clarence, and generally included is the satellite town of Kingston, part of the Municipality of Kingborough, into the Greater Hobart area. Other major population centers in Tasmania include Launceston in the north and Devonport and Burnie in the northwest. The sub-antarctic Macquarie Island is also under the administration of the state of Tasmania, as part of the Huon Valley Council local government area.

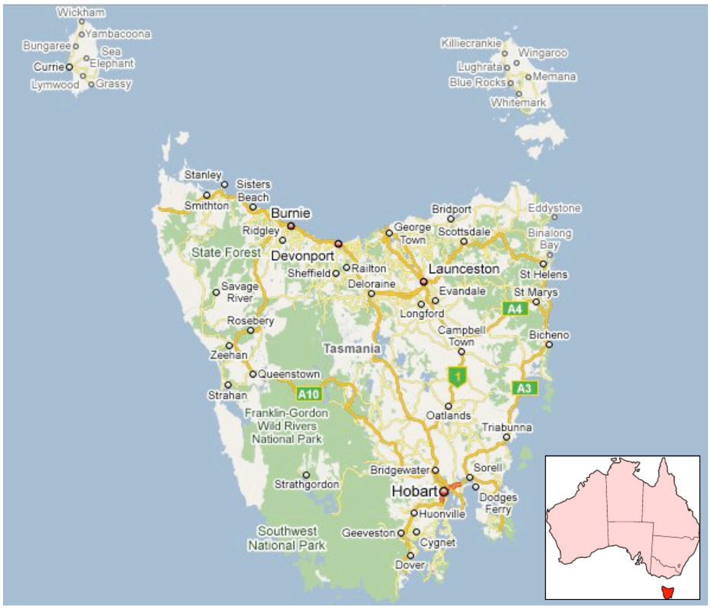

Figure No. 02. Tasmania, Australia (Source: Google maps).

The Midlands Region (area between Launceston and Hobart) is among the most complex bioregions in Tasmania. The diversity of native vegetation within the region is related to variation in altitude, rock types and landforms, as well as climatic gradients operating at a regional scale and local scale. The Midlands Region is Tasmania's agricultural heartland, and supports its largest population centers. Rainforests, mixed forests and swamp forests are locally distributed. The Midlands Region contains about 900 species of native vascular plants. Roughly 10% are endemic Tasmanian species. Over 200 threatened species occur in forest and non-forest vegetation in this region. This is a disproportionately high number due to the high extent of native vegetation loss and immediate threat to the remaining intact ecosystems by current business activities and associated invasive species. The region has a history of logging with drier forests such as the project site logged historically for pulpwood and firewood. Finally the Midlands Region has by far the lowest proportion of public land preserved in comparison to any other of Tasmania's bioregions.[1]

Physical Parameters of the RFPA

- Climate

The RFPA has a cool temperate climate with four distinct seasons. According to Launceston Airport, the project area's nearest weather station, summer lasts from December to February, when the average temperature is 24° C. Autumn lasts between March and May and experiences changeable weather, when summer weather patterns gradually change into winter patterns. The winter months are between June and July and are generally the wettest and coolest months. Winter maximums are 12° C on average. Spring is a season of transition, when winter weather patterns begin to change into summer patterns. Spring is generally the windiest time of the year with afternoon sea breezes starting to take effect on the coast. The average annual rainfall in Launceston is around 683 mm. Most rain falls in winter, and in summer the average can be as low as 31 mm per month (Figure No. 03)[2].

[1] Forest Botany Manual, Module 5, Midlands Region, Forest Practices Authority, Tasmania.
[2] Tasmania & Antarctica Climate Service Centre, Bureau of Meteorology. Site name: Launceston airport comparison. Site number: 091104. Latitude: 41.54 °S, Longitude: 147.20 °E. Elevation: 166 m. Commenced: 1931. Status: Open. Latest available data: 25 Sep 2008.

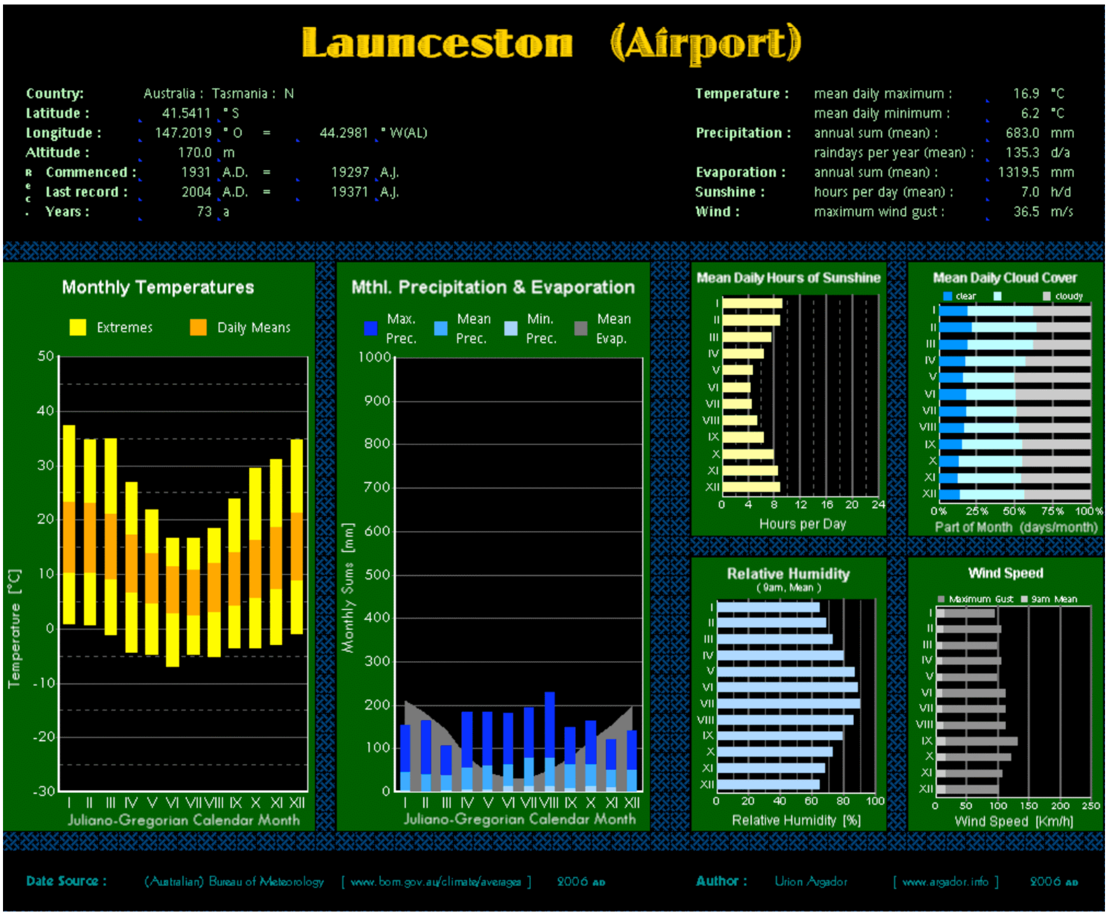

Figure No. 03. Climate conditions in the project zone (Source: Australia Bureau of Meteorology).

- Soil and geology

Since the RFPA lies in the rain shadow of the Central Highlands and western mountains, it is one of the driest regions of Tasmania (with less than 700 mm annual rainfall). Low effective rainfall and periods of drought are major limiting factors on the vegetation, particularly on the basalt hills.

Soils formed on Quaternary deposits and sand dunes are common. The relatively dry climate and high soil fertility is conducive to grass growth and grasslands and grassy woodlands occur naturally[3]. The RFPA and its surroundings present a different story from the rest of the state. Owing to a relatively dry climate and alkaline (mostly dolerite) parent material, these soils are relatively unleached and contain lime in the deeper subsoil. They are mostly classified as "prairie soils" or "brown earths" and bear some resemblance to the chernozems of Russia and North

[3] Harris, S. & Kitchener, A. 2005. From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation. Department of Primary Industries, Water and Environment, Printing Authority of Tasmania. Hobart.

America, although they are much lower in available phosphorus and somewhat acidic in the surface levels. Their higher nutrient levels, however, allow them to support productive pasture, grazing and grain crops.

G1.2. Types and Condition of Vegetation at the Project Area

Tasmania is globally known for its old growth native forest, endemic signature species, significant biological diversity and spectacular wild places. Tasmania is home to one of the world's last great temperate wilderness areas, to the world's tallest hardwood trees (which can grow to over 100 m in height), and to the largest tract of temperate rainforest in Australia. The exceptional ecological values of Tasmania's natural landscapes have been internationally recognized by a multitude of individuals and organizations, including the IUCN (multiple reports and recommendations from 1989 to 2008; *see*, for example, IUCN 1989[4] and IUCN 1990[5]), the Tasmanian Department of Parks, Wildlife and Heritage (DPWH 1990), and the Forest and Forest Industry Council's Balanced Panel of Experts (FFIC 1990)).

However, significant tracts of old growth native forest are still being logged or are scheduled to be logged. These ancient forested landscapes, which include globally significant examples of tall-eucalypt forests and rainforests, are essential for conserving wilderness, World Heritage values, biodiversity, threatened-species habitat, hydrological flows and carbon storage.

In the RFPA vegetation is predominantly dry sclerophyll forest with a small percentage of wet sclerophyll and some more open woodland, with some acacia on the lower slopes amongst partially-grazed land.

The growth and species distribution (and hence biomass distribution) of montane forests of south-eastern Australia is known to be dependent on such environmental factors as topographic water flow, seasonal climatic averages, edaphic conditions, aspect, fire history and microclimate[6,7]. Therefore one may expect to stratify sampling on the basis of a combination of topographic position, species, soil type and aspect. However, from observation of aerial photography and onsite observations it was noted that by far the cause of highest spatial heterogeneity on the RFPA is the history of timber extraction.

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[4] IUCN. 1989. World Heritage Nomination— IUCN Technical Evaluation 507, Tasmanian Wilderness (Australia). International Union for Conservation of Nature, Gland.
[5] IUCN. 1990. "Resolution 18.70". 18th Session of the General Assembly, Perth. 28th November—5th December 1990. http://www.iucn.org/congress/2004/ documents/IUCN_previous_Congress_outputs_ en.pdf Accessed on 29 July 2008.
[6] Cochrane, G.R. 1969. Ecological valence of mountain ash (Eucalyptus regnans F. Muell.) as a key to its distribution. Victorian Naturalist. 86, 6–10.
[7] Lindenmayer, D.B., Cunningham, R.B., Donnelly, C.F. & Franklin, J.F. 2000. Structural features of old-growth Australian montane ash forests" Forest Ecology and Management. 134, 189–204.

The eucalypt communities within the RFPA are easily identified by the dominant eucalypt or eucalypts in the canopy, which are usually found in combination with a specific type of understory and a specific type of environment occupied (Figure No. 04).

Figure No. 04. REDD Forests Project Area vegetation photo.

Dry sclerophyll eucalypt communities are highly adapted to fire, the composition and structure of these communities largely dependent on the intensity and frequency of fire events. Fire regime characteristics influence changes in floristic composition and structure and local extinctions (Williams 1991[8]). High-frequency, low-intensity fires in particular may result in one impact or a combination of many impacts. These include low species diversity; low ground cover; domination by bracken, tussock grass or sedge; erosion; reduction in terrestrial invertebrate diversity; loss of obligate seed regenerators; and loss of soil-stored seed (Duncan 1988[9]; Neyland & Askey-Doran 1996[10]; Gill *et al*. 1999[11]). Specific outcomes are closely dependent on substrate and soil types (Duncan 1988).

[8] Williams, K. 1991. Dry Sclerophyll Vegetation. In: Kirkpatrick, J.B. (Ed), Tasmanian native bush: a management handbook. Tasmanian Environment Centre Inc. Hobart.

[9] Duncan, F. 1988. Tasmania's Vegetation and its Response to Forest Operations. Working Paper No. 6, Environmental Impact Statement on Tasmanian Woodchip Exports Beyond 1988.

[10] Neyland, M. & Askey-Doran, M. 1996. Effects of Repeated Fires on Dry Sclerophyll (E. sieberi) Forests in Northeast Tasmania. In: Mesibov, R. (Ed), Biogeography of northeast Tasmania.
Records of the Queen Victoria Museum, Launceston.

[11] Gill, A.M., Woinarski, J.Z., & York, A. 1999. Australia's Biodiversity – Responses to Fire, Plants, Birds and Invertebrates. Department of Environment and Heritage, Canberra.

Crown dieback in the canopy of some forests and woods may occur naturally during drought but can be exacerbated by impacts such as grazing and burning pressure. The understory of some healthy dry sclerophyll communities has been identified as moderately susceptible to degradation by the plant pathogen *Phytophthora cinnamomi*. Infection by the pathogen can result in a general decrease in plant diversity. Species from the families Dilleniaceae, Epacridaceae, Fabaceae, Proteaceae and Rutaceae are particularly susceptible (Schahinger *et al.* 2003[12]). Closing access to infected areas is crucial to restricting the pathogen. Avoiding the creation of new tracks through the bush reduces the opportunities for infection (Kirkpatrick & Harris 1999[13]).

The main vegetation categories within the RFPA are described below (Figure No. 05).

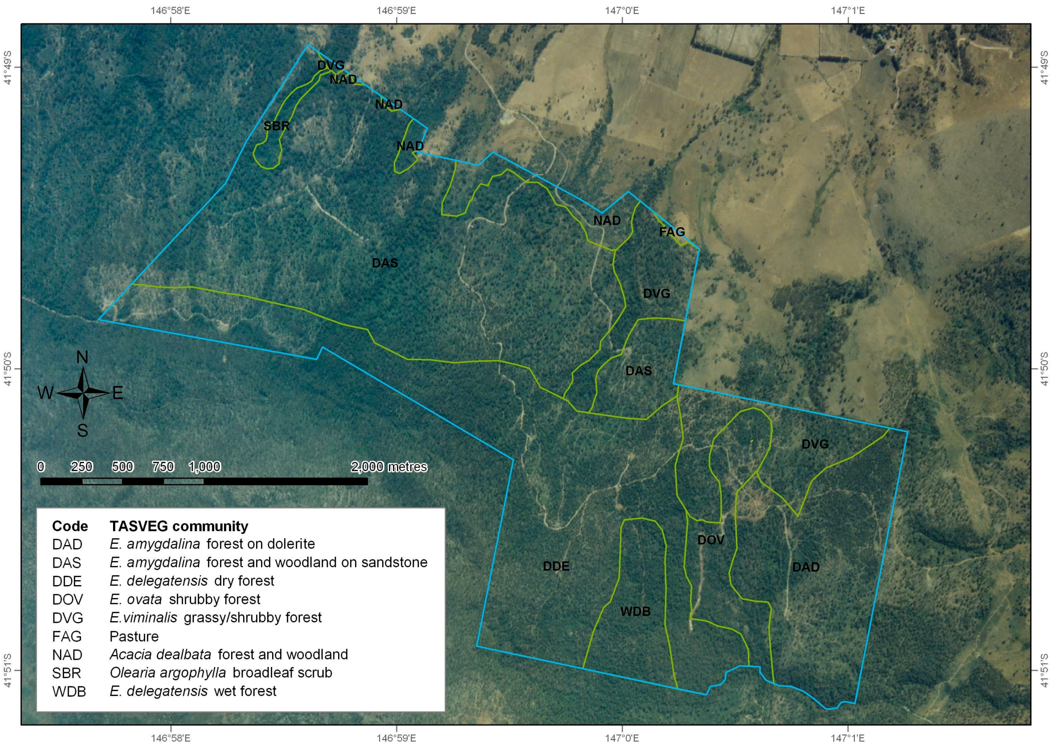

Figure No. 05. Vegetation categories within the RFPA are: (Source: Tasmania Department of Primary Industries and Water, Natural Values Atlas Report).

- DAD: *Eucalyptus amygdalina* forest and woodland on dolerite;
- DAM: *Eucalyptus amygdalina* forest and woodland on mudstone;
- DAS: *Eucalyptus amygdalina* forest and woodland on sandstone;

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[12] Schahinger, R., Rudman, T. & Wardlaw, T. (2003) Conservation of Tasmanian Plant Species and Communities Threatened by Phytophthora cinnamomi: Strategic Regional Plan for Tasmania. Technical Report 03/03, Nature Conservation Branch, Department of Primary Industries, Water and Environment, Hobart.

[13] Kirkpatrick, J.B. & Harris, S. (1999) The Disappearing Heath Revisited. Tasmanian Environment Centre Inc., Hobart.

• DDE: *Eucalyptus delegatensis* dry forest and woodland;
• DVS: *Eucalyptus viminalis* shrubby/heathy woodland;
• FRG: Regenerating cleared land; and
• NAD: *Acacia dealbata* forest.

• *Eucalyptus amygdalina* forest and woodland on dolerite (DAD)[14].

This community tends to have an uneven-aged open structure, with the dominant *E. amygdalina* trees rarely exceeding 25 m in most areas, but grading into ash-dominated tall open forest at higher elevations. *E. viminalis* may be present at lower elevations, and *E. delegatensis* and *E. dalrympleana* often present at higher elevations. *E. obliqua* can be associated with this community on lower slopes or gully flanks. *E. amygdalina* can form a clinal gradient with *E. pulchella* in some areas of the east and south-east.

The understory is variable, ranging from grassy to shrubby. At lower elevations, tall shrubs or small trees such as *Bursaria spinosa*, *Acacia dealbata* and *Banksia marginata* are characteristic, with the ground layer dominated by tussock grasses and low shrubs. At higher elevations, the understory is dominated by low shrubs such as *Leptecophylla juniperina* and *Lomatia tinctoria* and can be rich in grasses and herbs.

Occasionally within the highest rainfall areas of its range in fire-protected sites, broad-leaved shrubs more characteristic of wet sclerophyll communities can occur.

This community occurs mainly on dolerite and to a lesser extent, on basalt. It is generally found in areas of low rainfall on sites subject to occasional to frequent drought stress, such as ridges and tier surfaces and slopes with a northern or western aspect. At higher altitudes the community occurs with *E. delegatensis* forest, but tends to occupy drier sites. The main altitudinal range is 300-600 m. Sites tend to be well-drained with shallow to medium soil depth. Surface rock cover can be high.

• *Eucalyptus delegatensis* dry forest and woodland (DDE)[15].

This community is dominated by *E. delegatensis*, with *E. dalrympleana* a subdominant in some *E. delegatensis* communities. *E. amygdalina* is the most widespread peppermint subdominant species.

E. delegatensis typically forms open forests, though on exposed sites trees may often have a low, spreading, woodland form. Stands can be even- or uneven-aged.

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[14] Harris, S. & Kitchener, A. 2005. From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation. Department of Primary Industries, Water and Environment, Printing Authority of Tasmania. Hobart.
[15] Harris, S. & Kitchener, A. 2005. From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation. Department of Primary Industries, Water and Environment, Printing Authority of Tasmania. Hobart.

The composition and structure of the understory vary greatly, depending on fire frequency. The shrub layer is typically sparse in areas of high fire frequency. The tall shrub layer is generally sparse and species-poor, with the most frequent species being *Acacia dealbata*. Other species include *Exocarpos cupressiformis*, *Acacia melanoxylon*, *Banksia marginata* and *Olearia viscosa*. The lower shrub layer is also sparse, the most common species being *Pultenaea juniperina*, *Lomatia tinctoria*, *Olearia phlogopappa*, *Leptecophylla juniperina* subsp. *parvifolia* and *Cyathodes glauca*. The ground layer in frequently fired areas is dominated by tussock-forming grasses, with *Pteridium esculentum*, *Lomandra longifolia* and herb species also being common.

As fire frequency decreases, the prominence of the grasses decreases, with a corresponding increase in abundance and/or diversity of shrub and fern species. High altitude *E. delegatensis* on basalt has an understory dominated by grass, notably *Poa* species.

This community occurs mainly in association with dolerite, but also on basalt, sandstone and granite. The sites are typically well-drained. The surface rock can be continuous on talus slopes, boulder-fields and outcropping rock platforms. The altitude range of this community is about 500 m to 900 m (1,050 m on the Central Plateau), although in areas that receive cold-air drainage, it will extend downslope to below 300 m.

- *Eucalyptus delegatensis* forest with broad-leaf shrubs[16].

In *E. delegatensis* broad-leaf forest, the dominant *E. delegatensis* trees tend to be tall, generally more than 40 m. Moreover, the trees are often multi-aged, with two or three age classes reflecting fire ages and/or disturbance by selective logging.

Trees occurring across the range of *Eucalyptus delegatensis* forest with broad-leaf shrubs include *Acacia dealbata, A. melanoxylon* and *E. dalrympleana*.

The species composition, density and structure of the understory vary considerably in response to fire history, land-use, altitude and site conditions. *Bedfordia salicina* can form an almost continuous cover with *Cyathodes glauca* and be sub- or co-dominant. The shrub layer becomes taller, denser and more diverse on sites with greater fire intervals, shelter and more moisture. In these situations *Pomaderris apetala* and *Olearia argophylla* dominate the tall shrubs.

Herbs are usually low in both abundance and diversity as a result of low light at ground level, thick litter and, on dolerite substrates, high surface rock cover. The

[16] Harris, S. & Kitchener, A. 2005. From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation. Department of Primary Industries, Water and Environment, Printing Authority of Tasmania. Hobart.

most common species across the range are *Hydrocotyle hirta, Geranium potentilloides, Viola hederacea* and *Acaena novae-zelandiae*.

The diversity and abundance of ground ferns are high in most wet sclerophyll *E. delegatensis* forests, but the diversity of epiphyte ferns increases in the moister facies of this community.

This forest community is common in protected microclimates and/or moister sites, such as on southerly aspects or along the Eastern Tiers where there is relatively high rainfall.

- *Eucalyptus viminalis* shrubby/healthy woodland (DVS)[17].

The dominant canopy species in this forest community is *Eucalyptus viminalis*, which attains around 20 m in height, less on poorer sites. *E. pauciflora*, *E. ovata* and *E. amygdalina* may be present as subdominants.

On drier slopes, grasses and herbs dominate the understory, but in some places, *Acacia mearnsii*, *Allocasuarina verticillata* and *Bursaria spinosa* form an additional stratum of small trees. On moister sites, *E. viminalis* forest has an understory of *Acacia dealbata*, *Pteridium esculentum* and an herb-rich, grassy ground cover.

This forest community is established below 700 m on well-drained sites (ridges, hills, saddles and slopes), generally on dolerite or basalt (occasionally on sandstone) in the low-rainfall regions.

It is well adapted to dry conditions and is found on free-draining sites, which are often susceptible to drought.

- *Acacia dealbata* forest (NAD)[18].

This canopy is most often composed purely of *A. dealbata* although other species may sometimes be present as a minor component (e.g. eucalypt or broad-leaf wet sclerophyll or rainforest species, < 5%).

Trees can reach 20 m in height, but typically the community is short-lived and replaced by other wet forest communities (e.g. rainforest or wet eucalypt forest). Canopy cover can vary from dense in younger stands to sparse in more disturbed or older stands.

[17] Harris, S. & Kitchener, A. 2005. From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation. Department of Primary Industries, Water and Environment, Printing Authority of Tasmania. Hobart.
[18] Harris, S. & Kitchener, A. 2005. From Forest to Fjaeldmark: Descriptions of Tasmania's Vegetation. Department of Primary Industries, Water and Environment, Printing Authority of Tasmania. Hobart.

Understories are variable and range from *Pteridium esculentum* and shrub species, representative of disturbed sites, to regenerating wet forest species such as *Olearia lirata* and *O. argophylla*, to rainforest species such as *Nothofagus cunninghamii*. The understory often reflects the vegetation present before the disturbance. Except in riparian corridors subject to regular floods, the community reverts to the pre-disturbance community (e.g. wet eucalypt forest, rainforest) if left undisturbed and appropriate seed sources are present.

This community is most common on sites disturbed by fire, past vegetation clearing or floods. Generally, stands are less than 5 ha in size but are occasionally more extensive. The community occupies sites from flats to steep slopes and ridges on a variety of substrates, but most often is found on relatively fertile areas.

G1.3. Project Boundaries of the Project Area and the Project Zone

The RFPA southern boundary is defined by selective logged forests, the western boundary by private land ownership with selective logging and sheep grazing on previously forested land, the northern boundary by sheep grazing, oat cropping, exotic *Pinus radiata* plantation, and exotic *Eucalyptus nitens* plantations and the eastern boundary by sheep grazing and exotic *Eucalyptus nitens* plantation.

The project zone is located within the communities called Cressy, Poatina, and Bracknell. It is located in the Northern Midlands Council, one of twenty Local Government Areas in Tasmania. The Northern Midlands is one of the largest and most diverse municipal areas in Tasmania.

G1.4. Carbon Stocks within the Project Area

The vegetation type is predominantly dry sclerophyll forest with a small percentage of wet sclerophyll and some more open woodland, with some acacia on the lower slopes amongst partially-grazed land. The growth and species distribution (and hence biomass distribution) of montane forests of south-eastern Australia is known to be dependent on such environmental factors as topographic water flow, seasonal climatic averages, edaphic conditions, aspect, fire history and microclimate (Figures No. 06 and 07) (e.g. Cochrane 1969[19]; Lindenmayer et al. 2000[20]). Therefore one may expect to stratify sampling on the basis of a combination of topographic position, species, soil type and aspect. However, from observation of aerial photography and onsite observations it was noted that by far the cause of highest spatial heterogeneity on the RFPA is the history of timber extraction.

[19] Cochrane, G.R. 1969. Ecological valence of mountain ash (Eucalyptus regnans F. Muell.) as a key to its distribution, Victorian Naturalist. 86, 6–10.
[20] Lindenmayer, D.B., Cunningham, R.B., Donnelly, C.F. & Franklin, J.F. 2000. Structural features of old-growth Australian montane ash forests. Forest Ecology and Management, 134, 189–204.

Therefore the most obvious choice of site stratification would be in terms of logging type and age since logging.

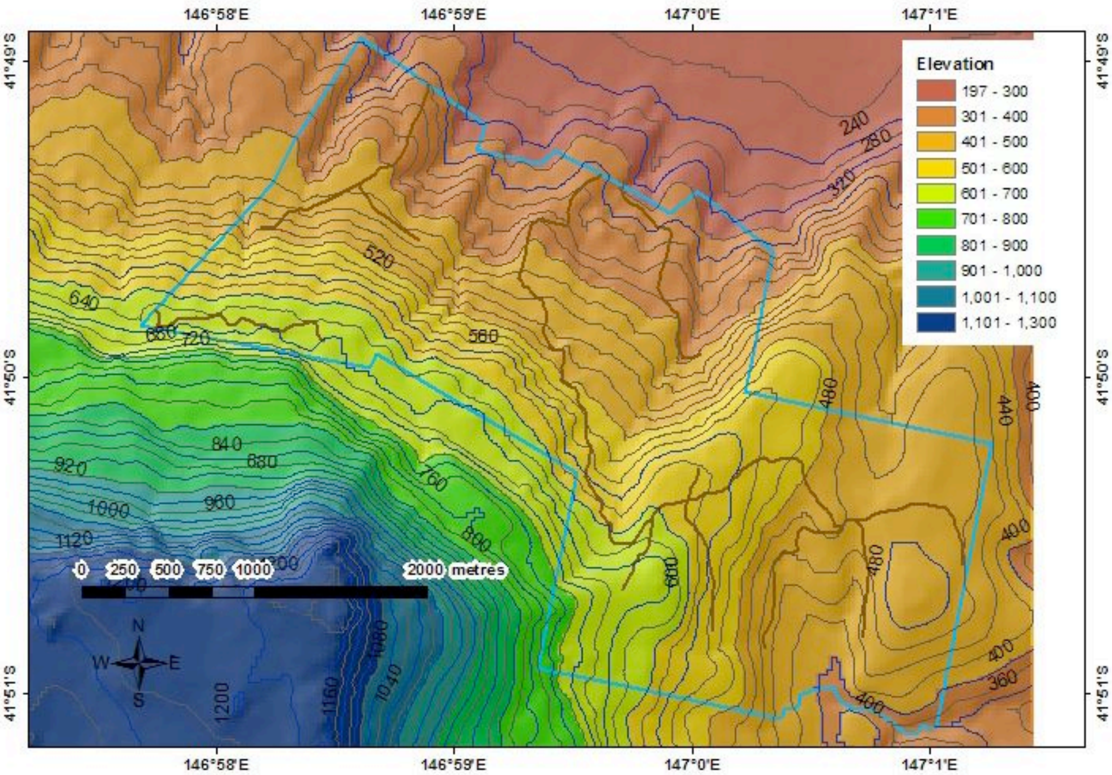

Figure No. 06. View of topography across the RFPA, based on a 25 m (horizontal) resolution digital elevation model (DEM).

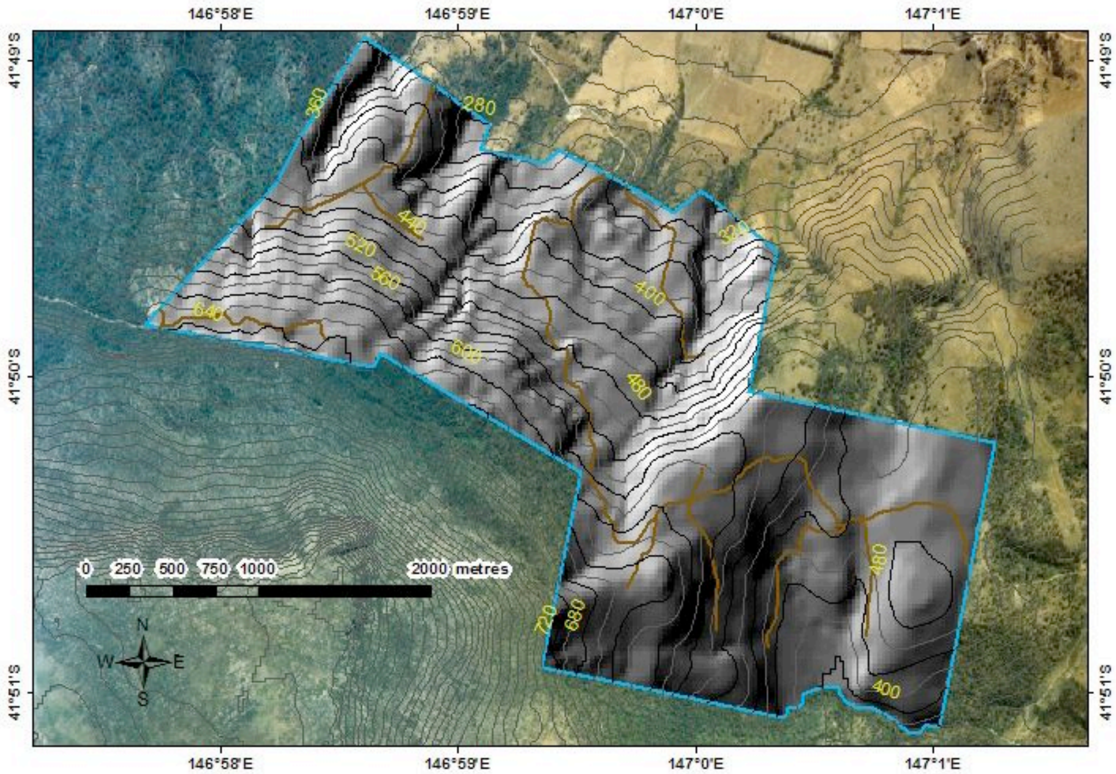

Figure No. 07. Digital elevation model (DEM) with hillshade from 315 degrees, showing aspect and rugged relief.

Throughout the RFPA the nature of logging has been mainly "high-grading", both in the choice of location of logging coupes and the individual trees and patches of trees felled within individual coupes. Four logging coupes have been harvested in the RFPA within the last 5 years (Figure No. 08). Although the registered plans for the coupes cover the major part of the RFPA, often less than the coupe area is harvested in each case. This is significant because it means that the harvested volume cannot be worked back to provide an estimate of biomass per unit hectare. The RFPA contains a mixture of old growth, "picked over" forest, selective logging and clear-fell. One large patch of contiguous, mostly unlogged old growth remains, measuring ~40ha, in the upper elevations of the central zone between the two recently logged sides of the RFPA. This is predominantly north-facing and dry sclerophyll, of lower potential biomass than of the remainder of the RFPA. Smaller patches of old growth, which were selectively logged without chainsaws (approximately pre-1945), are dotted across the upper elevations of the RFPA. This type of logging was labor-intensive and therefore more selective, but it was even conducted in what are presently designated as stream-side reserves, and rarely involved any attempts at specific stand regeneration. In the lower elevations of this central zone (between the recent coupes) is open woodland, which is a residual from heavy selective logging long ago.

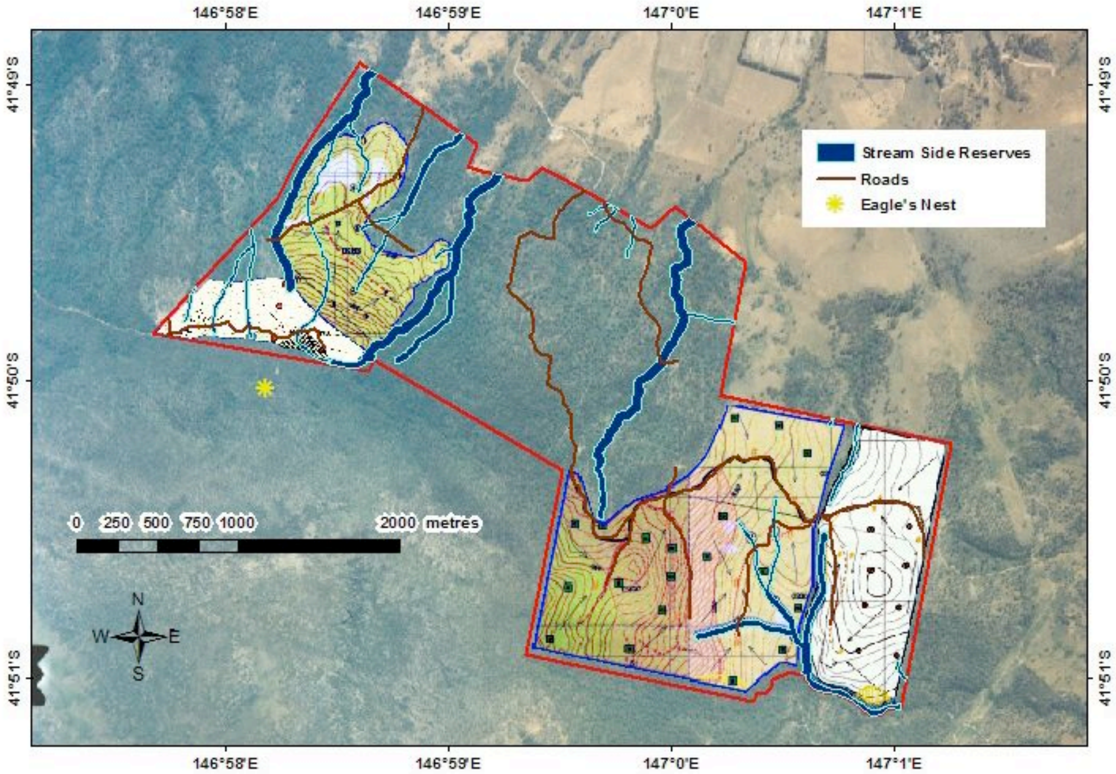

Figure No. 08. Roads, buffered stream-side reserves, and timber harvesting plan for four separate coupes.

The lower elevation portions of the RFPA have been subject to timber extraction for a variety of purposes, mostly for lumber and firewood, repeatedly over many decades. Broad-scale clearing was not enforced and so many large eucalypts remain. Notably however many of these lower elevation areas were not given any silvicultural prescription for forest regeneration; instead they have been used for pasture grass production for grazing.

Consequently many of the inter-tree areas and the understory in general have become thickened with *Acacia dealbata* (silver wattle), a local pioneer species. Some areas also have both bracken and silver wattle (another pioneer species). The eucalypt canopy in these areas takes the growth form of woodland trees. In the mid-elevation areas there is more evidence of natural eucalypt regeneration. The growth form of the canopy in the higher elevations, further from the grazing land-use, is that of forest trees, not woodland trees.

There are five reasons for not stratifying the data collection on the basis of the major influence on spatial heterogeneity (timber harvesting):

1) The harvesting of coupe C05CB142C, the largest coupe in recent years, with a plan area of 219 ha, had only just begun when the aerial photography and satellite imagery

were acquired. (Figure No. 09; therefore also, stratification could not be based on logging history as determined by remote sensing.)

2) Within a coupe the area harvested is not necessarily clearly delineated.

3) Although areas within coupes have not been harvested, in the RFPA they still contain a network of tracks with large variations in age, width, missing biomass and regeneration capacity.

4) Successive harvests (over many decades) have overlapping boundaries, thus creating a wide and virtually indeterminate variety of logging histories across the estate (Figure No. 10).

5) The lower elevations, although the trees have wider canopies and cover more projected area (for the same wood biomass) than forest trees, have had more individual trees removed but have not been subject to broad-scale clearing.

Thus overall, even though timber extraction is the major influence on the spatial distribution of biomass (apart from the more obvious, recent clear-fells) there is a gradual change in stand density across the RFPA. Any trends in this graduation were not discernible at a level, before fieldwork, which would allow stratification. Consequently, for the purpose of locating sampling sites before fieldwork, the RFPA was treated as a single stratum.

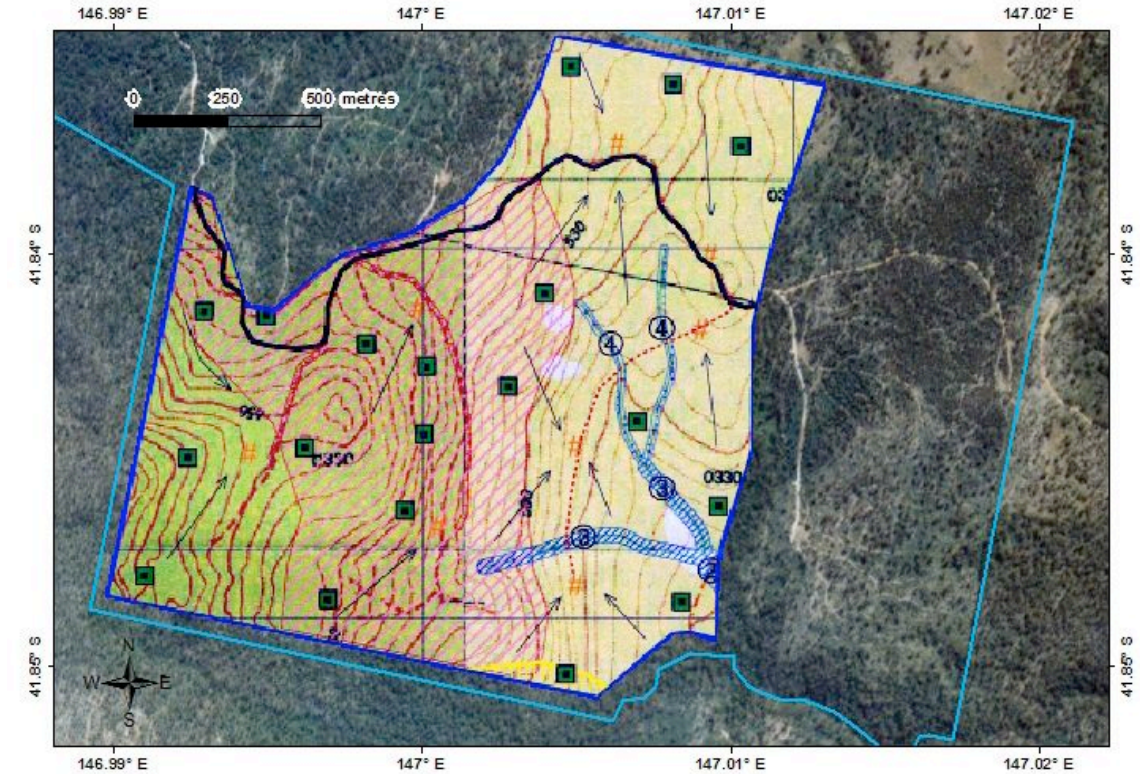

Figure No. 09. Timber harvesting plan for coupe C05CB142C and neighboring logged coupe LZ142B. In practice, a substantial portion (at least half) of this area was not logged in this operation.

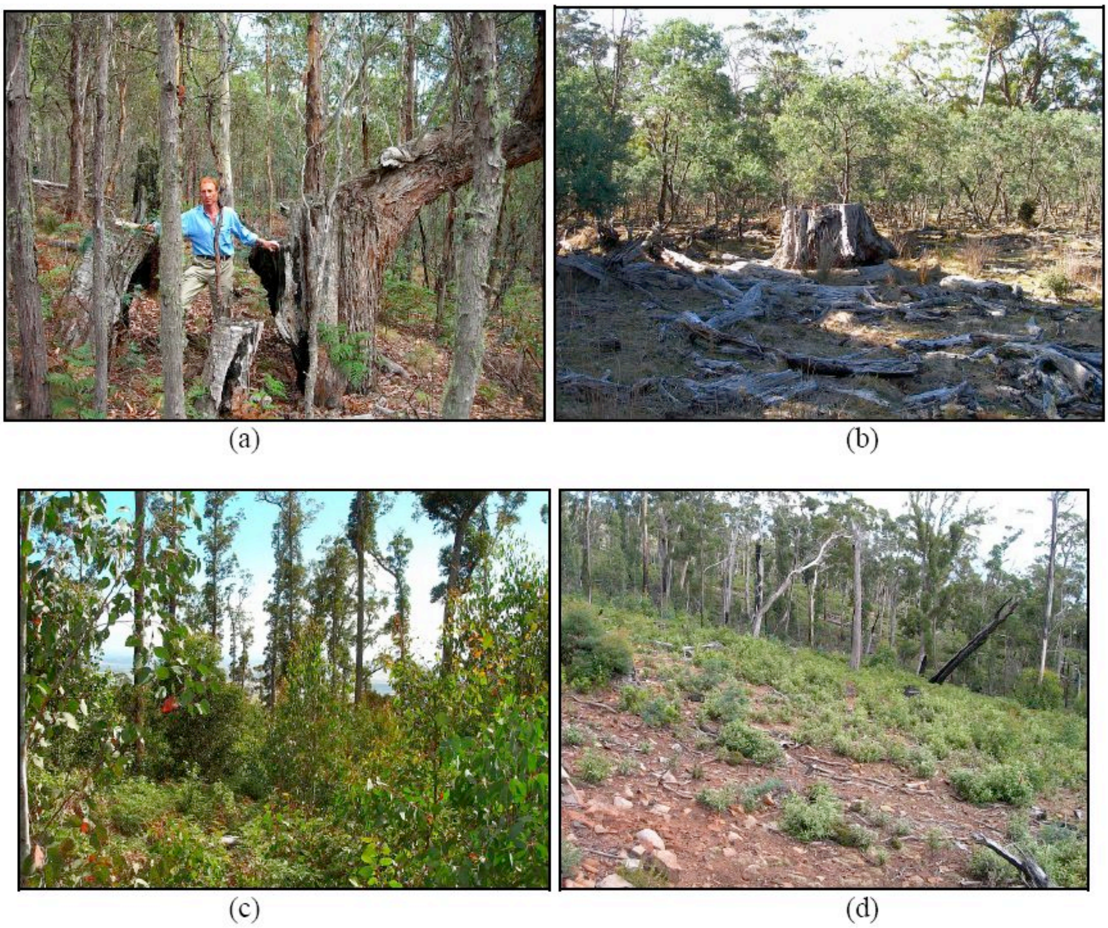

Figure No. 10. Different qualities of post-logging regeneration. Poor: (b) and (d). Good: (a) and (c). Old logging: (a) and (b). Recent logging: (c) and (d). Situations (b) and (d) have resulted in large portions of bare ground and re-growth of mostly early colonizer species, rather than late successional canopy species. All these types are represented within the PA and constitute complexity in stratification and carbon accounting.

An unsupervised classification was performed on the normalized difference for senescent vegetation index (NDSVI) image to allow modeling of specific categories of the standing carbon stock. A higher number of classes will undoubtedly increase the accuracy of the forecast, but for the purposes of an initial test the number of classes was limited to 4 (Figures Nos. 11 and 12).

The history of the four classes is the following:

- Class 2: selective logging of 20% in 1940, selective logging of 50% in 1975, and selective logging of 100% in 2006; or: the land subject to heavy logging in the early history of the farm and not regenerated, in the lower elevations of the central portion of the RFPA.

- Class3: selective logging of 20% in 1940, selective logging of 50% in 1975, and selective logging of 51% in 2006. (This latter logging is mostly the periphery of the more heavily logged areas, adjoining the land not logged in 2006.)

- Class 4: selective logging of 20% in 1940, and selective logging of 50% in 1975, with no further logging.

- Class 5: selective logging of 20% in 1940, with no further logging.

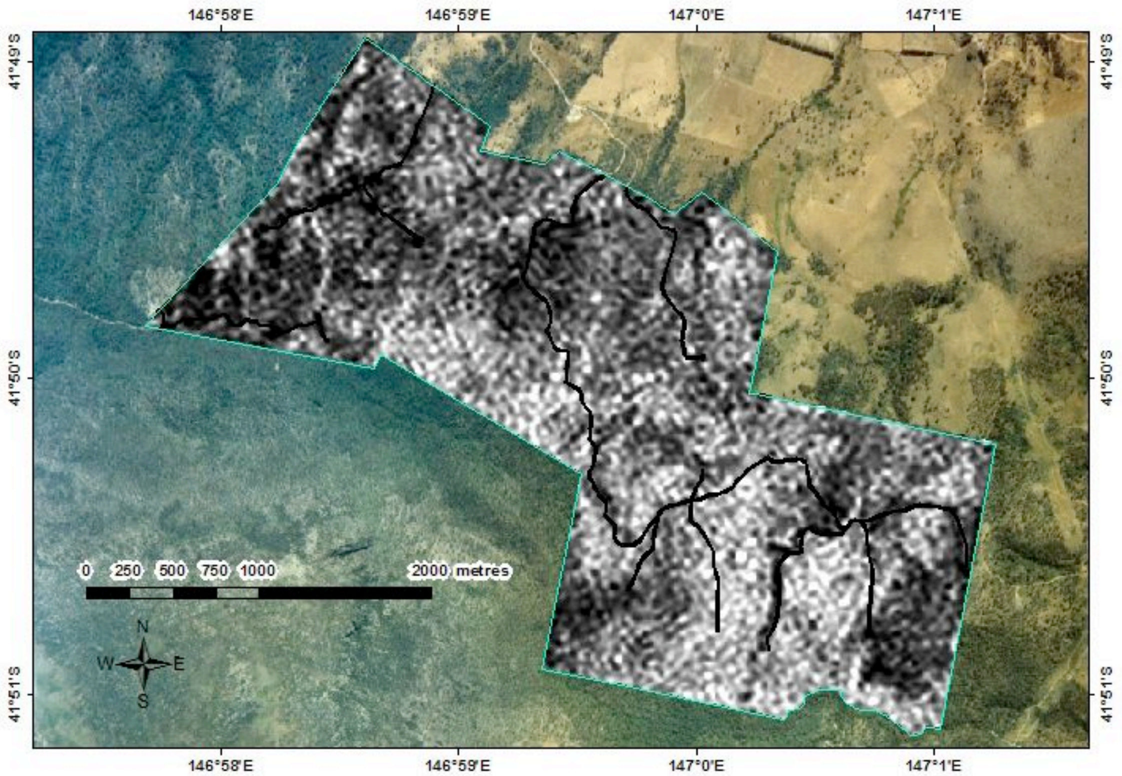

Figure No. 11. Normalized difference for senescent vegetation index (NDSVI) image. (White corresponds to a higher non-photosynthetic vegetation response.)

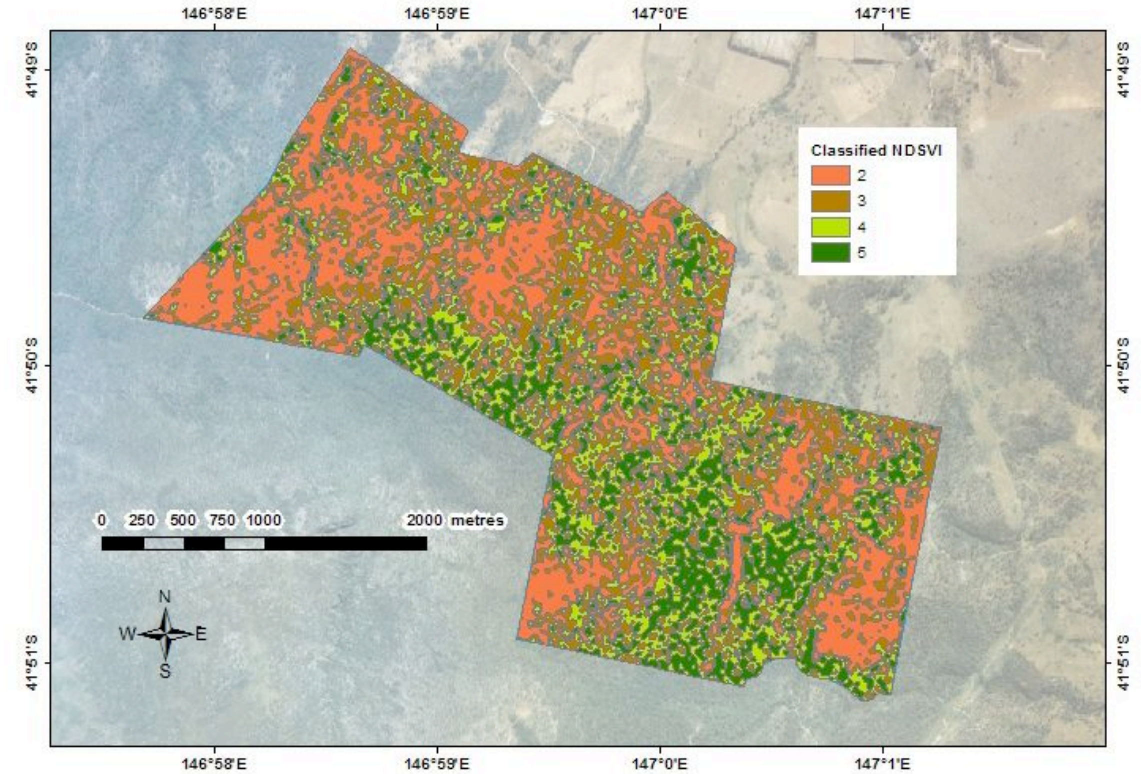

Figure No. 12. Classified normalized difference for senescent vegetation index (NDSVI) image. The stream-side buffers were subtracted from this image to yield the area that can be converted to plantation.

The derived biomass for the 4 classes across the RFPA is presented in the following table (Table No. 01).

Table No. 01. Derived biomass for the 4 classes across the RFPA*. Note that for the 95% confidence level for the low biomass class (#2) the minimum biomass was not left at negative but realistically reset to zero. The column for carbon includes the carbon in roots (root-shoot ratio of 0.14). Abbreviations: t – tonnes, CL – confidence level.

Class	Area (ha)	Average Aboveground Biomass (t/ha)	Average Aboveground biomass (t/ha), 95% CL	Carbon in biomass (t), 95% CL	Area (ha) minus reserves	Carbon in biomass not in reserves (t), 95% CL
2	255.79	26.52	-32.20	0	235.52	0
3	261.01	204.36	99.33	13,300	239.47	12,203
4	209.11	335.34	196.2	21,048	190.90	19,215
5	134.51	503.66	320.7	22,129	123.82	20,372
Total	**860.42**			**56,478**	**789.72**	**47,900**

* Note that for the 95% confidence level for the low biomass class (No. 2) the minimum biomass was not left at negative but realistically reset to zero. The column for carbon includes the carbon in roots (root-shoot ratio of 0.14). Abbreviations: t – tonnes, CL – confidence level.

Detailed methodology in the annex.

G1.5. Communities Located in the Project Zone

The RFPA is located within the communities called Cressy, Poatina, and Bracknell (Australian post code 7302). It is located in the Northern Midlands Council, one of twenty Local Government Areas in Tasmania (Figure No. 13).

The Northern Midlands[21] is one of the largest and most diverse municipal areas in Tasmania. It covers an area of 5,130 km^2, with an estimated population of 12,091 (2006), its population increased 9.6% between 1981 and 1991, compared with 6.3% between 1996 and 2006.

At the 2006 census, 2.3% of the Northern Midlands population reported being of indigenous origin, which equates to the national average. This low percentage is due to diseases introduced by British settlers and conflict with British settlers during 1803-33, when the population of the Tasmanian Aborigines was reduced from an estimate of around 5,000 to around 300. However, within the RFPA and surrounding communities there does not live any indigenous community.

The percentage of Northern Midlands residents stating they were Australian born has dropped: falling from 91.6% in 1991, to 88.2% in 2001 and 86.3% in 2006. 92.2% of Northern Midlands residents are Australian citizens, compared to a national average of 78%. 7.6% were born overseas, compared to the national average of 20%. 4.3% of residents were born in England, 2% in New Zealand, 0.7% in Scotland, 0.5% in Germany and 0.4% in the Netherlands.

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[21] Northern Midlands Council. 2008. Economic & community profile. Northern Midlands Council and Northern Midlands Business Association Inc.

English is the only language spoken at home in 94.7% of Northern Midlands households, compared to 78.5% Australia-wide.

Northern Midlands residents have a high-quality lifestyle, with many choosing to live the rural life in the area's historic towns and villages, whilst being close enough to the cities of Launceston and Hobart to access and enjoy the urban services and workplaces. The area has a number of excellent recreational areas and sporting facilities, and in particular, is renowned for its trout fishing rivers and lakes.

According to the Northern Midlands 2006 census, of the 5,449 residents recorded as employed:

- 17.4% stated they were managers;
- 15.1% technicians and trades workers;
- 15% laborers;
- 11.9% clerical and administrative workers;
- 11.2% professionals;
- 9.8% sales workers;
- 9.2% community and personal service workers; and
- 8.8% machinery operators and drivers.

The most common industries of employment were:

- 9.8% in sheep, cattle and grain farming;
- 4.4% in school education;
- 2.7% in residential care services;
- 2.6% in road/freight transport;
- 2.4% in cafes, restaurants and takeaway food services; and
- 78.1% in other diverse activities.

These communities have below average income as compared to Australian national statistics of earning potential.

The Northern Midlands produces a significant percentage of the state's meat sheep and cattle, wool and crops including peas, poppy, cereal, potatoes and onions.

Figure No. 13. Communities living around the REDD Forests Project Area (RFPA; Source: Google Earth).

G1.6. Current Land Use and Land Tenure in the Project Zone

Selective Logging

In each of the past seven years, an average of 35,431 ha of native forest have been logged in Tasmania, of which 15,852 were officially identified as "clear-cut." After these Tasmanian forests are clear-cut, the remaining vegetation is burned away with petrol-based incendiary bombs dropped from helicopters (Figure No. 14).

Figure No. 14. Tasmania clear-cutting practices[22].

These practices are being applied throughout Tasmania, including to groves of native eucalyptus trees that are biologically rare, very old, and grow to especially great heights. This is especially true of the more ecologically valuable wet eucalyptus forest areas, which comprised 24% (approx. 810,000 ha as of 2006) of Tasmania's 3.4 million ha of forests. By 1996, 43% of Tasmania's original wet eucalyptus forest had been logged. Now only 19.9% of the original area of these vital trees and 35.5% of their 1996 cover are protected in any kind of reserves. Therefore, 64.5% of Tasmania's wet eucalypt forests are open for logging; in particular, only 19.2% of the original cover of the rare and important *Eucalyptus regnans* forest and 24% percent of their 1996 cover are protected[23].

According to the 2005-2006 Authority Annual Report by Tasmania's Forest Practices Authority (FPA), 7% (more than 60,000 ha) of eucalyptus forests were cleared between 1996 and 2006 (Figure No. 15). More than 20% of *E. regnans* forests—the world's tallest hardwood trees, many of which are over 400 years old—were cleared during this period. These rapid rates of clearance confirm a 2003 report by the Tasmanian Resource Planning and Development Commission (RPDC) which found that "One of the most significant threats to natural diversity in Tasmania is the clearing of native vegetation and its replacement with that of a different land use activity (e.g., tree farms, agriculture, etc.)."

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[22] The truth behind Tasmanian forest destruction and the Japanese paper industry. Who logs them? Who buys them?. Rainforest Action Network.

[23] Derived from the State of Tasmania and the Commonwealth of Australia, Supplementary Tasmanian Regional Forest Agreement, Table 1, pp16-17 and Sustainability indicators for Tasmanian Forests 1996-2001 version-25.2.02. Table 1.1.b. p25, and "Indicators, Native Vegetation Clearing" in Resource Planning and Development Committee (2003), State of the Environment Tasmania 2003. See the website at: http://soer.justice.tas.gov.au/2003/indicator/101/index.php

The areas of native forest that are being clear-cut include areas designated as Old Growth Forest. Old growth forests, also called primary forests, are formed by old trees that have not been previously cleared for logging and are regarded as the most ecologically rich forests.

Old growth forest is only one class of special forests internationally recognized as High Conservation Value Forests, a term used to denote exceptional ecological value that is classified into one of six types of *High Conservation Value*[24]**.** These typically include forest areas that: 1) are habitat for threatened species, 2) contain old-growth or primary forests, 3) contain significant concentrations of endemic plants and animals, 4) are in or contain rare, threatened or endangered ecosystems, or 5) are fundamental to either the basic needs or cultural identity of local communities. In Tasmania, many of these high conservation value forests remain unprotected. As previously mentioned, a high conservation value forest of particular concern is the eucalyptus, which is rapidly being depleted by logging. Only 24% of the 1996 cover of these forests is protected.

In 2006, 31.5% of Tasmania's officially defined "old growth" eucalypt forest from its 1996 cover and, more critically, 43.7% of *Eucalyptus regnans* officially defined as "old growth" remained unprotected and open for logging. Indeed, every year since the 1997 Tasmanian Regional Forest Agreement (RFA), this precious and irreplaceable ecosystem has been progressively depleted.

Within the RFPA and surrounding areas, the vast majority of wood harvested from native forests is wood-chipped. The data presented by Forestry Tasmania's Annual Reports demonstrates that in 2006-07, 85% of the native-forest timber harvested from public land ended up as wood chips[25]. The four-year average is approximately 86%. Only 4% of the native-forest wood harvested ended up as sawn timber.

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[24] See ProForest's web site: http://www.proforest.net/publications/hiconvf or http://www.proforest.net/publications/resolveuid/5fa32551a72133deb3a7f0686b7ef8ec

[25] Forestry Tasmania's Annual Reports (FT 2004, FT 2005, FT 2006a, FT 2007c, Ryan 1999:61). FT. 2004. Annual Report 2003–2004. Forestry Tasmania, Hobart. FT. 2005. Annual Report 2004–2005. Forestry Tasmania, Hobart. FT. 2006a. Annual Report 2005–2006. Forestry Tasmania, Hobart. FT. 2007c. 2007–08 to 2009–10 Three Year Wood Production Plans. Forestry Tasmania, Hobart. Ryan, T. 1999. A Review of Log Segregation and Utilisation in Tasmania. Forests and Forest Industry Council. Hobart, April, 1999.

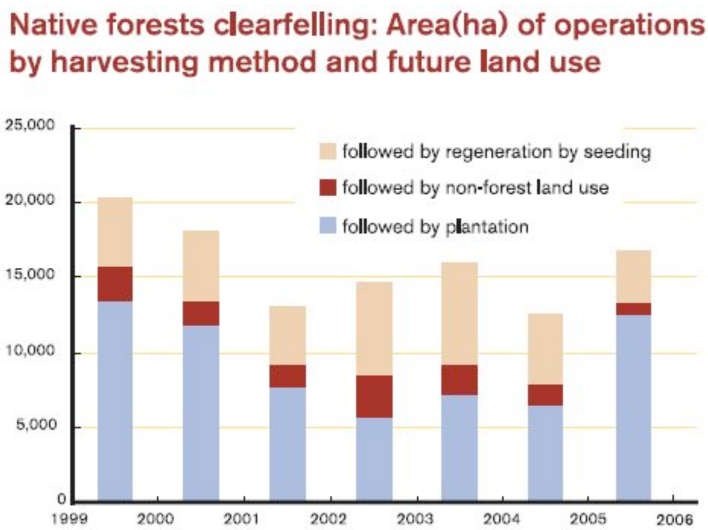


Figure No. 15. Tasmania native forest clearfelling. Area (ha) of operations by harvesting method and future land use.

The fate of Tasmanian old-growth trees that are logged is illustrated schematically in the following Figure No. 16.

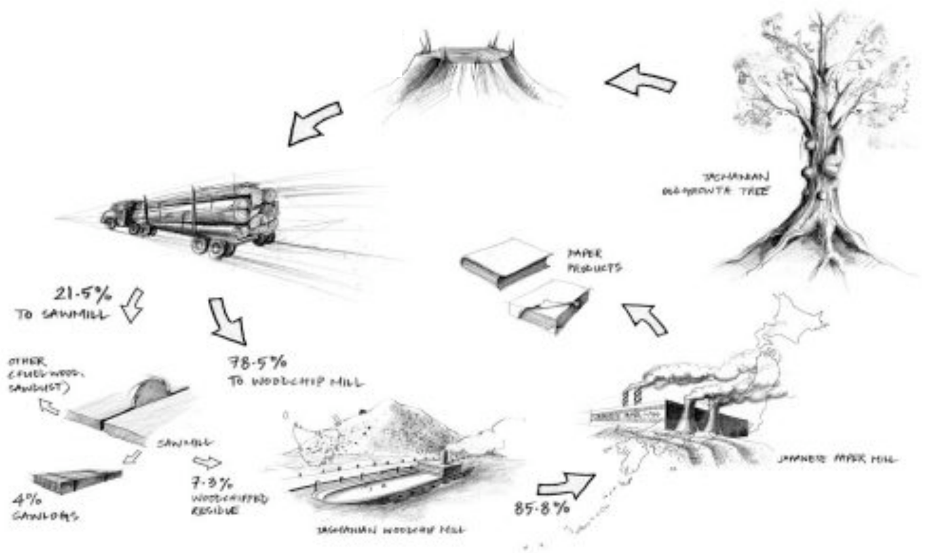


Figure No. 16. Schematic representation of REDD Forests Project Area old growth logging[26].

[26] From: The Wilderness Society (Tasmania) Inc and Still Wild Still Threatened. 2008. Oldgrowth for export. A report documenting the logging and woodchipping of Tasmania's oldgrowth forests.

Within the RFPA, from 1997 to 2007, according to timber agreements with buyers, in the project area more that 426.5 ha of old growth forest had been logged, corresponding to 31,270 m^3 of pulp and sawn wood (Table No. 02). Documents supporting this information are available to verifiers for review.

Table No. 02. Corresponding Forestry Practices Plans in the REDD Forests Project Area (Source: REDD Forests)

Forestry Practices Plans Code	Area (Ha)	Pulp Volume	Sawn Volume	Period	
				From	To
TAM129	65,0	5.000	300	*21/01/99*	*31/12/00*
TAM263	75,0	5.300	200	*18/03/00*	*31/12/02*
TAM411	26,5	4.000	250	*22/01/03*	*31/01/03*
TAM537	41,0	4.000	20	*18/02/04*	*28/02/04*
TAM805	219,0	12.000	200	*13/02/06*	*31/12/06*

The following maps correspond to scanned copies of the Forestry Practices Plans of logged activities carried out within the REDD Forests area (Figures Nos. 17, 18, 19 and 20).

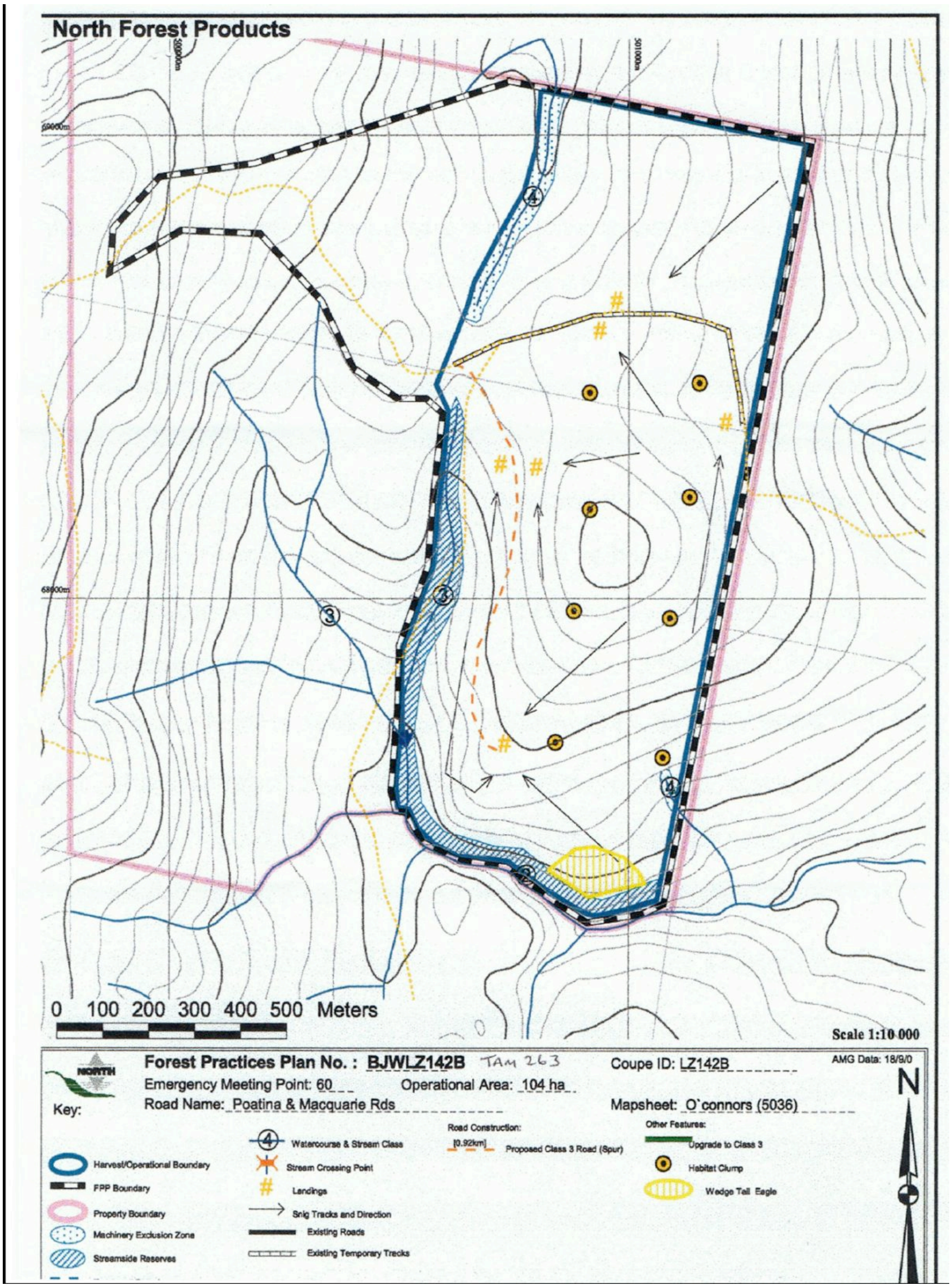


Figure No. 17. Land to be harvested by the Forestry Practices Plans code TAM 263.

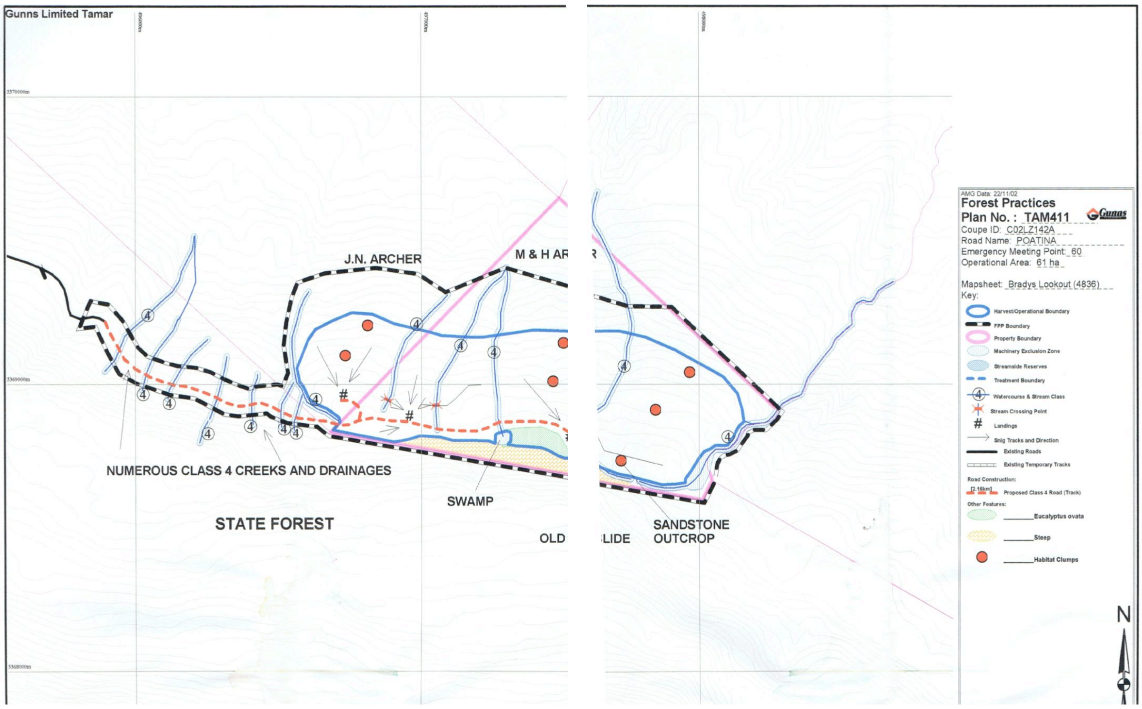


Figure No. 18. Land to be harvested by the Forestry Practices Plans code TAM 411.

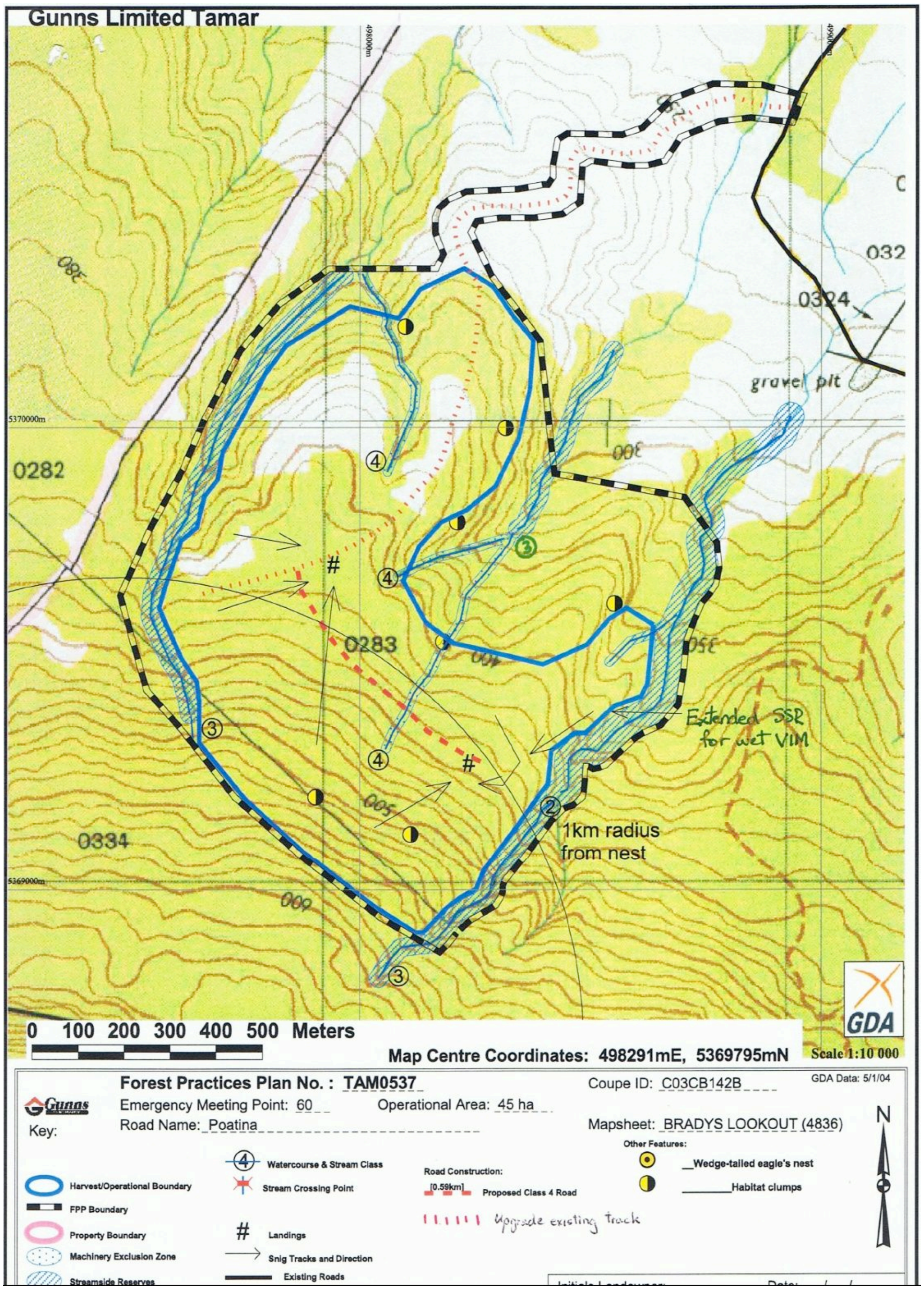


Figure No. 19. Land to be harvested by the Forestry Practices Plans code TAM 537.

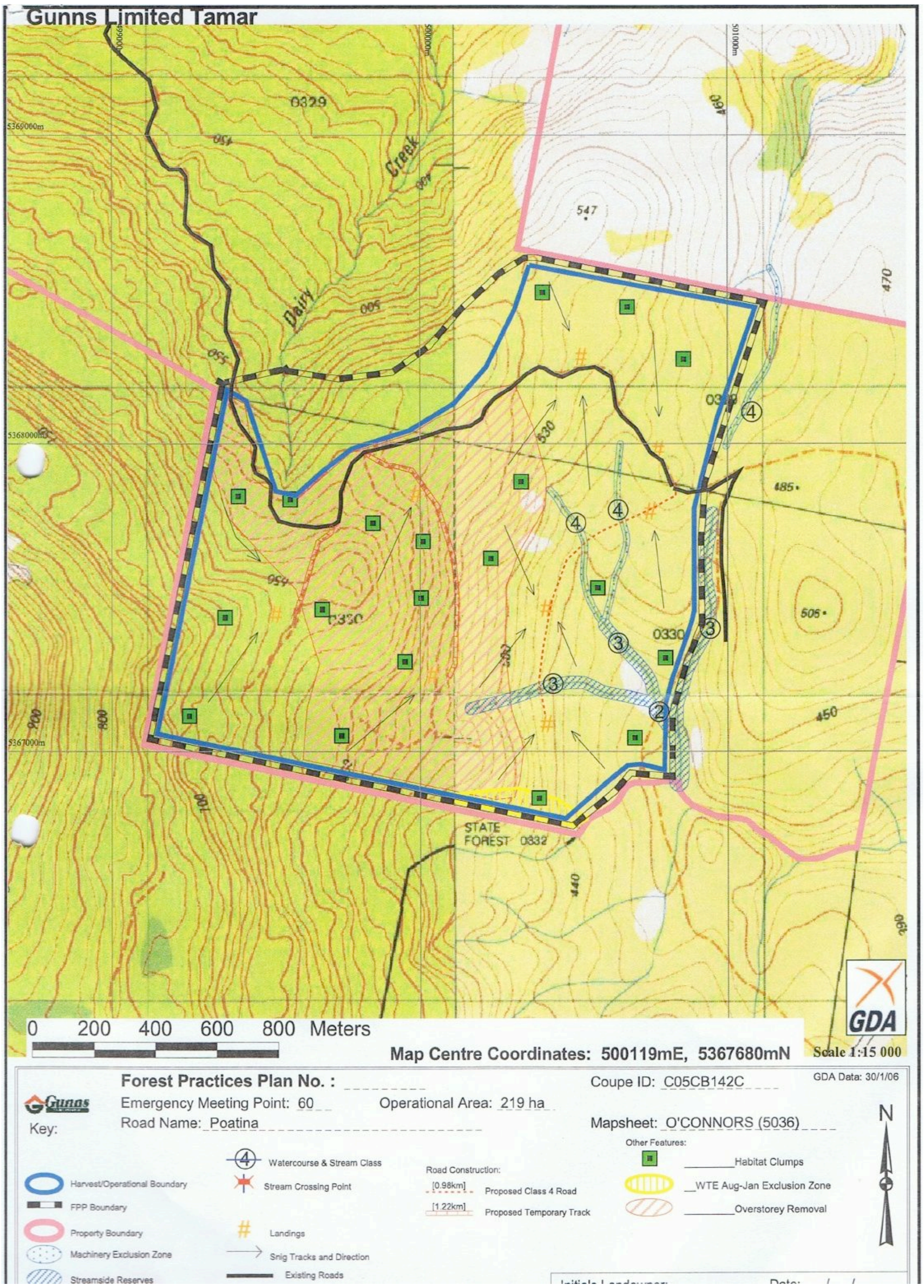


Figure No. 20. Land to be harvested by the Forestry Practices Plans code TAM 805.

Property Ownership

The project site has two tracts of land of approximately 1433.9 ha:

- Tract ID number 6753484 of approximately 692 ha. Documents include landowners – Tenancy as owners in Common-Equal shares. It is the intention of REDD Forests and the owners of this tract of land to execute an agreement for the transfer of carbon/logging rights. Search date 3/20/09.

- Tract ID number 6753476 of approximately 741.9 ha. Documents provided by REDD Forests include Woodside Park Pty Ltd as the owner of record. It is the intention of REDD Forests and the owners of this tract of land to execute an agreement for the transfer of carbon/logging rights. Search date 3/20/2009.

The following is the information about property ownership and cadastral parcels (this information is available for review by verifiers; Table No. 03 and Figure No. 21).

Table No. 03. Cadastral Parcel Information[27] (Source: REDD Forests Tasmania property information sheets)

Category	Information
Property ID	6753476
Title reference	126579 / 3; 126579 / 4; 126579 / 5; 126579 / 6; 126579 / 7; 214285 / 1
Address	4792 Poatina Road, Cressy Tas 7302
Land parcel identifier (LPI)	5600327; 5600283; 5600325; 5600324; 5600334; 5600326
Land area	741.9
Owners	Landowners - Tenancy in Common- Equal shares.
Property ID	6753484
Title reference	54087 / 1; 227401 / 1; 63 / 5136
Address	Poatina Road, Cressy Tas 7302
Land parcel identifier (LPI)	5600330; 5600329
Land area	692
Owners:	Woodside Park Pty Ltd.
Total area (hectares) available to the project	1433.9

[27] Taken from: http://www.thelist.tas.gov.au

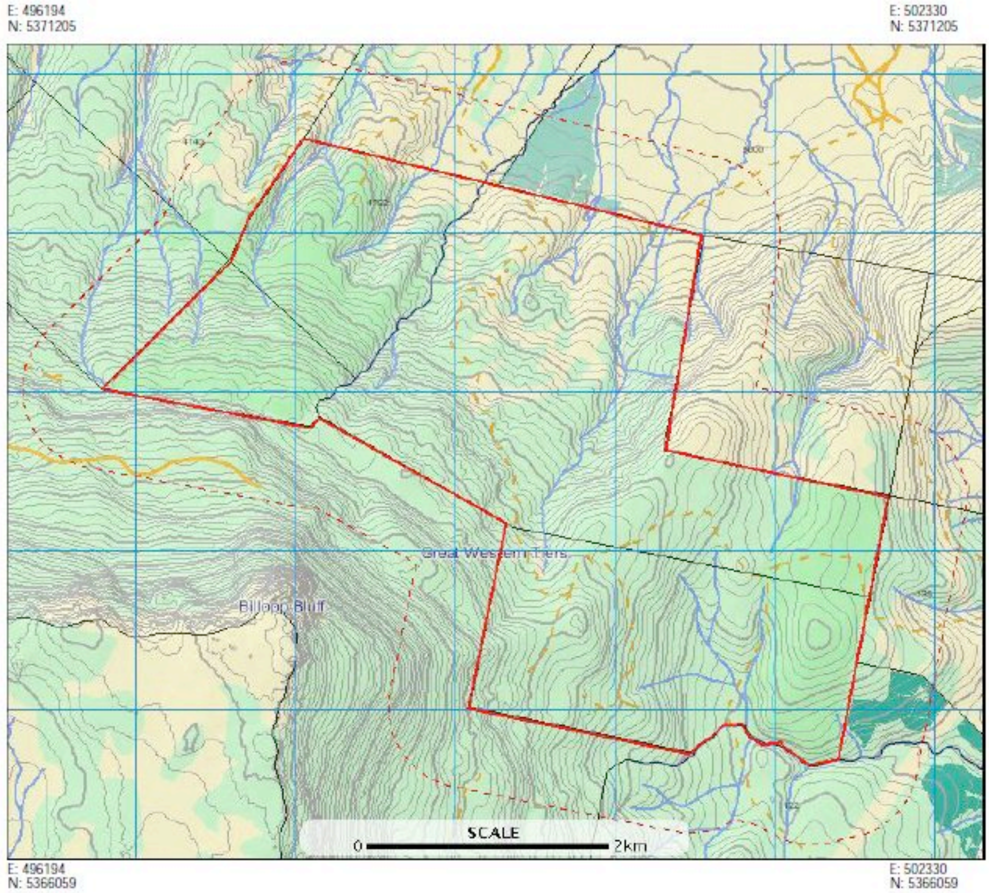


Figure No. 21. Project area constituted by two private lands.

G1.7. Current Biodiversity within the Project Zone

The project zone is a dry sub-humid cool inland lowland which lies in the Tamar Graben, an extensive plain bordered on the east and west by hilly topography developed on Jurassic and Tertiary igneous rocks and Permian mudstone. Quaternary sands and alluvium carry *Eucalyptus viminalis, E. pauciflora* and *E. ovata* open forest and woodland, while Tertiary deposits are vegetated by *E. amygdalina* open forest and woodland. Permian mudstone and Tertiary basalt line the major fault-controlled river valleys. Soils of the Northern Midlands are diverse and predominantly sandy, supporting extensive agriculture. Land use is primarily agriculture (grazing) with some forestry. Much of the region's vegetation has been converted to improved pasture, with grasslands and woodlands reduced to remnants.

The following items provide a summary of biodiversity values[28].

[28] Australian Natural Resources Atlas, Department of the Environment, Water, Heritage and the Arts. 2007. Biodiversity Assessment - Tasmanian Northern Midlands. Australian Government.

Ecosystems and species at risk

There are a total of 63 ecosystems in the Northern Midlands. Eight of these (13%) are endangered and 7 (11%) are vulnerable. Wet sclerophyll, *Eucalyptus* forests with shrubby understory, *Eucalyptus* woodlands with a shrubby understory, other forests and woodlands and other tussock grasslands occur in the inland of the region.

Threatened ecosystems in the Northern Midlands are generally in rapid decline. Threats are fragmentation and loss of remnants, clearing for agriculture, selective and clear-fell logging, firewood harvesting, weed invasion, dieback, changed fire regimes and grazing. Inundation by water storages and associated irrigation development is a threat to a range of vegetation types.

Species at risk

Threatened species are generally in decline. Historical clearing of natural ecosystems for agriculture and forestry and the ongoing fragmentation of remnants has affected most of the region and its threatened species. Herbs and orchids are severely affected by pasture improvement (plowing and the application of fertilizers), grazing and changed fire regimes. Weeds, notably gorse (*Ulex europaeus*) and willows (*Salix* spp.) are also a widespread threat to native species. Changes in hydrology due to drainage of wetlands, catchment-scale clearing and abstraction of water for livestock and irrigation, and water pollution are threats to aquatic species. Large vertebrates are at risk from loss of habitat, persecution and accidental death. The stochastic risk faced by species with low numbers of individuals and populations is identified as a threat in itself to many Northern Midlands taxa.

The following table presents the species at risk in the Northern Midlands (Table No. 04).

Table No. 04. Species at risk in Northern Midlands.

Group	**State listing**			**Commonwealth listing**		
	Extinct	**Endangered**	**Vulnerable**	**Extinct**	**Endangered**	**Vulnerable**
Plants	7	28	26	0	18	7
Mammals	1	0	0	1	0	2
Birds	1	0	0	1	3	0
Amphibians	0	0	1	0	0	1
Fish	0	0	1	0	0	1
Invertebrates	0	1	2	0	0	0
Total	9	29	30	2	21	11

Eucalypts and Acacias

- Endemism

Exists eucalypts and acacias endemic of this bioregion, 4 species of eucalypts recorded, and 1 acacia (*Acacia axillaris*). The eucalypts are *E. amygdalina, E. delegatensis* spp. *tasmaniensis, E. pulchella* and *E. rodwayi.* The overall condition of the endemic eucalypts in the bioregion is good with the trend static. Key threatening processes are clearing for forestry, agriculture, firewood collection, and associated remnant fragmentation and degradation. *Acacia axillaris*, an endemic species almost entirely confined in its distribution to this bioregion, is in fair condition with a declining trend. Significant populations of this species have been lost throughout its range in the bioregion as a result of broad-scale clearing for agriculture and through riparian vegetation loss and degradation. It is a fire-sensitive species and it is postulated that much of its non-riparian distribution has been lost through inappropriate fire regimes – populations along rivers are often in fire-protected sites.

• Richness

The level of species richness for eucalypts and acacias is low in the Northern Midlands.

Birds

Eleven of the 14 limited-range taxa confined to Tasmania have been recorded in the area. Five threatened taxa have been recorded, but for none is the bioregion of more than moderate importance. This is not surprising, since less than 20% of the land remains uncleared. Clearance has allowed a proliferation of introduced species; the bioregion has the highest exotic loading in the country with over 14% of all records being of introduced birds. There was too little data for analysis of guilds.

Mammals

There are 28 mammal species within this bioregion.

The critical weight range (35-5500 g) of mammals is the size range of Australian mammals that have been most affected by environmental changes following European settlement. In this bioregion, the fraction of mammal fauna within the critical weight range is 0.536.

Faunal attrition is a measure of contraction or loss of species richness within a region. A high index value means many species have declined or are extinct in the bioregion. The index can be used to compare the status of mammal fauna to regional attributes such as changes since European settlement and average annual rainfall. The faunal attrition index for mammals in this region is 0.21.

The range contraction index is a measure of the extent to which the range inhabited by a particular species has contracted. A high index value means that many of the species comprising the region's original mammal fauna have contracted from a high proportion of the regions they originally occurred in. The faunal contraction index for the mammal fauna in this bioregion is 0.2.

Endemic species are those restricted to certain regions. Regions containing endemic species are considered to have high biodiversity conservation values because opportunities to conserve those species do not exist elsewhere. A high index value means that the species comprising the original mammal fauna typically occurred in few bioregions. The faunal endemism index value for the mammal fauna in this bioregion is 0.59.

Extant (still surviving) species that have undergone major range contractions can be considered 'new endemics'. Bioregions that contain new endemic species are often important refugia for threatened species. The new endemism index for the mammal fauna in this bioregion is 0.57.

The number of introduced exotic mammal species that occur within this bioregion is 11. The number of extinct mammal species that previously occurred within this bioregion is 1.

The project site has 29 endangered species on site and/or within a 5 kilometer radius (see Table No. 05 and Figure No. 22)

Table No. 05. Endangered flora and fauna within 5,000 m of REDD Forests Project Area included as threatened in Tasmania Department of Primary Industries and Water (DPIW) and IUCN Red List status*[29]

Latin Name	Common Name	DPIW Status**	IUCN Status
	Flora		
Arthropodium strictum	Chocolate lily	R	
Austrodanthonia induta	Tall wallabygrass	R	
Brunonia australis	Blue pincushion	R	
Carex longebrachiata	Drooping sedge	R	
Epacris acuminata	Claspleaf heath	R	
Epilobium willisii	Carpet willowherb	R	
Glycine latrobeana	Clover glycine	V	
Glycine microphylla	Small-leaf glycine	V	
Hovea longifolia		R	
Hypoxis vaginata var. vaginata	Sheathing yellowstar	R	
Isoetes humilior	Veiled quillwort	R	
Pellaea calidirupium	Hotrock fern	R	
Stellaria multiflora	Rayless starwort	R	
Taraxacum aristum	Mountain dandelion	R	
Triptilodiscus pygmaeus	Dwarf sunray	V	
Viola cunninghamii	Alpine violet	R	
	Fauna		
Accipiter novaehollandiae	Grey goshawk	E	

[29] IUCN 2008. 2008 IUCN Red List of Threatened Species. <www.iucnredlist.org>. Downloaded on 30 March 2009.

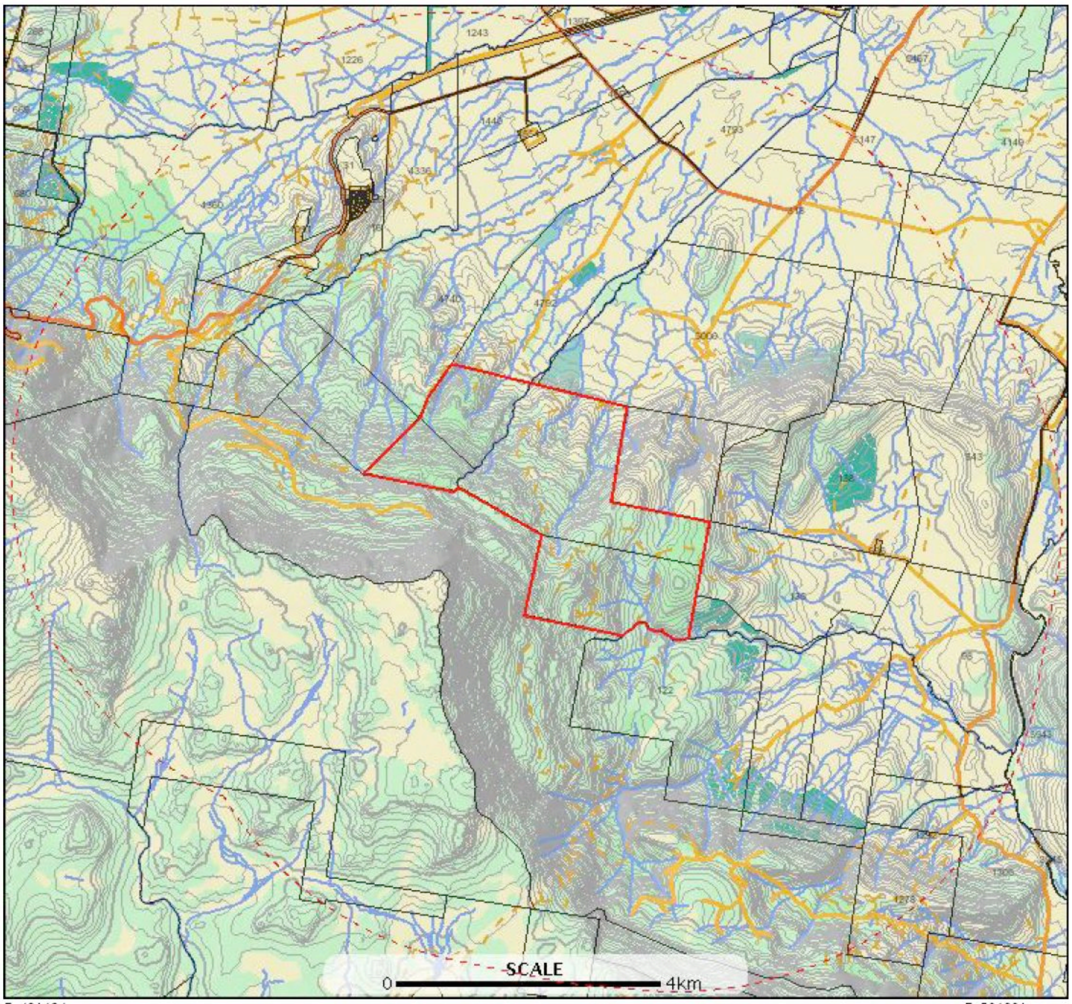
Latin Name	Common Name	DPIW Status**	IUCN Status
	Flora		
Aquila audax	Wedge-tailed eagle	E	
Dasyurus maculatus maculatus	Spotted-tail quoll	R	
Galaxias fontanus	Swan galaxias	E	Critically Endangered
Haliaeetus leucogaster	White-bellied sea-eagle	V	
Litoria raniformis	Growling grass frog	V	
Paragalaxias dissimilis	Shannon galaxias	V	
Paragalaxias eleotroides	Great lake galaxias	V	
Paragalaxias mesotes	Arthur's galaxias	E	
Perameles gunnii	Eastern barred bandicoot	V	
Sarcophilus harrisii	Tasmanian devil	E	Endangered
Tasniphargus tyleri	Great lake amphipod	R	
Tyto novaehollandiae	Masked owl	E	

* IUCN Red List of Threatened Species.

** (E) Endangered: Those species in danger of extinction because long term survival is unlikely while the factors causing them to be endangered continue operating. (V) Vulnerable: Those species likely to become endangered while the factors causing them to become vulnerable continue operating. (R) Rare: Those species with a small population in Tasmania that are at risk.

E: 491694
N: 5375705

E: 506831
N: 5375705



E: 491694
N: 5361559

E: 506831
N: 5361559

Figure No. 22. Sampling radio threatened flora and fauna analysis. (Red dotted line represents analysis radio.)

G1.8. High Conservation Values within the Project Zone

Forests are rare in Australia (covering approximately 5% of the continent) and old growth forests are even rarer (less than 8% of the old growth cover at the time of European settlement remains).

The Resource Assessment Commission noted in 1992 that logging old growth forest "potentially violates the precautionary principle in that an irreplaceable resource is being destroyed"[30].

In 1994, a CSIRO publication 'Ecology and Sustainability of Southern Temperate Ecosystems' noted in an article by Norton and May that "In the case of old growth eucalypt forests that have been subject to clear-felling, where virtually every live tree is removed, it may take several generations of the dominant overstory (i.e. 1500-2500 years) to recover the full range of structural diversity present in uncut forest (e.g. large live trees, large stags, collapsed large trees in various stages of decay)"[31].

And that "although precise data on the remaining extent of old growth eucalypt forests on fertile soils are limited, the extent of these ecosystems may be contracting rapidly due to integrated harvesting. Old growth forest ecosystems on fertile sites may be considered endangered". It is acknowledged that the Regional Forest Agreement failed to properly identify significant areas of Tasmania's old growth forests.

"Forest communities on fertile and accessible land were mostly alienated and mostly cleared whereas unproductive and remote forests were far better represented in reserves.

"…mature and old growth forests are far more than just young forest stands grown senescent. Such forests have distinctive properties and functions. Compositional, functional and structural complexity and diversity within the forests provide a myriad of habitats and niches for taxa and are themselves important components of biodiversity.

"The past legacies of forest use have created a highly fragmented and modified eucalypt forest estate. In eastern continental Australia it is rare to find areas of eucalypt forest larger than a few contiguous catchments that have not been roaded, fragmented and modified to some degree. Integrated harvesting further exacerbates ecosystem fragmentation and destroys or reduces the natural connectivity between and within ecosystems in the landscape."

These facts exemplify the importance of protecting old growth forests, particularly those set in a wilderness (or 'high ecological integrity') context.

Old growth examples of the most commercial forest types *E. regnans*, *E. delegatensis* and *E. obliqua* are all under-represented in the formal reserve system, which relies to a large extent on informal, often narrow linear reserves. They have also been heavily cleared for plantations.

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[30] Resource Assessment Commission, 1992, Forest and Timber Inquiry: Final Report, Vol 1. Australian Government Publishing Service.

[31] TW Norton and SR May, Towards sustainable forestry in Australian temperate eucalypt forests: ecological impacts and priorities for conservation, research and management, in TW Norton and SR May (eds), 1994, Ecology and sustainability of southern Temperate Ecosystems, CSIRO.

Old growth forest is only one class of special forests internationally recognized as High Conservation Value Forests, a term used to denote exceptional ecological value that is classified into one of six types of High Conservation Value[32]. These typically include forest areas that: 1) are habitat for threatened species, 2) contain old growth or primary forests, 3) contain significant concentrations of endemic plants and animals, 4) are in or contain rare, threatened or endangered ecosystems, or 5) are fundamental to either the basic needs or cultural identity of local communities.

In the Northern Midlands, many of these high conservation value forests remain unprotected. A high conservation value forest of particular concern is the eucalyptus, which is rapidly being depleted by logging. Figure No. 5 (vegetation map, above) shows the location of the eucalyptus forests considered as HCVF within the project area.

Description of Areas of High Conservation Value Located Within the Project Zone[33]

- Reedy Marsh and Dazzler Range
  - Very high biodiversity values including:
    - Threatened flora and fauna habitat;
    - High priority habitat for the spotted tailed quoll;
    - Identified migratory bird corridor;
    - Significant populations of threatened flora species;
    - Threatened (including endangered) lowland forest communities;
  - Relict wet forest communities;
  - Small and important areas of remnant old growth forest habitat and,
  - Important for landscape connectivity and integrity.
- Great Western Tiers
  - The Mole Creek Karst System outstanding and representative geomorphology at a national level (part of karst still unreserved is in proposed extension);
  - Other outstanding and/or representative areas of geo-heritage significance;
  - Very high biodiversity values including:
    - Threatened flora and fauna habitat;

[32] Rayden, T. 2008. Assessment, management and monitoring of High Conservation Value Forest (HCVF) A practical guide for forest managers. ProForest, Oxford.
[33] The Wilderness Society & Australian Conservation Foundation. 2004. Protecting Forests, Growing Jobs.

· Significant populations of threatened flora and fauna including specialist karst invertebrates, spotted tailed quolls, grey goshawks and wedge-tailed eagles;
· Threatened (including endangered) lowland forest communities;

· Important areas of both lowland and highland old growth habitat;

· The steepest climate gradients in Australia (climate-proofing);

· Very high levels of β (habitat) diversity;

· Outstanding scenic quality – tourism and recreation;

· Outstanding Aboriginal cultural heritage values; and,

· Important for landscape connectivity and integrity.

Additionally, the beautiful landscapes of the project zone represent a community value crucial in the sense of identity of its people. This is particularly important in small communities adjacent to spectacular mountains or coastlines.

For instance, the image of Tasmania as a place of enthralling natural beauty has become part of the economic backbone of many such communities and for Tasmania as a whole. Hundreds of thousands of tourists visit Tasmania because of its scenery. The decline in the Tasmanian population has recently been reversed because of the influx of mainlanders moving to Tasmania to enjoy a better quality of life.

G2. Baseline Projections

G2.1. Baseline Land Use

The "baseline projection" for the RFPA is manifested in the form of an imminent probability of clear-fell and possible conversion of all forest stands to either: plantation, "natural regeneration" or grazing land. Therefore without the project the activity on the area would be some combination of the IPCC "key category" named "Forest Land Remaining Forest Land" (code 3B1a) and "key category" "Forest Land to Cropland" (code 3B2b). Even though the 3B1a scenario is still forest by definition, there is a long-term lower carbon stock for the style of management applied routinely to forests such as in this project area. The activities of the proposed project come under the IPCC activity of 3B1a, in the Agriculture, Forestry and Other Land Use (AFOLU) Sector. The greenhouse gas to be assessed is CO_2.

G2.2. Additionality

As this is a project that reduces emissions from logging, the additionality is obvious: cessation of logging and halting deforestation.

The Government of Australia-Tasmania had not taken the political decision to terminate the forest concessions over the old growth forest and expand forest reserves. Without the REDD Forests Project, the concessionaires would have continued exploiting the forest for the remainder of the concession period. And, these concessions would likely have been renewed as they had been in the past.

G2.3. Carbon Stock Changes

The total amount of carbon that would be emitted (although not spontaneously) if the RFPA was cleared and converted to plantation is the carbon in biomass not in reserves plus the carbon in coarse woody debris not in reserves: total C emitted upon conversion to plantation, at the 95% confidence level is 47,900 + 927 = 48,827 tonnes - C which equals to179,050 tonnes of CO_2e, at the 95% confidence level.

G2.4. Baseline Communities

One of the impacts of the deforestation that would occur under the "without project" scenario is expected to be detrimental to the livelihoods of the communities in and around the project zone. In this place, the beautiful landscapes of the RFPA represent a community value crucial in the sense of identity of its people.

The logging activities that are forecast to occur without the creation and implementation of the REDD Forests Project would significantly erode the natural resources, economic backbone of many communities in the project zone that make a living from the hundreds of thousands of tourists that regularly visit the area attracted by its scenery.

The project proponents consider that in general, the communities will be better with this project than without it. It is supported by economic valuation surveys, which have proved to be a strong and useful tool in the analysis of welfare changes, and concluded that conservation and sustainable use of forest resource would deliver far more benefits to communities in the middle and long terms.

The main contributors in the conservation and selective use scenarios are water supply, flood prevention and tourism. Timber revenues play an important role in the deforestation scenario. Compared to deforestation, conservation of the ecosystems benefits all categories of stakeholders, except for the elite logging and plantation industry[34].

G2.5. Baseline Biodiversity

The baseline land-use scenario could lead to cause a decline in the biodiversity of the area, mainly because many of the endangered, threatened and endemic species would experience continued habitat loss, degradation and fragmentation (see Section G1.7).

The REDD Forests Project contains old growth forest area, rich in biodiversity and with several endemic species. This represents one of the very few hotspots of national biodiversity in Australia. The region was defined as a hotspot due to the large number of species that are endemic (unique) to the area, and because it is a refuge for a number of marsupials that are endangered, such as the spotted-tailed quoll (Dasyurus maculatus) and the eastern barred bandicoot (Perameles gunnii), mentioned above in the Table No. 5.

Habitat loss is identified as one of the principal causes of extinction of local species (Brooks *et al*., 2002[35]). Although these forests are commonly recognized as being rare and of great biological value, they are not protected under the inappropriately narrow definition of the Tasmanian Regional Forest Agreement.

Old growth forests are defined as "ecologically mature forest where the effects of disturbances are now negligible." On this basis, there are two criteria for assessing old growth: a) negligible unnatural disturbance, and b) maturity. However, the criteria for this definition of old growth are so strict that old growth forests need to have both a certain share of "senescent" forests in the canopy of mature forests and less than a certain share of "regrowth" forests or no record of logging in those areas[36].

In Tasmania, this is further compromised by the use of whole mapping units to determine whether areas are old growth. For example, if a forest area of 300 ha contains 30 ha that would meet the definition for old growth but the rest of the mapping unit is dominated by regrowth, the 30 ha of old growth forest would not be separately identified. These narrow definitions have resulted in many Tasmanian forests that otherwise would be classified as old growth not being defined as such, and therefore not even considered for protection.

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[34] van Beukering, P.J.H., Cesar, H.S.J. & Janssen, M.A. 2003. Economic valuation of the Leuser National Park on Sumatra, Indonesia. Ecological Economics 44: 43-62

[35] Brooks, T. M., Mittermeier, R. A., Mittermeier, C. G., Fonseca, G. A. B., Rylands, A. B. Konstant, W. R., Flick, P., Pilgrim, J., Oldfield, S., Magin, G & Hilton-Taylor, C. 2002. Habitat Loss and Extinction in the Hotspots of Biodiversity Conservation Biology 16 (4), 909–923.

[36] Members of the Tasmania-Commonwealth Regional Forest Agreement Environment and Heritage Technical Committee, (1996), Tasmanian-Commonwealth Regional Forest Agreement Background Report Part C, Environment and Heritage Reports vol.1, Chapter4. Oldgrowth and Appendix U, which is located at: http://www.stors.tas.gov.au/item/stors/7b1a99a1-b1c5-3568-3d36-1ace96793eeb/1/app_u.html. It shows those definitions of old growth in each forest type.

The logging activities of the original forest cover within the RFPA would greatly diminish the population's reserves of flora and fauna, resulting in a devastating loss of local biodiversity, contributing to put in danger of extinction those species whose distribution is restricted to the region. Endemic species, which have a restricted distribution, would be especially susceptible to the effects of deforestation. The reduction and fragmentation of their habitats would result in a significant loss of many endemic species' original populations.

G3. Project Design and Goals

G3.1. Major Climate, Community and Biodiversity Objectives

The REDD Forest Project aims to protect currently logged old growth forest from further logging activities and avoid the resulting GHG emissions in an area under great land-use pressure in the Northern Midlands, Tasmania.

The project is characterized by the creation and implementation of a protected forest in an area that would effectively be completely logged in a "business as usual" scenario. Its effective creation and implementation was only possible due to the prospect of implementing a financial mechanism to generate carbon credits from the reduction of emissions from improved forest management.

The project's major objectives are the following:

- Proving the commercial viability of using the carbon market to generate income for landowners that will equal or exceed the income from logging and, in so doing, lock up native and old growth forests for a 25-year period free from deforestation and/or degradation.

- By 2035, the Project activities will result in protecting part of the current old growth forest, which would emit 179,050 tonnes CO_2e (if the forest is cleared) or 73,824 tonnes CO_2e (if the forest is replaced by a monoculture plantation of non-native exotic eucalypts).

- Improving income earning potential for the landowner and surrounding communities, substituting income from carbon sequestration for income from logging.

G3.2. Major Project Activities

The Project will help to avoid legal logging by using carbon finance to eliminate the threat of land conversion and logging.

The success of this project depends on the following activities:

- The creation and implementation of the REDD Forests Reserve, May 2009;

- Development and implementation of the Reserve Management Plan: identifying demands and implementing all the necessary measures to promote the conservation of natural resources and biodiversity and to promote sustainable development within the limits of the reserve, starting from May 2009;

  · Ceasing logging on the property (February 2009);
  · Setting up biodiversity and carbon sample plots (completed February 2009);
  · Monitoring biodiversity and carbon sample plots (annually; beginning from February 2009);

- Generation of resources resulting from the sale of carbon credits generated by the project: depends on the actions implemented to curb logging and a program to monitor carbon emissions, as well as the signing of contracts with financial partners and the transfer of resources to a management endowment fund.

G3.3. Location of Project Activities

The REDD Forests Project is located in the Northern Midlands Council, North Tasmania (Figure No. 23).

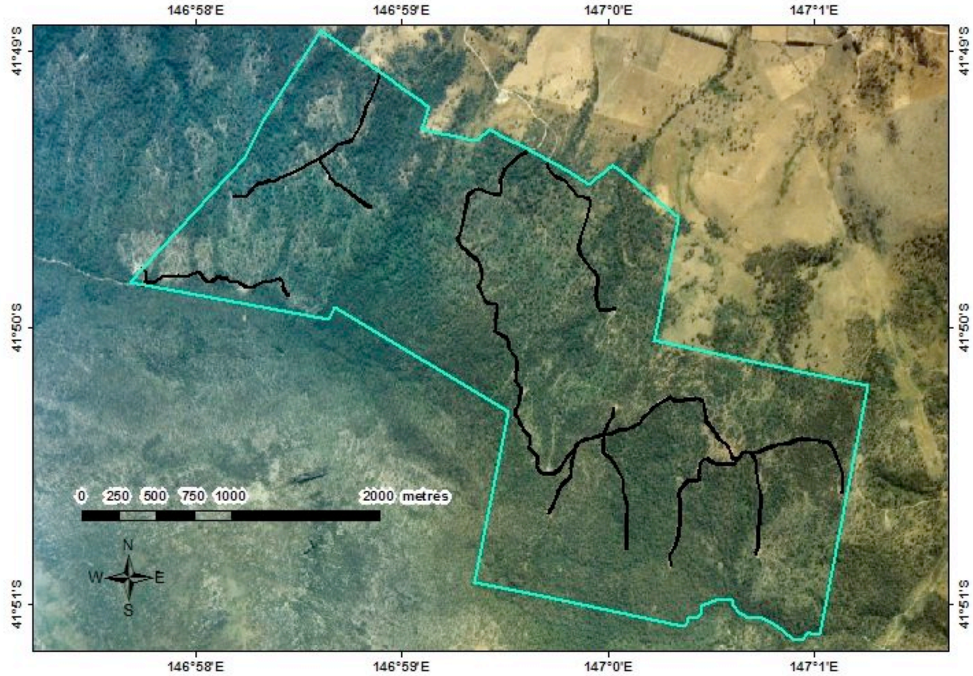

Figure No. 23. Project location.

G3.4. Time-frame and Project Accounting

Project proponents use a time-frame of 25 years for accounting for changes in carbon emissions between the baseline and project scenarios. This time interval permits:

- A reasonable estimation of medium term (25 years) of a baseline and carbon accounting, and
- Ensuring the longevity of carbon credits for a period of time that is relevant for climate change and atmospheric CO_2 levels.

The starting date of the REDD Forests Project is the month the reserve was created (February 2009), as well as the project crediting period:

Start of the crediting period: February 2009: the crediting period starts on the same date that the project starts. This date was defined as the first action of the project, which corresponds to the creation date of the reserve.

End date for the crediting period: February 2035. This is the end date for the baseline projections used in calculating the carbon stocks and dynamics.

Throughout the crediting period there will be periodic certifications performed by an accredited CCB certifying organization. These certifications will verify that the carbon remaining and accreting in the RFPA is in keeping with the values expected at the start of the Project. These certifications will be performed after obtaining the initial validation and every five years thereafter.

G3.5. Project Risks and Mitigation Measures

The greatest risks are from physical damage and fire or disease. Forests are more susceptible to fires; many forest species are vulnerable to increases in temperature and decreases in humidity and other changes in microclimatic conditions.

The measures adopted to mitigate these risks are (see parameters to be monitored B3.1):

- Periodically visits to the forest by a REDD Forests representative;
- Implement a health and protection control system;
- Investment in scientific research on forest dynamics; and
- Monitoring of local climate features, hydrological dynamics and biodiversity.

G3.6. Maintenance of High Conservation Values

Within the RFPA a great proportion of forests contain environmental and social values, such as wildlife habitat, watershed protection or archaeological sites considered as of outstanding significance or critical importance, old growth forest (see parameters to be monitored).

The RFPA will be managed according to the The High Conservation Value Forest Toolkit: a guide for forest managers[37]. The following are the four criteria governing management of High Conservation Value Forests:

1. Assessment to determine the presence of the attributes consistent with High Conservation Value Forests appropriate to scale and intensity of forest management.

   The purpose of this criterion is to ensure that any outstanding or critical values that occur within a forest management unit are identified. The HCVF within the project area had already done as shows in G1.8 and G2.5.

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[37] Jennings, S., Nussbaum, R., Judd, N. & Evans, T. 2003. The High Conservation Value Forest Toolkit. ProForest. Oxford.

2. Emphasis in the consultative portion of the certification process on the identified conservation attributes and options for the maintenance thereof.

   REDD Forests managers have already consulted with stakeholders on the options for the maintenance of any High Conservation Values that are identified (G3.8).

3. The management plan will include and implement specific measures that ensure the maintenance and enhancement of the conservation attributes consistent with the precautionary approach.

   The REDD Forests project eliminate the possibility of logging would greatly protect the population reserves of flora and fauna. The measures to be implemented will be included in the biodiversity plan (B1.2).

4. Annual monitoring to assess the effectiveness of the measures employed to maintain or enhance the applicable conservation attributes.

   Annual monitoring system will be implemented (B3.1).

G3.7. Measures Taken to Enhance Climate, Community, and Biodiversity Benefits Beyond Project Lifetime

Since this project is a high-profile project with remarkable benefits for the landowner and surrounding communities, the project development team believes it will not be difficult for the CCB benefits to continue to accrue beyond the project's timeline of twenty-five years.

Inherent in the project's design is the concept of protecting the land 'for a generation'. Beyond this the opportunities to continue the project for a further period will be significantly easier in a carbon valued environment with a greatly enhanced forest in terms of health, carbon value and enriched biodiversity.

Additionally, because these landowners will be paid for the carbon sequestration benefits of their land that will indirectly positively improve biodiversity and communities, they will be able to afford to continue their traditional lifestyle past the twenty-five year project timeline, further enhancing local sustainability.

By enhancing local sustainability, the landowners will in effect empower the concept of payment for environmental services within the Northern Midlands.

G3.8. Stakeholder Involvement

Local stakeholders have been involved with making the long-term decision to develop this property as a CCBA project. Stakeholders include:

- Landowners and their neighbours (who are keen to see the success of this project and are likely to participate in the extension of the project.
- Representatives from local NGO's

Later, the dissemination of general information about the Project will be achieved through the participation of team members in events, related to environmental conservation, climate, and sustainable development. The team will also publish articles in scientific journals and in the popular media. Furthermore, the Project will make available publications (on the REDD Forests website for example) and reports to document and disseminate the lessons learned by the Project inside and outside the Project boundaries.

G3.9. Publicization of Public Comment Period

REDD Forests have taken various steps to communicate and publicize the CCBA project during the public comment period.

First, this Project Design Document will be made available on the CCBA webpage (http://www.climate-standards.org) and open to comments from the public. This document will be also available to the public in hard copy during the public comment period, affording local stakeholders an opportunity to raise and address any grievances. The documents will be on public display at:

Northern Midlands Council
13 Smith Street
Longford Tasmania 7301
8:30 am to 4:45 pm Monday through Friday

G3.10. Conflict Resolution Tools

The project includes this process for hearing, responding to and resolving community and other stakeholder comments during the project life. REDD Forests will attempt to respond all reasonable comments raised, and provide a written response to comments within 30 days. Comments and project responses will be documented.

G3.11. Project Financial Support

REDD Forests is responsible for the project implementation and performance. They have the financial resources guaranteed to implement and manage this project. The project needs minimal capital to be developed, implemented, and monitored.

Anticipated project costs include sample plot monitoring and data analysis, biodiversity sampling, periodic verification to an appropriate carbon accounting mechanism, and publication of the project. These costs will be covered by own founds and the financial return from the realization of gains on the sale of carbon credits generated by this project

More information is available for review by the verifier during the site visit.

G4. Management Capacity and Best Practices

G4.1. Project Proponents

REDD Forests is the project proponent. REDD Forests has hired MGM International to develop the strategy, implementation, monitoring, and sales of the carbon credits generated by this project. REDD Forests has contracted with local landowners in Tasmania to represent them legally in carbon forestry issues.

- REDD Forests: REDD Forests is a leading forestry carbon project developer in Australia.

G4.2. Technical and Management Expertise

The project will be managed by a board of directors led by Stephen Dickey.

Stephen Dickey (REDD Forests Managing Director): is the founder and Managing Director of REDD Forests and has worked on climate change issues for the past 4 years, firstly with Oxfam and WWF-Australia, as consultant to the carbon offsetting company Climate Friendly for whom he brokered a 50% sale of the company to Macquarie Bank, and latterly as Managing Director of CDRS Pty Ltd., a carbon market consultancy.

Stephen is an experienced senior manager, having worked on four continents in regional or general manager positions with TNT, British Airways and Sabre Corporation and has successfully run his own business in the UK. Stephen's broad based international commercial experience combined with his depth of knowledge on the science and practicalities of climate change give him a rare set of capabilities and perspectives to lead REDD Forests.

Additionally, the project has the support of:

- Representatives of MGM International; and
- Independent local contractors.

G4.3. Capacity Building

As a pilot project using a small, privately owned parcel of land there are limited opportunities for capacity building. However, the project's success will engender an exponential extension of the project land and will, at that time, enable the project to provide organizational, management and technical capacity building activities to other landowners, as well as to insure their involvement in decision-making and implementation of programs and in conservation and sustainable development efforts.

The project management plan includes community-strengthening activities aimed to all landowners who own *Eucalyptus* forests that are under threat of being logged or have been logged. The purpose of this project is to engage local landowners to manage their *Eucalyptus* forests for carbon sequestration potential.

G4.4. Community Employment Opportunities

The project has already resulted in the employment of local contractors for in excess of 300 hours of paid consultancy and on-ground services.

Again, the project size limits the extent to which employment opportunities can be extended to the local community but, as stated before, its success will ensure the recruitment and employment of multiple local community members in the following disciplines;

- Project management services
- Ground services (monitoring and measurement)
- Land maintenance
- Forestry management

G4.5. Employment Laws

The project follows all the Tasmania Workplace Authority Standards, including the Forest Safety Code (Tasmania; 2007[38]). REDD Forests is obliged, under Australian and State laws to follow appropriate safe labor practices toward the prevention of injuries in the workplace, which is particularly critical for workers engaged in forestry operations. Additionally REDD Forests complies with all other applicable local, state, and national workplace standards.

G4.6. Employee Safety

As it was mentioned in the previous section, all local, state, and national workplace standards will be met at the moment of hiring of each staff member. Local regulations and safety concerns are discussed with each employee with an emphasis on guaranteeing workplace safety according to the laws (Australian Government national standards and the Australian Workplace Health and Safety Act[39]).

G4.7. Financial Health of the Implementing Organizations

REDD Forests is an Australian registered private limited liability company and, as such, is governed by the corporation laws of Australia which ensure that, at all times, the company remain financially solvent and able to meet its liabilities.

The company is owned by independent shareholders of good standing and has a Board of Directors (4 at present but likely to increase in number). It is sufficiently capitalised to ensure completion of the project.

G5. Legal Status and Property Rights

G5.1. Local Laws and Regulations

REDD Forests meets and follows all relevant local, state and federal laws and regulations including the Forest Safety Code (Tasmania; 2007[40]).

Tasmania Workplace Authority Standards and the Forest Safety Code ensure that forest operations are conducted in an environmentally acceptable manner on public and private

[38] Forest Safety Code (Tasmania) 2007
[39] Workplace Standards Tasmania. http://www.wst.tas.gov.au/safety_and_compliance
[40] Forest Safety Code (Tasmania) 2007

forest lands. The Act forms part of a broader legislative and policy framework that provides the basis for sustainable forest management in Tasmania. The Forest Practices Act places an emphasis on:

- Self-regulation;
- Planning before forest operations;
- Delegating and decentralizing approvals for forest practices plans and other forest practices matters;
- Maintaining a forest practices code which provides practical standards for forest management, timber harvesting and other forest operations;
- Developing public consultation and education;
- Providing for the rehabilitation of land in cases where the forest practices code is contravened;
- Managing an independent appeal process;
- Declaring private timber reserves - a means by which private land holders are able to ensure the security of their forest resources.

The Tasmania Workplace Authority Standards and the Forest Safety Code provide expert advice to the Board and to foster communication and cooperation among stakeholders. Various stakeholders with expertise in forest management on public and private land, forest harvesting, forest conservation and Tasmania's resource management and planning system are represented on the Council.

The Board appoints Forest Practices Officers who are responsible for planning, monitoring and certifying that Forest Practices Plans are prepared and implemented in accordance with the Forest Practices Code and any instructions issued by the Board.

Given that all required investments for the project were provided by the sponsor, the emission reductions achieved with the implementation of the project activity are clearly owned by REDD Forests.

G5.2. Documentation of Legal Approval

REDD Forests warrants that all actions and documentation for the project establishment as a carbon sequestration project have and will be met.

G5.3. Free, Prior, and Informed Consent

REDD Forests will have a legally binding agreement with the landowners which transfers the logging rights and concomitant carbon sequestration rights to REDD Forests Pty Ltd. The agreement also sets out the obligations and responsibilities placed on the landowners for the duration of the project.

G5.4. Involuntary Relocations

We have verified by direct observation that the project site does not have human inhabitants. Moreover, we have observed that the project does not involve the relocation or inward migration of any people.

G5.5. Illegal Activities

Not applicable to this project.

Since the main aim of this project is to created a protected area, the project activities are planned to guarantee the benefits provided by the status of protected area, inside and outside the REDD Forests Reserve. The biodiversity in the area around the reserve will benefit from the conservation of the natural resources and the activities aimed at reducing the negative impacts. Whenever an emergency is detected, the reserve management, the Advisory Council and the appropriate authorities will take the necessary measures.

G5.6. Carbon Rights

See G5.3 above

CLIMATE SECTION

CL1. Net Positive Climate Impacts

CL1.1. Net Change in Carbon Stocks

The total amount of carbon that would be emitted if the RFPA was cleared and converted to plantation is the carbon in biomass not in reserves plus the carbon in carbon wood debris not in reserves: total C emitted upon conversion to plantation, at the 95% confidence level:

47,900 + 927 = 48,827 C tonnes,

this equates to 179,050 tonnes of CO2-e, at the 95% confidence level.

As a second scenario, the FullCAM software (version 3.13.8, which is part of the National Carbon Accounting Toolbox; Richards and Brack, 2004[41]; Richards and Evans, 2004[42]; Waterworth and Richards, 2008[43]) was used for projecting the carbon stock and the alternatives available to converting a plantation for each of these four classes and for different logging histories.

It must be noted that several assumptions have been made in the construction of the scenarios, mostly with regard to the history of the site. There are also assumptions about the correlation between site index, logging history and derived land class—site index is considered to be primarily the main driver rather than the logging history for these scenarios. These assumptions create a level of uncertainty which is above that for the measurement of the standing carbon stock itself.

The percentage of tree removal, as part of the historical logging, was adjusted in FullCAM until the simulated carbon stocks matched those measured as part of this PDD for each of the four classes. The fate of the biomass upon logging was the FullCAM default for the geographic location except that a saw-log/pulp-wood ratio of 0.0342 was used, which came from the four most recent timber harvest waybills for the RFPA. A 60% recovery rate was used for the mature forest, with 40% going to the deadwood pool. These were reasonable proportions for this forest type, growth form, and age structure (Ximenes et al., 2008[44]).

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[41] Richards, G.P. & Brack, C. 2004. A continental biomass stock and stock change estimations approach for Australia. Australian Forestry. 67(4), 284-288.

[42] Richards, G.P. & Evans, D.M.W. 2004. Development of a carbon accounting model (FullCAM Vers. 1.0) for the Australian continent. Australian Forestry. 67, 277-283.

[43] Waterworth, R.M. & Richards, G.P. 2008. Implementing Australian forest management practices into a full carbon accounting model. Forest Ecology and Management. 255, 2434-2443.

[44] Ximenes, F.A., Gardner, W.D. & KAthuria, A. 2008. Proportion of above-ground biomass in commercial logs and residues following the harvest of five commercial forest species in Australia. Forest Ecology and Management. 256, 335-346.

The type of plantation chosen for the comparison was *Eucalyptus nitens* (shining gum) as this has long been a popular plantation species for this part of Tasmania, and has been planted on a neighboring property. The growth pattern and product recovery applied for the *E. nitens* was the default one in FullCAM for the particular geographic location.

- Class 2: The land history of this class is either: selective logging of 20% in 1940, selective logging of 50% in 1975, and selective logging of 100% in 2006; or: the land subject to heavy logging in the early history of the farm and not regenerated, in the lower elevations of the central portion of the RFPA. Note that from comparison of Figure No. 12 (above) with aerial photography and on-ground observations, the zones occupied by Class 2 are areas that contain areas mostly recently logged. This implies that for Class 2 (256 ha) there will be little gain in leaving these areas compared with converting them to plantation in 2010, except that preparation of ground for plantation involves more soil disturbance and possibly burning of remaining vegetation and coarse woody debris (CWD) which would entail some carbon emissions (Figure No. 24 and Table No. 06).

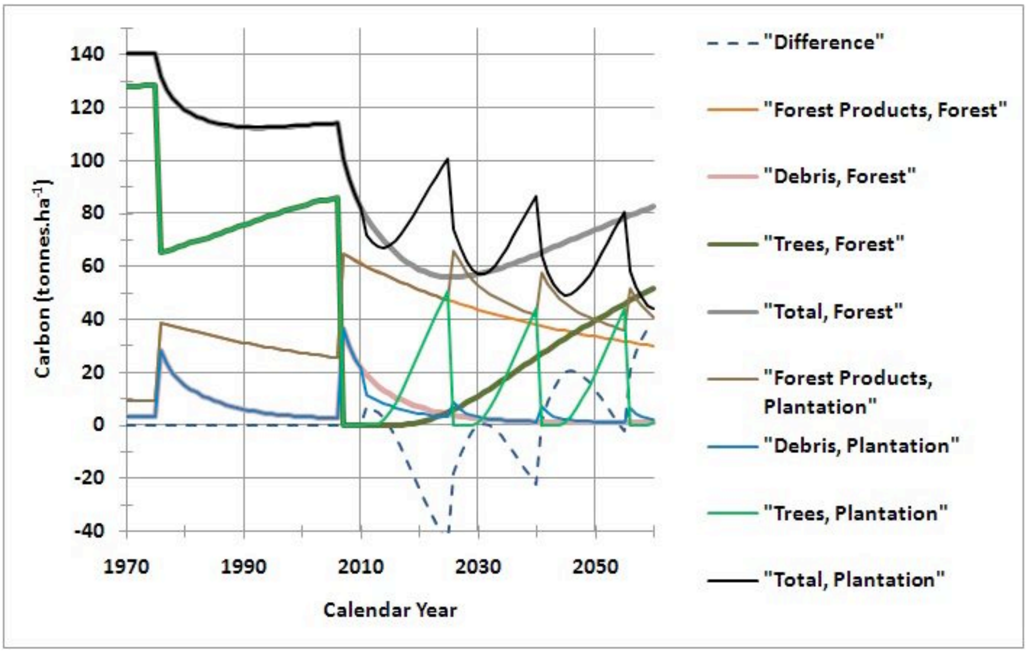

Figure No. 24. Carbon forecast for land in class 2: forest growth and conversion to plantation. For years where the "Difference" is positive there is net sequestration upon conversion to plantation, negative means a net emission.

Table No. 06. Carbon forecast for Class 2 land. The 25 year project average is in the right-hand column.

Year	Forest (t-C/ha)	Plantation (t-C/ha)	Difference (t-C/ha)	Diff. CO_2e (t CO_2/ha—)	Project Average (t CO_2/ha)

Year	Forest (t-C/ha)	Plantation (t-C/ha)	Difference (t-C/ha)	Diff. CO_2e (t CO_2/ha—)	Project Average (t CO_2/ha)
2010	82.47	82.47	0	0	
2011	78.66	71.77	6.89	25.25	
2012	75.38	69.4	5.98	21.91	
2013	72.49	67.68	4.81	17.62	
2014	69.89	67.11	2.78	10.19	
2015	67.55	67.84	-0.29	-1.06	
2016	65.43	69.67	-4.24	-15.54	
2017	63.55	72.31	-8.76	-32.1	
2018	61.89	75.5	-13.61	-49.87	
2019	60.46	79.03	-18.57	-68.04	
2020	59.26	82.72	-23.46	-85.96	
2021	58.29	86.47	-28.18	-103.25	
2022	57.52	90.19	-32.67	-119.71	
2023	56.95	93.84	-36.89	-135.17	
2024	56.57	97.37	-40.8	-149.5	
2025	56.36	100.77	-44.41	-162.72	
2026	56.3	74.3	-18	-65.95	
2027	56.38	67.21	-10.83	-39.68	
2028	56.58	62.31	-5.73	-21	
2029	56.9	58.92	-2.02	-7.4	
2030	57.32	57.11	0.21	0.77	
2031	57.82	56.95	0.87	3.19	
2032	58.39	58.23	0.16	0.59	
2033	59.03	60.59	-1.56	-5.72	
2034	59.73	63.69	-3.96	-14.51	
2035	60.48	67.25	-6.77	-24.81	-39.33
2036	61.26	71.09	-9.83	-36.02	
2037	62.08	75.03	-12.95	-47.45	
2038	62.93	78.99	-16.06	-58.85	
2039	63.8	82.88	-19.08	-69.91	
2040	64.7	86.68	-21.98	-80.54	
2041	65.6	64.09	1.51	5.53	
2042	66.52	57.93	8.59	31.47	
2043	67.45	53.68	13.77	50.45	
2044	68.38	50.76	17.62	64.56	
2045	69.31	49.32	19.99	73.25	
2046	70.25	49.45	20.8	76.21	
2047	71.19	50.98	20.21	74.05	
2048	72.12	53.56	18.56	68.01	

Year	Forest (t-C/ha)	Plantation (t-C/ha)	Difference (t-C/ha)	Diff. CO_2e (t CO_2/ha—)	Project Average (t CO_2/ha)
2049	73.05	56.86	16.19	59.32	
2050	73.97	60.61	13.36	48.95	
2051	74.89	64.61	10.28	37.67	
2052	75.81	68.72	7.09	25.98	
2053	76.71	72.83	3.88	14.22	
2054	77.61	76.88	0.73	2.67	
2055	78.49	80.82	-2.33	-8.54	
2056	79.37	58.46	20.91	76.62	
2057	80.24	52.42	27.82	101.94	
2058	81.1	48.29	32.81	120.22	
2059	81.95	45.5	36.45	133.56	
2060	82.79	44.17	38.62	141.51	36.2

For class 2 land the conversion of "forest" to plantation is a net sequestration in the first 25 year project period. The net sequestration in the first 25 years is because the class 2 land (according to the 95% confidence level) currently has no live carbon stock and *Eucalyptus nitens* (the plantation species) grows quicker than the local eucalypt species by natural regeneration.

The class 2 land consists primarily of the land logged in 2006 and to a lesser extent the degraded land in between the groves of mature eucalypts in the lower elevations of the central portion of the RFPA. It would not be practical to grade that degraded land in preparation for plantation in the normal way, due to the irregular cover of mature trees, thus requiring removal of those trees, which would entail conversion of some class 3 land also to plantation.

- Class 3: The land history of this class is either: selective logging of 20% in 1940, selective logging of 50% in 1975, and selective logging of 51% in 2006 (Figure No. 25 and Table No. 07).

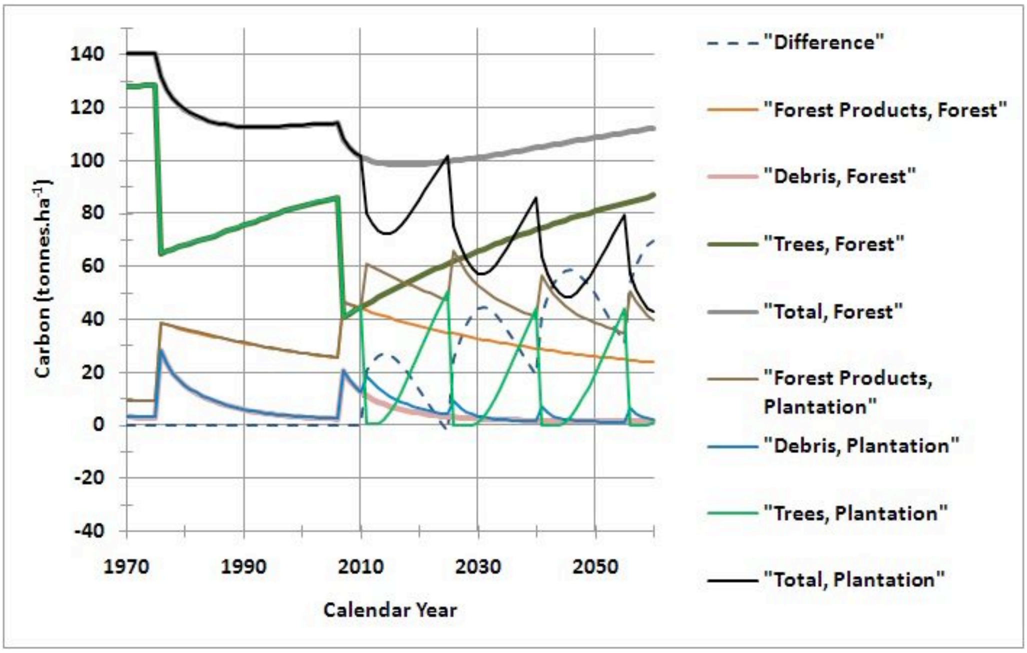

Figure No. 25. Carbon forecast for land in class 3: forest growth and conversion to plantation. For years where the "Difference" is positive there is net sequestration upon conversion to plantation, negative means a net emission.

Table No. 07. Carbon forecast for class 3 land. The 25 year project average is in the right-hand column.

Year	Forest (t-C/ha)	Plantation (t-C/ha)	Difference (t-C/ha)	Diff. CO_2e (t CO_2/ha)	Project Average (t CO_2/ha)
2010	101.46	101.46	0	0	
2011	100.5	79.67	20.83	76.32	
2012	99.82	75.98	23.84	87.35	
2013	99.33	73.27	26.06	95.49	
2014	98.99	71.92	27.07	99.19	
2015	98.75	72.01	26.74	97.98	
2016	98.61	73.31	25.3	92.7	
2017	98.54	75.51	23.03	84.38	
2018	98.53	78.31	20.22	74.09	
2019	98.57	81.49	17.08	62.58	
2020	98.66	84.87	13.79	50.53	
2021	98.8	88.34	10.46	38.33	
2022	98.96	91.82	7.14	26.16	
2023	99.16	95.23	3.93	14.4	
2024	99.38	98.56	0.82	3	
2025	99.63	101.77	-2.14	-7.84	
2026	99.9	74.72	25.18	92.26	

Year	Forest (t-C/ha)	Plantation (t-C/ha)	Difference (t-C/ha)	Diff. CO_2e (t CO_2/ha)	Project Average (t CO_2/ha)
2027	100.19	67.51	32.68	119.74	
2028	100.5	62.49	38.01	139.27	
2029	100.82	59	41.82	153.23	
2030	101.15	57.09	44.06	161.44	
2031	101.49	56.84	44.65	163.6	
2032	101.84	58.03	43.81	160.52	
2033	102.2	60.3	41.9	153.53	
2034	102.56	63.33	39.23	143.74	
2035	102.93	66.82	36.11	132.31	89.01
2036	103.3	70.58	32.72	119.89	
2037	103.68	74.46	29.22	107.07	
2038	104.06	78.36	25.7	94.17	
2039	104.45	82.2	22.25	81.53	
2040	104.83	85.94	18.89	69.21	
2041	105.22	63.25	41.97	153.78	
2042	105.6	57.05	48.55	177.89	
2043	105.99	52.75	53.24	195.08	
2044	106.38	49.79	56.59	207.35	
2045	106.76	48.31	58.45	214.17	
2046	107.15	48.4	58.75	215.27	
2047	107.53	49.9	57.63	211.16	
2048	107.92	52.44	55.48	203.28	
2049	108.3	55.7	52.6	192.73	
2050	108.68	59.43	49.25	180.46	
2051	109.06	63.4	45.66	167.3	
2052	109.43	67.48	41.95	153.71	
2053	109.81	71.56	38.25	140.15	
2054	110.18	75.58	34.6	126.78	
2055	110.55	79.5	31.05	113.77	
2056	110.91	57.1	53.81	197.17	
2057	111.28	51.04	60.24	220.73	
2058	111.64	46.88	64.76	237.29	
2059	112	44.07	67.93	248.9	
2060	112.35	42.72	69.63	255.13	171.36

For class 3 land the conversion of “forest” to plantation is a net emission in both the first 25 year project period and higher emission in the next 25 year project period.

- Class 4: The history of class 4 land is: selective logging of 20% in 1940, and selective logging of 50% in 1975, with no further logging (Figure No. 26 and Table No. 08).

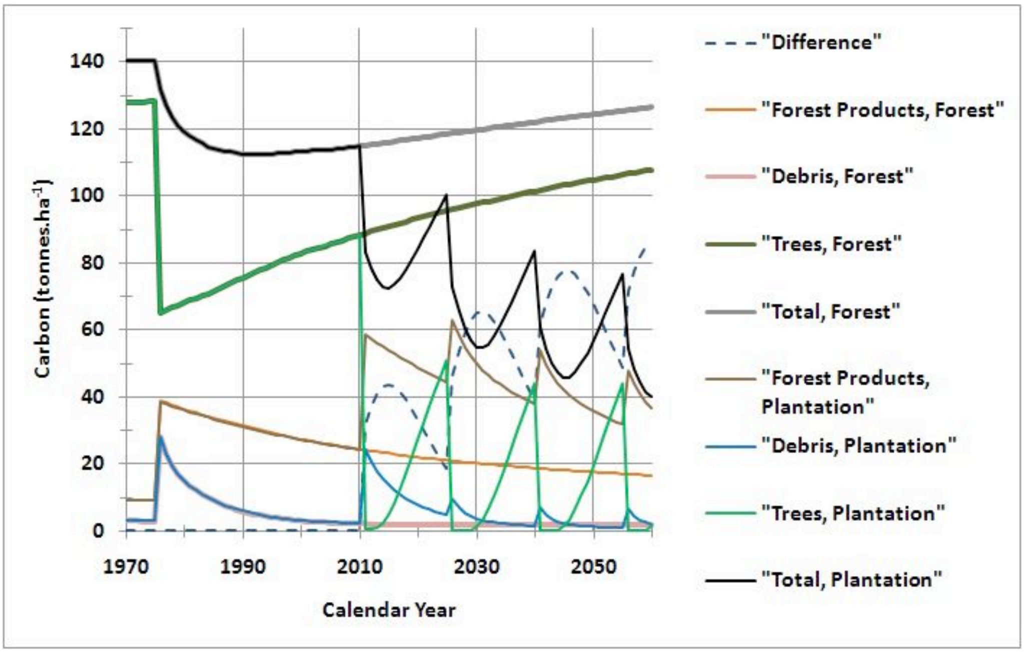

Figure No. 26. Carbon forecast for land in class 4: forest growth and conversion to plantation. Once the land is converted to plantation the difference is always positive (within the ensuing 50 years) and therefore there is net emission upon conversion to plantation.

Table No. 08. Carbon forecast for class 4 land. The 25 year project average is in the right-hand column.

Year	Forest (t-C/ha)	Plantation (t-C/ha)	Difference (t-C/ha)	Diff. CO_2e (t CO_2/ha)	Project Average (t CO_2/ha)
2010	114.93	114.93	0	0	
2011	115.15	83.23	31.92	116.96	
2012	115.37	78.44	36.93	135.32	
2013	115.6	74.92	40.68	149.06	
2014	115.83	72.96	42.87	157.08	
2015	116.07	72.57	43.5	159.39	
2016	116.3	73.48	42.82	156.9	
2017	116.54	75.36	41.18	150.89	
2018	116.78	77.89	38.89	142.5	
2019	117.03	80.83	36.2	132.64	
2020	117.27	84.02	33.25	121.83	
2021	117.51	87.31	30.2	110.66	
2022	117.76	90.62	27.14	99.44	
2023	118	93.9	24.1	88.3	
2024	118.25	97.1	21.15	77.5	
2025	118.49	100.2	18.29	67.02	

Year	Forest (t-C/ha)	Plantation (t-C/ha)	Difference (t-C/ha)	Diff. CO_2e (t CO_2/ha)	Project Average (t CO_2/ha)
2026	118.74	72.74	46	168.55	
2027	118.98	65.46	53.52	196.1	
2028	119.23	60.39	58.84	215.6	
2029	119.47	56.86	62.61	229.41	
2030	119.71	54.9	64.81	237.47	
2031	119.96	54.6	65.36	239.49	
2032	120.2	55.76	64.44	236.11	
2033	120.44	58	62.44	228.79	
2034	120.68	60.99	59.69	218.71	
2035	120.92	64.46	56.46	206.88	155.48
2036	121.16	68.2	52.96	194.05	
2037	121.39	72.06	49.33	180.75	
2038	121.63	75.93	45.7	167.45	
2039	121.86	79.75	42.11	154.3	
2040	122.1	83.48	38.62	141.51	
2041	122.33	60.74	61.59	225.67	
2042	122.56	54.52	68.04	249.31	
2043	122.79	50.21	72.58	265.94	
2044	123.01	47.25	75.76	277.59	
2045	123.24	45.76	77.48	283.89	
2046	123.47	45.84	77.63	284.44	
2047	123.69	47.33	76.36	279.79	
2048	123.91	49.87	74.04	271.29	
2049	124.13	53.13	71	260.15	
2050	124.35	56.84	67.51	247.36	
2051	124.57	60.81	63.76	233.62	
2052	124.79	64.89	59.9	219.48	
2053	125	68.97	56.03	205.3	
2054	125.22	72.98	52.24	191.41	
2055	125.43	76.9	48.53	177.82	
2056	125.64	54.49	71.15	260.7	
2057	125.85	48.43	77.42	283.67	
2058	126.06	44.27	81.79	299.69	
2059	126.26	41.46	84.8	310.72	
2060	126.47	40.11	86.36	316.43	239.29

For class 4 land the conversion of “forest” to plantation is a net emission in both the first 25 year project period and higher emission in the next 25 year project period.

- Class 5: The history of class 5 land is: selective logging of 20% in 1940, with no further logging (Figure No. 27 and Table No. 09).

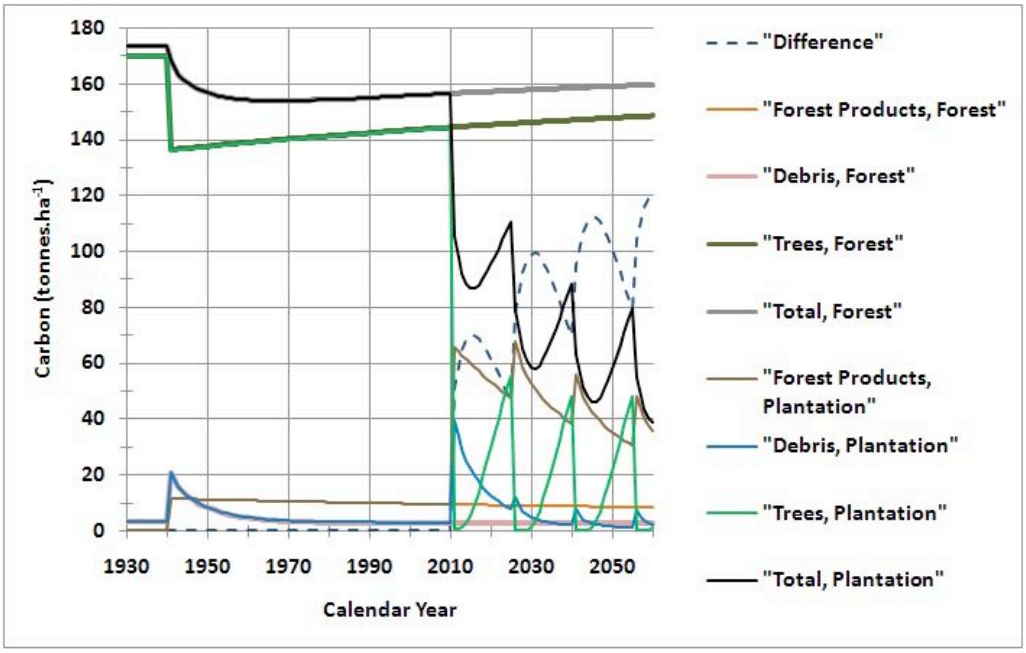

Figure No. 27. Carbon forecast for land in class 5: forest growth and conversion to plantation. Once the land is converted to plantation the difference is always positive (within the ensuing 50 years) and therefore there is net emission upon conversion to plantation.

Table No. 09. Carbon forecast for class 5 land. The 25 year project average is in the right-hand column.

Year	Forest (t-C/ha)	Plantation (t-C/ha)	Difference (t-C/ha)	Diff. CO_2e (t CO_2/ha)	Project Average (t CO_2/ha)
2010	156.44	156.44	0	0	
2011	156.51	105.22	51.29	187.93	
2012	156.59	97.78	58.81	215.49	
2013	156.66	92.19	64.47	236.22	
2014	156.73	88.62	68.11	249.56	
2015	156.8	86.99	69.81	255.79	
2016	156.86	86.96	69.9	256.12	
2017	156.93	88.1	68.83	252.2	
2018	157	90.07	66.93	245.24	
2019	157.07	92.58	64.49	236.3	
2020	157.14	95.42	61.72	226.15	
2021	157.2	98.43	58.77	215.34	
2022	157.27	101.52	55.75	204.27	
2023	157.34	104.61	52.73	193.21	

Year	Forest (t-C/ha)	Plantation (t-C/ha)	Difference (t-C/ha)	Diff. CO_2e (t CO_2/ha)	Project Average (t CO_2/ha)
2024	157.4	107.66	49.74	182.25	
2025	157.47	110.64	46.83	171.59	
2026	157.54	79.35	78.19	286.5	
2027	157.6	71.09	86.51	316.98	
2028	157.67	65.26	92.41	338.6	
2029	157.73	61.13	96.6	353.95	
2030	157.79	58.75	99.04	362.89	
2031	157.86	58.2	99.66	365.16	
2032	157.92	59.26	98.66	361.5	
2033	157.98	61.52	96.46	353.44	
2034	158.05	64.61	93.44	342.37	
2035	158.11	68.24	89.87	329.29	259.17
2036	158.17	72.17	86	315.11	
2037	158.23	76.24	81.99	300.42	
2038	158.29	80.34	77.95	285.62	
2039	158.35	84.39	73.96	271	
2040	158.41	88.34	70.07	256.74	
2041	158.47	63.17	95.3	349.19	
2042	158.53	56.24	102.29	374.8	
2043	158.59	51.4	107.19	392.75	
2044	158.65	48.05	110.6	405.25	
2045	158.71	46.31	112.4	411.84	
2046	158.77	46.31	112.46	412.06	
2047	158.83	47.85	110.98	406.64	
2048	158.89	50.54	108.35	397.01	
2049	158.94	54.03	104.91	384.4	
2050	159	58.02	100.98	370	
2051	159.06	62.3	96.76	354.54	
2052	159.11	66.69	92.42	338.64	
2053	159.17	71.09	88.08	322.73	
2054	159.23	75.43	83.8	307.05	
2055	159.28	79.66	79.62	291.74	
2056	159.34	55	104.34	382.31	
2057	159.39	48.3	111.09	407.04	
2058	159.45	43.67	115.78	424.23	
2059	159.5	40.53	118.97	435.92	
2060	159.55	38.99	120.56	441.74	361.55

For class 5 land the conversion of "forest" to plantation is a net emission in both the first 25 year project period and higher emission in the next 25 year project period.

Carbon Forecast

The forecast for the RFPA upon conversion to plantation is obtained by summing that for the four different classes derived from the unsupervised classification of the NDSVI image (i.e. summing the results from the right-hand columns of Table No. 06 to Table No. 09).

From Table No. 10 the carbon emission upon conversion to plantation for the first project period of 25 years is 73,824 t-CO_2e. It must be noted that this figure is more approximate than that calculated for loss of carbon stock upon clearing and burning, without the planting (owing to the approximations used in constructing these scenarios, as discussed above). To maintain the estimates of project benefit to a conservative minimum an error of ±40% should be put on this figure—giving 73,820 (±29.530), i.e. a minimum benefit of 44,294 t-CO_2e can be expected within the first project period of 25 years.

Table No. 10. Forecast for two project periods for the REDD Forests Project Area (RFPA).

Class	Area (ha)	First project period (t-CO_2e/ha)	Second project period (t-CO_2e/ha)	First project period (t-CO_2e)	Second project period (t-CO_2e)
2	235.52	-39.33	36.2	-9,263	8,526
3	239.47	89.01	171.36	21,315	41,036
4	190.9	155.48	239.29	29,681	45,680
5	123.82	259.17	361.55	32,090	44,767
Total	**789.72**			**73,824**	**140,009**

Not mentioned above are some additional carbon benefits arising from not converting the forest to plantation:

1) There is a marked loss of soil carbon that accompanies the intense burns and the plowing before plantation but this is not currently accommodated in FullCAM.

2) The stream-side reserves do not usually prosper as well beside a plantation as beside remnant forest, owing to loss from wind-throw, weed invasion, wilding invasion and accidental burning accompanying plantation.

3) Plantations of the fast-growing eucalypts are more fire-sensitive than native forest.

CL1.2. Net Change in Non-CO_2 Gases

The project does not expect the impact of non-CO_2 gases to be more than 5% increase or decrease of the project's overall greenhouse gas impact.

Carbon dioxide is the principal greenhouse gas emitted when a forest is deforested. Other gases such as methane (CH_4) and nitrous oxide (N_2O) are also emitted during deforestation, but in significantly lower quantities than CO_2). When compared to CO_2, the methane and nitrous oxide emissions from deforestation account for significantly less of the total potential of global warming effect from deforestation (Houghton, 2005[45]). Another likely source of non-CO_2 gases would be in avoided N_2O emissions by preventing the establishment of eucalyptus plantations and subsequent application of fertilizers. Since these are emissions that would occur in the baseline and will not occur with the project, the emission reduction estimates we project are more conservative.

CL1.3. Other GHG Emissions from Project Activities

No other GHG emissions as aforementioned are considered within the project activities.

CL1.4. Positive Net Climate Impact

According to Sections CL1.1 and CL1.2 (quantitative analyses) the contribution of the project toward climate change mitigation by GHG emission reduction is evident.

CL1.5. Avoided Double-Counting

There is no double-counting with the project in Australia – as it is a forest management project which is not counted by Australia in its Kyoto accounts. This can be seen in the National Carbon Offset Discussion Paper, Table 4.3 [46] which shows that "Forest management (plantation forests established before 1990 and all native forests on managed land that are maintained as forested land until 2012) are not counted towards Australia's Kyoto target."

Further, the white paper for Australia's Carbon Pollution Reduction Scheme[47] excludes deforestation and/or avoided deforestation and leaves forestry management methodologies out of scope. See Policy position 6.22 "The Scheme will cover only domestic emissions sources and sinks that are counted in Australia's Kyoto Protocol national account."

[45] Houghton, R. A. 2005. Tropical deforestation as a source of greenhouse gas emissions. In: Moutinho, P. & Schwartzman, S. eds. Tropical deforestation and climate change. Instituto de Pesquisa Ambiental da Amazônia - IPAM; Environmental Defense. Belém, Pará, Brasil. 131 p.

[46] http://www.climatechange.gov.au/carbonoffsetting/pubs/national-carbon-offset-standard-paper.pdf

[47] http://www.climatechange.gov.au/whitepaper/report/pubs/pdf/V1006Chapter.pdf

CL2. Offsite Climate Impacts

CL2.1. Types of Leakage

Neither emigration of people from the project area nor a reallocation of activities is an expected result of the project. The most plausible leakage scenario of the project activities is a leakage near zero, due to the low impact on the surrounding areas of the project activities.

Especially, none of the following indicators is present within the project area: displaced area under cropland and livestock grazing.

CL2.2. Mitigation of Negative Offsite Impacts

The project-related climate impacts are expected to be positive in terms of avoided emissions in other areas. In fact, the project implementation is expected to additionally reduce deforestation outside the project boundaries, as compared to the baseline scenario. This is consistent with recent studies on deforestation dynamics that indicate that the single measure of creating a protected area promotes reduction of deforestation in the surrounding areas.

For this reason, we consider that the implementation of the REDD Forests Project will not result in negative leakage, but rather an alternative land use in the project region that can generate economic revenues.

CL3. Climate Impact Monitoring

CL3.1. Carbon Pool Selection and Monitoring

The carbon pools covered by the REDD Forests project are:

- Above-ground biomass;
- Below-ground biomass;
- Wood products;
- Deadwood and litter.

We chose not to include soil carbon because its measurement was not practicably feasible with the available resources and because presently, there is no software available that can model its flux associated with the type of timber harvesting, or the forests types, associated with the PA.

The plots measured as part of this RFPA are permanent plots and therefore can be re-measured and their carbon stocks assessed as a function of time. Also, future remote sensing imagery can be acquired to both check on sequestration and to gain higher precision on estimates. Re-measurement, especially to ascertain land rehabilitation, is recommended at 5 year intervals.

CL3.2. Monitoring Plan

REDD Forests is committed to developing a full carbon monitoring plan and will disseminate this on the Internet within twelve months of validation of the project against the CCBA standards.

COMMUNITY SECTION

CM1. Net Positive Community Impacts

The project will stand as a model for other landowners to consider and, in so doing, will likely result in more and greater areas of threatened land being brought into the project as it extends.

The project has already provided, and will continue to provide employment for offsite contractors and service providers.

Those recruited to provide such services include;

- Curtin University, specifically the services of Dr. Christopher Dean who wrote the project based methodology used for the project.

- MGM international who are appointed as authors and developers of the project design document and who will actively participate in the promotion of the project internationally including as agents for the sale of the resultant carbon credits.

- Local botanists and field workers who have and will continue to create and monitor sample plots using the monitoring plans created for the project.

- Services of local government authorities for the provision of general field data, mapping and survey materials.

CM1.1. Community Benefits

As previously stated this pilot project is on a relatively small area on privately owned land and as such the community benefits of the projects alone will be minimal. That being said the success of the project will ensure exponential extension of the area under management and, at that time, considerable community benefits will be achieved. The following, however, holds true irrespective.

Logging old growth forest brings little wealth and few jobs to struggling, impoverished rural communities. According to Graham Green, of Timber Workers for Forests, in 1980 there were 205 registered sawmills employing 3,000 Tasmanians; by the end of 2003 there were fewer than 40 sawmills employing 1,350 people. A 2003 report in the Australian Financial Review revealed the Tasmanian industry in its entirety had shed more than 1,200 jobs since 1997. The logging industry has shifted its focus away from job-rich, high-value-adding processes such as saw milling. Wood chipping now dominates the industry and, as a low-value, high-volume process based on destructive logging practices that are highly mechanized, it is responsible for the massive decline in employment across the timber industry.

Key industries depend as much on the island's natural image as they do on the products they sell. There is growing concern in all these industries at the relentless damage being done to Tasmania's name by images of smoldering forest coupes. Tourism now employs 36,000 Tasmanians and in recent years tourism employment has grown at over 15 per cent per annum. However, tourist operators become ever more embarrassed at explaining away endless clear-fells, processions of log trucks and the strange vistas of single-species plantations. Scenic flight pilots take routes that avoid the scenes of devastation that run up to the very boundaries of World Heritage areas. Boat builders and furniture makers find it more difficult to get the timber they need. Tasmania's unique leatherwood honey industry faces great problems as the last stands of accessible leatherwood trees are destroyed. Organic farms suffer because of the widespread use of poisons[48].

Protecting the old growth forest is a crucial element in the sense of identity of Tasmanian people. This is particularly important in small communities such as the communities surrounding the RFPA, adjacent to old growth forest.

Additionally, the image of this forest as a place of enthralling natural beauty has become part of the economic backbone of project area-surrounding communities and for Tasmania as a whole. Hundreds of thousands of tourists visit these places because of their scenery.

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[48] Milieudefensie - Friends of The Earth Netherlands, Greenpeace Netherlands, ICCO – Interchurch Organization for Development Cooperation, IUCN Netherlands Committee, NCIV - Netherlands Centre for Indigenous Peoples, World Wide Fund for Nature. 2006. Legal Forest Destruction, the wide gap between legality and sustainability.

The decline in the Tasmanian population has recently been reversed because of the influx of mainlanders moving to Tasmania to enjoy a better quality of life.

The communities' net benefits will be estimated on the basis of socio-economic indicators considered of great importance in project zone communities.

To measure the net benefits, the project team evaluated how each of the project activities would impact the community regarding these issues, on an evolving line of development, moving from a critical situation to a desired condition, and all the necessary measures to improve on every line.

The following are the issues considered:

- Job opportunities;
- Landscape;
- Sustainable tourism;
- Environmental services;
- Forest management.

CM1.2. Impact on High Conservation Values

As mentioned above, no old growth forest will be impacted by this project. On the contrary, this project will positively impact the local community providing the landowners and their family's new income sources more profitable than harvesting timber for pulpwood.

CM2. Offsite Stakeholder Impacts

CM2.1. Potential Negative Offsite Stakeholder Impacts

The project is not expected to have negative social impacts on the communities outside of the REDD Forests Reserve. It is possible that the project could generate a slight negative economic impact initially because of the loss of jobs of sawmills workers (but even this is uncertain). This is greatly outweighed by additional employment opportunities and increased economic activity during the creation of the project and following after the initial phase of the Project.

The negative impacts on the communities will be estimated in the same manner mentioned above in section CM1.1. through socio-economic indicators considered of great importance in project area surrounding communities.

CM2.2. Plans to Mitigate Potential Offsite Impacts

If any negative impact is identified, the REDD Forests team and the community representative, will address such problems. The issue will be discussed and mitigation actions will be designed.

CM2.3. Unmitigated Offsite Impacts

No unmitigated social or economic impacts are expected from the project. To the contrary, the project should have positive impacts on the local economy (inside and outside the REDD Forests area) since it will promote economic development based on the rational use of natural resources.

CM3. Community Impact Monitoring

CM3.1. Community Impact Monitoring Plan

With the limited community impacts of the project as such we propose to implement a plan that will largely be influenced by the extension of the project. In this we will monitor and measure the following variable;

- Annual employment of local community personnel in man-hours actualized for the project and measured against the "without project" scenario (which would primarily be contracted-out logging labor and we can use the historical record for assessing this).

CM3.2. High Conservation Value Plan

Again, the limited size of the project prevents any meaningful HCV plan being implemented.

CM3.3. Community Impact Monitoring Implementation

REDD Forests is committed to developing a community impact monitoring plan and will disseminate this on the Internet within twelve months of validation of the project against the CCBA standards.

BIODIVERSITY SECTION

B1. Net Positive Biodiversity Impacts

B1.1. Biodiversity Impacts

The REDD Forests project zone has one of the most important histories of vegetation clearance and degradation in Australia (Northern Midlands is the second area in Australia). Less than 30% of the original vegetation remains—much of it in scattered small remnants in poor condition.

The past two decades have seen major changes in this landscape with serious and continuing problems of vegetation loss and degradation, soil erosion, degraded river systems, dry land salinity, rural tree decline, denuded north-facing slopes, inter alia.

The catchments are subject to timber harvest operations, and commercial firewood harvesting is widespread. Forest ecosystems that have been identified as threatened or as old growth forest continue to be cleared.

Less than 2% of the Northern Midlands is reserved in protected area networks and little public land exists. A total of 67,093 ha (56,786 ha forest and 10,307 ha non-forest) has been identified as rare, vulnerable or endangered ecosystems or as ecosystems with a high conservation priority. In this way, severe degradation and loss of biodiversity will continue unless new initiatives allow the forest conservation. The creation of the REDD Forests aims to protect currently logged old growth forest from further logging activities and avoid the resulting GHG emissions in an area under great land-use pressure in the Northern Midlands, Tasmania.

The project creates and implements a protected forest in an area that would effectively be completely logged in a “business as usual” scenario.

Considered the above mentioned, the net benefits for biodiversity of the project should be largely self-evident. The baseline scenario will witness a substantial amount of forest habitat being destroyed, degraded and fragmented. These outcomes would present an immediate threat to the viability of many species in the area. The project’s goal of eliminating selective logging has clear and compelling biodiversity benefits.

The loss of forest cover implies a loss of biodiversity and habitat for local flora and fauna, as well as the environmental services that the forest provides. This loss of forest also directly affects the conservation of the soils and disturbs the ecological processes on a larger scale; to say nothing of impacts on the community.

The project implements a biodiversity monitoring plan consisting of annual data collection (as was mentioned previously) to help with the prevention and identification of negative impacts on biodiversity and on the livelihood of the communities.

The biodiversity monitoring plan will be described in the Section B3.

B1.2. Impact on High Conservation Values

As mentioned above, no old growth forest will be impacted by this project. On the contrary, this project will have a positive impact because eliminating the possibility of logging would greatly protect the population reserves of flora and fauna, maintaining local biodiversity, reducing the risks on those species whose distribution is restricted to the region.

Endemic species, which have a restricted distribution, would especially benefit from the project, because the reduction and fragmentation of their habitats would result in a significant loss of many endemic species' original populations.

B1.3. Species Used by the Project

As mentioned above, the project is engaged only in the protection of existing native plant species (The vegetation categories within the RFPA are described above, G1.2 and Figure No. 05).

The main vegetation categories within the RFPA are the following:

- *Eucalyptus amygdalina* forest and woodland on dolerite;
- *Eucalyptus delegatensis* dry forest and woodland;
- *Eucalyptus delegatensis* forest with broad-leaf shrubs;
- *Eucalyptus viminalis* grassy forest and woodland; and
- *Acacia dealbata* forest.

B1.4. Exotic species in the project area

In the RFPA and surroundings, the only areas in which exotic species are found are small patches with trees of *Ulex europaeus* (Fabaceae family) and *Pinus radiate* (Pinaceae family).

The biggest non-native and invasive trees will be gradually removed from the project site using biological and industry-accepted best practices. Additionally, the project's capacity training in the communities will provide them with more environmentally suitable techniques and substitute exotic tree species with native ones.

B1.5. Genetically Modified Organisms

The project will not use any genetically modified species in its operations.

B2. Offsite Biodiversity Impacts

B2.1. Potential Negative Offsite Biodiversity Impacts

The project does not anticipate any offsite negative biodiversity impacts. Most offsite impacts will be positive since larger habitat and forest areas will improve the long-term viability of populations offsite.

B2.2. Mitigation of Potential Negative Offsite Biodiversity Impacts

If any negative impact is identified, the REDD Forests team and the community representative will address such problems with fast and effective solutions. The issue will be discussed and mitigation actions will be designed.

B2.3. Evaluation of Potential Negative Offsite Biodiversity Impacts

As mentioned above, the project does not anticipate any offsite negative biodiversity impacts. Most offsite impacts will be positive since larger habitat and forest areas will improve the long-term viability of populations offsite.

B3. Net Positive Biodiversity Impacts

B3.1. Biodiversity Impact Monitoring Plan

The aim of the monitoring plan is to sample biodiversity of a native forest which is managed as a carbon bank and compare this with an alternative scenario of clearfelling followed by establishment of *Eucalyptus nitens* plantation.

The monitoring plan will follow the directives used by scientific biodiversity inventories and appropriate statistical methods.

Vascular plant species richness has been chosen as an indicator of biodiversity since plant species are easily recorded and more likely to indicate site differences and trends. Furthermore, most fauna is mobile and less easily detected which means intensive surveying would be required to ascertain between-site differences and temporal trends.

A species list of vascular plants will be recorded from 6 quadrants in native forest on the project site. A subset of the permanent 45x45 meter quadrants used for carbon measurement will be used. Four 45x45 meter permanent quadrants will be established in the *Eucalyptus nitens* plantation close to the project site. This plantation has comparable site characteristics similar to the native forest carbon bank measured by elevation, geology, and aspect.

The plant species surveys will be conducted at the same time as carbon measurements, resulting in a time series of records from the permanent plots.

Analysis of the species lists will allow comparison of total species richness, proportion of non-native plant species and changes over time. If the native species are found to be in decline, management and protection actions will be undertaken to guarantee their conservation. This monitoring is expected to generate the knowledge required to develop proposals for managing these resources appropriately. All invasive species detected will be removed.

The collection of data will be recorded on data sheets provided by the project team. These sheets allow for the standardization of the information collection and permit information storage and processing.

The inventories will be conducted by ecological experts specializing in Tasmanian vegetation surveys and flora and fauna reports. Additionally, the specialists must have extensive specific knowledge of Tasmanian flora, fauna and field experience in Tasmania ecosystems.

B3.2. Biodiversity Impact Monitoring Effectiveness

The project activities will positively impact the old growth forest because of protecting the population reserves of these trees, maintaining local biodiversity and decreasing extinction risks.

The biodiversity monitoring plan mentioned previously includes issues about monitoring the old growth forest.

B3.3. Biodiversity Impact Monitoring Implementation

REDD Forests is committed to developing a biodiversity impact monitoring plan and will disseminate this on the Internet within twelve months of validation of the project against the CCBA standards.

ANNEX

Methodology for Baseline Carbon Assessment and Carbon Stock Forecast for the Woodside Estate

The carbon investment project is in the form of improved forest management (IFM). The IFM activity types within the REDD Forests Project Area (RFPA) of Woodside Park, consisting of 790, ha, are:

- Protecting currently logged and degraded forests from further logging;
- Protecting unlogged forests that would be logged in the absence of finance from carbon trade; and
- Conversion from conventional logging to reduced-impact logging (possibly employed later after the first project period of 25 years).

The current situation on the RFPA is one of regenerating forest stands with interspersed multi-aged old growth stands. Across the RFPA stands are both even -aged and multi-aged, and with a history of timber harvesting of varying intensities across different sections of the RFPA.

The "baseline projection" for the project area is manifested in the form of an imminent probability of clearfell and possible conversion of all forest stands to either: plantation, "natural regeneration" or grazing land. Therefore without the project the activity on the area would be some combination of the IPCC "key category" named "Forest Land Remaining Forest Land" (code 3B1a) and "key category" "Forest Land to Cropland" (code 3B2b). Even though the 3B1a scenario is still forest by definition, there is a long-term lower carbon stock for the style of management applied routinely to forests such as in this project area. The activities of the proposed project come under the IPCC activity of 3B1a, in the

Agriculture, Forestry and Other Land Use (AFOLU) Sector. The greenhouse gas to be assessed is CO_2.

Tasmania is the Australian state with the highest annual quota of wood products exported from native forests, with much of the timber milled for pulp before export. The dynamics of an industry of such size means that it is ravenous in its consumption of native forest timber from both old growth and regenerating native forests. The MBAC report (MBAC, 2007[49]) found that the biomass in the Tasmanian forest estate, as a whole, is currently a carbon sink owing mostly to the forests which are no longer in industrial production (the "non-commercial" forests). Removal of the Woodside project area from the commercial feedstock (or to more judicious timber selection at a later date) would similarly place it in the category of an ongoing carbon sink.

IPCC methodology

The IPCC tiers to be chosen (i.e. Tiers 1, 2 or 3) for estimating the different carbon pools depend on the details of the available data.

- The biomass is an IPCC "sub category"—the pool of focus in this project. Extant biomass data was calculated from measuring tree diameters (DBH) and converting to biomass using known allometrics (Keith et al., 2000[50]). Biomass across the RFPA was interpolated using both remote sensing and stratification based on logging history. Changes over time and with management activity, at the unit area level, were calculated using FullCAM which is part of the National Carbon Accounting Toolbox (which is part of NCAT; Richards and Brack, 2004[51]; Richards and Evans, 2004[52]; Waterworth and Richards, 2008[53]). Allometrics will be sourced from within NCAT and for preliminary calculations from the NCAS Technical Bulletin series (Department of Climate Change).

- Dead organic matter was measured on-ground.

- Soil organic matter was not measured or estimated, as within the project's forecast period of 30 years no net change is expected that could be measured to any

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[49] MBAC. 2007. Forestry Tasmania's Carbon Sequestration Position. MBAC Consulting Group Pty Ltd., Victoria Australia. 43pp.

[50] Keith, H., Barrett, D. and Keenan, R. 2000. Review of Allometric Relationships for Estimating Woody Biomass for New South Wales, the Australian Capital Territory, Victoria, Tasmania and South Australia. Technical Report No. 5b, National Carbon Accounting System. Australian Greenhouse Office, Canberra. 113 pp.

[51] Richards, G.P. and Brack, C. 2004. A continental biomass stock and stock change estimations approach for Australia. Australian Forestry: 67(4), 284-288.

[52] Richards, G.P. and Evans, D.M.W. 2004. Development of a carbon accounting model (FullCAM Vers. 1.0) for the Australian continent. Australian Forestry. 67, 277-283.

[53] Waterworth, R.M. and Richards, G.P. 2008. Implementing Australian forest management practices into a full carbon accounting model. Forest Ecology and Management. 255, 2434-2443.

significant or relevant degree of accuracy, and presently no software is available that can adequately model its flux with logging. Therefore estimation of this pool is not applicable here (N/A). However, if the science of soil carbon flux improves for this forest type in the near future then an estimate will be provided, for reference purposes.

The applicable basic equations for the basics of carbon budgeting between successive years or across longer durations are given in IPCC Guidelines for National Greenhouse Gas Inventories, 2006, Volume 4, Chapter 2. These were used for the calculations for this project.

Site Disaggregation (Stratification)

Given the history of timber extraction and the spatial heterogeneity the RFPA was not stratified.

Number of Sampling Plots and Sampling Design

A pilot project consisting of semi-randomly selected plots revealed that there was no correlation between biomass and an approximate gauge of logging intensity, as judged from aerial photographs. Thus systematic sampling was applied, with a regular array of sampling points (Figure No. 28). The choice of systematic [random] sampling follows the recommendations in the IPCC Good Practice Guidance on LULUC. The plots are of the type “permanent”.

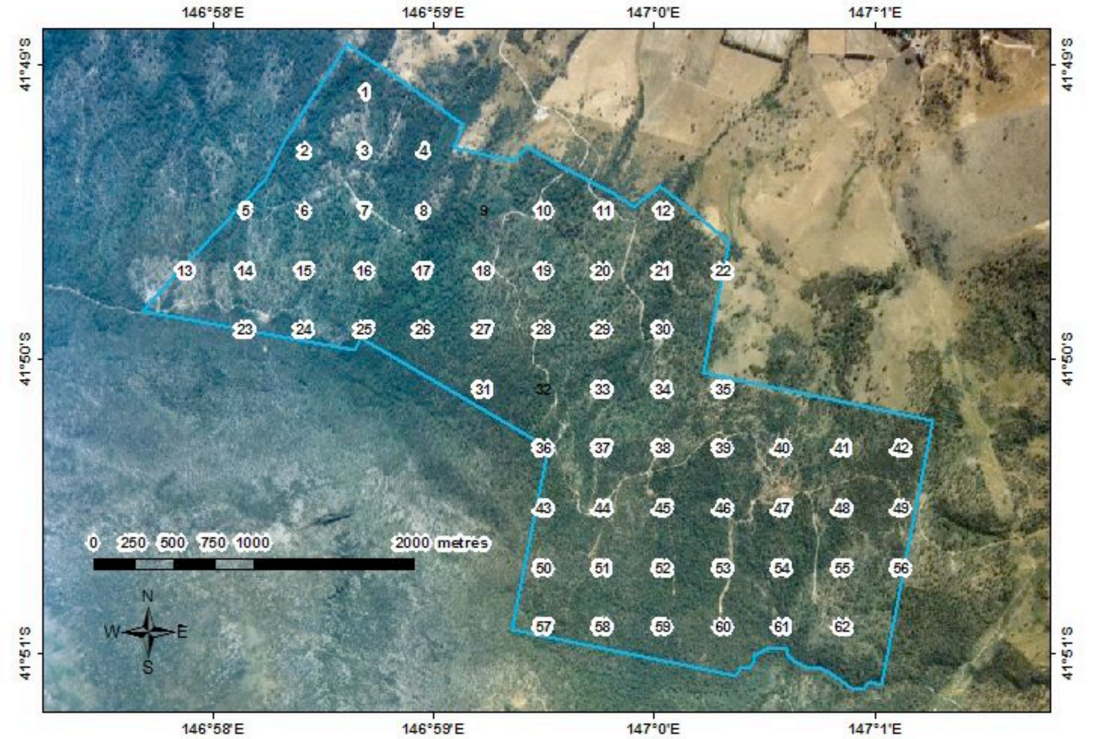

Figure No. 28. Regular array of sampling points. Numbers are the assigned plot numbers, which were used to index field data collection.

The pilot study sampling, with thirty 20 m radius plots (0.1257 ha each), yielded a mean biomass of 76.99 t-C/ha, with a standard deviation of 49.96, across all logging intensities.

To achieve an accuracy level of 10% this would require 168 plots over the 860 ha:
$n = ((2*49.96)/(0.1*76.99))^2$

The intensity of fieldwork necessary for 168 plots was infeasible with the available resources. Consequently a lower number of plots, and a lower precision estimate of the standing carbon stock, was chosen. It was found that 62 plots, each adjacent pair separated by 375 m, would give an accuracy of ~15%. Once all the field data has been collected, this accuracy level can be refined with application of appropriate data disaggregation.

Plot Design

Square plots were chosen over circular plots because moving the tape through an arc (to describe the circumference of the circle) was not mechanically possible in the forest. The individual plot dimensions were 45 by 45 m (0.2025 ha). This larger than normal plot size was chosen because many of the locations had mature vegetation and a diverse history, also because the smaller 0.13 ha plots used in the pilot study had failed to significantly correlate with the estimated spatial distribution of biomass. The sides of the plots were aligned with the magnetic compass directions (N, S, E and W) in the field. The trees measured in the plots were all of DBH (diameter at 1.3 m height) ≥ 20 cm. Subplots were also used to gauge smaller trees: 7 by 7 m for trees with DBH ≥5 cm, and 2 by 2 m for DBH of ≥2 cm. No trees were counted twice and the larger plots took precedence over the smaller plots. The subplots were located in the SW corners of the larger plots.

Plot Measurement—Collection of Field Data

Although the locations of the plots were, in theory, calculated before fieldwork, owing to the need to later match the results with remote sensing imagery (i.e. data disaggregation) a fine adjustment to the plot location was applied in the field to ensure that any one plot did not cross future data disaggregation boundaries such as creeks, major tracks, property boundary and, in particular, edges of timber harvesting zones. Also, as Landsat pixels are 25 m wide, the plot perimeters were kept at least 40 m from such boundaries.

The locations of plot corners were recorded using GPS and later entered into GIS format to enable biomass comparison with processed remote sensing imagery. The sides of the plots were determined in the field with compasses and measuring tapes. The SW corner of each plot was marked with a stake and flagging tape in the field. The other corners were marked with a small stake and flagging tape. Plot sides were marked with flagging tape during data collection. Thus, the plots are permanent and their locations can be retrieved for future data collection during the project period for verification of carbon stock change. Using the plot corner coordinates, field data on the slope, and a slope estimate from the digital elevation model (DEM), a slope correction can be applied to the calculated biomass per hectare.

Measurements were taken by a team of 2 pairs of 2 people, with each pair measuring a different plot. Procedures for data collection were refined and tested while working together on the first few plots, to ensure consistency across the RFPA. Each person was trained in the measurement of DBH according the Australian Forestry standard (which matches the IPCC guidelines), with additional detail specific to mature, native vegetation. At least one person in each team was a professional in identification of local plant species.

Data collected for each plot were:

- Vegetation community type (according to the Tasmanian vegetation classification system);
- Topographic slope and aspect (in degrees);
- Brief description of logging and fire history;
- Date, time, staff;
- Corner coordinate DBHs (as described above for the different sized plots) and tree hollows;
- Coarse woody debris (see below) and hollows;
- Photographs to record vegetation and disturbance characteristics;
- Any other noteworthy features.

DBHs were measured using the Australian Forestry standard (which matches IPCC guidelines) using DBH tapes: diameter at 1.3 m (while standing on the high side of the tree if the ground is sloping etc.). Both live and dead trees were recorded. The life stage of each tree was recorded in the categories: alive, senescent, dead, fallen and stumps (with stumps being assigned a decay class—see below). Tree basal hollows were recorded, approximated as either a cone or cylinder. Tree heights were not recorded for the 62 45x45 m plots because the available allometrics to determine biomass were dependent only on DBH. Taper formulas for stem volume, which use both DBH and tree height, are not available in the public domain and were not available for use in this project. Also such taper formulas would not generally be applicable within our RFPA because the stem taper would vary greatly between trees in the forest and those in the open woodland, even if species and provenance were identical.

Coarse woody debris (CWD) was measured where at least one end of the log or branch had a diameter ≥ 50 cm (Figure No. 29). Only the portion of the CWD lying within the 45x45 m plot was recorded. The decay stage of the debris was recorded as one of the categories solid, medium and soft. The stumps of logged trees were classified as CWD rather than trees (the main reason being that most trees had been felled below 1.3 m). Hollows in CWD were also recorded. Shapes of CWD were recorded as either: a cylinder, cone, or frustum of a cone (i.e. one or two diameters and one length, or height—for logged stumps).

Figure No. 29. Measuring coarse woody debris (CWD). Fallen old trees: (a) and (b). “Forest residue” from old logging: (c) and (d). Measuring hollows: (a) and (c). This CWD would all be “windrowed” and burnt upon conversion of the PA to plantation but is presently a significant part of the total carbon pool and consists of components supporting biodiversity. Items such as (d), a 40 cm log, would not be detected by spectral remote sensing as it is covered by photosynthetic vegetation.

Processing of Field Data

The complete set of recorded DBH data were converted to dry biomass, then to tonne-C/ha (t-C/ha), based on known allometrics for the species from the NCAS bulletins (Figure No. 30). Allometrics for some of the individual species in the RFPA were available from Keith et al. (2000)[54] as in the table below (Table No. 12). R^2 values listed in the table are composites based on separate components of the trees (e.g. sapwood and heartwood) but weighted corresponding to biomass distribution amongst the components.

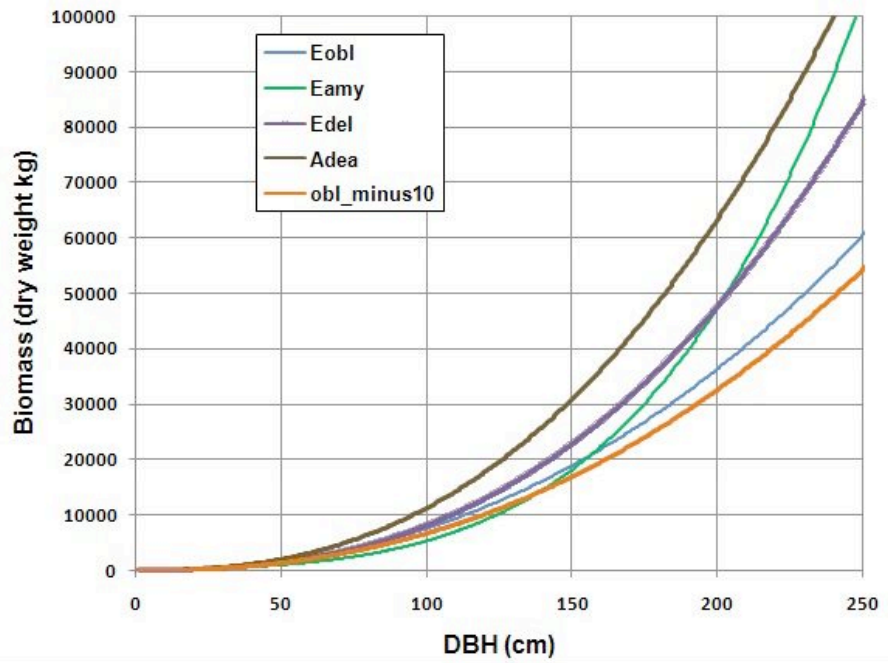

Figure No. 30. Comparison of biomass values derived from allometric formulas.

Table No. 12. Available allometrics and their DBH range.

Species	DBH range (cm)	R^2	Error mean square
E. delegatensis	11.9 – 83.2	0.95	0.1
E. amygdalina	21.5 – 51.2	0.92	0.05
E. oblique	26.2 – 284	0.99	0.025
A. dealbata	5 – 45	0.87	0.04

[54] Keith, H., Barrett, D. and Keenan, R. 2000. Review of Allometric Relationships for Estimating Woody Biomass for New South Wales, the Australian Capital Territory, Victoria, Tasmania and South Australia. Technical Report No. 5b, National Carbon Accounting System. Australian Greenhouse Office, Canberra. 113pp.

Two artificial allometric curves were formulated to cater for less known species or less known DBH values. This was necessary because the curves are exponential in nature and provide obtusely high biomass for high values if extrapolated outside of the originally measured DBH range.

One of these extra allometric curves equated to the biomass for *E. obliqua* minus 10% ("obl_minus10"). A second artificial curve corresponding to the minimum biomass for all species and obl_minus_10. For individuals with DBH values outside of the range of their allometrics or for species not covered by the above allometrics, the biomass assigned to each DBH value was that minimum biomass. Dead trees were assigned the biomass of this minimum minus a further 20%. Note that this process of minimizing attributable biomass for less known species or less known DBH values produces a highly conservative estimate of the standing carbon stock, and more so for the mature specimens. For example several *E. amygdalina* individuals had DBH values approaching 200 cm, but this process assigns the minimum biomass to them, being the biomass of an *E. obliqua* of 200 cm but minus 10%. This is quite significant as the baseline (benchmark against which the carbon credits for this project are compared) is a plantation whose growth rate and eventual carbon stock is not nearly as conservative. Consequently being conservative with our biomass determination of the standing stock means that the baseline has a competitive advantage, i.e. we are not overstating the benefits of the project.

Tree hollows (where present) were subtracted from derived tree biomass. The wood density was not sampled or derived from literature values. Instead a basic density of 0.55 g/cm3 was assumed. This value was also used to determine the dry biomass of CWD. Again, this is a conservative value (e.g. compared with 0.75 g/cm3).

The decay stage of the tree, CWD or hollow was used to adjust the biomass of the tree as derived from the allometric equations above. Dry biomass was divided by either 1, 2, or 3 depending on whether the assigned "decay stage" was "solid", "medium" or "soft" respectively.

The above-ground biomass for each tree was added for each plot and adjusted for the slope of the plot to obtain dry biomass per hectare. This process gave the biomass and CWD mass for each of the 62 plots.

Use of Satellite Imagery

One Landsat image was obtained (from the Department of Climate Change, Canberra) to enable mapping the spatial distribution of biomass across the RFPA (Figure No. 31). The acquisition date was February 26, 2006, i.e. a late summer image. Late summer images are the best (in Mediterranean climates) for discrimination of perennial versus annual vegetation (in this case, discrimination of woody vegetation versus a background of grazed grass). The image had been orthorectified and calibrated to a standard base (Furby, 2001[55]).

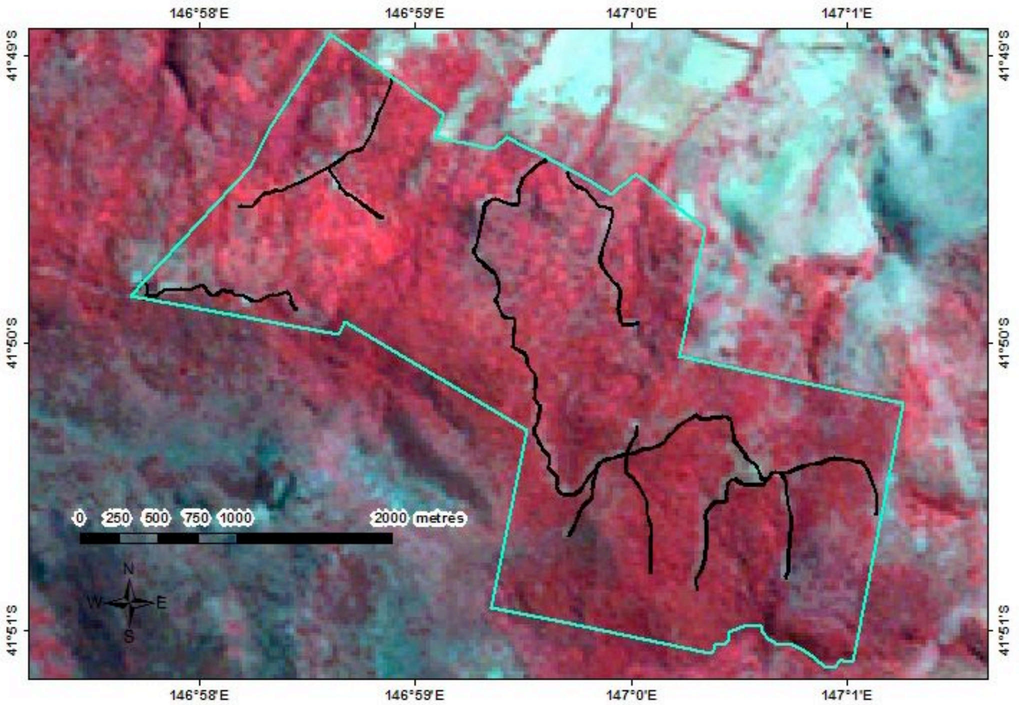

Figure No. 31. False color Landsat image (bands 4, 3, 2). Red corresponds to more photosynthetic vegetation. Note that with an acquisition date in late summer the grass in paddocks on lower elevations is dry and showing as unhealthy vegetation.

Two vegetation indices were calculated: “normalized difference vegetation index” (NDVI) and “normalized difference for senescent vegetation index” (NDSVI, where a SWIR band replaces the NIR band in NDVI). Relations between NDVI and biomass stock have been shown to be useful in spatial carbon accounting for forests (e.g. Zheng et al., 2004[56]). However, those relationships were best suited to forests with more even-shaped crowns than occur in Australian native eucalypt forests. Additionally, eucalypts frequently have leaves with the leaf area directed sideways (for climatic reasons), which allows light from the branches, understory and forest floor to have a strong influence over the spectrum received by the remote-sensing platform. For this reason we also used NDSVI, which has been shown to respond to non-photosynthetic vegetation (Figures No. 32 and 33, Dean,

55 Furby, S. 2001. Remote sensing of land-cover-change 1970–2000. Chapter 8. In: Richards, G. (ed.) Biomass Estimation Approaches for Assessment of Stocks and Stock Change. National Carbon Accounting System Technical Report No. 27. Australian Greenhouse Office, Canberra. 140pp.

56 Zheng, D.L., Rademacher, J., Chen, J.Q., Crow, T., Bresee, M., le Moine, J., Ryu, S.R.. 2004. Estimating aboveground biomass using Landsat 7 ETM+ data across a managed landscape in northern Wisconsin, USA. Remote Sensing of Environment. 93, 402–411.

2005[57]; French et al., 2000[58]; Mougenot et al., 2000[59]). NDVI and NDSVI were rescaled to range between 0 and 255, to allow comparison and because the GIS software was able to do more calculations with integer rather than fractional grids.

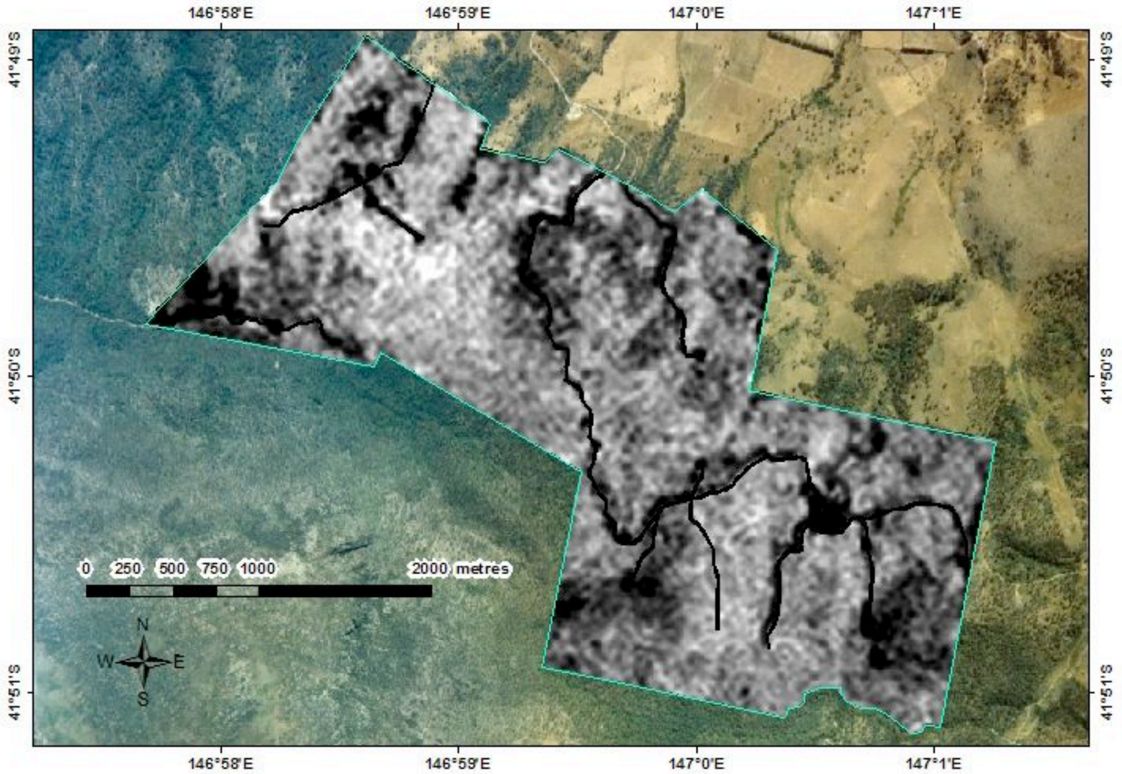

Figure No. 32. NDVI image. (White corresponds to a higher NDVI response.)

[57] Dean, C. 2005. Monitoring of Pastoral Rangeland Condition in the Southern Northern Territory (Australia) by Remote Sensing—Status and Prospects. In: Achim, R. and Hill, J. (Eds.) "Proceedings of the 1st International Conference on Remote Sensing and Geoinformation Processing in the Assessment and Monitoring of Land Degradation and Desertification", Trier, Germany, 7th – 9th September 2005, pp151-158.

[58] French, A.N., Schmugge, T.J. and Kustas, W.P. 2000. Discrimination of senescent vegetation using thermal emissivity contrast. Remote Sensing of Environment. 74: 249-254.

[59] Mougenot, B., Béugé, A., Chenbouni, G., Escadafel, R., Heilman, P., Qi, J., Royer, A. And Watts, C. 2000. Applications of vegetation data to resource management in arid and semi-arid rangelands. Presented at *VEGETATION 2000*. Lake Maggiore, Italy, 3rd-6th April 2000. http://vegetation.cnes.fr/vgtprep/vgt2000/begue.pdf.

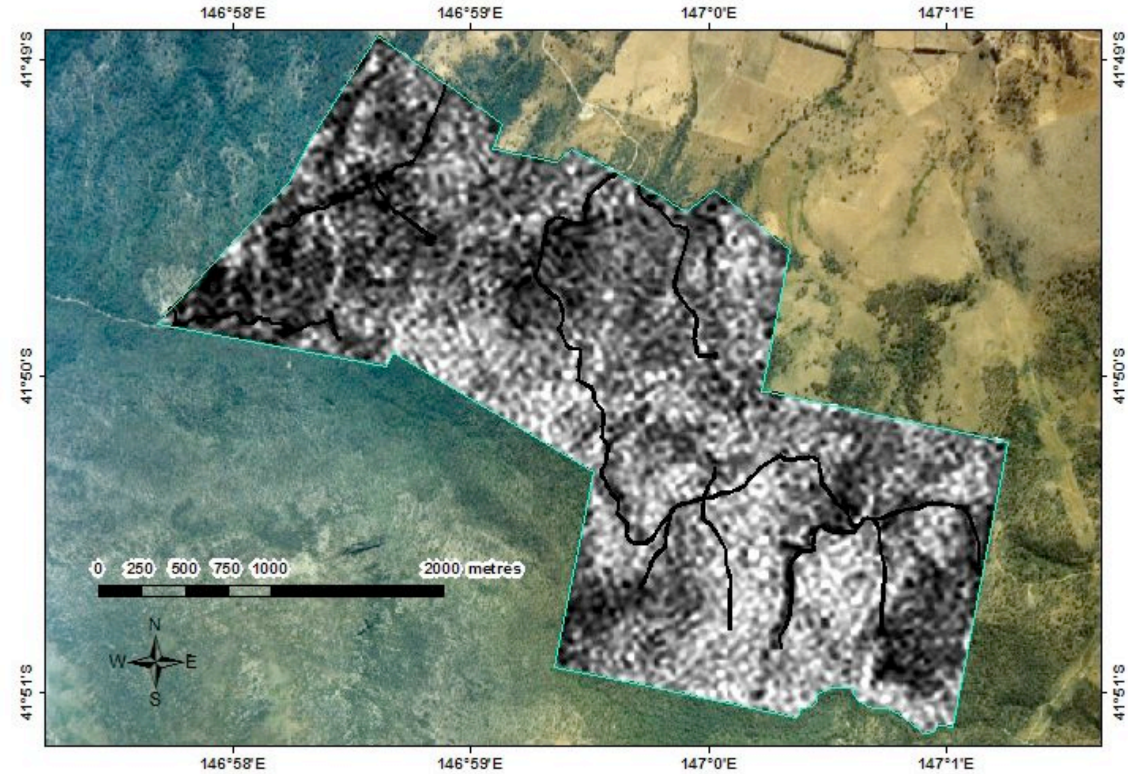

Figure No. 33. NDSVI image. (White corresponds to a higher non-photosynthetic vegetation response.)

From the graphs of vegetation index versus recorded biomass (Figures No. 34 and No. 35) three outlier points were noted. These corresponded to where the satellite imagery had been acquired before the most recent logging. These three data points were consequently removed from the data set. An additional eight ground-truth points were added; they corresponded to roads, with an estimated biomass of zero, as observed in the aerial photography and satellite imagery and confirmed on-ground—matching coordinates from imagery with those from a GPS. Only eight such points could be reliably detected in the imagery. Their polygons were digitized and their vegetation indices derived from the satellite as for the other polygons measured in the field.

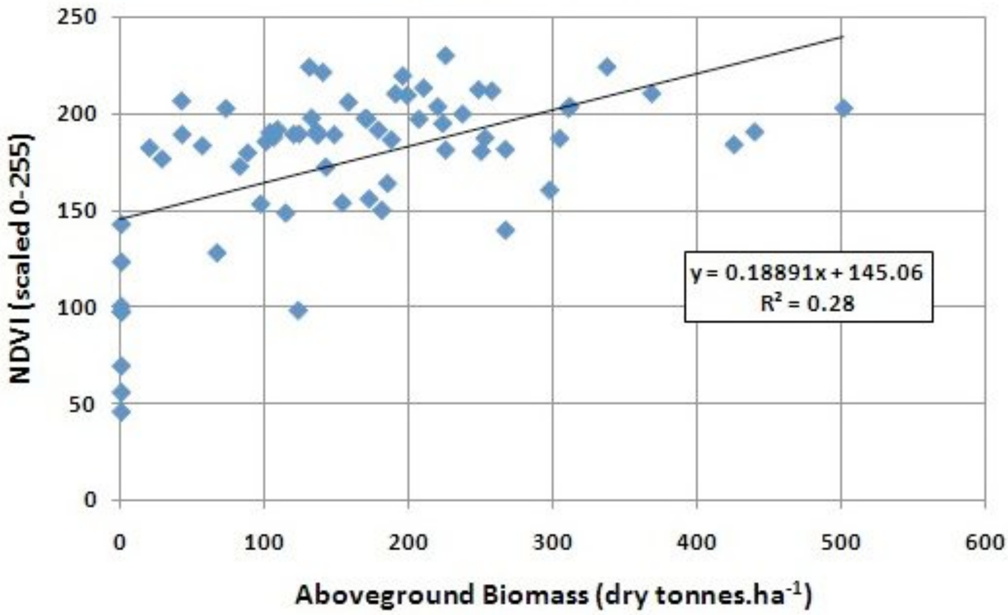

Figure No. 34. NDVI as a function of above-ground biomass.

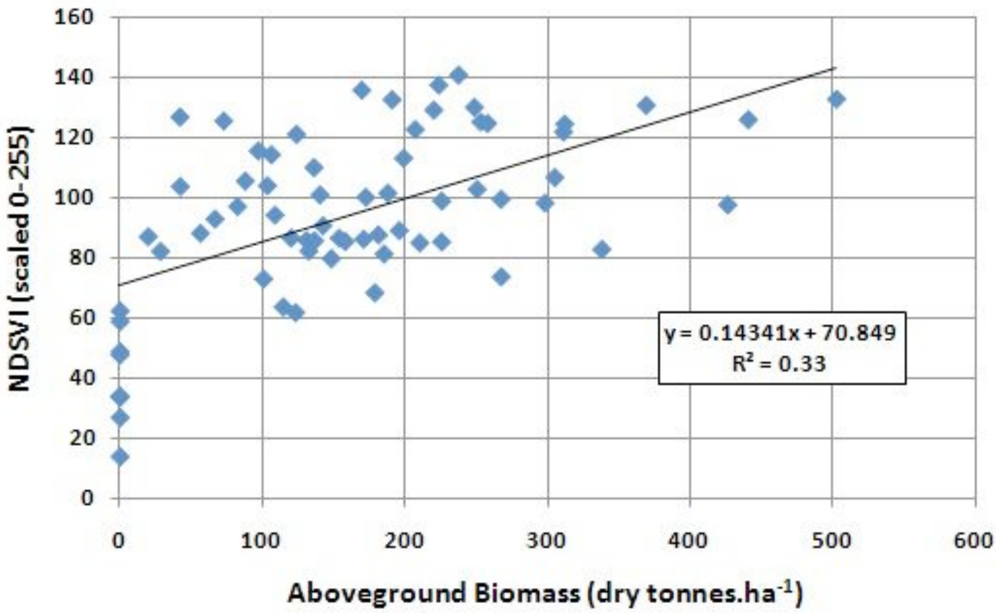

Figure No. 35. NDSVI as a function of above-ground biomass.

It was found that the NDVI interpretation was responding strongly to understory vegetation whereas the NDSVI was more responsive (than NDVI) to the taller vegetation. This was portrayed in the regression analyses from the plots (R2 of 0.28 compared with 0.33 respectively). A test was performed on NDVI+NDSVI but the R2 did not improve, so that index was not used further. As the correlation of biomass with NDSVI was higher than with NDVI, the regression formula was used in calculation of biomass for the RFPA.

The variance of vegetation index with above-ground biomass was high, owing to: (1) the diverse logging history and subsequent diverse vegetation structure and distribution, and (2) the fact that remote sensing from above cannot directly respond to stem length and hence woody biomass. This latter feature was evident in that higher vegetation indices were recorded for a plot with low biomass coming from a high number of young trees (plot #35: 37 trees, mean DBH 25 cm, live biomass 7,352 kg; NDVI 206(9), NDSVI 126(10)) than for a plot with mature trees (plot #20: 13 trees, mean DBH 91 cm, live biomass 77,675 kg; NDVI 184(7), NDSVI 97(16)). Nevertheless the vegetation indices were discriminating against low projected vegetative cover. Due to the very high variability in patterns of remnant tree distribution and individual tree biomass the only way to improve the certainty in estimates of standing carbon stock for this RFPA would be with the use of LiDAR, including ground-truthing with differential GPS.

The 95% confidence level regression results for NDSVI as a function of measured above-ground biomass are listed in Table No. 13: Regression summary for NDSVI as a function of above-ground biomass.

Table No. 13. Regression summary for NDSVI as a function of above-ground biomass.

R^2 0.33	**Adj. R^2 0.32**	**St. error 23.3**	**N 67**	**F 32.182**	
	Coefficient	**St. error**	**P-value**	**Lower 95%**	**Upper 95%**
Intercept	70.8493	5.0304	2.0x10-21	60.8029	80.8958
Slope	0.143410	0.02528	3.5x10-7	0.092923	0.193897

An unsupervised classification was performed on the NDSVI image to allow modeling of specific categories of the standing carbon stock. A higher number of classes will undoubtedly increase the accuracy of the forecast, but for the purposes of an initial test the number of classes was limited to 4.

The classes were converted from raster to vector (polygons) and layered on the NDSVI layer to obtain average NDSVI values for each class. The regression relationship derived is:

NDSVI = (0.14341 x *above-ground_dry_biomass*) + 70.849 (Eq No. 1);

Where *above-ground_dry_biomass* is in t/ha.

(Note also that this formula can be used to estimate biomass for each 25x25 m pixel across the RFPA—producing a biomass stock surface.) The parameters for the upper 95% confidence limit were used to determine the lower biomass corresponding to the 95% confidence limit. (The upper limit is used to calculate the lower biomass because the equation has to be inverted to obtain biomass from NDSVI.) Solving Eq No. 1 for biomass and using the values of the variables corresponding to the 95% confidence level gives the above-ground biomass (dry) as:

above-ground_dry_biomass = (NDSVI – 80.8958)/ 0.193897 (Eq No. 2);

The streams' centerlines in the RFPA were digitized as lines and buffered to form polygons. The harvesting plans were used as a guide as to the reserve width. Three classes of streams were noted, with reserve widths of 20, 40 and 60 meters. Roads were digitized and buffered to give a road width of 6 m (a typically measured width on-ground). These polygons, theoretically representing areas that could not be further logged or converted to plantation, summed to 71 ha, and were classed as "reserves" for the purpose of this methodology (Figure No. 36). The polygons corresponding to these reserves were subtracted from the four classes to give the amount of carbon in each class that is not in reserve.

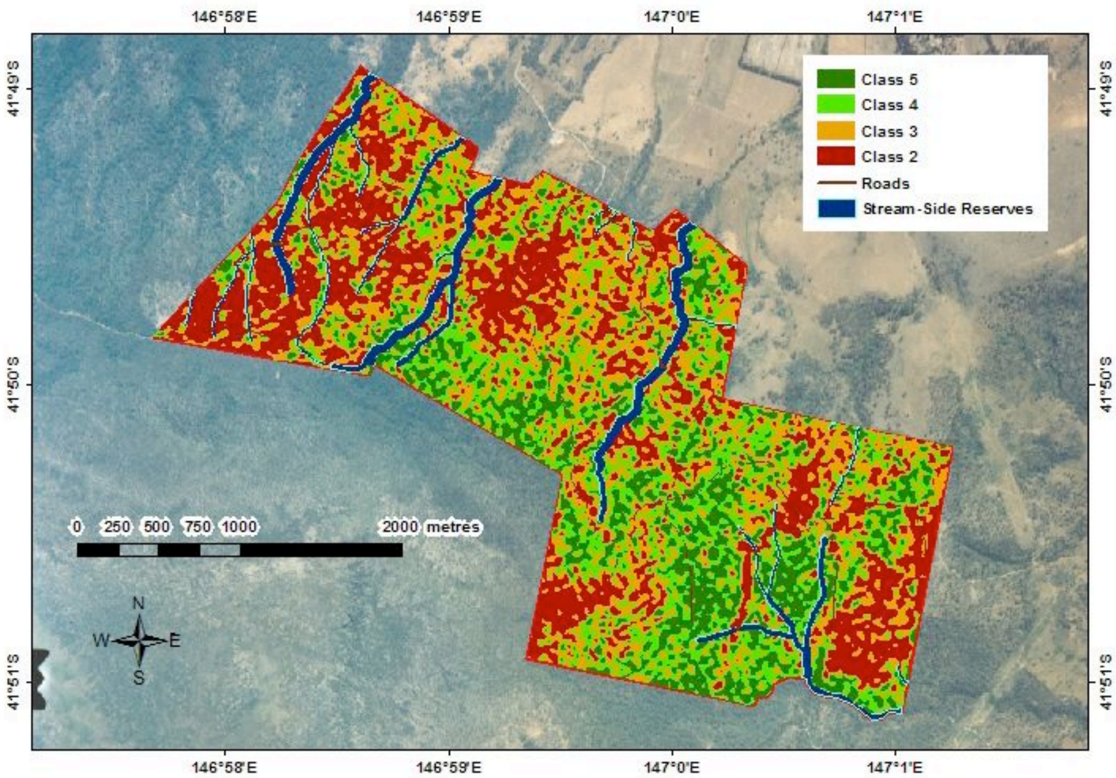

Figure No. 36. Classified NDSVI image showing areas to be reserved from conversion to plantation.

The root:shoot ratio applied was 0.14 to get the total biomass. The carbon in each class was derived from the dry biomass by multiplying by 0.45 (a conservative value, as 0.50 is sometimes used).

The CWD debris had no significant correlation with any remote sensing index nor with any other stratification category. This was due to the large amount of debris left after the older style logging, some of which had been collected for firewood or left where it fell; and with more recent logging it had mostly been gathered into a heap and burnt, or remained at the log landing site.