FEM075

Procedures for the assessment, identification and demarcation of old-growth forest

March 2017

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Parks and Wildlife

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Reference details

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Cover

Top: Western jarrah forest, Dickson forest block
Photo – Department of Parks and Wildlife

Below: Eastern jarrah forest, Stoate forest block
Photo – Department of Parks and Wildlife

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Procedures for the assessment, identification and demarcation of old-growth forest, FEM Procedure No. FEM075

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Version number	Date approved	Approved by	Brief Description
1.0	February 2017	Issued for consultation with the CPC	Documents the draft procedures applied when reviewing the status of forest for unmapped areas of old-growth forest.
1.1	15 March 2017	Director, Forest and Ecosystem Management Division	Documents the procedures applied when reviewing the status of forest and fulfils Management Activity 6.3 of the *Forest Management Plan 2014-2023*.
2.0	28 March 2017	Director, Forest and Ecosystem Management Division	Final approved procedures

Contents

Figures

1 Background and context

1.1 Purpose

This document describes procedures to assess areas of native forest to determine if they meet the criteria for classification as old-growth forest, and for demarcating the boundary of areas classified as old-growth forest in the field.

These procedures reflect the requirements of Management Activity 6.3 of the *Forest Management Plan 2014-2023* (FMP) (Conservation Commission 2013).

1.2 Scope

These procedures apply to native forests on lands managed by the Department of Parks and Wildlife in the Swan, South West and Warren Regions.

1.3 Old-growth forest as a formal classification of forest

The origin of criteria for forest that would be given the formal classification of 'old-growth forest' was the Comprehensive Regional Assessment undertaken for the Regional Forest Agreement (RFA 1998a, 1999). The extent of old-growth forests was mapped during the preparation of the RFA, and since 2000 all identified areas of old-growth forest are set aside from timber harvesting. The initial identification of areas of forest that satisfied the criteria for old-growth forest was mainly achieved by intersecting datasets in the department's Forest Management Information System (FMIS) that were relevant to the criteria. In jarrah forest this was supplemented by limited ground survey to identify areas that may have been minimally disturbed and therefore qualify as old-growth forest (RFA 1998a, b).

The spatial datasets used to identify old-growth forest included:

- Forest type
- Stand structure and density
- Harvest history
- Mining and grazing history
- Silvicultural history
- Dieback mapping
- Karri stand development stages.

These principal datasets were themselves derived from the intersection of other contributing datasets.

1.4 The need for procedures to assess forest for areas of old-growth forest

The *Forest Management Plan (2014-2023)* requires all areas of old-growth forest to be protected in formal or informal reserves.

The original datasets used to derive and map old-growth forest extent contain minor errors from various sources, such as incomplete records of past disturbances, minor

misclassification within the themes, or local boundary variations due to differences in the scale that the original mapping took place. Consequently, in the planning of disturbance operations some areas of forest may occasionally be identified as possibly being incorrectly mapped. The suspected incorrect mapping might be either forest classified as old-growth forest that is now thought not to be old-growth forest, or forest that is not classified as old-growth forest that may in fact be old-growth forest.

Either way, before an area of forest can be classified as old-growth forest, or a mapped area of old-growth forest declassified, a detailed assessment of all relevant factors used to determine old-growth forest status is required. The procedures in this document comprise that assessment process.

1.5 Identification of areas for review of their old-growth forest status

Areas of forest requiring assessment for their old-growth forest status generally arise in two main ways:

- Notification from Parks and Wildlife or Forest Products Commission (FPC) staff who find candidate areas when planning and demarcating forest for timber harvesting, or other disturbance activities; or
- Nomination by the public, using local knowledge of forest areas scheduled on the rolling three-year indicative timber harvest plan.

2 Definitions of old-growth forest

The definition of old-growth forest is derived from the nationally agreed general definition used in the Regional Forest Agreement viz. *Old-growth forest is ecologically mature forest where the effects of disturbances are now negligible* (JANIS 1997). To be operationally effective, specific definitions are required for each forest type.

Four broad forest types are recognised for defining old-growth forests in the south west.

2.1 Jarrah and jarrah/tingle forest (including mixtures with marri)

In jarrah and jarrah/tingle dominant types ‘old-growth forest’ is defined as ‘uncut (never harvested) forest or forest subject to minimal disturbance and that is not affected by *Phytophthora cinnamomi’* (RFA 1998a).

‘Minimal disturbance’ is when an area of jarrah forest has been previously harvested and shows evidence of harvesting (such as stumps), but very limited or no visible evidence of structural change to the overstorey. Areas that show evidence of harvesting that was sufficiently intense to have resulted in persistent regrowth, or created the potential for regrowth to persist as a result of that harvesting, have been disturbed to a level greater than ‘minimal disturbance’ and are not regarded as old-growth forest (Bradshaw 1998).

The method used by the Department for identifying areas of ‘minimal disturbance’ is informed by stump numbers and their spatial distribution (see Section 5).

2.2 Karri, karri/tingle and karri/jarrah[1] forest (including mixtures with marri)

In karri-dominant forests, old-growth forest is defined as 'uncut (never harvested) forest that is dominated by overstorey trees possessing mature or senescent characteristics' (RFA 1998a).

In this definition a mature or senescent forest is one 'where mature and senescent trees have a crown cover of 25 percent or more' (Bradshaw and Rayner 1997).

2.3 Wandoo forest and woodland

The definition of old-growth forest in wandoo forest and woodland is 'uncut (never harvested) forest and woodland' (RFA 1998a).

2.4 Jarrah woodland

Old-growth forest is uncut (never harvested) forest and woodland which is not affected by *Phytophthora cinnamomi*. However, in practice all areas mapped as jarrah woodland (including those previously cutover) have been set aside from timber production as informal reserves (Diverse Ecotype Zones) under the Forest Management Plan.

2.5 Minimum area

In all forest types the minimum contiguous area recognised as a distinct patch of old-growth forest (or non old-growth forest within an old-growth forest) is two hectares. The sampling and assessment unit will be the raster cells maintained in the FMIS. This allows for consistent integration with other corporate datasets that inform the timber harvest planning and disturbance approval processes, and comprises an appropriate scale for ongoing management. The use of the FMIS grid provides an objective, reproducible and comprehensive sample frame for field survey and interpretation of areas.

2.6 Forest type

The dominant forest type determines which of the old-growth forest definitions (and hence assessment criteria) apply within a nominated area. The mapping of dominant forest types for the south west was originally undertaken through an Aerial Photograph Interpretation (API) program (Bradshaw *et al* 1997), which provides the basis of the corporate dataset maintained within FMIS. In some mixed forest types containing similar proportions of jarrah, karri and marri the understorey floristics will be used to determine the dominant forest type. For example, areas of jarrah-karri mix containing a jarrah understorey which enables dieback interpretation will be considered jarrah dominant. Areas dominated by pure mature marri trees are rare, and will be assessed for old-growth forest status under the jarrah forest definition.

[1] A mixed forest containing 2 or more karri stems or stumps per hectare is included as karri type for this purpose.

3 Assessment Step 1 – identifying areas requiring no further assessment

When stands nominated for review are within areas scheduled for timber harvesting or associated disturbances, some decisions on the old-growth forest status of an area can be made without detailed analysis. These relate to their tenure, disease status (presence of *Phytophthora cinnamomi* infestation) or intensity of previous disturbance.

3.1 Tenure and reserve status

Most areas requiring assessment of their old-growth forest status arise from timber harvesting that is planned in the area. However, timber harvesting is excluded from formal and informal reserves, and therefore areas within these reserves that are nominated for review of their old-growth forest status are already protected from timber harvesting.

In Step 1 of the assessment process, all boundaries of formal and informal reserves within the area being assessed will be shown on the base map in relation to the assessment area. A check of pending Informal Reserve Amendment Requests is then required to ensure that there are no variations proposed to these reserve boundaries. There is no need to physically check these boundaries where no changes are proposed.

If the area subject to assessment is wholly contained within formal or informal reserves, no further analysis is usually required. This outcome is recorded (see Section 7). If the reserves cover only part of the nominated area, that part of the assessment area within the reserves can be excluded from further analysis unless specifically requested.

However, where disturbance from proposed harvesting activities is not the impetus for the assessment of old-growth forest status, progression to Assessment Steps 2 and 3 are required, regardless of the presence of reserves.

3.2 *Phytophthora* dieback occurrence

Infestation by *Phytophthora* dieback is categorised as a significant disturbance, and precludes jarrah and jarrah/tingle forests from being classified as old-growth forest.

Where the dominant forest type of the area being assessed is jarrah forest, the most recent intensive (detailed) mapping of *Phytophthora* dieback infestation should be consulted to determine the dieback status. The extensive (broad-scale) *Phytophthora* mapping conducted during the 1970s is less reliable for this purpose. If the broad-scale mapping or other indirect information suggests the possibility of *Phytophthora* dieback presence in the assessment area, detailed mapping should be considered before other analyses are undertaken.

If the review area is wholly contained within areas of *Phytophthora* dieback infestation, jarrah forest areas cannot be classified as old-growth forest. This information is recorded (see Section 7) and no further analysis of the assessment area is required.

If the *Phytophthora* dieback infested area covers only part of the assessment area, the boundaries should be indicated on the project map and the infested areas removed from further analysis.

3.3 Other disturbance

Evidence of extensive disturbance arising from grazing, mining and previous farming excludes an area from further analysis. Corporate datasets for grazing and mining can be checked, whilst abandoned farms (for example within former soldier settlement scheme areas) that have regenerated to native forest are usually identified through comparison of the historical API map for the area with current imagery depicting a persistent regrowth cohort. Similarly, areas which have received an intensive silvicultural stand improvement treatment (for example the 1930s treatments) will also be excluded from further analysis.

4 Assessment Step 2 – aerial photo interpretation

4.1 Background information required for further assessment

A variety of information exists that is relevant to the determination of the old-growth forest status of an area of forest or woodland. Some of this information is critical to the determination of old-growth status, while other information will assist in understanding likely disturbance history.

The following historical and current information should be examined for the subject area and its surrounds:

- Old-growth forest extent (current mapped occurrence)
- Forest type
- *Phytophthora* dieback occurrence
- Karri development stages
- Harvest history (including integrated sawlog operations, sleeper, SEC pole, charcoal and mine-prop operations)
- Terrain slope/gradient (historically, very steep terrain has been excluded from timber harvest operations)
- API types (1950-1965)
- Historical silvicultural treatment (including post-1985 silvicultural objectives, historical stand improvement treatments, and forest rehabilitation treatments)
- Other forest disturbance activity (basic raw material extraction, clearing for roading and infrastructure alignments)
- Historical and recent aerial photography
- Tenure
- Tramways (historic timber extraction tramways throughout the south west)

- Previous land use (particularly ex-farmland and lands treated under the Private Property Timber Reserved for the Crown process)
- Fire history/frequency (timing of bushfire and prescribed fire events relative to size, pattern and relative age of regeneration cohorts)
- Mining history (historical extent of clearing and rehabilitation).

The major source of most corporate data used for this analysis is the Department's Forest Management Information System (FMIS).

Information gathered from some or all of these data streams can be used to support interpretation of the nominated area and further decisions can be made in relation to the validity of field reconnaissance and survey. In some instances this information may preclude the nominated area from being classified as old-growth forest or woodland, but field confirmation may still be required to confirm the historical disturbance extent and intensity.

4.2 Disturbance history from aerial photographs

Aerial photography can be used to determine the upper canopy cover, disturbance level and the regrowth component of many forest types. Recent photography (for example, within the last five years) is used to determine the presence and extent of a regrowth component in all forest types. In recent years Forest Management Branch (FMB) have acquired high resolution (to 10 cm pixels) colour digital imagery which can be viewed in 3D for many forest areas, and where available, these images provide a valuable tool to examine the disturbance history and regrowth persistence in the assessment area.

Historical aerial photography can also be used to measure the disturbance level in a jarrah forest type for the purposes of determining whether past operations could be defined as minimal disturbance. If photography of sufficient quality or resolution is not available for interpretation, then a full stump survey will usually be required (see Assessment Step 3).

All interpretation should be done to a minimum resolution of two hectares. The process of aerial photograph interpretation will vary depending on the type of imagery obtained and the year the area was recorded as previously harvested.

The areas classified as, or possessing the characteristics of a Diverse Ecotype Zone (DEZ) (i.e. sites with less than 30 per cent maximum potential natural crown cover) are informal reserves. These areas do not require further interpretation if the proposed activity is timber harvesting, as these areas are already set aside from harvesting. If areas possessing these characteristics are not already classified as an informal reserve, then an Informal Reserve Amendment form should be prepared to update the FMIS database.

4.2.1 Jarrah and jarrah/tingle forest

The variability of silvicultural objectives and harvesting techniques within the jarrah forest since European settlement (Bradshaw 1999), combined with the natural variation of regeneration within these areas, makes it challenging to interpret the origin of the

regrowth component solely from photography. It is especially difficult to interpret the origin of the regrowth component if the area was previously harvested in the period 1930 to 1960, and only recent photography is available. Ideally, photography captured soon after harvest events should be sourced to interpret for obvious signs of disturbance from the harvesting activity. FMB maintain an archive of black and white, colour and digital photography from the range of harvest, timber inventory and land monitoring projects conducted in the south west forests, including the set of black and white photographs captured at 1:15,840 scale for the comprehensive API program conducted during 1950 to 1965. These photos are a key source for checking disturbance history to inform a review of old-growth forest status.

4.2.2 Interpretation of historical imagery

Interpretation of old aerial photography will be undertaken to classify the observable level of disturbance within the assessment area. This aims to identify heavily disturbed areas likely to be excluded from old-growth forest status, and to refine the extent of any field survey that may be required. Classification of areas into high, medium and low levels of disturbance (Figure 1) will use the following sequence:

1. Interpret and define areas showing **high levels** of disturbance from timber harvesting, i.e. in which large gaps in the forest canopy and extensive snig tracks and landings are clearly evident. These areas will be classified as not old-growth forest.
2. Interpret and define areas showing a **low level** of disturbance, i.e. in which there is little or no evidence of previous harvest activity, no snig tracks and the forest canopy remains intact. These areas will need to be verified in the field to determine if a full stump survey is required (see Step 3) before they can be classified as old-growth forest.
3. Remaining areas with a **medium level** of disturbance are candidate old-growth forest and require stump survey to determine the disturbance levels (see Step 3).

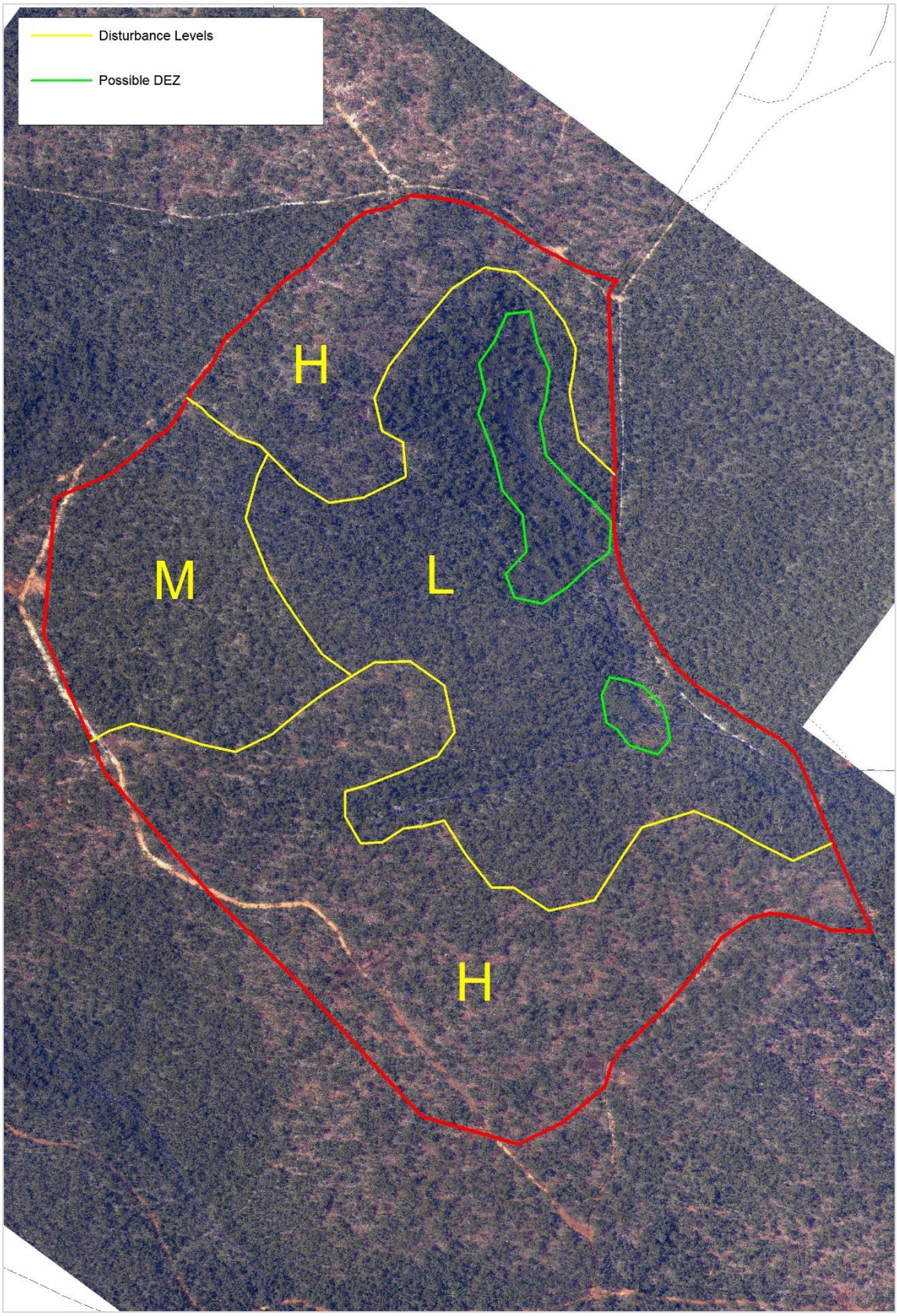

Figure 1. An example of aerial photo interpretation of jarrah forest into areas of high, medium and low levels of disturbance from a previous timber harvesting event(s).

4.2.3 Interpretation of recent imagery

The presence and size of a regrowth cohort relative to the time of recorded last harvest can be inferred from interpretation of recent photography. However, the pattern and relative composition of sapling, pole and mature components can vary due to the timing of past regeneration events arising from timber harvesting, or gap creation following bushfire, storm and other natural events. Consequently, the interpretation of a regrowth cohort in areas recorded as previously harvested is an insufficient indicator on its own of old-growth forest status, and field checking is generally required to confirm the origin of the regrowth. Experience in the range of jarrah forest types indicates that areas with a regrowth component comprising greater than 40 per cent of the total canopy cover will almost always be designated as not old-growth forest, provided that the regrowth component is a direct result of disturbance activities.

4.2.4 Karri and karri/tingle forest

Karri and karri/tingle forest types do not have a minimal disturbance component (refer to Section 2.2) in the definition of old-growth forest. Therefore, photo-interpretation in these forests aims to classify an assessment area differently from jarrah forest types.

Using available photography, categorise forest into areas dominated by regrowth and mature components, then:

- Identify areas with more than 25 per cent crown cover of mature and senescent trees to a minimum resolution of 2 hectares (Figure 2). These are potential areas of old-growth forest. All other areas are not old-growth forest.
- Within the potential old-growth forest, any substantial areas of regrowth need to be examined to determine if it has resulted from harvesting or natural disturbance. These areas will generally require field survey to determine the presence of stumps (see Section 5).

Figure 2. Example of recent high resolution digital imagery examined in 3D environment to identify senescent trees within an area being assessed for potential old-growth karri forest.

4.2.5 Wandoo forests

Wandoo does not have a minimal disturbance component in its definition of old-growth forest, so interpretation of imagery is less intensive than for jarrah types.

Using available photography, interpret forest into regrowth and mature components. Areas where less than 15 per cent of the total canopy is regrowth have proven a reliable indicator of potential old-growth forest, and a field survey for stumps is required to determine their old-growth forest status (see Step 3).

5 Assessment Step 3 – field survey of stump occurrence

Candidate old-growth forest areas identified in Step 2 require a field survey to determine the level of disturbance they have experienced in past harvesting activities. This is achieved by conducting a series of linear transects to survey the number and distribution of stumps resulting from timber harvesting. When areas of jarrah forest are being assessed and the *Phytophthora* dieback status of an area has not been previously determined, the incorporation of a registered dieback interpreter into the survey team should be considered in order to expedite the final determination of old-growth forest status.

When preparing to survey a forest area for stumps, the following activities are undertaken.

5.1 Setting up the survey lines for sampling

Overlay the 0.5 hectare (70.7 metres x 70.7 metres) cell FMIS grid onto a GIS mapping workspace that includes the assessment area, photo-interpreted disturbance level boundaries from Step 2, formal and informal reserves, and mapped occurrence of *Phytophthora cinnamomi* infestation. Include roading, hydrology and forest blocks in the mapping layer as guides to assist with the orientation of survey lines. In areas of forest with dense overstorey or understorey, a field reconnaissance may be required to ascertain the accessibility of proposed survey lines.

Using the 0.5 hectare cell FMIS grid for orientation, set up survey lines to cover the entire assessment area. To ensure total coverage of each 0.5 hectare cell, space survey lines between 25 – 30 metres apart and orient them in a north-south or east-west direction (Figure 3). This spacing enables data collection for each cell, and coincides with the minimum scale at which many of the historical silvicultural systems were applied in the jarrah and karri forests (e.g. Australian Group Selection System during the 1940s).

Depending on the structure and condition of forest areas adjacent to the assessment area, the survey lines may need to be extended to sample the stump occurrence within the two hectares beyond the border of the assessment area. For example, assessment areas adjacent to dieback infested jarrah forest, even-aged karri regrowth or recent harvesting will not require further sampling beyond the border because the influence of the two hectare cells of non old-growth forest on the status and attribution of the adjacent two hectare cell(s) in the assessment area is clear. However, where the status of border cells within the assessment area may be influenced by the adjoining forest (e.g. an extension of minimally disturbed jarrah) the sampling should confirm the status of the adjoining forest.

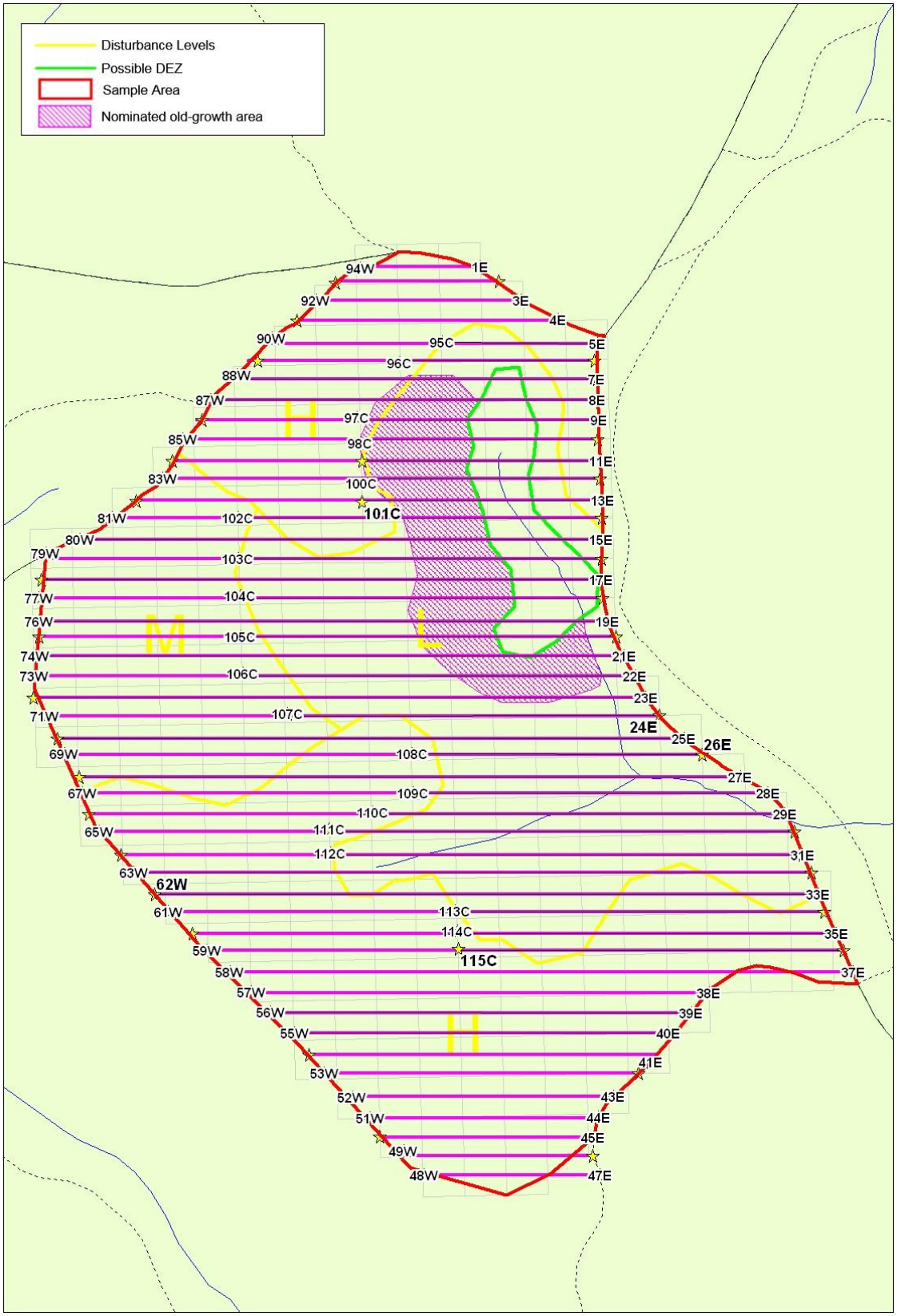

Figure 3. Orientation, spacing and labelling of survey lines for sampling of stump occurrence within an assessment area of forest.

5.2 Sampling intensity

The sampling intensity varies according to the forest type and the disturbance categories identified in the aerial photographic interpretation work undertaken in Step 2.

Jarrah forest types

Candidate old-growth forest areas or areas classified as having low disturbance that do not contain *P. cinnamomi* and are not DEZ – undertake field survey of every survey line.

Areas classified as having medium disturbance – undertake field survey of every second survey line.

Areas classified as high disturbance (i.e. where regrowth, snig tracks, landings and other disturbance patterns are clearly visible) – sample only one or two representative survey lines to verify the disturbance status.

Karri forest types

Field survey every second survey line, increasing to every line where necessary, to confirm the pattern and occurrence of stumps is consistent with the category determined in the aerial photographic interpretation.

Wandoo forest types

Field survey every second survey line, increasing to every line where necessary, to confirm the pattern and occurrence of stumps is consistent with the category determined in the aerial photographic interpretation.

Figure 4 depicts the layout of transect lines designed to sample the varying forest type and disturbance categories within an area of forest under assessment for potential old-growth forest.

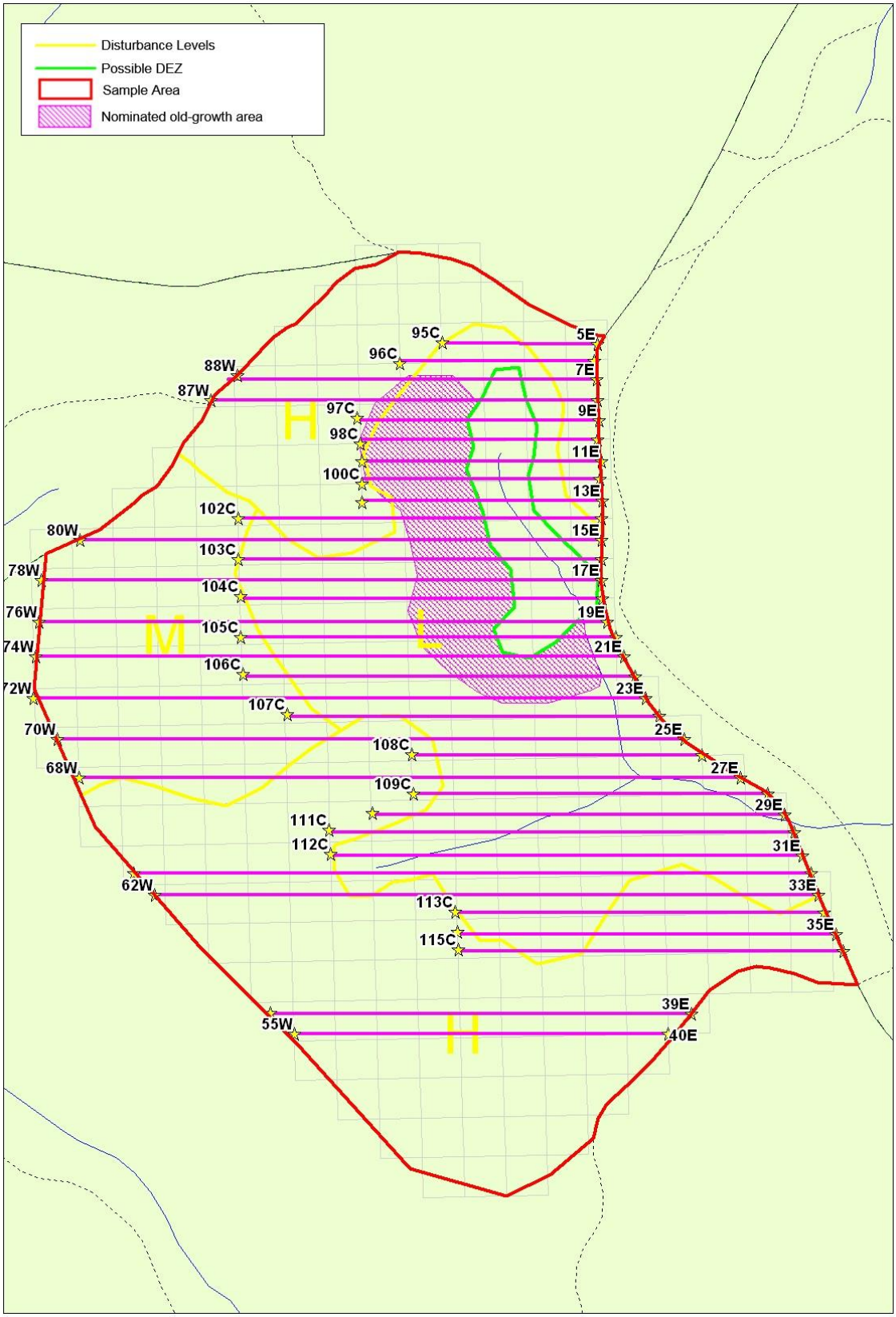

Figure 4. Map of the final transect lines selected for field survey using the sampling intensity ruleset (above) for each disturbance category. The FMIS grid is depicted in the background.

If the survey results are inconclusive for any disturbance category, the sampling intensity should be reviewed and further survey lines sampled to confirm the old-growth forest status of the area.

5.3 Field survey procedures

The procedure used to survey for stumps in the field is as follows:

- Search for stumps within 15 to 20 metres each side of the transect line. Focal points for stump searching are patches of regrowth, obvious gaps in the forest canopy and adjacent to historic snig tracks and tramways.
- Paint-mark each identified stump (to prevent double counting) and record its location using a GPS unit. If a cut stump is not observed but sectioned logs and crown components exist and are logically oriented, the butt log should be marked as the stump position.
- Record observations on the understorey density, regrowth presence and the location of other disturbance characteristics such as snig tracks, loading ramps, tramway formations, water points and landings. The relative size and pattern of stumps can be helpful to interpret harvest history, as many jarrah and wandoo stands may have been subjected to multiple harvest events over the last century, giving rise to several regrowth cohorts. The size of dominant trees in each cohort relative to the site quality can be helpful to infer the timing of previous regeneration events. Dense understorey in some jarrah landforms may indicate a reason for poor jarrah regeneration (and hence the absence of a regrowth cohort), or the lack of a seed crop following a harvest event.
- Download the recorded waypoints for all stumps found in the survey to create a single GIS layer of stump locations.

5.4 Stump identification

The appearance of stumps will vary depending on the tools used to fell or notch the trees and the extent of weathering and degrade from natural events. However, a stump must have a clear-cut edge (flat top) which can be associated with the felling event. FMB maintain a reference collection of images of historical stumps arising from the cross-cut, axe, circular and chainsaw eras to inform observations.

Depending on the time elapsed since the last harvest event, the frequency and intensity of past fires (bushfires and prescribed) and the background level of termite activity within the area, some stumps may have completely degraded or disappeared since the harvest event. In these cases a greater emphasis is to be placed on the interpretation of the broader pattern of regrowth observed in the field and aerial imagery, and the available historical information. For example, early silvicultural treatments sometimes involved heaping of crown debris onto stumps to facilitate burning of the stumps and deter coppice formation. Burnt stumps in some parts of the jarrah and wandoo forests have been observed to be marked by cavities and discolouration in the soil, whilst old coppice stands will have occluded and grown-over stumps.

5.5 Interpreting stump data

Once the field sampling has been completed it is necessary to interpret the stump data to obtain meaningful boundaries for areas of minimal disturbance (jarrah forest types) and old-growth forest. In southern forests resampling has indicated that the recorded stump numbers are often an underestimate of true stump numbers due to the visibility and access restrictions of dense understorey, whilst in the northern jarrah and wandoo forests, underestimates can occur where stumps have decayed or otherwise disappeared.

The number of stumps used to define nominal disturbance is informed by previous surveys conducted by both the Conservation Commission and the Department. As a general guide, areas with a lower natural stocking of trees will require less stumps per hectare to change the structure of the forest and thus change it's old-growth forest status.

The number of stumps which constitutes more than minimal disturbance is guided by the natural basal area (maximum site potential) for an area relative to the size of gaps created by the removal of overstorey (and hence the potential to establish a persistent regrowth cohort). Establishment of seedlings or release of the lignotuber pool can arise from small gaps created by the removal of individual trees in the mature canopy, while persistence of the regrowth is enhanced as the gap size increases. The minimum gap size currently preferred for commercial operations is two mature tree heights, but the persistence of a regrowth cohort from previous harvest or natural events is evident at much smaller scales of disturbance to the upper canopy. This can be observed in regrowth patches within areas cutover to the single tree and group selection practices applied in the 1930s, where a change in mature crown cover greater than around 5% has resulted in persistent regrowth cohorts.

In western jarrah forest (defined as areas receiving higher than 900 mm annual rainfall – as per the silviculture guidelines) a threshold of 6 or less stumps per two hectares indicates a minimally disturbed area. Based on analysis of historic inventories and field observations across the range of areas assessed for old-growth forest in the last decade, this scale of disturbance results in a change in the mature crown cover of greater than 10 per cent, and provides sufficient space for regrowth to persist.

In eastern jarrah forest (defined as areas receiving less than 900 mm annual rainfall – as per the silviculture guidelines) a threshold of 3 or less stumps per two hectares generally indicates a minimally disturbed area, although this threshold may need to be varied in areas where observable stumps are considered to significantly underestimate the evidence of past harvesting due to multiple bushfire events or degrade.

5.5.1 Jarrah forest (interpreting for minimal disturbance)

In jarrah forest, patches of forest larger than 2 hectares which are uninfested with *Phytophthora* dieback, and do not contain stumps or signs of human disturbance, will be classified as old-growth forest. Interpretation of stump numbers to define the boundary of areas which have been 'minimally disturbed' and constitute old-growth forest, involves the following process:

1. Combine the assessment area external boundary, the 0.5 hectare cell FMIS grid and the stump location data within a GIS (Figure 5).
2. Attribute the 0.5 hectare FMIS grid cell with the number of stumps recorded in each cell (Figure 6).

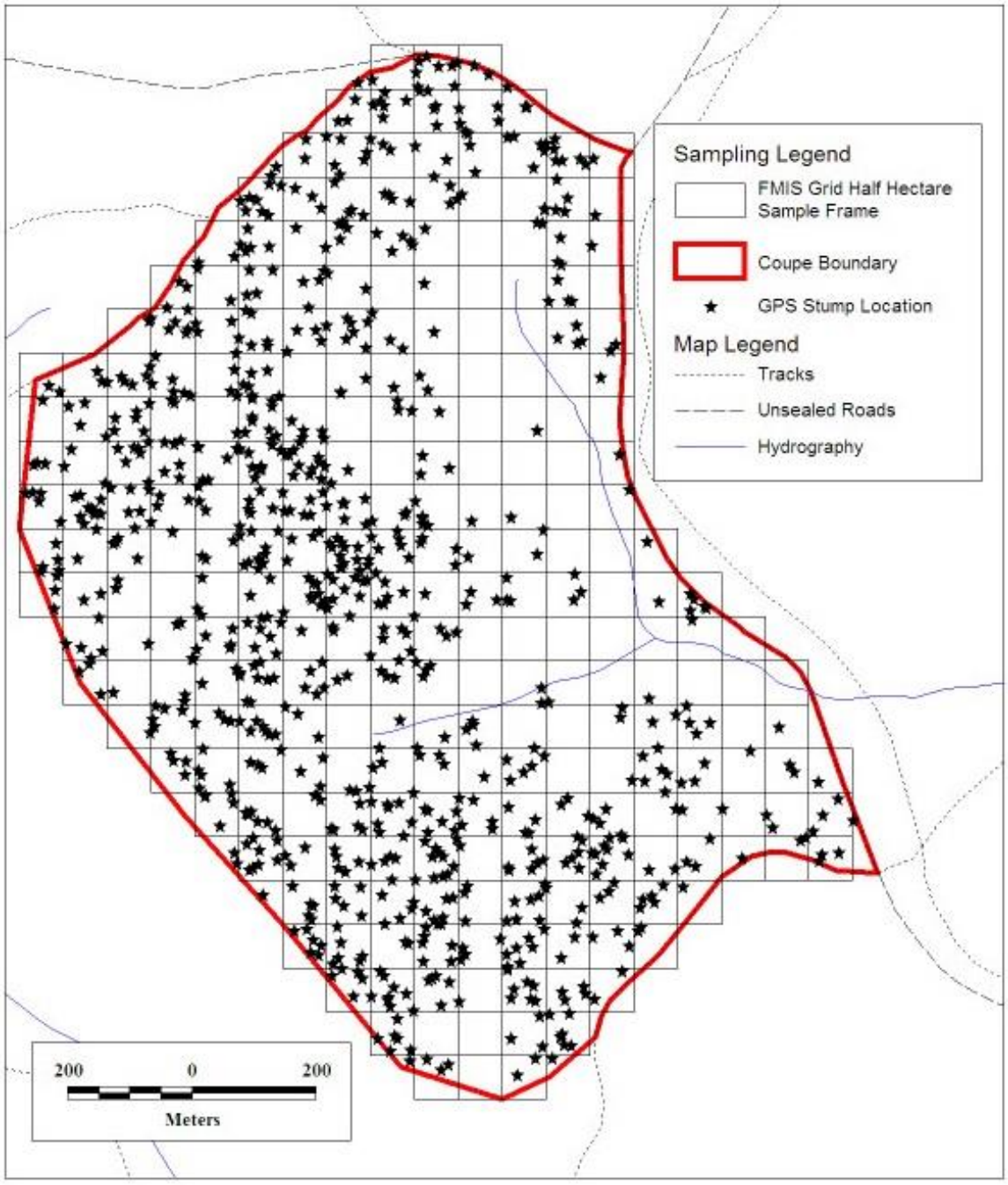

Figure 5. Half hectare FMIS sample frame, stump location data and the external boundary of harvest coupe/assessment area.

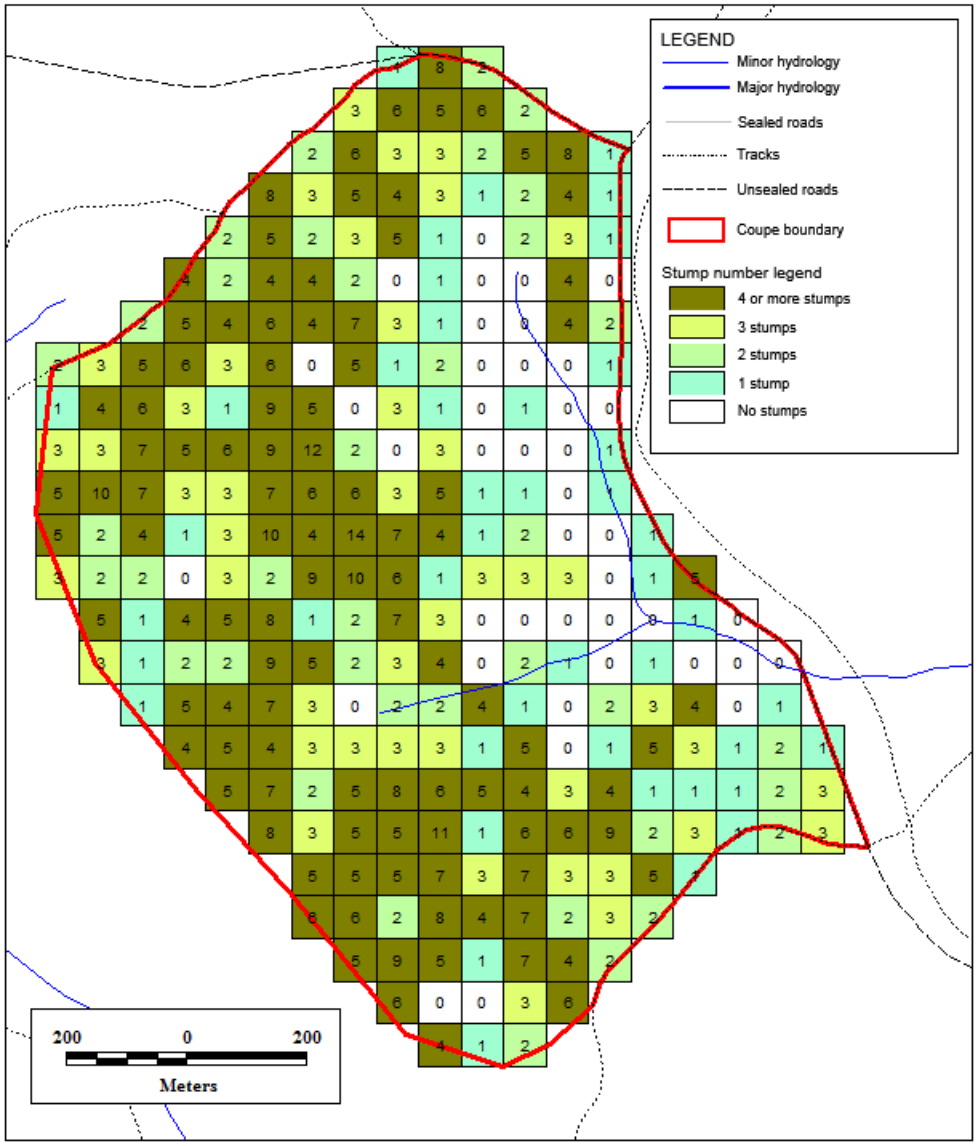

Figure 6. FMIS sample frame of 0.5 hectare cells, attributed with the number of stumps recorded during the field survey.

The candidate old-growth forest patches are identified at the minimum 2 hectare scale, with final mapping of the boundaries (and subsequent demarcation in the field) undertaken at the 0.5 hectare scale. This enables integration or alignment of the boundaries of the old-growth forest patches with other informal reserve and data layers. Consequently, the interpretation of minimal disturbance needs to be done using the stump threshold at the 2 hectare level, and refined within each candidate 2 hectares by applying a further threshold to ensure inclusion of 0.5 hectare FMIS grid cells that would otherwise be excluded from old-growth forest status due to high stump numbers being clumped in one quadrant of the 2 hectare cell.

To identify 2 hectare areas of minimum disturbance, each 0.5 hectare FMIS grid cell is compared to its three neighbouring cells to identify any 2 hectare combinations which fall below the threshold.

For example, with the threshold value of 6 stumps or less per 2 hectares in the first step and then 2 or less stumps per hectare in the second step, the following 2 hectare combinations in Figure 7 are classified as minimally disturbed:

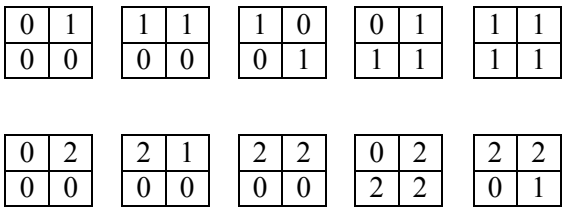

Figure 7. Combinations of four half hectare FMIS grid cells with stump numbers which can be interpreted as minimally disturbed at the two hectare level.

The combination of four half-hectare FMIS grid cells cannot contain areas which are more than minimally disturbed at the 0.5 hectare grid cell i.e. any FMIS grid cell cannot have more than two stumps in it.

The boundary is defined at this two hectare level, commencing from a two-hectare cell of old-growth forest (either no stumps or minimally disturbed) and progressively expand through evaluation of adjacent cells. The final boundary encompassing areas of no previous disturbance and minimal disturbance is depicted in Figure 8.

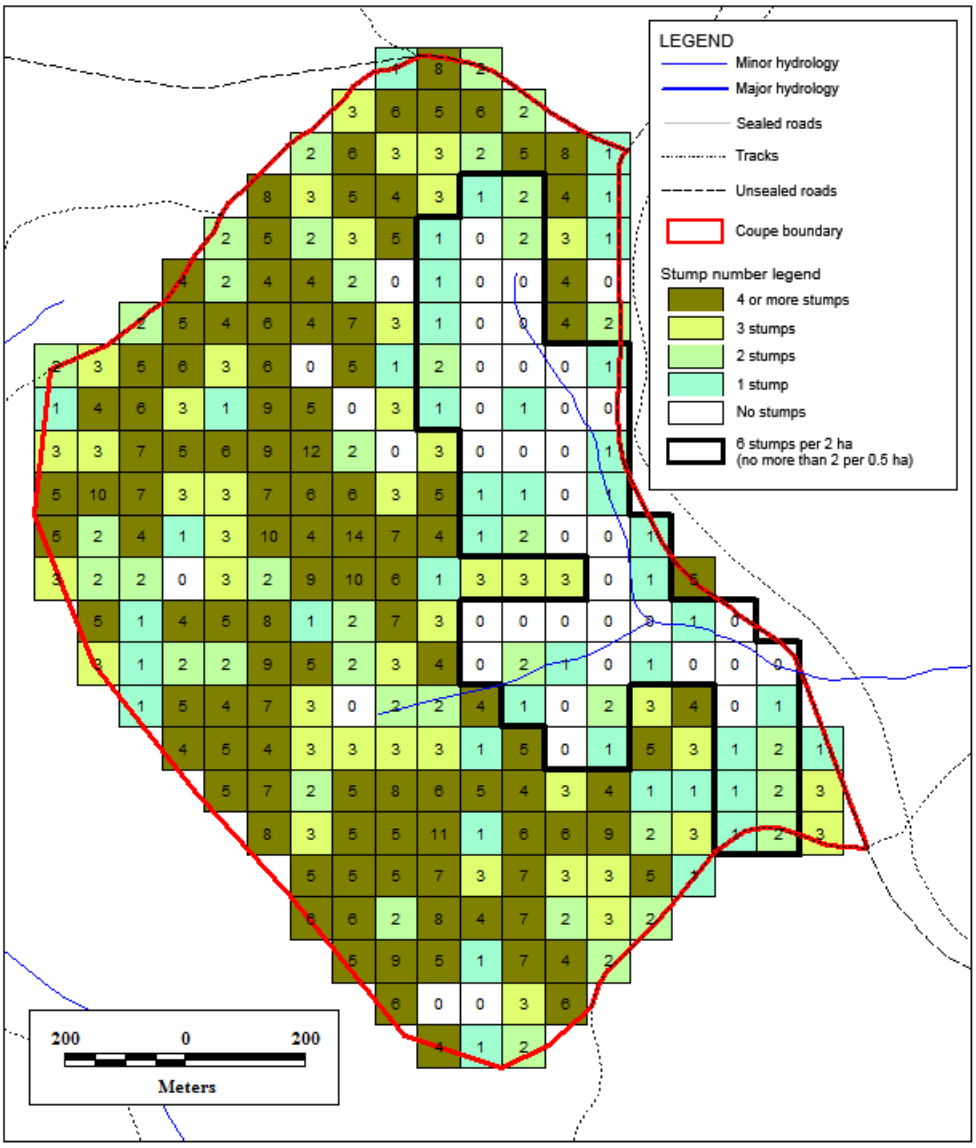

Figure 8. FMIS sample frame attributed with stump numbers and final area of undisturbed and minimal disturbance in jarrah forest type.

5.5.2 Karri forest and wandoo forest and woodland (interpreting for old-growth forest)

The process for delineating old-growth forest boundaries in karri and wandoo forest from stump data is as follows:

1. Combine in GIS the external assessment boundary, the 0.5 hectare FMIS grid cells and the stump location file.
2. Attribute each 0.5 hectare FMIS grid cell with the number of stumps recorded in it.
3. Within the assessment area locate any two hectare areas of never-harvested forest (four 0.5 hectare FMIS grid cells as a square that have no stumps). This indicates an old-growth forest patch.

6 Constructing the old-growth forest layer

The final boundary of the old-growth forest within the assessment area is determined by the forest type and structure, through integration of stump data, historical records and field observations of disturbance, and observations of any regrowth patterns arising from previous silvicultural and regeneration events.

Areas excluded from the old-growth forest layer will include:

- regrowth dominant areas arising from harvest events or other human disturbances
- areas of jarrah forest and woodland infested with *Phytophthora* dieback
- areas of jarrah forest that are more than minimally disturbed
- areas of karri or wandoo forest that have been previously cut over.

In the area depicted in Figure 8, the final boundaries of the previously unmapped old-growth forest is depicted in Figure 9.

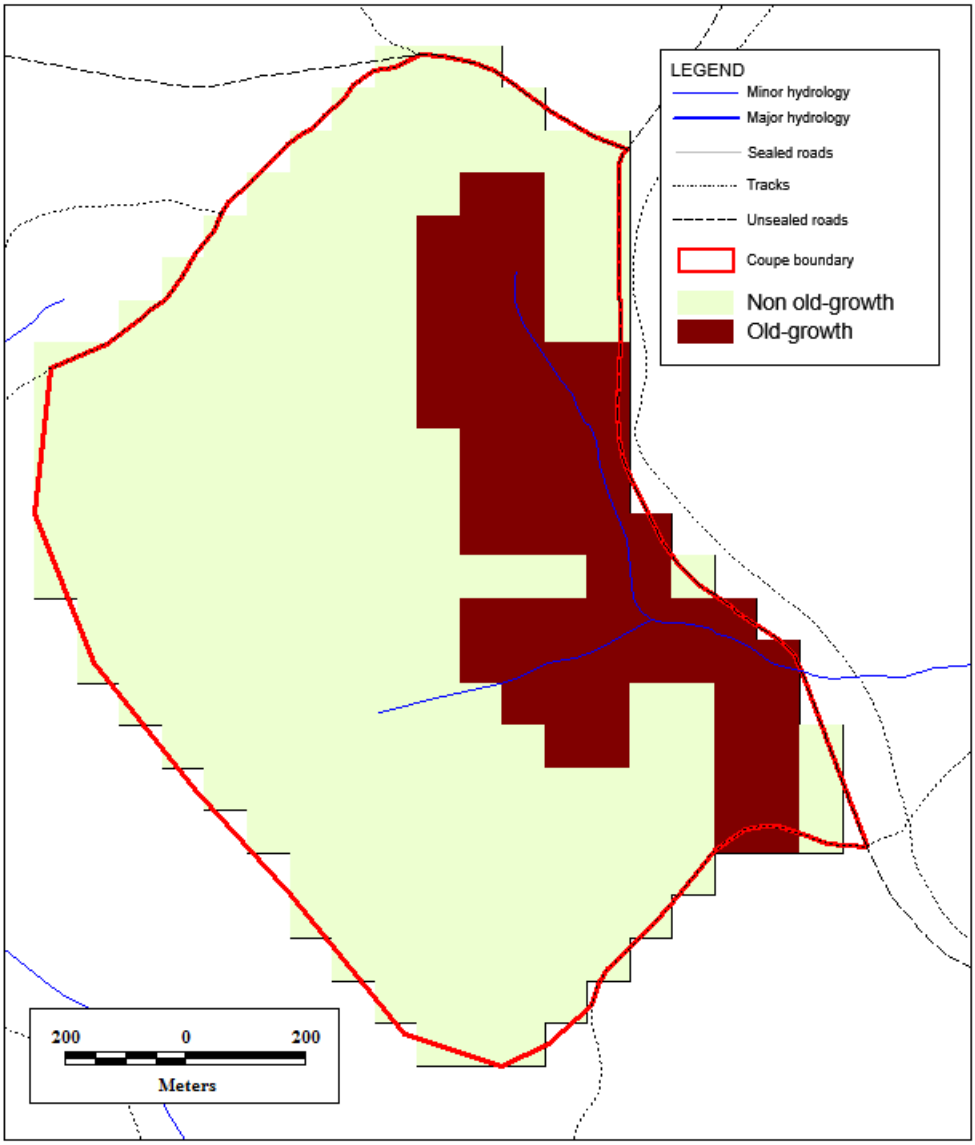

Figure 9. Map depicting the final boundary of the previously unmapped old-growth forest area.

7 Reporting

A brief report on the process and outcome of each old-growth forest status assessment will be prepared. The routine approval and data management process for informal reserve amendments will apply, which involve the submission of an informal reserve amendment form for review by the Regional Leader Sustainable Forest Management, approval by the Manager FMB, and notification to the proponent and field operations personnel. For areas nominated by public stakeholders, a copy of the report and subsequent determination will be provided for information and published to the Parks and Wildlife website.

In accordance with Management Activity 6.1 in the FMP, a map depicting the extent of old-growth forests and any changes to their status (including those arising from the

application of these procedures) will be published to the Parks and Wildlife website each year.

8 Data Management

Changes to corporate datasets arising from an old-growth forest assessment will be corrected through the routine departmental processes. These may include changes or updates to datasets depicting old-growth forest, forest type boundaries, harvest history, harvest extent, *Phytophthora* dieback occurrence, or karri development stage.

Most of these datasets have an annual update cycle. However, where the previously unmapped old-growth forest is located within a harvest coupe, a new coupe base map depicting the revised boundaries for the old-growth forest informal reserve will be issued following approval of the change in status by the Manager FMB.

9 Demarcation of old-growth forest boundary in the field

The boundaries of the previously unmapped old-growth forest that has been identified through this assessment process will need to be demarcated in the field prior to any disturbance activity being conducted in areas adjacent to or near the old-growth forest.

Demarcation will be undertaken using a differential GPS to plot the final boundary as supplied by the Department. In timber harvest coupes the old-growth forest boundary will be indicated in the field using standard paint markings (refer FPC *Procedure 74 – Demarcating harvest exclusion areas in native forest coupes*). Once demarcated, Forest Products Commission staff will not be required to undertake any further verification.

The pixilated FMIS boundary will be ‘smoothed’ or rationalised to a natural boundary using the distribution of stumps, available aerial photography and the centroid of each half hectare FMIS cell. The linework derived from this rationalised boundary will be demarcated in the field. An example of a proposed demarcation boundary is depicted in Figure 10. The boundary should always stay the correct side of the FMIS polygon centroid to ensure it retains its classification within FMIS.

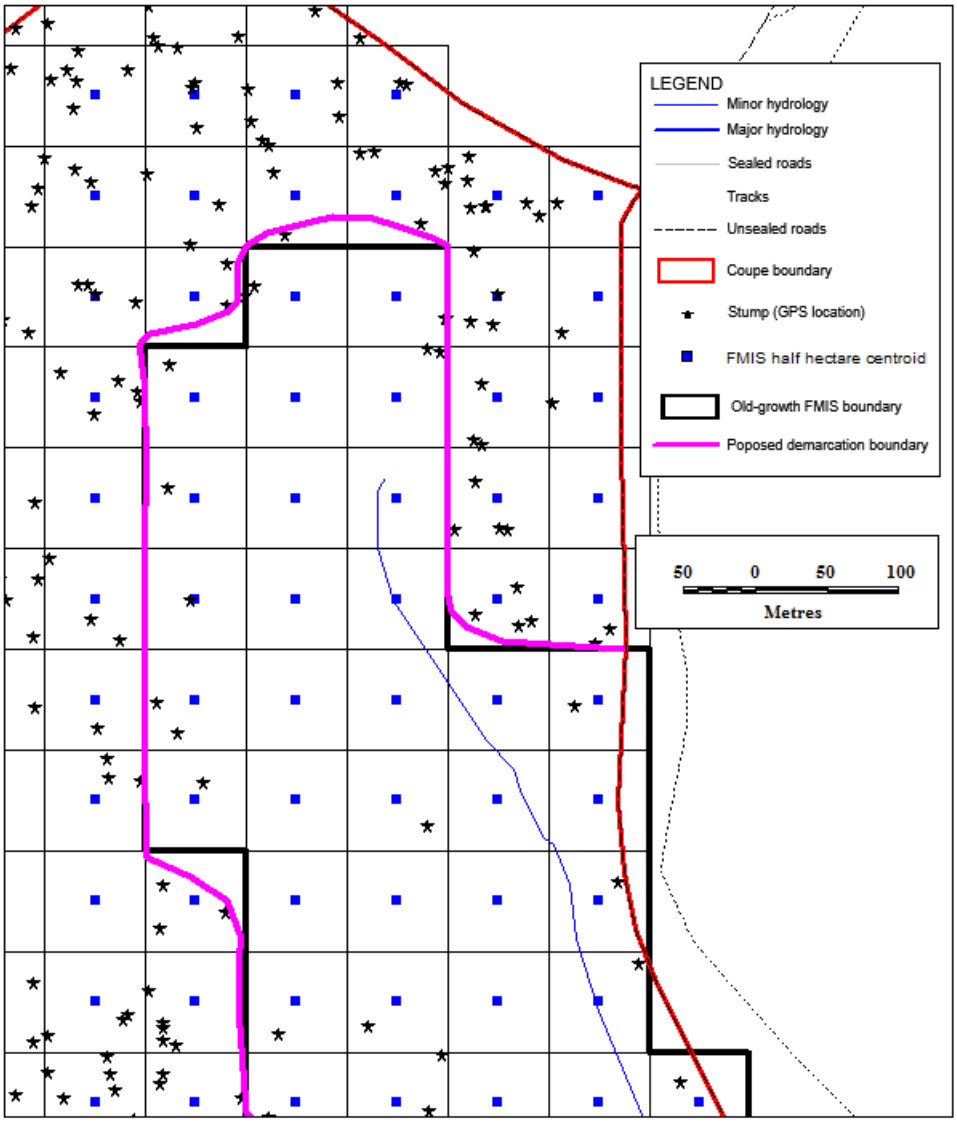

Figure 10. Proposed demarcation to a natural boundary using FMIS polygon centroids, aerial photography and stump distribution as a guide.

10 References

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