Private Native Forestry Old-growth and Rainforest Re-evaluation by Scientific Services Division

AERIAL PHOTOGRAPH INTERPRETATION AND DATA MANAGEMENT PRACTICES

August 2009 (with minor corrections January 2010)

Aerial Photograph Interpretation Practices

Implementation Practices

Re-evaluation of PNF Old-growth and Rainforest mapping is undertaken according to the following implementation practices. Appendix A discusses how these practices have been developed in order to meet the mapping outcomes required by the PNF Code of Practice's Guidelines.

Area assessed for Old-growth and for Rainforest

- The area of assessment for PNF Old-growth forest and Rainforest is the entire property for which the PVP is made, defined by cadastral parcels. Assessment for the entire property is initiated by a landholder challenging any part of the previous mapping on the property, regardless of whether it is Old-growth or Rainforest mapping. In all cases, assessment is made of both previously mapped and unmapped areas. Both PNF Old-growth forest and Rainforest areas are re-mapped where they occur. Where Old-growth is found near the boundary of a property, assessment needs to extend outside the property in order to determine if the total area of Old-growth, inside and outside the property, exceeds 5 ha. The revised map is issued by the Department for the entire property. It shows areas where Old-growth or rainforest have been found to occur. The map also shows areas within the property boundary where assessment has found that these forest types do not to occur.

Old-growth forest re-evaluation

- The growth stages of regrowth and senescence are defined by API according to the descriptions in *Notes – PNF Old Growth Forest Field Verification* (Department of Environment and Climate Change, 2007a)

- A polygon is disturbed if any of the forms of disturbance listed in Table 1 of the Old-growth Protocol (Guideline No. 2) is observed by API to occur over 50% or more of the area of the polygon. The form of disturbance is to be recorded (by code letter or in text) for the polygon in the API report or in the GIS attribute table.

- Only a conjoined area of 5 ha or more in size will be mapped as an Old Growth Forest polygon. If an Old Growth Forest area crosses a property boundary, the total extent of the conjoined Old Growth Forest area, within and outside the property, is used in determining the 5ha threshold. However, only that part of an Old Growth Forest polygon that falls within a property boundary (which may be less than the 5ha threshold) will be displayed on the property's map

Rainforest re-evaluation

- To be rainforest, vegetation does not need to have a continuous canopy, but it does need to be tree dominated. Vegetation is tree dominated where more than 50% of the vegetation cover is provided by trees (woody plants more than 3m in height with a single stem or branches well above the base).
- Only rainforest areas that exceed 0.5ha are mapped.
- Viney Scrub (Forest Type 26 of Research Note 17) will not be mapped as Revised PNF Rainforest.
- All Rainforest should be mapped as polygons as far as possible:
  - Where a rainforest area exceeds 2 ha it is to be mapped as a polygon;
  - Where a rainforest area is less that 2ha and more that 0.5ha, and cannot be suitably mapped as a polygon (for example, mapping is being done onto a plastic overlay rather than by on-screen digitising into a GIS), then:
    - ➢ if greater than 200m long and less than 100m wide, the area can be mapped as a line;

> ➤ if less than 200m long, the area can be mapped as a point.

- In determining the 0.5ha mapping threshold, the total extent of the Rainforest area is considered, within and outside any property boundary that intersects it, but only that part of the Rainforest area that falls within a property boundary (which may be less than the 0.5ha threshold) will be displayed on the property's map.

Field Inspection

In determining the need for additional evidence from field inspections to support API:

- Field inspection is to be recommended for those areas that cannot be mapped-out with confidence and where API alone cannot clearly observe the presence of all defining attributes needed for an identification of Revised PNF Old-growth or Revised PNF Rainforest. A forest area can be confidently mapped-out if a clear presence can be observed on an aerial photograph of:
  - for Revised PNF Old-growth: more than 10% regrowth or more than 50% disturbance;
  - for Revised PNF Rainforest: non rainforest emergent species (including brushbox and turpentine) exceeding 30% of the upper stratum crown cover.

Results from field inspection are to be used by the API officer as feedback to assist in future mapping and to make any necessary adjustments to current mapping.

In targeting field inspections for quality assurance purposes, priority areas are:

- large areas of previous CRAFTI mapping that would be mapped-out;

- forests with high canopy covers;

- forests where canopy gaps may occur naturally, rather than as a result of disturbance (eg sandstone landforms)

- forest ecosystems classified as "regionally significant" in a draft Regional Vegetation Management Plan (rare, endangered and vulnerable; highly inadequately reserved; severely depleted; predominantly endemic).

Positional accuracy of data

- Mapped features have an estimated limit to their positional accuracy of approximately 25m. This limit applies to any use of the data and its validation by field inspection.

Reporting the results of API

The results of API assessment are recorded in a combined report form for revised PNF Old-growth and rainforest. A worked example and instructions are shown in Appendix A.

This form is intended to provide a consistent and standardised format to capture the minimum information needed to report an assessment. It is best completed electronically so that the size and number of columns and rows can be adjusted according to the amount of information needed for each case. Officers are free to add any further information needed, either within the spaces provided for comments or on additional pages.

Hard copies of API officers' reports are kept on file for audit and reporting purposes.

Aerial Photograph Supplies

Aerial photographs used in the re-evaluation program are currently obtained from the Department's libraries, from the Department of Land's offices, or purchased from LPI Bathurst. The re-evaluation program will also use ADS40 digital imagery when it becomes available. Details of photo libraries and procedures for loans and purchase are given in Appendix B.

APPENDIX A

Aerial Photograph Interpretation Implementation Practices

The definitions and general procedures used in the re-evaluation of PNF Old-growth and rainforest mapping are given in the two documents:

- *Private Native Forestry Code of Practice Guideline No. 2. Protocol for re-evaluating old-growth forest on private land* (Department of Environment and Climate Change, 2007a)
- *Private Native Forestry Code of Practice Guideline No. 3. Protocol for re-evaluating rainforest on private land* (Department of Environment and Climate Change, 2007b)

In the PNF re-evaluation program, these are commonly referred to as the "Protocols".

These Protocols refer to the previous CRAFTI program and to some of its mapping practices (like disturbance indicator codes). The PNF re-evaluation program differs in a number of significant ways to the CRAFTI program. It requires its own particular concepts of Old-growth and Rainforest to be mapped and differs to CRAFTI in terms of:
- the scale, intensity and speed of mapping undertaken;
- the level of field inspection that may accompany API;
- the scrutiny by private landholders of the map products;
- the use of the final map products in regulating private commercial activities.

The PNF re-evaluation program requires implementation practices capable of delivering its own mapping outcomes, for its own purposes, according to the definitions and procedures set out in the Protocols.

The following is a collation of the current implementation practices, with some background discussion on their development according to the Protocols.

1.   Area assessed for Old-growth and for Rainforest

Provisions in Old-growth and Rainforest Protocols (Guidelines No. 2 and 3)

In considering the area of assessment, the Old-growth Protocol states that:

- "a landholder should … apply to DECC for evaluation of the area proposed for PNF" and also "identify the area in dispute" (p.4, Landholder procedure);

- "During field investigations all areas of potential old-growth forest will be assessed, whether previously mapped or not" (p.5, DECC procedure)

The Rainforest Protocol states:

- "the landholder should … apply to DECC for evaluation of the area proposed for private native forest" (sic) (p. 2, Landholder procedure);
- "a DECC aerial photograph interpretation (API) interpreter will assess the forest area …" (p. 2, DECC procedure);
- "During field investigations, all rainforest areas will be assessed, whether previously mapped or not (p. 2, DECC procedure);
- "re-evaluation of disputed areas will be undertaken by a DECC API specialist … to map the actual extent of rainforest on the property" (p. 3, Aerial photographic interpretation).

Discussion

The area that is assessed and becomes subject to the Department's revised mapping needs to be clearly defined. Unlike CRAFTI, re-evaluation of PNF Old-Growth and rainforest is not a comprehensive regional mapping program. It is targeted at specific areas of interest. It is not undertaken over all the areas previously mapped under CRAFTI, but only on those properties where a challenge has been made to the CRAFTI mapping. Areas

that have been assessed by the Department acquire a different mapping status to areas that have not been assessed. As a result of assessment, some areas are "mapped-in" as Old-growth or as rainforest, and some areas are "mapped-out", over the area that has been defined as subject to assessment. These distinctions need to be clear in the revised maps that are produced, and in the GIS data that records the results of the assessment.

In developing implementation practices for the Old-growth Protocol, API might only be targeted at that part of the previous CRAFTI mapping on a property that has been specified by a landholder (the area in dispute). But, according to the Old-growth Protocol, field inspection, when required, clearly needs to assess "all areas of potential old-growth forest, whether previously mapped or not".

The Rainforest Protocol differs slightly to the Old-growth version. In implementing it, API needs to "assess the forest area" and produce a map of "the actual extent of rainforest on the property".   When field inspection of rainforest is required -- just as for Old-growth -- all areas need to be assessed, whether previously mapped or not.

Implementation of the Protocols might also undertake Old-growth and rainforest re-evaluation independently, since they are subject to different Protocols with different methodologies.

Depending on what implementation practice is developed, a number of scenarios might arise, such as:

- a landholder specifies that only part of the previously mapped CRAFTI Old-growth on a property is to be re-evaluated and so becomes the "area in dispute"; API identifies that the area is not Old-growth but, in doing so, identifies that other areas on the property, not previously mapped, should be mapped as Old-growth; but, because these other areas were not disputed by the landholder, they are not formally re-evaluated and are not shown on the revised map;

- a landholder specifies that previously mapped CRAFTI rainforest areas on the property are to be re-evaluated; API re-evaluates the rainforest but also finds revisions that should be made to the previous Old-growth mapping (perhaps an area mapped as rainforest is actually Old-growth, or adjoins an Old-growth area that has not been mapped); but, because the landholder did not request an Old-growth re-evaluation, the Old-growth mapping is not formally re-evaluated or shown on the revised map.

Since the Department issues a revised map for the whole property, which shows both Old-growth and Rainforest, both scenarios present difficulties. The Department cannot issue a map that it knows to be incorrect, even partly. So, in order to avoid doing so, the map issued might only show those areas on the property that have been assessed, and where revised mapping applies, and other "unassessed" areas, where the original CRAFTI mapping still applies. This would be complicated and potentially confusing, but could be done. However, it would still be known to the Department that part of the original mapping for the property is incorrect. But, this information would not have been recorded or communicated, even though that incorrect mapping would be used in preparing a PVP that applies to the property.

Clearly, such outcomes are unacceptable. Implementation practices need to be developed to ensure that they cannot occur.

Added to these issues:

- the Old-growth Protocol states in Step 3 of assessing old-growth status that: "when information on the spatial extent of any rainforest present … is taken into account, the resultant layer defines the extent of old-growth forest on the site." (p. 6, Methodology used for aerial photograph interpretation on old-growth forest); and

- the Rainforest Protocol states that: "reassessment will not occur on non-loggable areas, for example … old-growth forests" (p. 3, Field assessment);

These provisions require that Old-growth and Rainforest re-evaluation inform each other.

Furthermore, re-evaluation sometimes results in the mapped status of a forest as Old-growth or as Rainforest being interchanged: through changes in mapping definitions, differences in mapping accuracy between previous and recent mappers, or changes that have occurred in the forest, for example, after removal of a eucalypt overstorey to reveal rainforest.

So, as a consequence of the provisions in the Protocols, Old-growth and Rainforest re-evaluation cannot be implemented independently.

Implementation

To provide clarity in implementation, the following practice is followed:

> ***The area of assessment for PNF Old-growth forest and Rainforest is the entire property for which the PVP is made, defined by cadastral parcels. Assessment for the entire property is initiated by a landholder challenging any part of the previous mapping on the property, regardless of whether it is Old-growth or Rainforest mapping. In all cases, assessment is made of both previously mapped and unmapped areas. Both PNF Old-growth forest and Rainforest areas are re-mapped where they occur. Where Old-growth is found near the boundary of a property, assessment needs to extend outside the property in order to determine if the total area of Old-growth, inside and outside the property, exceeds 5 ha. The revised map is issued by the Department for the entire property. It shows areas where Old-growth or rainforest have been found to occur. The map also shows areas within the property boundary where assessment has found that these forest types do not to occur.***

2.   Old-growth forest re-evaluation

Provisions of the Old-growth Protocol (Guideline No. 2)

In regard to the API methodology for re-evaluating old-growth, Guideline No. 2 provides a definition and a three step procedure.

Definition

"The old-growth forest definition in the Code is further refined as:
Ecologically mature forest where the effects of disturbance are now negligible that have an area of forest greater than 5 hectares where:

- the overstorey 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 overmature (senescent) growth

- the effects of unnatural disturbance are now negligible." (p.3)

Procedure

The Protocol describes procedures for API that involve:
- use of latest available aerial photographs;
- assigning a measure of structural maturity (regrowth, mature, senescing) based on crown forms (with Woodgate *et al* (1994) cited as a reference);
- assigning a measure of disturbance using CRAFTI disturbance indicators (listed in Table 1 of the Protocol with Resource and Conservation Division (1997) cited as source);
- assigning an old-growth status based on structural maturity and assessed disturbance level.

The Protocol then sets out details of a field validation technique.

Discussion

From the definition, three characteristics of PNF Old-growth forest are crucial to its identification by API and by field assessment: regrowth, senescence and negligible disturbance. The Protocol provides no explicit definition for any of these key terms. But, it does refer in places to "CRAFTI API mapping disturbance indicators" for use in the Department's API procedures, and it does cite Woodgate *et al* (1994) and Resource and Conservation Division (1997) (the CRAFTI manual) as references.

The CRAFTI manual, as well as the draft *Guide to Using CRAFTI Data* (National Parks and Wildlife Service, 1999), describe procedures used in the CRAFTI structural mapping program to map forest growth stage using an attribute coding system for: regrowth crown cover %, senescence crown cover %, site height class, mature crown cover %, regrowth size class, relative stand density and disturbance indicator.

From this coding, a growth stage called "Candidate Old-growth" was derived, with different derivation rules for public and private land, as the most likely areas of old-growth occurrence, to support decision making for the Regional Forest Agreements.

During later preparation of draft Regional Vegetation Management Plans (early 2000s), another derivation of old-growth was made from these CRAFTI codes for purposes of regulating vegetation clearing.

For the current PNF PVP program, yet another combination of CRAFTI codes has been used to select a layer of "PNF Old-growth". This is the data that has been exported from the original CRAFTI structural mapping to be used as the Department's best approximation of Old-growth for the purpose of providing an initial sketch map to landholders who wish to prepare a PNF PVP.

By use of its own particular definitions and procedures, the Old-growth Protocol then establishes another entity, that could be termed "**Revised** PNF Old-growth", which does not necessarily coincide with any of these previous derived layers from the CRAFTI data.

By requiring its own particular refinement of the Old-growth concept to be mapped, the PNF program is not an equivalent process to CRAFTI growth stage mapping.

Regrowth and senescence definitions

Although the CRAFTI Manual (Resource and Conservation Division, 1997) provides no definition for regrowth and senescence, the draft *Guide to Using CRAFTI Data* (National Parks and Wildlife Service, 1999) does cite Jacobs (1955) and Woodgate *et al* (1994) as its sources of definition for growth stages.

The growth stage classification of these authors is further adapted and explained in *Identification of Old Growth Forests Field Identification on Private Land* (Department of Environment and Conservation, 2004). This document provides detailed descriptions and line diagrams able to be used for field and API identification.

Parts of this document were then incorporated into *Notes – PNF Old Growth Forest Field Verification* (Department of Environment and Climate Change. 2007a) which was distributed to Departmental staff during Old-growth identification training sessions in 2007.

These two DEC publications then provide definitions for regrowth and senescence that have their origin in the same sources used for CRAFTI.

Disturbance measure and threshold

In regard to disturbance level, the Old-growth Protocol states that in an old-growth forest "the effects of unnatural disturbance are now negligible" and that the API officer will assign a disturbance significance level to a forest stand being mapped, and so an old-growth status. However, the Protocol does not make clear what disturbance level is to be used in determining old-growth status or, in other words, what forms of disturbance can, and cannot, be considered to be "negligible unnatural disturbance".

CRAFTI assessed disturbance with a combination of two measures:

- **intensity** using a rating of relative stand density (a rating of a forest's disturbance intensity compared to a "natural" stand), and
- **extent** using disturbance indicator descriptions (codes used to record the presence of disturbances affecting more that 50% of the polygon's forest canopy, ie a measure of disturbance in excess of a defined areal extent).

The Old-growth Protocol's own field validation technique uses a third disturbance measure: **percentage frequency** (percentage of 30m radius sample areas along a transect that have a disturbance – occurring as either a point source or spatial area -- observed anywhere within them). It uses a 50% threshold to define disturbance for the transect.

But, the Old-growth Protocol is silent on what disturbance measure should be used by the API officer (as opposed to the field inspection officer) – intensity, extent or percentage frequency – and what threshold value identifies disturbance that is not "negligible".

The API implementation practice with the closest fit to the Protocol's concept of 50% disturbance, and to the CRAFTI procedure of assigning disturbance codes to polygons, is to use a 50% threshold, with disturbance types (listed in Table 1 of the Old-growth Protocol) assessed by their spatial extent within a polygon.

<u>5 hectare mapping threshold</u>

The Department issues a map to a landholder that shows Old-growth and rainforest areas (and other natural resource mapping) clipped to the boundary of the property that is subject to the PNF PVP. The map does not imply that these features do not extend beyond the property boundary, it merely does not display their extent elsewhere.

In implementing the Protocol's requirement that Old-growth is only mapped as "an area of forest greater than 5 hectares", the Department could use the rule that no Old-growth area is mapped where its area within a property boundary is less than 5 hectares. Such a rule would mean that an area of Old-growth continuous with a large area outside a property would not be mapped where its extent within the property (ie: after clipping) was below 5 hectares.

It is unclear if this is the Protocol's intention. However, this implementation would implicitly rely on another feature to define Old-growth forest: distribution according to property boundary. The Protocol does not use this in its definition: it simply refers to the ecological and disturbance characteristics of Old-growth, and its forest area. It makes no reference to extent within a property boundary. That is, clipping an Old-growth area (that exceeds 5 hectares) to a property boundary is a procedure followed by the Department simply for the purpose of displaying the Old-growth data, but it is not part of the definition used in mapping Old-growth areas.

Implementation

For the purpose of clarity and consistency in implementing the Protocol, SSD uses the mapping rules:

- ***The growth stages of regrowth and senescence are defined by API according to the descriptions in "Notes – PNF Old Growth Forest Field Verification" (Department of Environment and Climate Change, 2007a)***

- ***A polygon is disturbed if any of the forms of disturbance listed in Table 1 of the Old-growth Protocol (Guideline No. 2) is observed by API to occur over 50% or more of the area of the polygon. The form of disturbance is to be recorded (by code letter or in text) for the polygon in the API report or in the GIS attribute table.***

- ***Only a conjoined area of 5 ha or more in size will be mapped as an Old Growth Forest polygon. If an Old Growth Forest area crosses a property boundary, the total extent of the conjoined Old Growth Forest area, within and outside the property, is used in determining the 5ha threshold. However, only that part of an Old Growth Forest polygon that falls within a property boundary (which may be less than the 5ha threshold) will be displayed on the property's map***

3.   Rainforest re-evaluation

Provisions of the Rainforest Protocol (Guideline No. 3)

The Rainforest Protocol provides:

- a definition of vegetation that is to be mapped as rainforest, and exclusions from the definition (p. 1);
- a minimum mapping threshold of 0.5ha (p. 1);
- a requirement that API uses CRAFTI mapping rules (p. 2);
- a list of areas to be excluded from API assessment (p. 3)

Discussion

Similarly to Old-growth, a "PNF Rainforest" layer has been derived from CRAFTI structural mapping data for purposes of displaying to landholders the Department's best approximation of rainforest areas. It includes the

areas coded as "rainforest" by CRAFTI mappers. So, this PNF Rainforest layer does coincide with its counterpart in CRAFTI.

The Rainforest Protocol establishes through its own definition of "rainforest" another new entity to be mapped: "**Revised** PNF Rainforest". A map of Revised PNF Rainforest will not necessarily coincide with the PNF Rainforest layer derived from CRAFTI, simply due to differences in some of the defining attributes, even if the same mapper were to use the same photos.

Because of a number of differences between the PNF and CRAFTI mapping programs, implementation practices are needed that are specific to PNF purposes. Key differences between the two programs are:

- PNF uses a explicit definition for "rainforest" specifying percentage composition limits of rainforest and non-rainforest species in various strata. CRAFTI, rather than following a definition, mapped as rainforest the four forest leagues making up the Rainforest Group of *Research Note 17* (Forestry Commission of New South Wales, 1989) plus Forest type 53 (Brush Box).

- CRAFTI mapped to a minimum mapping threshold for rainforest of "detectability" on a 1:25,000 aerial photo, understood as 1 ha or 6 rainforest crowns (Fisher *et al*, 2000b), however the Protocol requires mapping to 0.5 ha.

- CRAFTI documentation varies in its statements on what upper threshold was used for eucalypt and brushbox emergence to exclude a polygon from being mapped as rainforest. The CRAFTI Manual (Resource and Conservation Division, 1997) states that 5-35% crown cover percent emergence was used as a guide for rainforest that could be confidently mapped (above that range the polygon would be mapped as eucalypt). The *Guide to Using CRAFTI Data* (National Parks and Wildlife Service, 1999) and metadata statements (Fisher *et al*, 2000a and Fisher *et al*, 2000b) state that no strict upper limit was used, but 30-50% crown cover percent emergence was a guide to the visible rainforest that was mapped. However, the Protocol sets a formal 30% maximum, and makes it explicit that emergence of brushbox and turpentine, as well as eucalypts, above that threshold excludes a polygon from being mapped as Revised PNF rainforest. That is, Forest Type 53 (Brush Box) is excluded.

- CRAFTI mapping assumed a continuous rainforest canopy beneath emergents, while the PNF definition requires only that vegetation be "tree dominated".

- The Rainforest Protocol lists areas to be excluded from assessment: "non-loggable areas, for example, slopes greater than 30 degrees, old-growth forest and non-commercial areas" (p. 3), whereas CRAFTI did not exclude these areas.

As a consequence, implementation of the PNF Rainforest Protocol will need to produce a number of different outcomes to CRAFTI mapping:

- large areas of CRAFTI rainforest mapping, such as areas with brushbox and turpentine emergence, will not be mapped as Revised PNF rainforest;

- Revised PNF Rainforest will be mapped down to 0.5 ha;

- when detected, non-commercial areas that are not targeted for forestry purposes, such as Viney Scrub (Forest Type 26 of Research Note 17), will not be mapped as Revised PNF Rainforest;

- areas without continuous rainforest canopy, but tree dominated and with the required species composition in its various strata, will be mapped as Revised PNF Rainforest.

Implementation

For clarity in implementing the Rainforest Protocol, SSD follows the practices:

- *To be rainforest, vegetation does not need to have a continuous canopy, but it does need to be tree dominated. Vegetation is tree dominated where more than 50% of the vegetation cover is provided by trees (woody plants more than 3m in height with a single stem or branches well above the base).*

- *Only rainforest areas that exceed 0.5ha are mapped.*

- *Viney Scrub (Forest Type 26 of Research Note 17) will not be mapped as Revised PNF Rainforest.*

- *All Rainforest should be mapped as polygons as far as possible:*
    - *Where a rainforest area exceeds 2 ha it is to be mapped as a polygon;*
    - *Where a rainforest area is less that 2ha and more that 0.5ha, and cannot be suitably mapped as a polygon (for example, mapping is being done onto a plastic overlay rather than by on-screen digitising into a GIS), then:*

> ➢ *if greater than 200m long and less than 100m wide, the area can be mapped as a line;*
> ➢ *if less than 200m long, the area can be mapped as a point.*

- *In determining the 0.5ha mapping threshold, the total extent of the Rainforest area is considered, within and outside any property boundary that intersects it, but only that part of the Rainforest area that falls within a property boundary (which may be less than the 0.5ha threshold) will be displayed on the property's map.*

4.   Field inspections

Provisions of the Old-growth and Rainforest Protocols (Guidelines Nos. 2 and 3)

In regard to the circumstances when field inspection might be undertaken, the Old-growth Protocol states:

- "If the area in dispute is less then 10% of the mapped area of old-growth forest, no field investigation is required and the determination will be done using the latest aerial photographs only" (p. 5, DECC procedure);

- "Field site assessment may be needed to verify mapped interpretations with actual ground features when it is difficult to discriminate between senescing and mature growth stages of tree crowns" (p.5, Methodology – Step 1).

The Rainforest Protocol states:

- "If field work is required for further validation, the steps in the next section will be followed. If field work is not required, the revised mapping will be taken as the new rainforest map" (p. 3, Aerial photograph interpretation).

Discussion

Neither Protocol defines the circumstances when field inspection must be undertaken, or provides any clear decision rules to be followed in initiating one. Instead, they focus on the procedures to be followed in the event of a field inspection being required.

In considering how to implement the Protocols, there are three main purposes that field inspection can serve:

1. to collect additional information when API alone cannot confidently map an area;
2. to resolve any dispute over the accuracy of areas mapped by API alone;
3. to assess the accuracy of API results, as part of a quality assurance program.

These three forms of field inspection are initiated by different decision rules and may target different areas. All provide opportunities for staff to gain feedback helpful in enhancing the re-evaluation program.

1. Additional information to support API

Under the Protocols, the Department uses two forms of evidence to make its mapping decisions:

- observation on aerial photographs of the defining attributes that are specified in the Protocols;
- additional data from field transects (when undertaken) collected according to the procedures set out in the Protocols.

According to the Protocol, to be Revised PNF Old-growth an area needs to show all three of the attributes: less than 10% regrowth and more than 10% senescence and less than 50% disturbance. But, simply because a certain attribute cannot be seen on an aerial photograph – say, more than 10% senescence – it does not necessarily mean that it does not occur at the area. It may just not be observable on the photograph for a variety of reasons, such as shadow, terrain, transparency of crowns, photo quality, and so on. That is, absence of evidence of an attribute cannot be considered to be evidence of its absence. But, where the **presence** of an attribute is clearly observed on an aerial photograph, then it obviously occurs, unless the observation is mistaken.

Given the logic of the definition of Old-growth in the Protocol, an area can be identified as **not** being Revised PNF Old-growth if on an aerial photograph the **presence** can be observed of either more than 10% regrowth or more than 50% disturbance. If both of these attributes cannot be clearly observed on an aerial photograph, then the area might be Old-growth: certainty can only be achieved through a field inspection.

By the same reasoning, if more than 50% disturbance or more than 10% regrowth cannot be observed on an aerial photograph, an area might be mapped as Old-growth through API. But field inspection may subsequently show that disturbance and regrowth do occur there, although they could not be observed on the photos, so the area is not actually Old-growth.

Similarly, under the rainforest Protocol, tree dominated vegetation can be identified as **not** being Revised PNF Rainforest if on an aerial photograph the **presence** can be observed of non-rainforest emergents with more than 30 % of the upper stratum crown cover. If this attribute cannot be clearly observed on an aerial photograph, then the area may be rainforest.

Given the nature of the definitions and the nature of API, API alone has greatest certainty in observing the presence of attributes that exclude an area from being PNF Old-growth or PNF Rainforest. That is, API alone is best at mapping-out areas. But, where an area cannot be mapped-out with confidence, the precautionary principle requires that it should be mapped-in.

So, during the initial API phase, additional information from field inspection will be most needed for those areas that cannot be mapped-out with confidence. Recommendation for field inspection from API staff will need to target those areas proposed to be mapped-in as Revised PNF Old-growth or Rainforest, where API alone cannot clearly observe the presence of all defining attributes needed for a confident identification.

In this case, the decision to undertake a field inspection is made by API staff. Once a recommendation has been made, this initial stage of mapping cannot be completed until the field results are obtained and any amendment needed is made to the mapping.

2. Dispute resolution over mapping accuracy

Field inspection may be required for the purposes of dispute resolution with a landholder.

There will be occasions when an initial map produced by API alone may be subsequently disputed by a landholder since:

*   API alone may not always be able to observe attributes that result in an area being mapped-out with confidence (for example, in the case of Old-growth, disturbance beneath a dense canopy);
*   where areas cannot be confidently mapped-out the precautionary principle requires that they be mapped-in;
*   not all areas being mapped-in will be able to be field checked before revised mapping is provided to a landholder.

Such disputes can be expected to concern the accuracy of areas being mapped-in, more than areas being mapped-out.

The Protocols establish field inspection as a dispute resolution process if a map produced by API alone should be challenged by a landholder. The decision to undertake the field inspection is made by the PNF Section of CCPP, based on justifications provided by the landholder and available Departmental resources. Results are provided to SSD as feedback to the API officer and to enable any amendments needed to the mapping to be made.

3. Quality assurance

Field inspection of areas mapped-in, or possible areas to be mapped-in, is initiated either by the landholder or the API officer. A quality assurance program is also needed to check areas that have been mapped-out by API.

Field inspection of mapped-out areas is needed since it is possible to make errors in observing attributes that exclude an area from being identified as Revised PNF Old-growth or Rainforest (ie: for Old-growth, regrowth or disturbance, or, for Rainforest, the percentage of non-rainforest emergents).

Resource limitations require quality assurance to be undertaken strategically, targeted at areas where API errors are most likely to occur and where environmental harm resulting from any API error will be highest. Such areas can include:

- large areas of previous CRAFTI mapping that would be mapped-out;

- forests with high canopy covers;

- forests where canopy gaps may occur naturally, rather than as a result of disturbance (eg sandstone landforms);

- forest ecosystems classified as "regionally significant" according to draft Regional Vegetation Management Plans (rare, endangered and vulnerable; highly inadequately reserved; severely depleted; predominantly endemic)

Assigning priorities to field inspections

The amount of field inspection that is undertaken depends on the Department's allocation of resources. However, from SSD's perspective, in considering the implementation of the mapping program, there is a clear priority order:

1. Field inspection to provide additional information for the API officer is needed in all cases. Otherwise, mapping cannot be satisfactorily completed.

2. Field inspection to resolve disputes with landholders is needed for fairness, in those cases where a justifiable case can be established for a significant level of error in the mapping.

3. Field inspection for quality assurance purposes is needed to provide feedback to API staff and to provide confidence in the program, for a sample of areas strategically selected to test the accuracy of API.

For any fixed allocation of resources, there will be a trade-off between the amount of field inspection undertaken for priorities 2 and 3, since undertaking priority 1 needs to be mandatory. Until now, most resources for field inspection have been consumed by priorities 1 and 2.

Implementation

In determining the need for additional evidence from field inspections to support API:

- *Field inspection is to be recommended for those areas that cannot be mapped-out with confidence and where API alone cannot clearly observe the presence of all defining attributes needed for an identification of Revised PNF Old-growth or Revised PNF Rainforest. A forest area can be confidently mapped-out if a clear presence can be observed on an aerial photograph of:*

  - *for Revised PNF Old-growth: more than 10% regrowth or more than 50% disturbance;*

  - *for Revised PNF Rainforest: non rainforest emergent species (including brushbox and turpentine) exceeding 30% of the upper stratum crown cover.*

Results from field inspection are to be used by the API officer as feedback to assist in future mapping and to make any necessary adjustments to current mapping.

In targeting field inspections for quality assurance purposes, priority areas are:

- *large areas of previous CRAFTI mapping that would be mapped-out;*

- *forests with high canopy covers;*

- *forests where canopy gaps may occur naturally, rather than as a result of disturbance (eg sandstone landforms)*

- *forest ecosystems classified as "regionally significant" in a draft Regional Vegetation Management Plan (rare, endangered and vulnerable; highly inadequately reserved; severely depleted; predominantly endemic).*

Positional accuracy of data

Provisions of the Old-growth and Rainforest Protocols (Guidelines Nos. 2 and 3)

Both Protocols state that mapping is to be done using 1:25,000 aerial photographs.

Discussion

API mapping is currently performed using traditional 1:25,000 analogue photographs viewed as stereo pairs under a stereoscope. Polygon, point and line features are either captured directly into a GIS with on-screen digitising over a rectified aerial photograph or satellite image background, or traced onto a plastic overlay with subsequent scanning, rectification and digitising into a GIS. The estimated limit to the positional accuracy of the resulting mapped features is approximately 25m.

Implementation
- ***Mapped features have an estimated limit to their positional accuracy of approximately 25m. This limit applies to any use of the data and its validation by field inspection.***

Reporting the results of API

Provisions of the Old-growth and Rainforest Protocols (Guidelines Nos. 2 and 3)

There are no reporting requirements specified in the Protocols.

Discussion

The Old-growth and rainforest mapping is a significant state-wide data set with applications to Private Native Forestry, to a number of other programs of the Department and to programs outside the Department. It has a high profile among a wide range of stakeholders. It needs to be managed with these responsibilities in mind. Changes to it are not made lightly and when they do occur an adequate recording system is needed to document them. A recording system needs to operate at two levels:
- Reporting by API officers of their observations and any recommendations for field inspection (discussed here);
- Storage and management of the data in a GIS (discussed in a separate section)

In reporting their work, the API officer needs to:
- spatially define areas that do and do not meet the criteria set out in the Protocols for Revised PNF Old-growth and Rainforest;
- provide attribute data for those spatial features, according to the Protocol's criteria;
- provide additional notes and explanation where necessary enabling the reason for the revised mapping status to be understood;
- identify any areas where the assessment is uncertain and field inspection is needed;
- record information enabling peer review and auditing of the re-evaluation process;
- be able to use a simple and easy reporting format that all officers can complete in a consistent way.

Implementation

> ***The results of API assessment are recorded in a combined report form for revised PNF Old-growth and rainforest. A worked example and instructions are shown below.***

> ***This form is intended to provide a consistent and standardised format to capture the minimum information needed to report an assessment. It is best completed electronically so that the size and number of columns and rows can be adjusted according to the amount of information needed for each case. Officers are free to add any further information needed, either within the spaces provided for comments or on additional pages.***

> ***Hard copies of API officers' reports are kept on file for audit and reporting purposes.***

PRIVATE NATIVE FORESTRY: RAINFOREST AND OLD GROWTH RE-EVALUATION - AERIAL PHOTOGRAPH INTERPRETATION REPORT

PNF Case number: *Date API completed:*

Aerial Photographs used:

1:100,000 Sheet	Date	Run	Photos

API Results:

Map unit/ Polygon/ line/point number*	Rainforest				Old Growth					Field check? (Y/N)	Comments (including any amended vegetation description)
	Non assessable	Assessable areas			Disturbance level		Regrowth <10% (Y/N/?)	Senesc-ence >10% (Y/N/?)	OG? (Y/N/?)		
	NLI **	RF spp§ >50% (Y/N/?)	NRE*** <30% ? (Y/N/?)	RF? (Y/N/?)	<50% (Y/N/?)	Indicators present ****					

For definitions and procedures refer to PNF Code of Practice Guidelines . 2: Protocol for re-evaluating old-growth forest on private property and No. 3: Protocol for re-evaluating rainforest on private property

*record numbers on map units drawn on hard copy or in GIS polygons; §% RF spp in stratum of greatest cover (not necessarily upper stratum); **Non-Loggable Indicators include: slopes >30 degrees, old growth forests, non-commercial areas; *** NRE = Non Rainforest Emergents; ****indicator codes: X (recent logging), C (older logging), GZ (crown gaps), GA (crown gaps & thick pioneers), GW (crown gaps & thick exotic pioneers), W (exotic weeds), L (lantana), S (stags), D (dieback), P (grazing or its infrastructure), B (landslips), O (past clearing signs), J (constructed tracks, transmission lines), e (erosion), b (landslips), m (mining), R (rural residential subdivision), J (other)

General comments:

Signed: *API Officer name:*   *Date:*

PRIVATE NATIVE FORESTRY: RAINFOREST AND OLD GROWTH RE-EVALUATION - AERIAL PHOTOGRAPH INTERPRETATION REPORT
E X A M P L E

Aerial Photographs used:

1:100,000 Sheet	Date	Run	Photos

API Results:

Map unit/ Polygon/ line/point number*	Rainforest				Old Growth					Field check ? (Y/N)	Comments (including any amended vegetation description)
	Non assess able	Assessable areas			Disturbance level		Regrowth <10% (Y/N/?)	Senesc-ence >10% (Y/ N/?)	OG? (Y/N/?)		
	NLI **	RF spp§ >50% (Y/N/?)	NRE*** <30% ? (Y/N/?)	RF? (Y/N/?)	<50% (Y/N/?)	Indicators present ****					
1		N	N	N	N	GA,GZ	N	?	N	N	Extensive recent disturbance. Snig tracks and extensive regrowth obvious throughout – not OG
2 – 5		Y	Y	Y						N	Several patches of rainforest near centre of property
6					Y		Y	Y	Y	N	Hard dry site, transparent crowns but clearly OG
7		N	N	N	?		Y	Y	?	Y	Little regrowth, obvious senescence present, but needs field check for disturbance
8					Y		Y	Y	Y	N	Only small section of this OG may be within property. Large undisturbed OG area extends to north of property.
9		N	N	N	Y		Y	?	?	Y	Only little disturbance and regrowth seen. Appears to be mature forest with no observable senescence. Field check of senescence needed.
10 - 15		N	N	N	N		N	N	N	N	Remainder of property assessed and no rainforest or old-growth found.

For definitions and procedures refer to PNF Code of Practice Guidelines . 2: Protocol for re-evaluating old-growth forest on private property and No. 3: Protocol for re-evaluating rainforest on private property

*record numbers on map units drawn on hard copy or in GIS polygons; §% RF spp in stratum of greatest cover (not necessarily upper stratum); **Non-Loggable Indicators include: slopes >30 degrees, old growth forests, non-commercial areas; *** NRE = Non Rainforest Emergents; ****indicator codes: X (recent logging), C (older logging), GZ (crown gaps), GA (crown gaps & thick pioneers), GW (crown gaps & thick exotic pioneers), W (exotic weeds), L (lantana), S (stags), D (dieback), P (grazing or its infrastructure), B (landslips), O (past clearing signs), J (constructed tracks, transmission lines), e (erosion), b (landslips), m (mining), R (rural residential subdivision), J (other)

General comments:
Extensive logging disturbance observed over much of property. Areas of rainforest found near centre of property (polygons 2-5). Not clear if disturbance present in polygon 7 or senescence present in polygon 9 – field checks needed. Large area of old-growth at polygon 6 and also to north of property, part of which also extends into property at polygon 8.

Signed: **API Officer name:**   **Date:**

Instructions for completing API Report Form

The form has columns for each of the defining attributes of Revised PNF Old-growth and Rainforest that are listed in the Protocols. The columns are grouped into two parts – for Old-growth and for Rainforest – and the form is completed for both.

Number each mapping unit (polygon, line or point) and place a Y (Yes), N (No) or ? (uncertain) in the column for each defining attribute, where API enables that attribute to be observed in that mapping unit. Where the attribute cannot be clearly observed mark it as uncertain (?). The notes at the foot at the table give a brief description of the column headings used. But, for a full explanation of the defining attributes see the Protocols themselves.

The last column in the Rainforest and Old-growth group of columns (headed RF ? and OG ?) are to record the resulting Rainforest or Old-growth status of that map unit resulting from the API observations.

The main points to note in completing the form are:

- The logic of "<" and ">" is set up so that if a Y is recorded for **every** defining attribute in the RF or OG group of columns, then the overall decision in the last column for RF or for OG is also Y.

- For Rainforest, if API results in an N being recorded for **any one** of the columns RF spp > 50% or NRE < 30%, then the overall decision would be N for that feature (ie RF = N if NRE < 30% = N).

- For Old-growth, if API results in an N being recorded in **any one** of the columns Disturbance < 50 % or Regrowth < 10%, then the overall decision would be N for that feature (ie OG = N if Regrowth < 10% = N).

- However, also for Old-growth, if API results in a Y being recorded **in both** the columns Disturbance < 50 % and Regrowth < 10%, and API alone (without data from field transects) cannot observe Senescence > 10%, then, following the precautionary principle, the feature cannot be excluded as being Old-growth: instead a field check should be recommended. That is, API alone cannot exclude an area from being Old-growth simply by the non-observance of Senescence in excess of 10%, without either disturbance exceeding 50%, or regrowth exceeding 10%, also being present.

- Rainforest and old-growth are mutually exclusive, so if either of them is Y for a map unit, there is no need to fill out columns for the other forest type for that polygon (all can be assumed to be N).

- But, if either OG or RF is N for a polygon, then the attributes for the other forest type all need to be recorded (ie if RF = N for a map unit its OG status also needs to be recorded and must not be left blank).

- Where a number of map units all share the same attributes they can be grouped into one row of the table (eg: polygons 2-5 all with Y for Rainforest attributes).

- The report needs to record the assessment over the whole property. Ideally, the whole property should be mapped into separate units and numbered. Where it is impractical to map and number a large number of units, simply to show that the remainder of the property has been assessed as neither old-growth nor rainforest (eg: cleared or highly disturbed land), then the last row of the table could be labelled "Remainder of property" and the rest of the table's columns then completed. It is essential that there is no part of the property that is left unreported.

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APPENDIX B (officer contact details removed for privacy reasons)

Aerial Photograph Supplies

*** ---- *this Appendix being updated --- ***

Loans

The main photograph libraries used are:
- Department of Lands, Grafton: Level 1, 76 Victoria St
- DECCW, Grafton: Level 3, 76 Victoria St (incorporating the previous Inverell library)
- DECCW, Kempsey
- DECCW, Taree
- DECCW, Newcastle

Photos can be borrowed from the Department of Lands in Grafton library on level 1 in Grafton (the Loan Book needs to be filled out). Arrangements have been made to borrow aerial photo contact prints from two other Lands offices. Contacts are:
- Crown Lands Division Tamworth, Department of Lands

    Land Administration East, South Region, Department of Lands

 The understanding with these two Lands' offices is:
- loan requests to be made by email;
- an understood loan period limited to two weeks, with additional approval from Dept Lands for any extension;
- early return to Dept Lands if the photos are required by them;
- replacement by DECC of any lost or damaged photos.

Purchases
*** ---- *this section being updated ---- ***

Databases

Photos held in the former Inverell, Grafton and Newcastle libraries (and elsewhere) have been entered into the Access database on Inverell server at:
> \\Dlwc_tree\.INVE_SPATIAL.INVE.BARW2.BARWON.DLWC\WORKAREAS\INVEGIS\Imagery\AirPhoto Database\CURRENTAirPhotoDatabase

Listings for the Grafton Lands, Grafton DECCW and Kempsey DECCW libraries are in:
> \\Dlwc_tree\.GRARO_SPATIAL.GRARO.NTHCST.DLWC\Work\analysis\LRP\SPATIAL\Dave\Data-PNF\Aerial_Photos\Libraries

Flight Diagrams

Georeferenced flight diagrams are at:
> \\Dlwc_tree\.GRARO_SPATIAL.GRARO.NTHCST.DLWC\Work\\analysis\LRP\SPATIAL\airphoto-keydiags\RunMaps

Airview site

The Department of Lands Airview site displays a scanned image of the latest aerial photos and can be searched through a graphical interface. It can be useful to use this site to check what photos cover the area of interest before making purchases or borrowing from other libraries. It is at: http://www.lands.nsw.gov.au/airview