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Independent Quality Assurance review of DECCW's Old Growth and Rainforest Private Native Forestry assessment protocols interpretation and implementation

This report was prepared by Aerial Acquisitions for Department of Environment, Climate Change and Water NSW (DECCW). It does not necessarily represent the views or policy of DECCW.

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Executive Summary

An independent review of DECCW Old Growth and Rainforest Private Native Forestry assessment protocols interpretation and implementation was initiated by DECCW. The Review involved using contract Aerial Photo Interpretation specialists to follow DECCW procedures for implementing the Old-growth forest and rainforest protocols.

The Review found that the protocol implementation is working very well for rainforest and is identifying rainforest with a high level of accuracy.

The implementation of old-growth is highly variable and problematic and has apparently resulted in some areas of old-growth being potentially available for harvest. The main recommendations to improve this outcome are the use of good quality imagery and significantly increased fieldwork by aerial photo interpreters.

Field measurement by DECCW PNF officers was found to be similar to measurement by Contractors. As is expected in measuring variables such as growth stage, there is variation however the data do not show any systematic differences. The measurement of disturbance factors did show some systematic differences, however it was at a level that did not affect outcomes. Nevertheless there does need to be calibration with EPRG to ensure that field measurement techniques are consistently applied. Peer review of a proportion of old-growth and rainforest PNF PVPs is also recommended.

Documentation of procedures and the ability to track what has happened at any given property is excellent. DECCW have also demonstrated a culture of continuous improvement. All staff encountered were very professional and skilled, and demonstrated a focus on implementing the protocols as accurately and efficiently as possible.

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1 Introduction

The NSW Department of Environment Climate Change and Water is responsible for administering the Native Vegetation Act (2003). Changes to the Act on August 1 2007, prescribe that:

"harvesting of timber for the purposes of PNF(Private Native Forestry) requires approval through a Private Native Forestry Property Vegetation Plan (PNF PVP) that ensures environmental outcomes are improved or maintained. A PNF PVP is a legally binding agreement between a landholder and the Department of Environment, Climate Change and Water (DECCW)."
(http://www.environment.nsw.gov.au/pnf/)

In consultation with stakeholders, DECCW has prepared protocols for assessing rainforest and old-growth forest, which are then excluded from the area available for timber harvest. The protocols are a critical component of PNF PVPs from both environmental protection and cost/efficiency perspectives. DECCW has implemented a review of the protocols with the following aim and terms of reference:

Aim of Project

To undertake a quality assurance assessment of DECCW's application of the protocols in order to:

1. Improve the repeatability and reliability of procedures
2. Ensure the adequacy of supporting documentation
3. Inform any future review of the protocols

Terms of Reference

The project shall review;

1. Consistency and accuracy of PVP maps as they relate to rainforest and old growth assessment procedures.
2. Adequacy of DECCW processes to accurately represent the intent of the protocol and to provide sufficient and detailed documentation to justify assessment decisions.
3. Rigor, repeatability and reliability of the aerial photo interpretation and field assessment processes, with reference to the appropriate use of field validation.
4. Any areas of the protocol that are ambiguous or unclear.
5. Any other observations about the adequacy of DECCW's approach to identify and therefore achieving protection of rainforest and old growth.
6. Recommendations on changes to DECCW procedures to address any issues identified above.

DECCW also defined the following stages for the review:

Stage 1 Desktop Aerial Photo Interpretation

1.1 Review DECCW API process documentation and definitions used for API

1.2 Select target PVPs

1.3 API assessment

Stage 2 Field verification

Stage 3 Reporting and feedback

2 Stage 1 – Desktop Aerial Photo Interpretation

2.1 Review DECCW API process documentation and definitions used for API

The following documents were reviewed:

1. Private Native Forestry Code of Practice Guideline No.2 – Protocol for re-evaluating old-growth on private property (Department of Environment and Climate Change, 2007a)
2. Private Native Forestry Code of Practice Guideline No.3 – Protocol for re-evaluating rainforest on private property (Department of Environment and Climate Change, 2007b)
3. Aerial Photograph Interpretation and Data Management Practices, last update January 2010
4. Natural Resource Management Field Assessment Guidelines - Identification of Rainforests Field Guide – Department of Environment and Conservation (NSW), August 2004
5. Natural Resource Management Field Assessment Guidelines - Identification of Old Growth Forests Field Guide – Department of Environment and Conservation (NSW), August 2004
6. NOTES – Department of Environment and Climate Change – North East Branch, July 2007 PNF Old Growth Forest Field Verification

Documents 1, 2, 4, 5 and 6 are included as appendix 1. Document 3 is an unpublished working document.

2.1.1 Old-growth Protocol

The old-growth Protocol: "Private Native Forestry Code of Practice Guideline No.2 – Protocol for re-evaluating old-growth on private property", was developed in consultation with a range of stakeholders and sets out the agreed protocol for identifying and validating old-growth forest on private land. It includes the definition of old-growth forest derived from the Joint ANZECC/MCFFA National Forest Policy Statement Implementation Sub-committee (JANIS 1997):

"Old-growth forest is ecologically mature forest where the effects of disturbance are now negligible".

The old-growth protocol expands on this to provide a more detailed definition:

"Ecologically mature forest where the effects of disturbance are now negligible that have an area of forest greater than 5 hectares where:

- the over-storey is in late to over-mature growth stage with the presence of relatively large old trees (many containing hollows and often with the presence of dieback or dead branches in the crown)
- the age (growth) structure of the stand measured as relative crown cover consists of less than 10% of regeneration and advance growth, and more than 10% of late to over-mature (senescent) growth
- the effects of unnatural disturbance are now negligible.

The old-growth protocol describes characteristics of old-growth forest with respect to concepts of ecological maturity and disturbance.

The steps in identifying old-growth forest on private land are then outlined including landholder procedure and DECC(W) procedure. As part of PNF PVP processes, landholders are provided with an existing old-growth map, derived from Comprehensive Regional Assessment Aerial Photo Interpretation Project (CRAFTI) data. The landholder can either accept the old-growth mapping or apply to DECCW for evaluation and new growth stage mapping. This process is represented diagrammatically in Figure 1 below (which is figure 2 in the old-growth protocol).

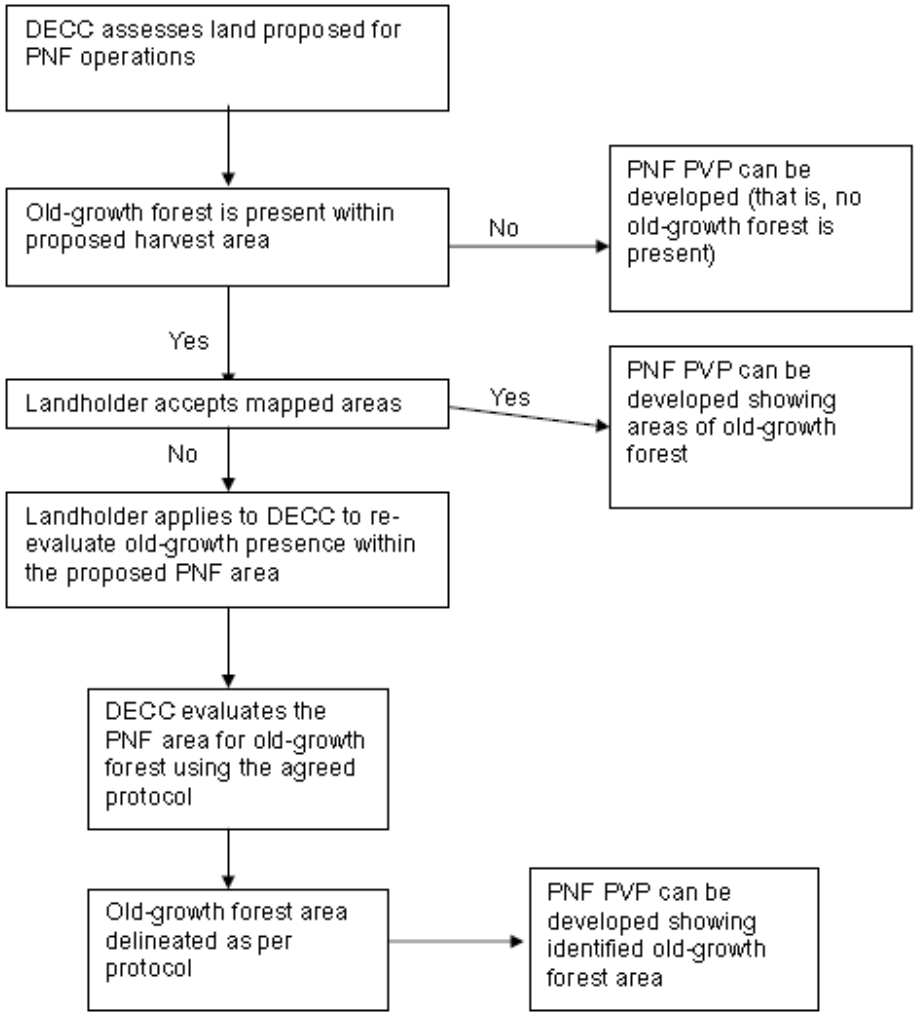

Figure 1: Summary of the process for determining old-growth forest

A three-step methodology for using aerial photo interpretation of old-growth forest is provided. This includes: 1) determining ecological maturity - regrowth, mature and senescing; 2) assigning a disturbance level using indicators as described in CRAFTI; and 3) assessing old growth status.

A field validation technique for validating growth stage and disturbance is then specified. Field work is not necessary but may be initiated by the interpreter where required. Fieldwork involves using a point-to-plant measurement procedure with data recorded on to a specified tabular format ('pro forma'). Sampling rates are also specified.

The protocol does contain some ambiguity and does not include sufficient detail for implementation. DECCW PNF has had to resolve issues during implementation and these have been detailed in the operational document "Aerial Photograph Interpretation and Data Management Practices". These issues are addressed in Chapter 4.

2.1.2 Rainforest Protocol

The rainforest protocol: "Private Native Forestry Code of Practice Guideline No.3 – Protocol for re-evaluating rainforest on private property" was developed in consultation with a range of stakeholders. It sets out the protocol for indentifying and validating rainforest on private land.

The rainforest protocol defines rainforest as:

"Rainforest is tree-dominated vegetation where the tree stratum (over 3 metres in height) which has the greatest crown cover has rainforest species making up 50% or more of the crown cover, except where non rainforest emergent species (including brushbox and turpentine) occur and exceed 30% or more of the upper stratum crown cover".

Rainforest includes all areas of rainforest mappable at a 1:25000 scale. Rainforest also includes areas exceeding 0.5 hectares occurring as isolated clumps or lineal strips of rainforest trees.' The process is represented diagrammatically in Figure 2 (which is figure 2 in the rainforest protocol).

In comparison to the old-growth protocol (12 pages) the rainforest protocol is short (5 pages) which is a reflection of the relative difficulty in mapping old-growth forest. The rainforest protocol also requires relatively few operational decisions for implementation, however some implementation decisions were necessary and these have been addressed by DECCW PNF in the unpublished "Aerial Photograph Interpretation and Data Management Practices". Implementation of the protocol is discussed in Chapter 4.

2.1.3 Aerial Photograph Interpretation and Data Management Practices

The Protocols require assessment of old-growth forest and rainforest for PNF PVPs. Assessment procedures were developed by staff from three different DECCW divisions: Private Native Forestry; Environmental Regulation and Protection Group; and Scientific Services Division. These procedures are detailed in the unpublished operational document: Aerial Photograph Interpretation and Data Management Practices.

This document is comprehensive with detailed arguments and reasoning for selecting particular procedures in implementing the protocols. It is testament to the professionalism of the staff and the importance placed upon accurately implementing protocols.

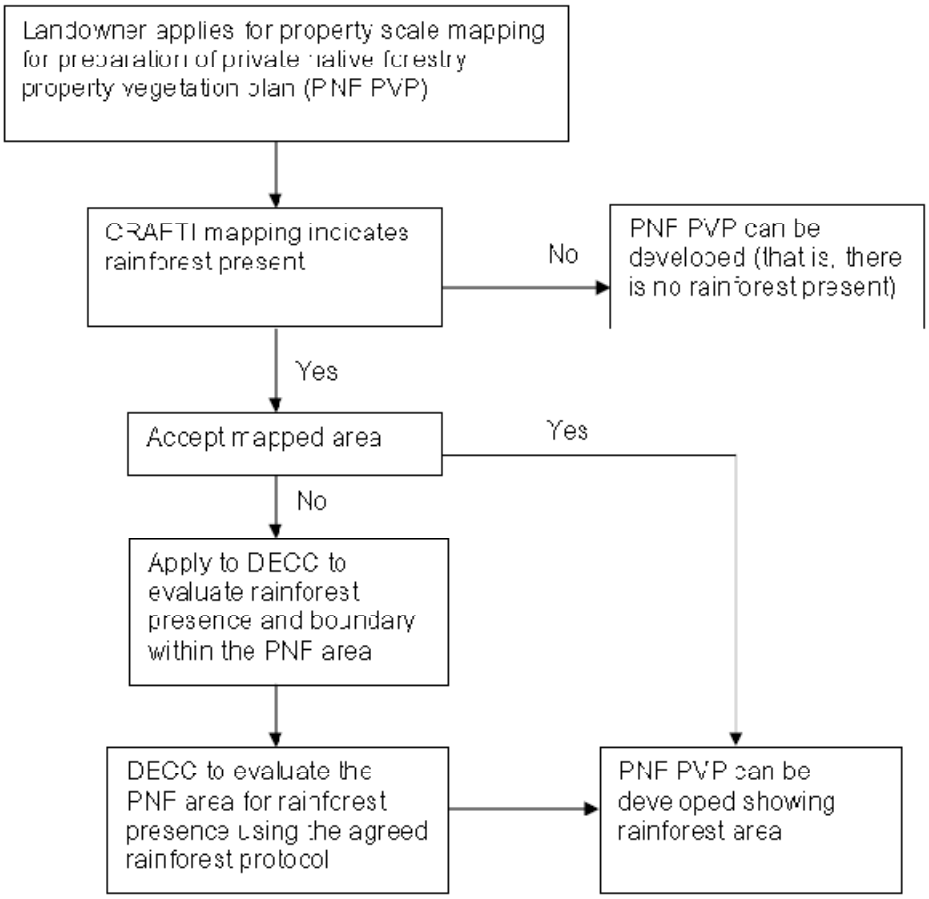

Figure 2: Summary of Rainforest Protocol process

A major consideration is that the mapping to be performed for PNF PVPs has intrinsically different specifications to that employed in CRAFTI. CRAFTI was designed to in the Comprehensive Regional Assessment to inform decisions on public land use, particularly which areas would become part of the reserve system and which would be available for timber production. For example minimum polygon size is smaller, the level of field work is increased, and the level of scrutiny from landholders imposes another source of information on the assessment process.

2.1.4 Guidelines and field verification documents

Documents 4 and 5 provide guidelines for identifying rainforest and old-growth forest.

Document 6 was specifically developed for DECCW PNF to assist in: identification of growth stages for individual trees; identification and quantification of disturbance factors; and calculation of field-gathered data into final decision on growth stage of an area of forest.

These documents detail the technical aspects of identification of rainforest and old-growth. Comprehensive understanding of the concepts explained in these documents is essential to implementing the protocols.

2.2 Selection of Target Properties

A number of criteria were provided for selecting properties to be part of the review:

- Up to 2000 hectares of combined CRAFTI rainforest and old-growth was to be assessed or up to 20 properties
- Target a range of forest types including if possible, Sandstone Plateaux, New England forest types where dieback may be present, dry coastal Mahogany forest types.
- Properties which had the greatest percent change in old-growth and rainforest areas between CRAFTI to PNF PVP assessment.
- Exclude the 16 or so properties south of Sydney for logistic and cost reasons.
- The area/property is currently unlogged as part of the current PVP to allow for field checking.

DECCW Private Native Forestry provided the following spreadsheets containing data to assist in selection properties:

- All PNFcases with OG and RF assessments.xls
- PNFOGRF_ReassessedANDApproved_at19Jan2010.xls
- List of possible PNF cases for QA review.xls

The lead consultant then compiled all the relevant data into one spreadsheet, (ReassessedANDApproved_X_Possible.xls). The spreadsheet was created by combining PNFOGRF_ReassessedANDApproved_at19Jan2010.xls and List of possible PNF cases for QA review.xls.

The properties were sorted based on the amount hectares of combined CRAFTI RF/OG. The range of values was 1568 ha to < 1 ha. Properties that had a total of between 350 and 100 ha of CRAFTI RG/OG were shortlisted. This was required in order to sample a variety of forest types in a range of locations. Too many hectares on one property would decrease the range of forest types sampled.

Shortlisted properties were sorted firstly in descending order of total percent change between CRAFTI RF/OG and DECCW PVP RF/OG, then total area of CRAFTI RF/OG. Twenty-three properties were selected containing a total of 3664 ha of CRAFTI RF/OG, which satisfied both the area and number of property criteria. These properties include areas in New England forest types as well as what are indicated to be Mahogany forest types. Sandstone plateaux forest types (North of Grafton) were also included. Properties were selected from this list with properties at the top of the list being selected first. Some properties were excluded due to reported completion of timber harvesting and the inability therefore to map RF/OG prior to harvest. Ultimately twelve properties were selected by the lead consultant and are shown graphically in Figure 3.

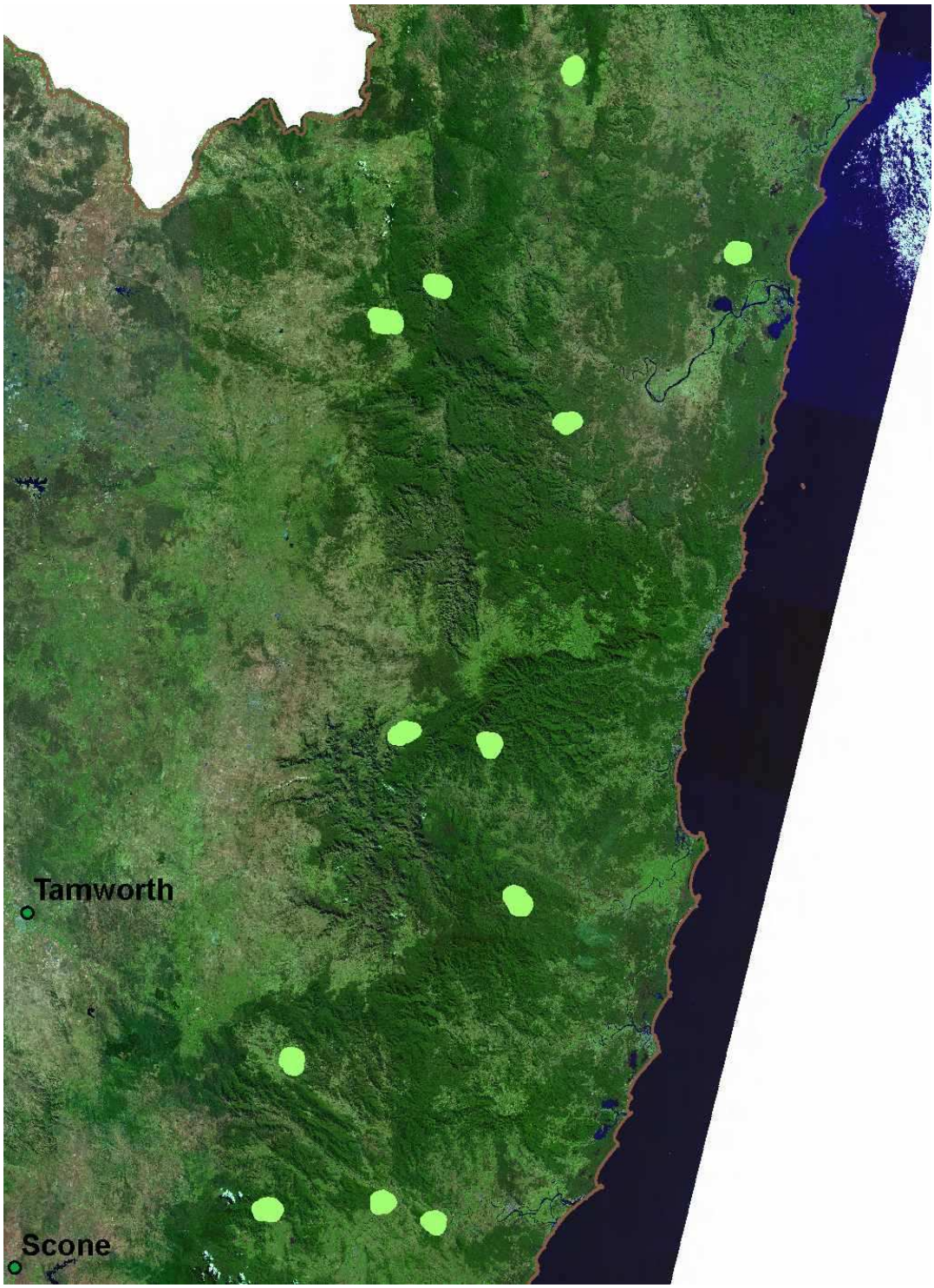

Figure 3: Satellite Image of North-Eastern NSW showing distribution of selected properties.

2.3 API Assessment

2.3.1 Contract Interpreters

Aerial Photo Interpreters were engaged to undertake mapping of rainforest and old-growth using procedures used by DECCW. Initially two north coast-based interpreters were identified by DECCW. DECCW has requirements for Sole Trader contractors to have professional indemnity and public liability insurances, however neither of the nominated contractors had these insurances. As a result of these delays and personal reasons one of the contractors withdrew. A search of available interpreters who had not been involved in preparing PNF PVP rainforest and old-growth revealed that no local interpreters were available. Inquiries were made in Victoria and an interpreter was located. Insurance cover was provided via a sub-contract arrangement through Aerial Acquisitions P/L. Unfortunately delays led to overlap with other contract work that the interpreter and lead contactor had scheduled, which led to further delays e.g. one contractor was only available now to work 2-3 days per week.

Both interpreters have many years experience in mapping forest vegetation from stereo viewing of aerial photos.

API contractor 1 has worked on CRAFTI on the NSW north coast and was also engaged in work for other divisions within DECCW, with significant experience in environmental and ecological applications.

API contractor 2 also worked on CRAFTI on the NSW south coast and has significant experience in Victoria including a range of ecological and forestry applications.

2.3.2 Office-based API

Contract interpreters were instructed to apply the definitions used by DECCW to map rainforest and old-growth in the selected properties. Interpreters were provided with:

- Boundaries of selected properties in ESRI shapefile format - a digital format which allows viewing the boundaries along with other mapped information in Geographic Information Software (GIS) packages.
- Copies of the documents reviewed in section 2.1 – ie. The Protocols and guidelines
- Aerial Photo stereo pair prints covering the target properties.

As is usual practice, interpreters viewed the Aerial photographs using stereoscopes at 2 to 4 times magnification to generate a three-dimensional visual representation of the property which was used to assess the growth stage and disturbance level. Polygons representing areas of similar apparent growth stage and disturbance are delineated on overlays placed over the photographs. These polygons are then digitised into a Geographic Information System to create a shapefile – a digital mapping file format. The location of the polygon is estimated by visually comparing the photo prints with an ortho-rectified image (SPOT5 satellite image or aerial photography). This process is subject to spatial errors of 25m or more.

2.3.3 Stage 2 Field verification

Field verification was undertaken by the two API contractors with the Lead Consultant and support from DECCW Private Native Forestry field officers. The PNF field officers provided access and logistic support along with information about processes used at individual properties.

API contractors briefly inspected each property visited, however transects were not measured. The contractors independently decided on which areas to inspect. While the lead consultant and PNF officers accompanied the contractors to assist with navigation and safety precautions, the contractors acted independently.

Of the 12 selected properties, eight were inspected. Some of the properties were not available for field inspection for various reasons including: the time taken to get there was excessive; the landholder was not available; or the property had changed hands and the PNF PVP was no longer current.

After field inspection both API contractors reviewed their old growth and rainforest mapping and made adjustments as they deemed necessary.

Results from the brief field inspections showed a wide variation between the two contractors. DECCW took a decision to undertake more fieldwork using transects to test DECCW transect methodology and implementation and assist in resolving differences between contract API results. Five properties were visited. At each property DECCW PNF Officers and contractors measured the same transect points independently to provide a direct comparison of transects. Contractors then measured some more transects to inform their assessment before producing their final version of mapping.

The methods used by the contractors were similar but not identical to those used by DECCW due primarily to logistic constraints. For example the contractors were starting with a 'blank canvass', rather than viewing CRAFTI polygons. Also the procedures used by DECCW have changed over the last couple of years to increase efficiency and refine ambiguity in the Protocols.

Figure 4: View of Transect T7-2 on property 7

Figure 5: Transect measurement in action

Figure 6: Stand with high-levels of senescence

Figure 7: Mature or Late Mature? In transect measurement, a single tree can mean the difference between Old-growth or not.

3 Stage 3 Reporting and feedback

3.1 Summary Results

3.1.1 Comparison of Office-based API

The availability of office-based API from the two contractors resulted in four versions of rainforest and old-growth mapping which were based on little or no fieldwork, i.e. the two contract versions, CRAFTI and DECCW pre-field check. Note however the DECCW API was initiated by landholder dispute over the CRAFTI old-growth, and follows field work feedback from other properties. The figures are included to show that API results vary with the amount of fieldwork performed. Overall figures from the four versions of mapping are presented below in Table 1 and Figure 8 (note that one property was assessed only after fieldwork and is included in this data).

Table 1: Summary data after Office-based Contract API

All Property Summary		Assessed Rainforest		Assessed Old-growth		Neither RF or OG	
Source	*Total Area*	*Hectares*	*%*	*Hectares*	*%*	*Hectares*	*%*
DECCW	9466	685	7.2%	318	2.6%	9005	92.6%
API1	9466	436	4.6%	1969	20.8%	6937	73.3%
API2	9466	684	7.2%	1088	11.5%	7694	81.3%
CRAFTI	9466	629	6.5%	1640	16.9%	7452	76.7%

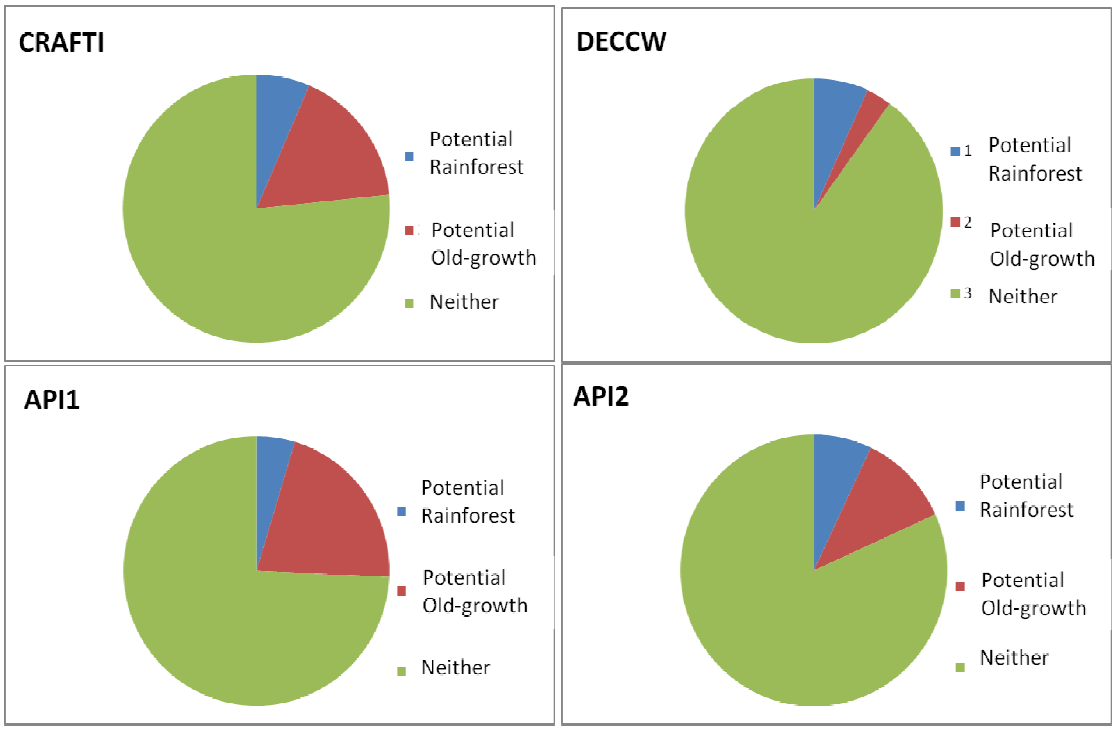

Figure 8: Comparison of total mapped area of rainforest and old-growth forest from four sources after contract office-based API (derived from Table 1).

Office-based interpretation of old-growth forest varied from a low of 318 hectares from DECCW to a high of 1969 hectares from API1. The most obvious conclusion from this data is that office-based API of old-growth forest is highly variable.

Office-based interpretation of rainforest was more consistent, with a low of 436 hectares by API1 and a high of 685 from DECCW.

Along with variation in the total mapped area of rainforest and old-growth the distribution of areas also varied, with rainforest being fairly consistent and old-growth highly variable. Some areas of forest were assessed as old-growth by only one of these versions.

3.1.2 Comparison of Contract API after field work

One office-based version, and versions after two visits to the field resulted in three sets of mapping for each API contractor. The total area of rainforest and old-growth forest for each of these three versions is shown in Table 2 and Figure 9 . The areas identified by the two contractors varied markedly for both the office-based API and the brief field visit. Once transects were measured the total area of rainforest and old-growth forest became similar.

Table 2: Summary of total area of rainforest and old-growth for each of three versions of API for each contractor.

API		Mapped Rainforest		Mapped Old-growth		Neither RF or OG	
Source	*Total Area*	*Hectares*	*%*	*Hectares*	*%*	*Hectares*	*%*
API1 V1	9466	436	4.6%	1969	20.8%	7060	74.6%
API2 V1	9466	684	7.2%	1088	11.5%	7694	81.3%
API1 V2	9466	451	4.8%	2127	22.5%	6887	72.8%
API2 V2	9466	700	7.4%	318	3.4%	8447	89.2%
API1 V3	9466	469	5.0%	1024	10.8%	7973	84.2%
API2 V3	9466	513	5.4%	923	9.7%	8031	84.8%

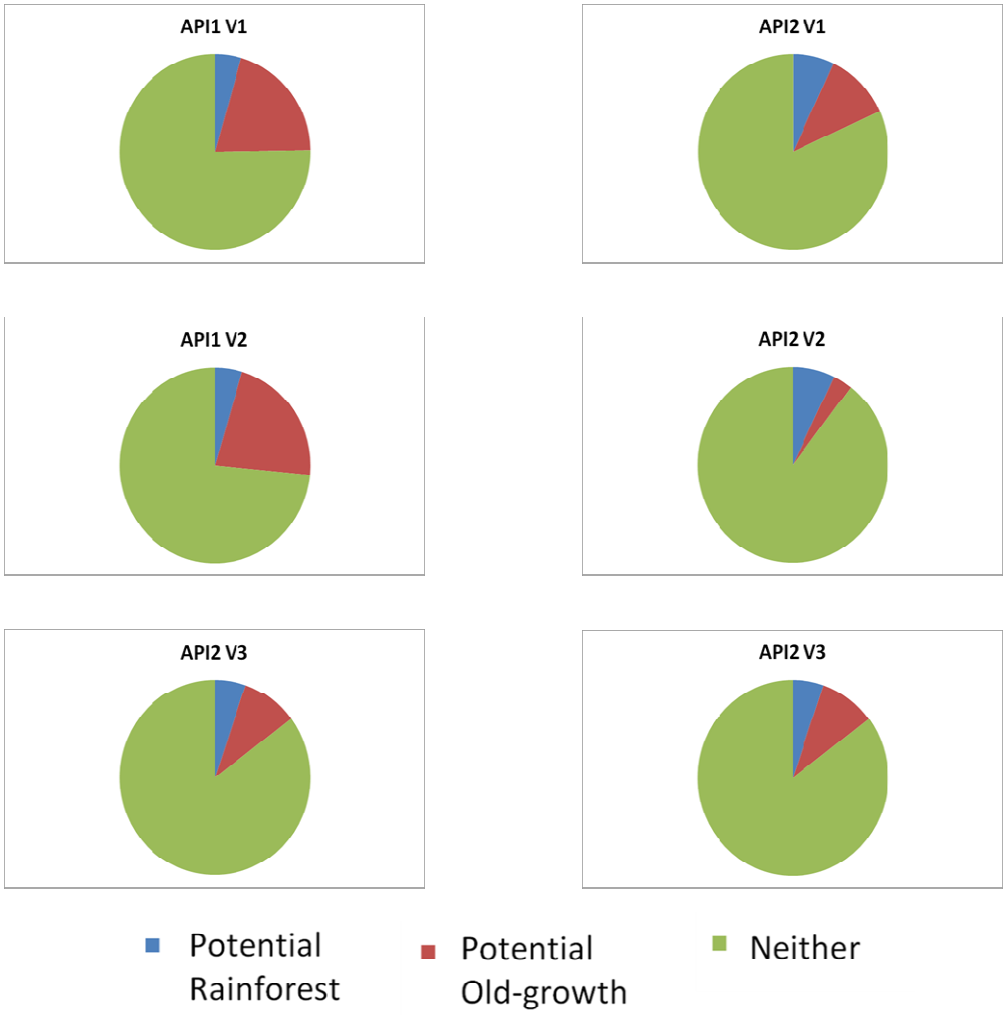

Figure 9: Total areas of rainforest and old-growth forest after three versions of API from each contractor

Although the total area of assessed rainforest and old-growth converged after field work, the areas had limited overlap. See section 3.1.3 for more information on this observation.

3.1.3 Comparison of Post-field work Assessment

Summary data for the final assessments for CRAFTI, DECCW, API1, and API2 are presented below in reduced.

Table 3 and Figure 10. Assessed Old-growth forest ranged from a low of 253 Ha by DECCW to a high of 1475 from CRAFTI. Assessed rainforest ranged from a low of 464 by DECCW to a high of 570 by from CRAFTI. However the distribution of assessed rainforest and old-growth was highly variable. Final old-

growth and rainforest assessments for CRAFTI, DECCW, API1, and API2 were compared in GIS (Geographic Information System) software to assess this variation. This data is summarised in the Table 4 and Table 5 below, and is presented graphically as individual property summaries in Section 3.2. Note that assessment by the Contractors and CRAFTI was not subject to scrutiny and potential dispute by the landholders, it is expected that if they were, the amount of old-growth would be further reduced.

Table 3: Total areas assessed after field work.

API		Mapped Rainforest		Mapped Old-growth		Neither RF or OG	
Source	*Total Area*	*Hectares*	*%*	*Hectares*	*%*	*Hectares*	*%*
CRAFTI	9466	570	6.0%	1475	15.6%	7422	78.4%
DECCW	9466	464	4.9%	253	2.7%	8750	92.4%
API1 V3	9466	469	5.0%	1024	10.8%	7973	84.2%
API2 V3	9466	513	5.4%	923	9.7%	8031	84.8%

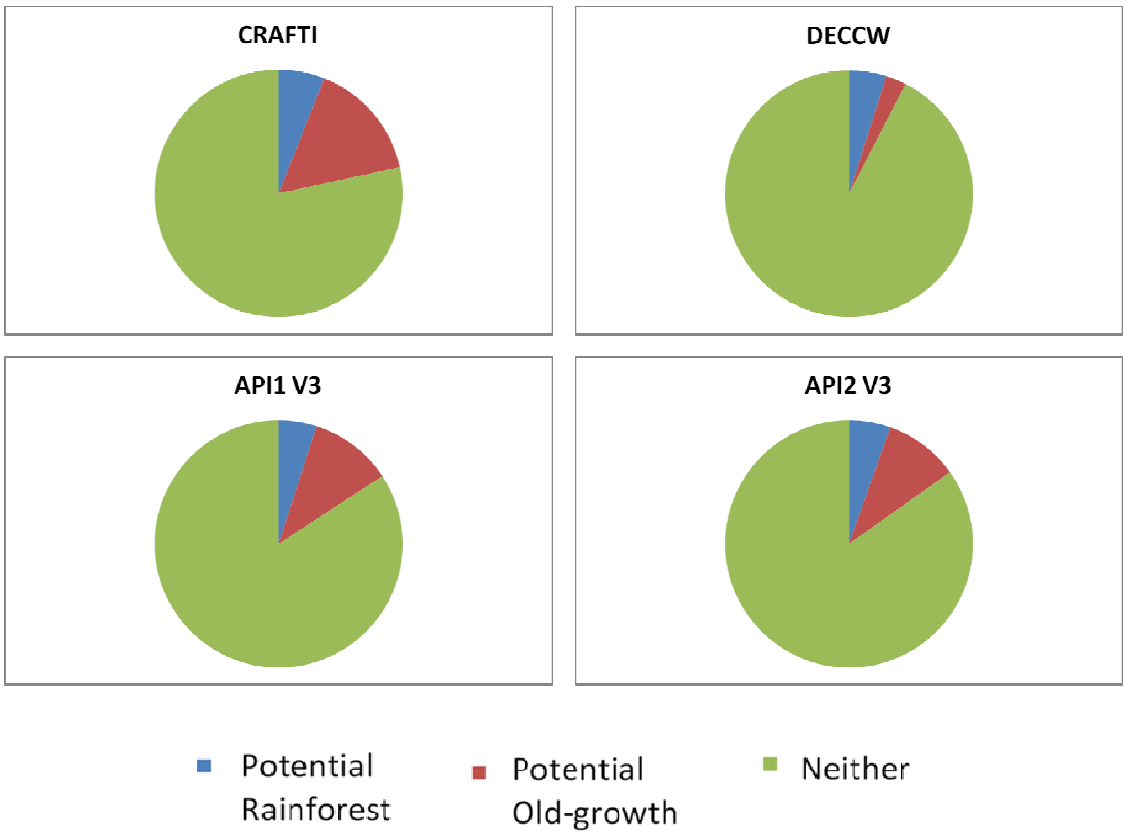

Figure 10: Total areas of Rainforest and old-growth forest for final assessment after fieldwork.

Tables 4 and 5 present the results of overlaying the different assessments, and answer the question: what is the area in common between different versions of API?. Table 4 shows for example that the area assessed as old-growth forest by both CRAFTI and API1 was 456 Ha, which is 31% of the total area assessed by CRAFTI as old-growth, and 45% of the total area assessed by API1 as old-growth.

Table 4: Area and percentage of overlap between different old-growth assessments.

Old-growth	CRAFTI		API 1		API 2		DECCW		Overall	
Area (ha)	1470		1024		923		253		2386	
	Area (ha)	Percent	Area (ha)	Percent	Area (ha)	Percent	Area (ha)	Percent	Area (ha)	Percent
Area and % overlap with Crafti	na	na	456	45%	350	38%	166	66%	na	na
Area and % overlap with API 1	456	31%	na	na	347	38%	135	53%	na	na
Area and % overlap with API 2	350	24%	347	34%	na	na	40	16%	na	na
Area and % overlap with DECCW	166	11%	135	13%	40	4%	na	na	na	na
Area overlap of API1, API2 and DECCW	na	na	na	na	na	na	na	na	18	1%
Area overlap of API1, API2 and DECCW with Crafti	na	na	na	na	na	na	na	na	15	1%

Table 5: Area and percentage of overlap between different rainforest assessments

Rainforest	CRAFTI		API 1		API 2		DECCW		Overall	
Area (ha)	570		469		512		463		843	
	Area (ha)	Percent	Area (ha)	Percent	Area (ha)	Percent	Area (ha)	Percent	Area (ha)	Percent
Area and % overlap with Crafti	na	na	354	75%	350	68%	390	84%	na	na
Area and % overlap with API 1	354	62%	na	na	309	60%	320	69%	na	na
Area and % overlap with API 2	350	61%	309	66%	na	na	324	70%	na	na
Area and % overlap with DECCW	390	68%	320	68%	324	63%	na	na	na	na
Area overlap of API1, API2 and DECCW	na	na	na	na	na	na	na	na	256	34%
Area overlap of API1, API2 and DECCW with Crafti	na	na	na	na	na	na	na	na	244	29%

Only 15 Hectares of forest was assessed by all four versions as old-growth, which is approximately 1% of the cumulative total area assessed as old-growth.

Results for rainforest assessment are relatively consistent with a DECCW/CRAFTI agreement level of 84% and an API1/2 agreement level of 68%. Note that API2 is less experienced in identifying NSW north coast rainforest. Agreement levels increased after fieldwork and would likely achieve a higher level as experience increased.

3.1.4 Factors Contributing to High Levels of Variation in Old-growth Forest Assessment

The main reasons for the variability of old-growth mapping are:

- The intrinsic variability of Aerial Photo Interpretation
- The difficulty in interpreting old-growth forest particularly on low-quality photography
- Limited fieldwork by Aerial Photo Interpreter
- The fact that the DECCW was subject to another round of landholder review

3.1.4.1 Variability in Aerial Photo Interpretation

Variability in Aerial Photo Interpretation has been noted in the scientific literature for decades. In numerous scientific studies interpretation results have been shown to vary between individuals and by one individual on different days – results that are borne out by the data in this study.

Variability is related to the ease of interpretability of particular features. It is very easy to distinguish houses from pasture, a lake from a plantation, or forest from non-forest. It is significantly more difficult to distinguish Old-growth forest from disturbed Old-growth forest, especially where the disturbance is older than ten years.

In order to minimise variation it is important to improve what can be influenced – image quality and fieldwork.

3.1.4.2 Image Quality

All the properties in this study were assessed using older, film-derived photograph prints. Compared to digital imagery from the current range of digital sensors, these photography prints are low quality. Figures 7 and 8 below show the contrast in quality between older film-based imagery and new digital imagery.

Digital Imagery also has the advantage that when used on screen, zoom levels can be very high and colour can be adjusted. Both the images below are shown at a scale of approximately 1:1500, however when using photographic prints and a stereoscope with 4-times magnification, scale is limited to about 1:6000.

Higher levels of spatial accuracy can also be achieved using digital imagery onscreen to do interpretation. Using prints and felt-tip markers - a polygon line of 1 mm wide translates to a width on the ground of 25 metres. Using digital imagery on-screen allows capture of polygon lines to be accurate to approximately 5 metres.

Use of digital imagery in a 3-dimensional stereo environment has been available since around 2000 and has recently got significantly cheaper with the availability of 3D capable liquid crystal display (LCD) panels. Provision of recent 3D digital imagery interpreted in a digital 3D on-screen environment will help maximise accuracy of interpretation. Given that some of the API is performed under contract, and that most contractors do not have their own 3D GIS software and hardware, it is likely that to achieve this, DECCW will need to allow contractors to use DECCW hardware and software.

Field work using stereoscopes can be performed using digital imagery. It is simpler to do this with digital frame cameras, but is also possible with ADS40/80 imagery. Field work with digital imagery has the advantage that prints can be produced at whatever scale the interpreter prefers and navigation can be supported by having a two-dimensional version of the imagery loaded onto handheld GPS. It is

Figure 11: Example of 15 cm GSD (Ground Sample Distance – equivalent to pixel size) image produced from a Vexcel UltraCamD digital camera. Approx. scale = 1:1500

Figure 12: Example of scanned 1:25 000 film image – from NSW LPMA. Approx. scale = 1:1500 (Note these images are not the same location)

technically possible to have a stereo 3D image loaded onto a laptop computer in the field however the practicalities of doing this – e.g. damage to laptops; adequate backlighting; problematic glare; linking stereo software to GPS - are yet to be overcome in a cost-effective manner.

There are numerous commercial providers of digital imagery, though DECCW appear constrained to primarily use Land and Property Management Authority imagery. This does result in use of imagery (and other remote sensing data) that is not acquired with specifications tailored towards particular end-uses. The Victorian Government's Coordinated Imagery Program is a useful model in which the end users of the imagery decide on specifications such as pixel size and scheduling suited to their application.

In order to improve the rigor, repeatability and reliability of the aerial photo interpretation it is recommended that DECCW use 3D-stereo digital imagery that is less than five years old. Where such imagery is not available, acquisition of new imagery is recommended.

Recommendation 1: Use 3D-capable digital imagery captured within the last five years with one of the new range of digital sensors, and interpreted on-screen in a 3D environment. Acquire new imagery where such imagery is not already available.

3.1.4.3 Landholder Review

A factor contributing to the difference in results between CRAFTI, API1, API2 and DECCW is that in four cases the landholder disputed the assessment by DECCW and requested field validation. This involved additional field work (or was included in initial field work in the case of property 11) targeted at areas where the landholder had recollection of logging. None of the other assessments were subject to this procedure which would have the effect of reducing DECCW assessed old-growth relative to the other assessments.

3.1.4.4 Fieldwork

Fieldwork is an essential component of identifying and delineating difficult-to-interpret features. All the experienced native vegetation/ forest interpreters known to the author, baulk at the idea of interpreting old-growth without fieldwork. In some cases the level of disturbance on private property will mean that old-growth can be reliably excluded without fieldwork because the forest structure is in easy-to-recognise stages such as recent logging, even-aged regrowth or plantation. However where forests are multi-aged and disturbance is getting older than about ten years interpretation becomes difficult and reliability decreases.

The person doing the interpretation needs to go to the field. Forest varies enormously in expression of structural characteristics. In property 2 where the comparison transect was measured, the stand was dominated by large eucalypts with an even-aged understorey of wattle. From an office-only interpretation it is likely that the shaded wattle understorey could be interpreted as being eucalypt regrowth. It was only upon visiting the field that the nature of the understorey was revealed and a correct interpretation made.

Similarly in the south-east of property 7, the stand appeared on the photography to have a two-aged structure. There were large emergent crowns, above a secondary layer of smaller, rounder crowns. Upon

field inspection it became obvious that the large trees were Blackbutt emergents over a layer of shorter, but mature layer of species such as Turpentine, Bloodwood and Grey Gum.

In the south-west of property 7, what looked to be an intact canopy on the (low-quality) imagery was even-aged Blackbutt that had regrown from a ring-barking event, probably post-second world war.

As interpreters get to know the history of an area, as revealed in the forest structure of today, the reliability and efficiency of API will increase – however this must be based on the interpreter doing fieldwork to really get an appreciation of prevailing forest structure conditions and appearance on the photography.

Use of cruise sampling is suggested to increase field-work efficiency. Cruise sampling involves walking through a target area, stopping periodically and estimating the parameters of interest - in this case disturbance indicators and growth stage percentages. Estimates are calibrated by transect measurement and where visual estimates have low confidence, transects would be measured. By combining cruise sampling with field-based aerial photo navigation, disturbance event boundaries - such as the limit of old clearing or logging - can be identified on the ground and on the photo. If these boundaries are visible as structural variation from the aerial photo perspective, then they can be reliably interpolated based on photo appearance.

In the current methods used by DECCW the interpreters doing the assessment rarely go to the field. In order to improve the rigor, repeatability and reliability of the aerial photo interpretation it is recommended that fieldwork be significantly increased particularly where CRAFTI old-growth is being re-assessed out of old-growth and where these decisions are based on interpreting older disturbance in mixed-age forests.

Recommendation 2: Aerial Photo Interpreters undertake field work for old-growth and rainforest assessment, particularly where altering CRAFTI old-growth status is likely, and in mixed-aged forests where disturbance is older than 10 years.

3.1.5 Problem Forest Types

DECCW nominated these specific forest types as being particularly difficult: New England forest containing dieback; Sandstone plateaux; white mahogany ridges in coastal foothills.

While it is acknowledged that these forest types are difficult to assess, the solution is for the aerial photo interpreter to do more fieldwork. Unanticipated forest structure is to be expected and using stereo photography in the field is the only way to target field work to pick up the variation.

3.1.5.1 Accreditation of Interpreters

Over many years of doing aerial photo interpretation and supervising API projects, it has become apparent that there has been a large range in the aptitude and experience of people engaged to do API.

It is suggested that DECCW consider implementing an accreditation process for people to be engaged to do API that requires expertise in forest/native vegetation mapping. This is outside the scope of this study and is hence not given recommendation status.

3.1.6 Comparison of DECCW and Contractor Transect Measurements

Five transects were measured by both DECCW PNF Officers and API Contractors to be used to assess reliability and repeatability of transect measurement. All measured transects are presented in Appendix 2. A summary of the data collected is presented in Table 6. The first point of each transect was measured with discussion between contractors and PNF Officers. The remainder of the comparison transects where measured with DECCW PNF officers acting independently of the contractors. The contractors assisted each other in measuring transects and making decisions on growth stage. It would have been preferable to have the contractors act independently however we did not have the necessary field labour to achieve this.

Contractors utilised the DECCW PNF procedures and support documents before and during transect measurement.

Regrowth, mature and senescent relative crown cover percentages were generally similar between the two measurements, except for the senescent estimate on transect T7-1, were DECCW measured 1.8 % and contractors measured 13%. In this case the stand was a lower site-quality and many of the dominant canopy trees were around the mature/late mature boundary. This does reflect a difference is assessing this critical boundary on this transect, and highlights the need to regularly recalibrate growth-stage assessment. However the data did not show systematic difference between DECCW PNF Officers and contractor assessment of mature/senescence across all transects.

Senescence classes (i.e. A > 30%, B 10% - 30 %, C < 10%) were the same for both crews on three transects, with DECCW recording a higher senescent class (B compared to C) on transect T8-1, and the contractors recording a higher senescence class (B compared to C) on transect T7-1.

All transects measured by both crews resulted in trace (less than 10%) levels of regrowth.

Disturbance counts were the only measure that showed any systematic difference between the two crews, with DECCW recording a total disturbance count of 26 and the contractors 18 across the five transects, being higher on three transects and the same on two. However while the total count did show this variation, there was no impact on the outcome. In all transects, the Contractors and DECCW measured transects recorded the same disturbance rating. Disturbance count differences does highlight some ambiguity in transect assessments. In the comparison transect on property 11 (T11-1), an old constructed track meandered in and out of the transect. The contract crew only recorded the track once, even though it appeared at more than one point. The DECCW crew recorded it any point in which it occurred. Whether or not to include a single constructed track at many points in a transect needs to be clarified. Also on this transect, the contract crew missed seeing a group of three stumps, which DECCW PNF officers noted 'you would have to be standing on to see it' as it was covered by vegetation. This highlights the need for diligence in searching for disturbance factors.

During fieldwork there was some discussion as to whether 6 or more entries in the disturbance table constituted significant disturbance. This was referred to as '6-across' the table or '6 up' the table. It was concluded that the correct interpretation was the disturbance had to be observed at more than 50% of points (i.e 6 out of a 10 point transect) to qualify as significant.

The final growth stage assessment ("PNF Growth Stage") was the same in three transects. However, in terms of affecting exclusion from harvesting, the only difference is T7-1, in which the DECCW result

would make the area available for harvest but the contract API would result in exclusion as PNF Old-growth. Given the difficulty in reliably assessing growth stage between observers and even by a single observer at different times, this is a good result. However assessment of tree growth stage may 'drift' over time, and therefore it is essential that regular calibration exercises are undertaken by officers undertaking transect measurement, and that calibration exercises be performed with officers outside DECCW PNF, preferably from DECCW EPRG group.

Table 6: Summary data from transects measured by both DECCW and API Contractors

Transect	Crew	Regrowth	Mature	Sensescent	Growth Stage	Disturbance Count	Disturbance Rating	PNF Growth Stage
T8-1	DECCW	1.4	86.7	11.9	TB	10	Significant	Disturbed Old Growth
T8-1	Contract	0.7	91.6	7.7	TC	7	Significant	Disturbed Mature Forest
T11-1	DECCW	0.1	83.8	16.1	TB	5	Not Significant	PNF Old Growth
T11-1	Contract	0.2	76.9	22.9	TB	2	Not significant	PNF Old Growth
T2-1	DECCW	3.6	85.3	11.0	TB	1	Not Significant	PNF Old Growth
T2-1	Contract	0.9	88.7	10.4	TB	1	Not significant	PNF Old Growth
T7-1	DECCW	0.2	98.0	1.8	TC	0	Not Significant	Mature Forest
T7-1	Contract	0.4	86.5	13.0	TB	0	Not significant	PNF Old Growth
T9-1	DECCW	1.0	46.6	52.4	TA	10	Significant	Disturbed Old Growth
T9-1	Contract	4.5	34.1	61.5	TA	8	Significant	Disturbed Old Growth

Recommendation 3: Undertake annual old-growth and rainforest field assessment calibration exercises with EPRG staff, to ensure transect measurement is being carried out consistently.

3.1.7 Comparison of Transect Results and DECCW Old-Growth Assessment

The table below shows the measured PNF growth stage results for each transect. Five comparison transects were measured by both DECCW and Contractors. Two additional transects were measured by the Lead Consultant and two were measured by the Contractors as part of their own field investigations.

All of the transects were measured in areas that had been assessed as not PNF old-growth. Of the 5 comparison transects, two (T2-1, T11-1) were measured as PNF Old-growth by both DECCW and Contractors, and one (T7-1) was measured as PNF Old-growth by the Contractors by not DECCW.

Of the four transects measured by the Lead Consultant and Contractors, two were measured as PNF Old-Growth.

Table 7: : Transect results, Note that all transects where measured in forest assessed as not PNF Old-Growth by DECCW

Property	Transect	Type	Measured by	Growth Stage	Distrubance Count	Disturbance Rating	Growth Stage
2	T2-1	Comparison	DECCW	TB	1	Not Significant	PNF Old Growth
2	T2-1	Comparison	Contract	TB	1	Not significant	PNF Old Growth
7	T7-1	Comparison	DECCW	TC	0	Not Significant	Mature Forest
7	T7-1	Comparison	Contract	TB	0	Not significant	PNF Old Growth
7	T7-2	Field work	Lead Consultant	e	5	Not Significant	Young Forest
7	T7-3	Field work	Contractors	TB	0	Not Significant	PNF Old Growth
8	T8-2	Field work	Lead Consultant	TB	7	Significant	Disturbed Old Growth
8	T8-3	Field work	Contractors	TA	4	Not Significant	PNF Old Growth
8	T8-1	Comparison	DECCW	TB	10	Significant	Disturbed Old Growth
8	T8-1	Comparison	Contract	TC	7	Significant	Disturbed Mature Forest
9	T9-1	Comparison	DECCW	TA	10	Significant	Disturbed Old Growth
9	T9-1	Comparison	Contract	TA	8	Significant	Disturbed Old Growth
11	T11-1	Comparison	DECCW	TB	5	Not Significant	PNF Old Growth
11	T11-1	Comparison	Contract	TB	2	Not significant	PNF Old Growth

Transect measurement measured on properties 2, 7, 8 and 11, resulted in PNF old-growth classification in areas that were not identified by DECCW assessments as being old-growth. Transect measurement by DECCW PNF Officers were found to have a high level of consistency with the Contractors. Therefore the reason that old-growth is being missed is not transect measurement – it is that office-based API is not effectively directing transect measurement because of unreliable identification of potential Old-growth. This highlights the main issue with the whole process - Aerial Photo Interpretation of difficult-to-recognise features requires that the interpreter undertake fieldwork to increase accuracy and reliability. This is addressed in Recommendation 2.

3.1.8 Utility of CRAFTI Data

It is disturbing that such a high level of variability is apparent in different versions of old-growth assessment. This variation is certainly also within CRAFTI data. CRAFTI data is currently used by DECCW procedures to filter out properties where CRAFTI indicates that PNF Old-Growth forest is not present. It is unquestionable that areas of old-growth forest exist that were not mapped during CRAFTI, and therefore that the current procedures may make some areas of old-growth available for harvest.

The majority of cases old-growth forest has been left unlogged for reasons such as: it is not economically viable because of species that are not favoured for milling, or the areas are inaccessible - and generally these conditions prevail and mean it will not be harvested. This observation however increases the value of any areas of commercial/accessible forest that remain in the old-growth condition.

Use of CRAFTI data as a filter for identifying which properties to apply the old-growth protocol is not supported by this study. This study has shown high variability in aerial photo interpretation results particularly in office-based API of old-growth – an observation that is supported by numerous scientific papers. Variability and inaccuracy is greatest where old-growth API is undertaken without adequate field-work. CRAFTI interpreters had very little access to private property – it was not supported by significant field-work. Additionally CRAFTI was applied with precautionary principle guidelines to identify

'Candidate Old-Growth'. Although CRAFTI was the best information at the time and was useful in reserve selection decision-making, it is not appropriate to use it for regulation on private property. There are areas of old-growth outside CRAFTI and much of the area mapped as candidate old-growth is clearly not old-growth due to both inaccuracy and variability in the initial mapping, as well as disturbance since completion CRAFTI.

It is suggested that all PNF PVP properties are subject to old-growth assessment regardless of the presence of CRAFTI old-growth. This issue is outside the scope of this review and hence is not a recommendation, however it is highlighted for consideration.

3.1.9 Integrity of CRAFTI Data

The CRAFTI data set covers all native forests across all tenures, over the mapped areas in the Upper and Lower North East regions. During the current processes, where the re-assessment assigns polygons out of old-growth status due to growth stage or disturbance that was not mapped during CRAFTI, those polygons are effectively incorrect however an updated code is not assigned. This creates holes or voids in the CRAFTI data set. It would be preferable that the whole property was assigned new codes to all of the property to maintain a complete coverage of up-to-date data.

It is recognised that this issue is complex and beyond the scope of the Review. Hence it is not included as a recommendation, however is highlighted as an issue for DECCW as custodian of the CRAFTI data.

3.1.10 Peer Review

Peer review of API was routinely undertaken during both the Broad Old-Growth Mapping project and CRAFTI. In order to maintain confidence in the reassessment of old-growth forest and rainforest, and provide feedback to inform the on-going process it is recommended that a 10% sample DECCW PNF PVP be peer-reviewed.

Recommendation 4 : Initiate a peer-review process of old-growth and rainforest assessment for sample of PVPs (e.g 10%).

4 Addressing Terms of Reference

4.1 Consistency and accuracy of PVPs as they relate to rainforest and old growth assessment procedures developed to implement the protocols.

Analysis of the data collected by this review show that consistency and accuracy of PVPs is shown to be very high for assessing rainforest however the old-growth assessment is problematic. Transects measured on properties 2, 7, 8 and 11 indicate the presence of old-growth outside the area mapped by DECCW, indicating inaccuracy in old-growth assessment. The main issue for old-growth assessment is that the fieldwork for aerial photo interpretation is inadequate. This can be improved by following recommendations 1 and 2 by using good quality up to date imagery and increasing fieldwork.

4.2 Adequacy of DECCW processes to accurately represent the intent of the protocol and to provide sufficient and detailed documentation to justify assessment decisions.

Analysis of the data collected by this review show that the processes used by DECCW accurately represent the intent of the rainforest protocol however do not accurately represent the intent of the old-growth protocol, mainly due to use of low-quality imagery and lack of API fieldwork. The documentation provided is excellent and there was little difficulty in tracing back through the procedures used.

4.3 Rigor, repeatability and reliability of the aerial photo interpretation and field assessment processes, with reference to pre-cautionary field validation.

Rigor repeatability and reliability of aerial photo interpretation for rainforest assessment is very good.

Rigor repeatability and reliability of aerial photo interpretation for old-growth assessment is a problem that needs to be addressed, indicated by: the measurement of PNF old-growth transects outside the area assessed by DECCW; and the high level of variability between versions of API. The aerial photo interpretation procedure lacks adequate field work and the old film-based prints are difficult to interpret.

Office-based API assessment for mapping areas out of old-growth should be limited to easy-to-recognise stand features such as recent logging, obvious mining/clearing disturbance, and greater than ten percent regrowth. Given the inconsistency in assessing old-growth demonstrated by large variation in total area and location by all versions of API, the pre-cautionary principle needs to be more strictly applied. The decision to map areas as ‘not old-growth’ due to older logging or disturbance should only be taken with the support of adequate field-work, not purely on the basis of office-based API.

The rigor repeatability and reliability of field assessment procedures is very good. However the location of old-growth assessment field work is not being adequately directed by office-based API.

4.4 Any areas of the protocol that are ambiguous or unclear.

The rainforest protocol is clear and simple to apply.

The old-growth protocol does contain ambiguity though most of these are technical details that do not have a great influence, and have been resolved by DECCW during implementation. For example:

- Page 5: "Latest available colour 1:25,000 scale aerial photographs will be used to interpret the growth stage …"

  NSW LPMA moved away from capturing 1:25 000 prints and now are using newer, superior Leica ADS series digital imagers which is being used where available.

- Page 7: " the minimum transect length is 10 points at a 50-metre spacing along a straight line …" .

  Some polygons will not have a length that will allow a 450 metre transect. Also a straight line may not be a representative sample of the polygon. DECCW procedures allow for deviation from a straight line. The minimum transect length of ten points is becomes redundant if the first 6 points show disturbance – DECCWs procedures allow a transect to be deemed complete if disturbance is demonstrated to be at more than 50% of points, before ten points are measured (e.g. the first 6).

- A disturbance indicator on page 9 under point 2 includes this statement for older logging:

  "This indicator therefore must be a combination of stumps over 40 centimetres in diameter **and** gaps **and** clusters **or** regrowth **or** thick regeneration of native pioneers or weeds"

It seems that the wording should be clusters '**of**' regrowth rather than '**or'.** Application of this indicator is ambiguous because the term 'cluster' is not well defined.

4.5 Any other observations about the adequacy of DECCWs approach to identify and therefore achieve (achieving) protection of rainforest and old-growth.

DECCWs approach to achieving the protection of rainforest is effective.

The approach to protection of old-growth is problematic. The main failings of the current procedures are the use of low-quality old imagery and the lack of fieldwork for API. The remainder of procedure including field transect measurement and documentation are excellent.

4.6 Recommendations on changes to DECCW procedures to address any issues identified above.

4.6.1 Recommendation1:

Use 3D-capable digital imagery captured within the last five years with one of the new range of digital sensors, and interpreted on-screen in a 3D environment. Acquire new imagery where such imagery is not already available.

4.6.2 Recommendation 2:

Aerial Photo Interpreters undertake field work for old-growth and rainforest assessment, particularly where altering CRAFTI old-growth status is likely, and in mixed-aged forests where disturbance is older than 10 years.

4.6.3 Recommendation 3:

Undertake annual old-growth and rainforest field assessment calibration exercises with EPRG staff, to ensure transect measurement is being carried out consistently.

4.6.4 Recommendation 4:

Initiate a peer-review process of old-growth and rainforest assessment for sample of PVPs (e.g 10%).

Murray Webster 30/11/2010