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# Application Of The Protective Measures And Forest Practices Into A Quantitative Database

Upper North East and Lower North East Regions

A project undertaken as part of the NSW Comprehensive Regional Assessments

July 2000

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# **APPLICATION OF THE PROTECTIVE MEASURES AND FOREST PRACTICES INTO A QUANTITATIVE DATABASE**

**UPPER NORTH EAST AND LOWER  
NORTH EAST REGIONS**

**State Forests Of New South Wales**

A project undertaken for  
the Joint Commonwealth NSW Regional Forest Agreement Steering Committee  
as part of the  
NSW Comprehensive Regional Assessments  
project number NA57/ESFM

**For more information and for information on access to data contact the:**

**Resource and Conservation Division, Department of Urban Affairs and Planning**

GPO Box 3927  
SYDNEY NSW 2001

Phone: (02) 9228 3166  
Fax: (02) 9228 4967

**Forests Taskforce, Department of the Prime Minister and Cabinet**

3-5 National Circuit  
BARTON ACT 2600

Phone: 1800 650 983  
Fax: (02) 6271 5511

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The project was primarily developed and implemented by Forest Resources Branch, Forest Policy and Resources Division, State Forests of New South Wales

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# PROJECT SUMMARY

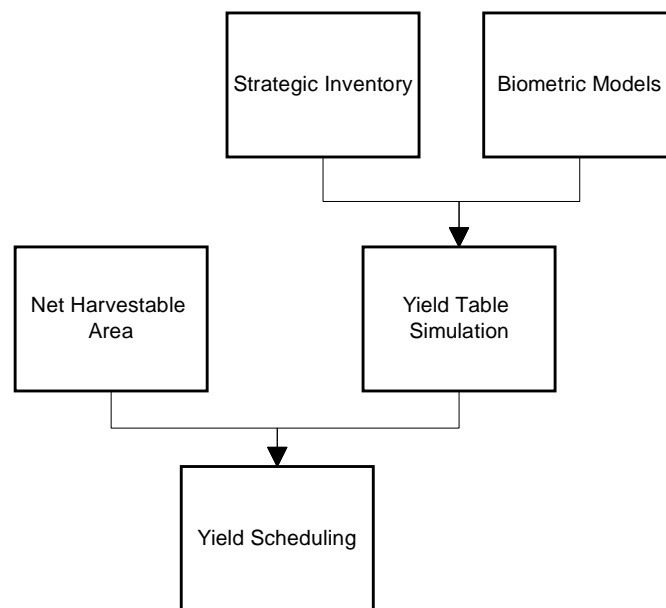
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This report describes a project undertaken as part of the Comprehensive Regional Assessments of forests in New South Wales. The Comprehensive Regional Assessments (CRAs) provide the scientific basis on which the State and Commonwealth Governments will sign Regional Forest Agreements (RFAs) for major forest areas of New South Wales. These agreements will determine the future of these forests, providing a balance between conservation and ecologically sustainable use of forest resources.

This project is one of five modules of the Forest Resource and Management Evaluation System (FRAMES), which was the tool used in CRA/RFA negotiations to calculate sustainable wood flows over time.

**FIGURE 1: FRAMES MODULES AND RELATIONSHIPS**

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## Project Objectives

The project was conducted to develop a quantitative database describing current and proposed protective measures and management practices in the State forests of the Upper North East and Lower North East CRA regions. The specific objectives of the project were to:

- Build a comprehensive Arc/Info planning database that clearly and accurately identifies the location and extent of State forest land covered by protective measures.
- Develop a rational account of State forest lands in various management eligibility categories.

## Methods

The location and extent of the various harvest exclusion areas was sourced from other available CRA projects and independently estimated impact where no previous CRA project result was available. The sourced and estimated harvest exclusion area was

collated by forest practice or measure into separate layers within a Geographic Information System (GIS). Individual layers were combined into a single Arc/Info coverage using a series of GIS “overlay” operations. The resulting database identifies both the original feature locations as well as the combined impacts of all contributing layers.

By maintaining the complete, original detail of contributing factors, it was possible to assess different sets of exclusion criteria during the negotiation process. The approach taken was to perform the heavy GIS processing workload prior to negotiations, building a database that could subsequently be used for reasonably rapid analysis of negotiation phases and results.

### **Key Results and Products**

The primary product was the development of data sets for the Upper North East and Lower North East CRA regions. In addition, a computer program was produced to generate summaries of the data sets under various combinations of protective measures and reserve designs.



# 1. INTRODUCTION

## 1.1. NET HARVEST AREA

The Net Harvest Area (NHA) represents the portion of State forest land that is available and accessible for timber production operations. A number of factors cause reductions in the area available for harvesting, including:

- agreed management practices such as the Pollution Control Licence issued by the Environment Protection Authority and conservation protocols issued by the National Parks & Wildlife Service;
- terrain factors (eg. steep slopes and rockiness);
- accessibility factors (road and extraction access);
- leasehold conditions (timber availability encumbered by lease conditions);
- State Forests management priorities (eg. visual quality retention, reserves, Preferred Management Priorities<sup>1</sup>);
- operational factors (eg. proximity to exclusion zones, haulage impediments);
- economic factors;
- merchantability factors; and
- nomination for inclusion in a formal or informal reserve (ie. from C-PLAN).

## 1.2. EXTENT OF COVERAGE

The Net Harvest Area database was produced for State Forests land only. Other tenures are not considered available for harvest within the FRAMES resource assessment.

Separate databases were produced for the Upper North East and Lower North East CRA regions. A database was also produced for the Southern CRA and this is documented in a separate project report.

## 1.3. DATABASE DESIGN

At the request of the ESFM group, the database was built in an Arc/Info coverage format. The general method was to estimate the location and extent of the areas excluded from harvesting which were generated from NPWS Conservation Protocols, Pollution Control Licence conditions, and operational restrictions in separate GIS layers. The independent estimates were then combined into a single Arc/Info coverage using a series of GIS “overlay” operations. The resulting database identifies both the original feature locations as well as the combined impacts of all contributing layers. By maintaining the complete, original detail of contributing factors, it

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<sup>1</sup> PMPs were superseded with the Forest Management Intent Zones (FMZ) Classification in the derivation of the Final State Position and Regional Forest Agreement

was possible to reselect and assess new combinations of protocols during the negotiation process. The approach taken was to perform the heavy GIS processing workload prior to negotiations, building a database that could subsequently be used for reasonably rapid analysis of negotiation phases and results.

Figure 2 shows the relationships between the components and stages used to derive the FRAMES native forest net harvest area database.

## **1.4. METHODOLOGY**

Five classes of harvest exclusions were determined from the State Forest preferred management priority zoning, NPWS conservation protocols, EPA Pollution Control Licence, and operational considerations. Each class includes a series of individual layers of exclusion types. Refer Table 1A for summary of harvest exclusion types and modelling approaches.

### **Type “A” Protective Measures**

These layers identified, known and locatable areas where complete exclusions of timber harvest are applied to protect conservation or other values. The output was a geo-spatial polygon database depicting the estimated locations of the protected areas. Section 2.1 describes the individual Type “A” layers captured.

### **Type “B” Protective Measures**

These zones represented areas where timber harvesting may occur, but practices are designed to protect values often present in the broader forest matrix. Type “B” restrictions were implemented using restricted silvicultural practices to ensure adequate habitat tree and recruitment tree retention. For modelling purposes the impacts of these practices were expressed in the FRAMES yield simulator (refer Section 2.2).

### **Type “C” Protective Measures**

Type “C” protocols described resource values that cannot be located in advance of harvest planning, but must be protected as they are encountered during field operations. Typically the protective measure is a 100% harvest exclusion zone around the feature of interest. The impact of these measures was modelled using the species specific protocol “Strike Rates” (refer Section 2.3).

### **Operational Restrictions**

Operational restrictions are deductions of areas unsuitable for harvesting operations due to physically and economically inaccessible reasons, steep slopes, and unmerchantable forest types. Areas which are operationally unsuitable were modelled in two ways. Mapped areas were modelled as direct polygon exclusions, while unmappable exclusions were accounted for using net harvest area modifier reductions (refer Section 2.4).

### **Non-Native Forest**

Areas of non-native forest which included purchased land for plantations establishment, softwood and hardwood plantations were excluded from the Gross area of State Forest. These were modelled as direct polygon exclusions.

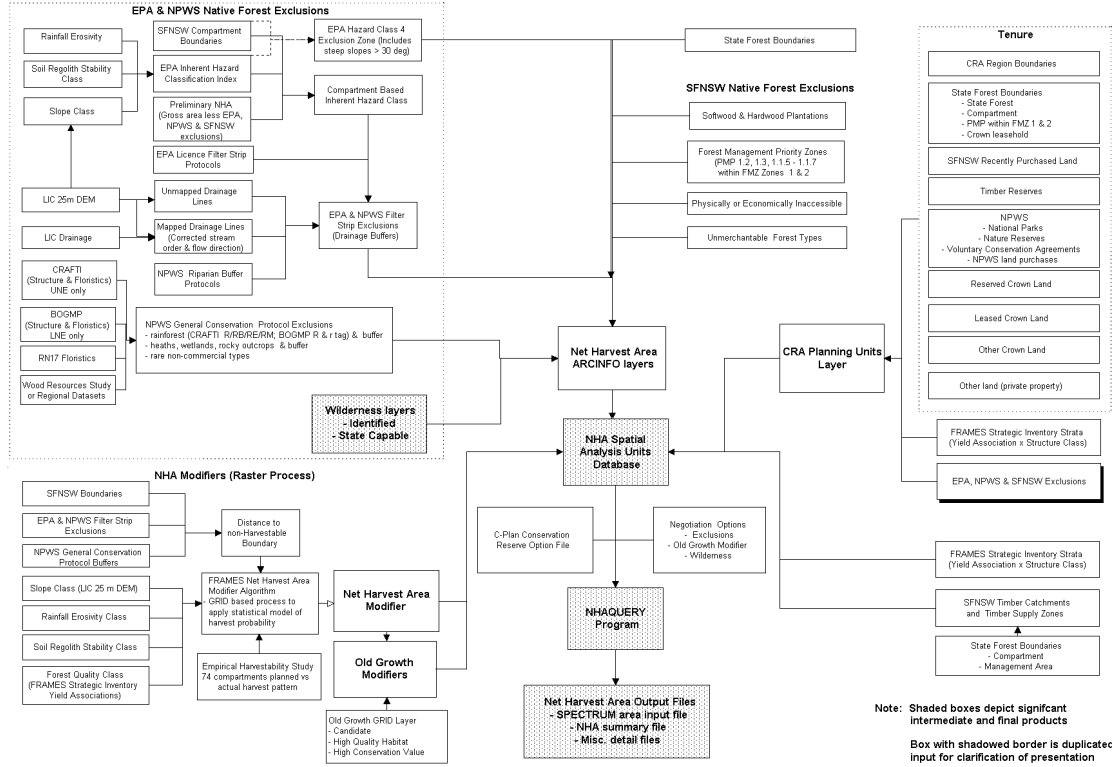
**TABLE 1A: HARVEST EXCLUSION TYPES AND MODELLING APPROACH**

Exclusion	Exclusion Type	Exclusion Modelling Approach	Notes
Purchased land	Non-Native Forest	Mapped Exclusion	
Softwood plantations	Non-Native Forest	Mapped Exclusion	
Hardwood plantations	Non-Native Forest	Mapped Exclusion	
Heath	Type A protective measure	Mapped Exclusion	
Rocky Outcrops	Type A protective measure	Mapped Exclusion	
Wetlands	Type A protective measure	Mapped Exclusion	
Rare non-commercial forest types	Type A protective measure	Mapped Exclusion	
Rainforest			
- RN17	Type A protective measure	Mapped Exclusion	
- r BOGM	Type A protective measure	Mapped Exclusion	LNE only
- ry & rd BOGM	Type A protective measure	Mapped Exclusion	LNE only
- embedded type r BOGM	Type A protective measure	Mapped Exclusion	LNE only
- CRAFTI	Type A protective measure	Mapped Exclusion	UNE only
Preserved native forest (PMP 1.3)	Type A protective measure	Mapped Exclusion	
Unavailable native forest (PMP 1.2, 1.1.5, 1.1.6, 1.1.7)	Type A protective measure	Mapped Exclusion	
PCL Inherent Hazard Level 4	Type A protective measure	Mapped Exclusion	
Filter strips on mapped drainage	Type A protective measure	Mapped Exclusion	Refer footnote No. 1
Filter strips on unmapped drainage	Type A protective measure	Mapped Exclusion	
Wilderness			
- State Capable	Type A protective measure	Mapped Exclusion	
- Identified	Type A protective measure	Mapped Exclusion	
Unmerchantable types	Operational restriction	Mapped Exclusion	
Slopes >30 degrees	Operational restriction	Included as HAZ4 mapped exclusion	
Physically & Economically Inaccessible	Operational restriction	Mapped Exclusion	
Net area modifier			
-unmapped operational restrictions	Operational restriction	NHA Modifier	
-Old Growth - Candidate	Type A protective measure	NHA Modifier	
-Old Growth - High Quality Habitat excl. sA & tA	Type A protective measure	NHA Modifier	
-Old Growth - all High Quality Habitat	Type A protective measure	NHA Modifier	
-Old Growth - High Conservation Value	Type A protective measure	NHA Modifier	
Habitat & feed tree retention	Type B protective measure	Yield simulation implicit constraint	
Formal & informal reserves	Reservation for JANIS criteria	Mapped Exclusion	
Unmapped threatened flora & fauna strikes	Type C protective measure	Strike rate - post modelling volume reduction	

1. Field assessment may identify the area as a drainage depression and not require a filter strip. This has not been quantified but is considered to have negligible impact.



Figure 2: FRAMES NATIVE FOREST NET HARVEST AREA DATABASE DERIVATION



Insert A3 page with Figure 2 – flowchart



# 2. HARVEST AREA EXCLUSIONS

## 2.1. TYPE "A" PROTECTIVE MEASURES

Type "A" protective measure boundaries were derived from existing data sets, primarily SFNSW Research Note 17 (RN17) for floristic and CRA Aerial Photography Interpretation (CRAFTI) or Broad Old Growth Mapping (BOGM) for structural characteristics. The Pollution Control Licence filter strips were derived from Land Information Centre (LIC) digital elevation models. The integrated data set was constructed by overlaying base layers (such as RN17 and CRAFTI), and then using a query operator to form "regions" representing the features of interest. Sliver polygons less than 0.01 ha in size were eliminated during the overlay process.

### 2.1.1. Heath

This protocol was modelled according to the specification provided in the NPWS draft Revised Protective Measures document of August 22, 1998 (RPM-22/08/98). RN17 types 223 and 224 were used to define heath areas. The entire extent of the RN17 223 and 224 type polygons were excluded. Buffer zones of 20 metres were added around polygons of more than 0.1 ha but less than 0.5 ha surface area. Buffer zones of 40m were added around polygons of greater than 0.5 ha surface area. The buffer zones were measured out from the edge of the RN17 type polygon.

### 2.1.2. Rocky outcrop

This protocol was modelled according to the RPM-22/08/98. RN17 types 234 were used to define rocky outcrops. The entire extent of RN17 type 234 polygons was excluded. Buffer zones of 20m were added around polygons of greater than 0.1 ha but less than 0.5 ha surface area. Buffer zones of 40 ha were added around polygons of greater than 0.5 ha surface area.

### 2.1.3. Wetland

This protocol was modelled according to the RPM-22/08/98. RN17 types 231 and 235 were used to identify wetland areas. The entire extent of the RN17 231 and 235 type polygons were excluded. Buffer zones of 10 metres were added around polygons of more than 0.1 ha but less than 0.5 ha surface area. Buffer zones of 40m were added around polygons of greater than 0.5 ha surface area. The buffer zones were measured out from the edge of the RN17 type polygon.



#### **2.1.4. Rare non-commercial forest type**

Based on advice from Andrew McIntyre (NPWS Northern Zone, 20/07/98) the following RN17 forest types were designated as “Rare non-commercial” under conservation protocol number 35:

21, 30, 31, 32, 33, 42, 51, 52, 63, 64/1, 66, 82/1, 94, 96, 98, 101, 103, 104, 105/1, 105/2, 107, 109, 110, 119, 125, 127, 129/1, 129/2, 130, 131, 136, 137, 141, 162, 164, 171, 172, 175, 176, 178, 180, 182, 203, 204, 207, 213, 214, 215, 225

The RN17\_RNC exclusion layer was created by selecting all polygons from the RN17 type layer from the above set of codes.

#### **2.1.5. Rainforest**

Rainforest types were defined from RN17 type layers, supplemented by CRAFTI structural data in the UNE region, and BOGM data in the LNE region.

RN17 rainforest types were modelled according to advice provided by Andrew McIntyre (NPWS Northern Zone, 20/07/98). All RN17 rainforest types were excluded. In addition, RN17 types 10, 11, 12, 13, 14 and 15 (warm temperate rainforest) were assigned a 20 metre exclusion buffer.

#### **2.1.6. Preserved native forest (PMP 1.3)**

SFNSW preferred management priority (PMP) land classification system was used to identify available timber lands that were scheduled for preservation. PMP type 1.3 (Preserved native forest) identifies:

“representative areas of native forest or areas of unique, rare or uncommon biological values which have been reserved to protect these values. Most of these areas will be Flora Reserves or Forest Preserves. They will remain undisturbed except for site-specific treatments and uses, which are prescribed in an approved working plan and do not prejudice the special values.”

All PMP 1.3 areas were mapped exclusions.

#### **2.1.7. Unavailable native forest (PMP 1.2, 1.1.5, 1.1.6, 1.1.7)**

SFNSW PMP land classification system was used to identify available timber lands that were scheduled for non-timber uses. These areas included:

- PMP 1.2 Undeveloped Native Forest. Areas of native forest (generally 10 ha or more) in which the production of timber products, in particular, will be low or non-existent.
- PMP 1.1.5 Special Emphasis Catchment Protection. Areas which form catchments of domestic water supplies or environmentally sensitive aquatic ecosystems.
- PMP 1.1.6 Special Emphasis Visual Resource Protection. Areas of particular visual sensitivity such as areas of vegetation along roads, escarpments or hillsides, which form noticeable landscape components and require special consideration to maintain visual quality.
- PMP 1.1.7 Special Emphasis Flora and/or Fauna Protection. Areas containing habitats of flora or fauna of special significance and areas reserved for general habitat protection, where the preservation of the area as PMP 1.3 is not warranted or is under consideration.

All PMP 1.2, 1.1.5, 1.1.6, and 1.1.7 were mapped exclusions.

All of the special emphasis PMP 1.1.6 class was excluded, as it was not possible to separate the class into those lands which are available for timber harvesting and roading. It should be noted that this PMP classification was superceded by the FMZ classification in the final area determination used for the NE Regional Agreement.

#### **2.1.8. Wilderness**

NPWS provided ArcView shapefiles delineating “identified wilderness” and “State capable wilderness” for both the UNE and LNE CRA regions. These layers were converted to Arc/Info coverage format and added to the Net Harvest Area database.

#### **2.1.9. Filter strip**

The Pollution Control Licence conditions require that protective filter strips be implemented along all drainage lines, prescribed streams, watercourses, wetlands, swamps and major water storages. For the purpose of the Licence, drainage lines are defined by on ground occurrence. Subsequently filter strips are implemented on unmapped drainage lines in addition to those present on standard Land Information Centre topographic maps.

The current database that maps the locations of drainage features fails to record the location and occurrence of all drainage lines. An alternative method was devised to estimate the occurrence of drainage features, including the unmapped drainage lines (refer Section 3.1).

An automated methodology was used to estimate drainage line locations from a digital elevation model. The methodology provided an estimate of filter strip locations and areas affected. The project was designed as input to a strategic land allocation process, and the results are not of operational quality. The strategic estimate of drainage feature occurrence can be expected to vary from the actual drainage features when applied in an individual compartment. It is therefore not intended that the results from individual compartments be used for any operational planning purpose.

Refer to Section 3.1.4 for the methodology for filter strip determination.

#### **2.1.10. Inherent hazard class 4**

Estimates of inherent hazard class 4 areas were developed according to the Pollution Control Licence methodology. Data layers used as input to the calculation of the index included compartment boundaries (from SF GIS database), slope class (from LIC 25m digital elevation model), rainfall erosivity and soil regolith stability (Murphy, Fogarty & Ryan), as per Licence requirements. These data sets were combined using an ARC/INFO GIS overlay operation.

The silviculture systems proposed for use in the RFA regions included single tree selection (STS) with a maximum basal area removal of 40%, and Australian group selection (AGS), with a maximum net harvest area removal of 22.5%. The intensity of these operations falls within the Pollution Control Licence definition of “Native forest logging with less than 50% canopy removal within the net harvestable area (dozer/skidder extraction)”. The less than 50% canopy removal limit is consistent with the Pollution Control Licence applications submitted by SFNSW in NE NSW.

Refer to Section 3.2 for the methodology for inherent hazard class 4 determination.

### 2.1.11. Non-native forest

Non-native forest areas are forest zones which are harvested but are not included in the calculations of net harvest area, and are subsequently expressed as a deficit against the gross area.

Purchased land and softwood plantations were not considered for dedicated reservation in the RFA negotiations, and therefore deficit zones were developed for these areas from coding found in the tenure database.

Hardwood plantations were available for reservation, however, hardwood plantations have a different set of protocols than native forest and thus different sets of exclusion rules apply. In order to avoid applying the incorrect set of exclusions, the entire area of hardwood plantation as identified in the ESFM database were listed as a deficit zone. A separate estimate of net harvestable area for hardwood plantations was assembled and used during the wood supply analysis.

## 2.2. TYPE "B" PROTECTIVE MEASURES

Protective measures within this category included habitat tree and feed tree retention. This protective measure is applied across areas where harvesting is permitted, and represents a reduction in net harvest volume, not net harvestable area. The FRAMES yield simulator was used to produce estimates of yield and residual stand volumes under various silvicultural operations on all site types. The yield simulation process was monitored to ensure that the required level of habitat tree retention was achieved for all silvicultural systems.

Refer to Section 3.3 for the main methodology used in the Yield Simulator project to incorporate Type "B" protective measures into calculations of volume availability. For a complete explanation of the Yield Simulator project (NA14/FRA), refer to the report Yield Simulator, Upper and Lower North East CRA Regions (SFNSW, 2000).

## 2.3. TYPE "C" PROTECTIVE MEASURES

The Conservation Protocols put in place by the Interim Assessment Process included a wide range of prescriptions to protect threatened flora and fauna that were triggered by records of those species in logging areas. Many of the records occur as a result of surveys undertaken during the harvest planning phase. The prescriptions therefore can not be mapped in advance, and estimates of effect on volume could not be calculated as a regular function across the landscape (as in the case of retained habitat trees). To assess the impact of these prescriptions an *a posteriori* analysis was done on a selection of compartments harvested in the past (refer Appendix 2 for list of compartments). The area lost to each identified prescription according to the harvest plan was calculated on the compartment sampled with normalisation to a unit of 1000 hectares.

The method arrived at a 7.6% loss of area across the UNE and LNE CRA regions. Subsequently after consideration of the effects of the harvest exclusions on net area, this figure was proportionally decreased to 6.71% of net harvest area. This method, which could be verified and repeated, was accepted as the rate of loss of volume from prescriptions that could not be mapped or generalised.

Refer to Section 3.4 for the methodology for the calculation of volume reduction due to Type "C" conservation protocol prescriptions.

## 2.4. OPERATION REDUCTIONS THROUGH FRAMES

Although all of the timber remaining in the area outside the previous “A”, “B” and “C” protective measures are deemed eligible for harvest, a proportion of the timber has little likelihood of harvest due to physical and operational impediments to harvesting. It was essential to get an accurate estimate of the impact of these operational restrictions in order to avoid overestimating long run sustainable wood supply.

There were two general classes of area reductions due to operational factors in the FRAMES Net Harvest Area (NHA). The first class is mapped areas where the locations of operationally unsuitable land are known and 100% of these areas are deducted from the harvestable area. Mapped areas included inaccessible areas (eg. no road access), non-productive forest types, steep slopes, and PMP zones. Some of these areas were partially accounted for by application of Type “A” features. Since these sites are explicitly mapped no double counting of areas occurred. The second general class of includes those areas which either cannot be mapped or cause a partial reduction in timber availability within a planning unit. The second class of area was deducted from the harvestable area using area reduction factors. Particular care was taken to avoid double counting of areas.

### 2.4.1. Slope greater than 30 degrees

Using conventional techniques, logging does not occur on slopes greater than 30 degrees. All slopes greater than 30 degrees were excluded as part of the inherent hazard class 4 category. There was no requirement to build another layer to exclude this category.

### 2.4.2. Physically and economically inaccessible areas

All State forest areas within the LNE and UNE were assessed by local staff to determine which large blocks of native forest were unavailable for future harvesting for physical or economic reasons.

Physically and economically inaccessible (PEI) areas included:

- Areas that contained significant steep areas (>30° slope), or other physical impediments: rock, cliffs, dissected drainage systems or wetlands, rainforest areas or other non-commercial forest types, rare plant communities, etc. that prevent the accessing of adjoining forest areas.
- Areas of State forest that have no current road access, and that are considered unsuitable to road in the future due to their landlocked nature by either National Park, adjoining freehold tenure, topographic features (eg. major creek and river systems, rainforest areas, steep lands, unsuitable soil conditions, etc.), or
- Areas of State forest that have no current road access suitable to meet current logging guidelines (SFNSW code of logging practice, EPA licence, NPWS Protocols, Fisheries conditions, roading guidelines etc as per IFOA) and that are considered uneconomical to road in the future, as the cost of constructing roads exceeds the required return on capital from the area.

The bulk of the area in PEI exclusion areas are already removed from the net harvestable area by primary exclusion factors (eg. slope > 30° degrees, rainforest and other non-commercial forest types, EPA filter strips, etc.) The additional areas that are removed by PEI classifications are then generally small pockets within larger surrounding exclusions, or landlocked or un-roaded areas.

### 2.4.3. Unmerchantable types

The FRAMES strategic inventory delineated areas of common structural and floristic composition (refer SFNSW, 1999). Detailed field sampling (temporary sample plot measurements) provided the basis for volume estimation. The following table shows the scheme used to classify State forest tenure into FRAMES inventory strata. Codes 1 to 31 represents productive forest stands for which growth and yield information has been compiled. Codes 95 to 99 represents unmerchantable types for which yield information is unavailable. (Refer Table 2A). Although the area of unmerchantable forest types is available for harvesting, FRAMES records show that no merchantable volume is available, and in reality these areas will not be logged. These areas were thus removed from the estimated productive land base in order to provide a more accurate accounting of State forest production possibilities.

**TABLE 2A: SCHEME USED TO CLASSIFY STATE FOREST LAND INTO FRAMES INVENTORY STRATA**

Yield Association	Structure class							
	e1 small regrowth	E2 Large regrowth	e3 regrowth of unknown size	A High senescing %	B medium senescing %	C low senescing %	Blank	other
Moist blackbutt	1	7	7	11	18	25	96	95
Moist coastal eucalypts	2	8	8	12	19	26		
Semi moist and tall dry eucalypts	3	9	9	13	20	27		
Dry blackbutt and spotted gum	4	10	10	14	21	28		
Dry sclerophyll	5			15	22	29		
Moist tablelands	6			16	23	30		
Dry tablelands				17	24	31		
Other	97						99	98

The UNMERCH exclusion layer was created by selecting all polygons having FRAMES strata codes of 95 to 99.

Unmerchantable Types includes a small area of unlabelled merchantable strata (no floristic and/or structure codes i.e. strata 95 & 96 ) and areas of unmerchantable types (Negligible Productive Types, Rainforest, hardwood and softwood plantation, and Non-Eucalypt Associations).

### 2.4.4. Net harvest area modifier

The net harvest area modifier generates a projection of the likely reductions in net harvest area due to field characteristics within a harvest unit that have not been accounted by the mapped exclusions. Such factors included soft, boulder strewn or rough terrain, areas up-slope of buffers where falling is impracticable, and areas up slope of buffers where access is difficult. The modifiers were developed from empirical studies of planned versus actual harvesting operations.

Refer to Section 3.5 for the methodology for FRAMES net harvest area modifier.

#### 2.4.5. Old growth exclusions

Estimates of the extent of old growth exclusion zones were provided by NPWS in raster format during negotiations. Several old growth surfaces were provided: candidate old growth; high quality habitat old growth; and high conservation value old growth. This format was incompatible with the Type “A” exclusion zone methodology, so an alternative technique had to be developed to incorporate old growth factors into the net harvest area calculations.

Raster surfaces were combined with the net harvest area modifier surface, in order to reduce the net old growth available area in each grid cell. The raster images were registered to the same cell size and grid origin, and the old growth surfaces were used to “mask out” areas where harvesting would be excluded. Grid cells within the old growth exclusion zones were assigned a harvest probability of zero.

A number of variations on the net harvest area modifier were developed:

NHAM	The original net harvest area modifier from the FRAMES study.
NHAM_OG	Original modifier plus candidate old growth excluded
NHAM_HQOG	Original modifier plus HQH Old Growth sA and tA excluded
NHAM_HQOG2	Original modifier plus all HQH Old Growth excluded
NHAM_HCV	Original modifier plus HCV Old Growth excluded
NHAM2	Second version of the modifier re-factored to exclude filter strip effects.
NHAM2_OG	New modifier plus candidate old growth excluded
NHAM2_HQOG	New modifier plus HQH Old Growth sA and tA excluded
NHAM2_HQOG2	New modifier plus all HQH Old Growth excluded
NHAM2_HCV	New modifier plus HCV Old Growth excluded



# 3. SPECIFIC METHODOLOGIES

## 3.1. METHODOLOGY FOR FILTER STRIP DETERMINATION

The basic methodology used hydrological operators from the Arc/INFO GRID modelling package to extract and order drainage features. In particular, the FLOWDIRECTION, FLOWACCUMULATION, STREAMORDER, and GRIDLINE commands were used to extract the drainage lines. Once the features were identified, the Arc/INFO commands IDENTITY and BUFFER were used to create appropriately sized filter strip buffers. The details of the methodology is described in the following sections.

### 3.1.1. Mosaic LIC digital elevation models for each CRA region

LIC had generated the 25m Digital Elevation Model (DEM) in blocks of approximately 50km by 50km. It appears that the blocks were generated independently, because the margins of each block overlap by a small amount (usually 150m), and there can be vertical discrepancies of up to 20m in some of the overlapping cells. Additional steps were taken to join the blocks together and create a “hydrologically sound” DEM. Tasks in this step included:

#### *Identification of LIC DEM blocks that make up each CRA region*

Each CRA region contained 15 to 20 LIC blocks. Block names were identified from the index map.

#### *Trim blocks to 2-cell overlap*

The geographic extent of the blocks was examined to determine the amount of overlap. The excess coverage from each block was trimmed off to leave a 2-cell width overlap.

#### *Check vertical discrepancy at block boundaries*

The vertical discrepancy between overlapping sheets was examined for extreme errors. Errors within nominal limits were handled by subsequent steps that mosaic the blocks or by the depression filling process.

#### *MOSAIC tiles together to ‘feather’ differences*

The set of tiles that make up a CRA region were joined together using a MOSAIC process that averaged the values between adjacent cells. The purpose of this step was to ‘smooth’ the join where the values between the two tiles were not the same.

### 3.1.2. Fill drainage depressions in the digital elevation models

The process of automatically extracting drainage lines from a digital elevation model required that the input DEM be “hydrologically sound”. The elevation surface must not contain depressions (also known as sinks) where water flows in but not out a cell. Sinks are a rare phenomenon in nature, but can easily be introduced into digital elevation models from input or processing errors. The LIC-produced DEM contained sinks that were likely introduced when



the DEM was sub-sampled from 12.5m to 25m. The MOSAIC process that joins the blocks also introduced sink errors. The process to correct these errors involved increasing the elevation values within sinks to the height of the surrounding boundary. This “filling” operation created a flat surface that allowed drainage out of the sink area and into the downstream catchment. A number of tasks were involved in this process:

#### *Assess degree of error*

A series of steps were run to identify sinks and measure their depth. These steps involved the following GRID functions and commands:

- Determine flow direction using the FLOWDIRECTION function.
- Find sinks using the SINK function.
- Determine contributing watersheds for each sink using the WATERSHED function.
- Determine minimum and maximum elevations in each sink using the ZONALMIN and ZONALMAX function.
- Compute the maximum sink depth by subtracting the ZONALMIN value from the ZONALMAX value.

#### *FILL hydrological sinks within DEM*

The FILL command was run with the z-value as determined in Section 3.1.3.

### **3.1.3. Extract drainage lines**

A single-direction flow model was used to estimate drainage locations. The tasks for this step included:

#### *Calibrate up slope catchment size*

The automated process required a threshold value be established to limit the formation of drainage lines. The data set used for calibration contained detailed studies of recent harvest plans that identified LIC drainage as well as unmapped drainage lines requiring protection of filter strips (Data used for Net Harvest Area Modifier Project, refer Appendix 2, SFNSW, 2000). This data set was used for two purposes: to determine the average up slope catchment of first order streams; and to provide a relationship between terrain type and up slope catchment size.

The average up slope catchment area for the end-points of all drainage lines was used as the calibration value. Specifically, this involved:

- finding the X-Y location of the upper end points of each first order stream;
- running the FLOWACCUMULATION process to determine the up slope catchment size for the entire DEM;
- using the SAMPLE command to determine up slope catchment sizes for the selected end point locations.

#### *Process*

The processing step involved thresholding each cell in the flow accumulation matrix according to the up slope catchment size values determined in the previous step. Two sets of thresholds were used: One for only mapped streams, and one for both mapped and unmapped streams. Once the stream locations were identified, the resulting network was ordered using STREAMORDER, and converted into vector format using GRIDLINE.

### 3.1.4. Build filter strip buffer

The vector drainage locations derived in the previous step were buffered out to the appropriate distances in order to reflect the Pollution Control Licence protective conditions. The steps in this process included:

#### *Determine the net area by compartment*

Pollution Control Licence conditions require an assessment of the area of operations. This may vary from the total compartment area due to restrictions on steep slopes, PMP zones, fauna protocols, inaccessibility, etc. State Forests provided a preliminary assessment of net harvest area for each compartment from the preliminary stratification of the strategic inventory.

#### *Classify compartments by hazard class*

The hazard class for each compartment was assessed using the Pollution Control Licence procedure.

#### *Attach compartment hazard class to each stream line*

The derived drainage lines were “overlayed” onto the hazard class layer, in order to tag each line with the appropriate degree of required protection.

#### *Buffer according to stream order and hazard class*

Buffers were generated according to the Pollution Control Licence by each stream order and hazard class.

Filter strip buffers were generated with the following widths from the Pollution Control Licence:

**TABLE 3A: FILTER STRIP WIDTHS**

	Inherent Hazard 1 (metres either side)	Inherent Hazard 2 (metres either side)	Inherent Hazard 3 (metres either side)
Unmapped	10	10	15
1 <sup>st</sup> Order	10	15	20
2 <sup>nd</sup> Order	15	20	25
3 <sup>rd</sup> Order	20	25	30

Note that the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order buffers apply only to LIC mapped drainage. The unmapped filter strip widths apply to the extensions derived through this project.

## 3.2. METHODOLOGY FOR INHERENT HAZARD CLASS 4 DETERMINATION

Hazard classifications were used in their original format to estimate the locations of hazard class 4 areas. Hazard classes were also aggregated to a compartment level for buffer strip determination. The basic procedure was as follows:

- Convert the Net Harvest Area and compartment layers into grids using the POLYGRID command. Use the same extent and resolution as the inherent hazard layer in order to avoid re-sampling.
- Create a new grid of just the Inherent Hazard 4 using a command such as:  
ih4 = con(ih == 4, 4)
- Create a Net Harvest Area mask by combining the NHA grid with the IH4 grid. Areas within the Net Harvestable Area should have a value of 1, and those outside the NHA (eg. IH class four or inside a PMP) should have a value of NODATA. Set this new layer as the mask using the SETMASK command.

- Create 3 new grids containing each of the inherent hazard classes:
  - ih1 = con(ih == 1, 1)
  - ih2 = con(ih == 2, 2)
  - ih3 = con(ih == 3, 3)
 Build VAT's for each of these grids.
- Use TABLES to relate these files together by zone number. Compute hazard class frequencies for each zone. Compute the zone (compartment) level hazard from the following rule:
  - if IH3 >= 20% then hazard class = 3
  - else if IH2 + IH3 >= 40% then hazard class = 2
  - else if IH1 >= 60% then hazard class = 1
  - else error!

The resulting aggregate value was joined to the compartment attribute table in the GIS.

### **3.3. METHODOLOGY FOR INCORPORATION OF TYPE "B" PROTECTIVE MEASURES INTO THE YIELD SIMULATOR**

Zones with Type "B" protective measures represent areas where timber harvesting may be conducted, but practices are restricted in order to protect identified features. Protective measures within this category included habitat tree retention. This protective measure is applied across areas where harvesting is permitted, and represents a reduction in net harvest volume, not net harvestable area. Type "B" restrictions are implemented by using restricted silvicultural practices - the harvesting operations are modified to ensure habitat tree retention.

The FRAMES yield simulator was used to account for Type "B" restrictions. The FRAMES yield simulator generates estimates of yield and residual stand volumes under various silvicultural operations on all site types independent of any direct habitat tree retention constraint. The impact of silviculture on habitat tree numbers is simply monitored and the forest silviculture is modified where necessary to ensure that the required level of habitat tree retention was achieved for all silvicultural systems. Since the range of silvicultural options modelled did not violate the minimum number of retained habitat trees required, modification to the silvicultural options was not required. The number of habitat trees standing at the end of each 5 year period of the modelling planning horizon are reported in the statistics section of the yield simulator report (SFNSW, 2000), in terms of the number of trees per hectare with a hollows count for < 40 cm and >= 40 cm.

### **3.4. METHODOLOGY FOR THE ASSESSMENT OF THE FREQUENCY AND EFFECT OF THE TYPE "C" CONSERVATION PROTOCOL PRESCRIPTIONS**

#### **3.4.1. Introduction**

As part of the FRAMES net harvestable area study an assessment of the impact of Type "C" protective measures was undertaken. NPWS undertook an assessment using pre-logging flora and fauna survey data and finalised harvesting plans as a source of information. The aims of this assessment were to determine:

- the frequency which species are encountered in production forest in UNE and LNE regions;
- the area of forest affected by the application of a prescription invoked when features mentioned above are encountered in state forest; and
- the average effect of the Conservation Protocols.

### 3.4.2. Methods

#### 3.4.2.1. Selection of sample areas

The assessment was based on compartments that had harvesting plans prepared and pre-harvesting surveys conducted. Compartments were selected from each forest management area covered by Northern Zone of the NPWS. For those management areas that had determined Environmental Impact Studies or harvesting operations that did not require RaPIC approval, SFNSW is not required to send the relevant material (survey report and harvesting plan) to NPWS. Consequently they were unable to sample these management areas.

The strategy aimed to sample all of the relevant forest management areas in Northern Zone, and ensure there were at least two samples from each management area representing approximately 1,000 hectares sampled. These sampling aims were met in most cases; Murwillumbah, Styx and Bulahdelah Forest Management Areas had only one sample each and five of the thirteen management areas had less than 1000 hectares of compartment area sampled.

#### 3.4.2.2. Species selected for determining strike rates

In determining strike rates not all features were assessed. Species that did not invoke a management response or the response was not of a type “C” nature (mapped exclusion) were not considered in this assessment.

Individual species prescriptions selected for assessment were: *Mixophyes balbus*, *M. iteratus*, *Philoria kundagungan*, *P. loveridgei*, *P. sphagnicolis*, Masked and Powerful Owls, Rufous Scrub-bird, Brush-tailed Phascogale, Hastings River Mouse, Koala, Squirrel Glider, Golden-tipped Bat, Large-footed Myotis and threatened flora species (prescriptions 1 – 3). Other species prescriptions that represented a very minor component were lumped into “other”. This includes approximately 280 animal and 700 plant species as defined in the Threatened Species Licence (now part of IFOA). Other non-species features (connection corridors and mines) that were considered category C features were also assessed.

#### 3.4.2.3. Data used

Based on the information provided in the survey report and harvesting plan, the number of existing records in the compartment(s) and the number of new records from the pre-harvesting surveys was recorded. For existing records, only those that had a potential impact on volume in the compartment were counted. For example, only threatened frog records from within the compartment were counted and only Brush-tailed Phascogale records from within three kilometres of the compartment were counted.

For some species, the number of sites where the species was recorded were counted. For example, for the Golden-tipped Bat the number of sites was recorded rather than the number of individuals recorded because the prescription relates to the site of detection, not the number of individuals.

The compartment areas used were the Gross Area of the compartment taken from the Harvesting Plan. The Net Harvest Area was taken, for this project, to be the gross area of the compartment minus type “A” prescriptions. Type “A” prescriptions included PMPs, riparian buffers, rainforest, old growth and steep and inaccessible areas, this information being generally available from the Harvesting Plans. However, in some instances, information regarding type “C” prescriptions were incorporated into information regarding type “A” prescriptions. Wherever possible, figures were adjusted to avoid double counting, but it was acknowledged there may be some minor level of double counting between type “A” and type “C” features.

The Mapped Harvest Area used to calculate the Type “C” Protective Measure adjustments was approximated with the Net Harvest Area. The table below summarises the elements used to determine the Mapped Harvest Area as defined in the “Review of Statewide Protective Measures and Forest Practices” (1999). There are some elements of the Mapped Harvest Area which could not be accounted for e.g. unmapped streams, so the Net Harvest Area is larger than the Mapped Harvest Area.

**TABLE 3B: COMPARISON OF ELEMENTS FOR THE DETERMINATION OF TYPE “C” PROTECTIVE MEASURES**

Elements for Mapped Harvest Area	Elements for the Net Harvest Area
Purchased land	Not encountered
Softwood plantations	Not encountered
Hardwood plantations	Hardwood plantations excluded
Physically and economic impediment	See last category
Preserved native forest	Not encountered
Unavailable native forest	Flora and Fauna emphasis areas most frequently encountered
Rock – Research Note 17	Rock
Wetland – Research Note 17	Wetland
Heath – Research Note 17	Heath
Rainforest – Research Note 17	Category A rainforest
Rare non-commercial forest types	Rare non-commercial forest types
Inherent hazard level 4	Hazard category 4 and slopes likely over 30° subject to confirmation in the field
Filter strips on mapped drainage	Filter strips (taken to be protection to mapped streams above riparian buffers)
Identified wilderness	Identified wilderness
BOGM A & B rainforest	Category A and B rainforest
Identified cat C rainforest and Old Growth from stump counting	Identified Category C rainforest and Old Growth Forest
Wilderness capable	Not encountered
	Various other categories: uncommercial; inaccessible, not accessible, non merchantable, agricultural clearing, improved pasture

#### 3.4.2.4. Calculation of strike rates

The strike rate for each species was calculated for each compartment(s), as the number of records in each compartment(s) divided by the gross area of the compartment(s). The overall strike rate was calculated as the mean strike rate per hectare for each species across the 28 samples and converted to an average number of records per 1000 hectares (gross compartment area).

#### 3.4.2.5. Determination of area of forest affected by application of Type “C” prescriptions

To determine the effect of the application of the prescription on the Net Harvest Area, the area of each prescription mapped on the Harvesting Plan Operational Map was measured using a map wheel for linear features and the grid square technique for polygons. Where mapped exclusion areas overlapped with Type “A” features the area of overlap was not counted towards the area of the prescription. For example, where connection corridors overlap with mapped streams the area of the riparian buffer was calculated and excluded from the gross area of the connection corridor. The overlap between type “C” features was taken into account and portioned appropriately between prescriptions. The strike rate data (Refer Appendix 2) were used to determine the mean effect per hectare and the mean effect per 1000 hectares (Net Harvest Area).

### 3.4.3. Results

Twelve species specific prescriptions, large forest owls (masked and powerful) the three flora prescriptions, mines, connection corridors and “Other” prescriptions were assessed in 28 areas from thirteen forest management areas covering 82 compartments (Table 3C). For details see Appendix 2. The gross compartment area sampled was 18,071 hectares, the total net harvest area was estimated to be 11,064 hectares or 61% of the gross compartment area.

**TABLE 3C: SUMMARY OF STRIKE RATE ASSESSMENT**

Management Area	Number of assessments	Number of compartments <sup>1</sup>	Gross area (ha)	Net harvest area (ha)
Murwillumbah	1	2	520	167
Casino	3	18	5,110	1,793
Urbenville	2	3	753	571
Tenterfield	2	7	657	464
Grafton	3	10	1,746	1,441
Coffs Harbour	3	4	806	694
Dorrigo	2	6	1,278	1,055
Urunga	4	8	1,409	870
Styx River	1	3	1,181	729
Walcha/Nundle	2	5	1,231	868
Gloucester	2	9	1,221	905
Chichester	2	5	1,581	979
Bulahdelah	1	2	578	529
Total for all MA	28	82	18,071	11,064

#### 3.4.3.1. Strike rates

The summary of strike rates and the area effect of each prescription is presented in the Table below.

**TABLE 3D: STRIKE RATES (RECORDS PER 1000 HA GROSS COMPARTMENT AREA) FOR THE TYPE “C” PRESCRIPTIONS**

Species	Strike Rate (records per 1000 ha)
<i>Mixophyes balbus</i>	0.85
<i>Mixophyes iteratus</i>	0.11
<i>Phyloria kudagungan</i>	0.00
<i>Phyloria loveridgei</i>	0.00
<i>Phyloria sphagniclois</i>	0.00
Rufous Scrub-bird	0.21
Brush-tailed Phascogale	0.46
Hastings River Mouse	0.11
Koala records	5.38
Koala high use areas	0.46
Squirrel Glider	0.44
Gold-tipped Bat	1.20
Large-footed Myotis	0.13
Threatened Flora prescription A	0.48
Threatened Flora prescription B	0.00
Threatened Flora prescription C	4.97
Connection corridors	3.69
Mines	0.10

<sup>1</sup> Number of compartments include parts of compartments

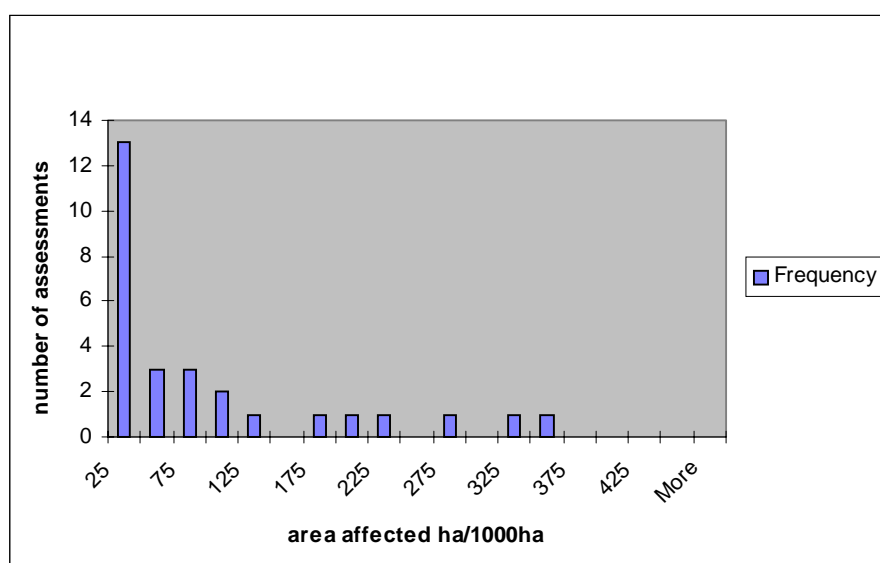
### 3.4.3.2. Area of forest effected by application of Type “C” prescriptions

The average net effect of the application of these prescriptions was estimated at 76.30 hectares per 1000 hectares or 7.6%, for all samples (Table 3E). The data is extremely skewed to the right and alternative measures of central tendency include median 30.97 ha/1000 ha (3%) and mode 0 ha/1000 ha (0%) (Figure 3). In thirteen of the twenty eight samples (46%) the effect was less than 2.5 ha/1000 ha (2.5%) (Figure 3). This suggests that in most cases the type “C” prescriptions have relatively minor effect on net harvest area with a few instances where the effect is significant; an effect of greater than 200 ha/1000 ha or 20% e.g. Thumb Creek.

**TABLE 3E: AREA EFFECT (HA/1000 HA NHA) OF TYPE “C” PRESCRIPTIONS AVERAGED ACROSS THE LANDSCAPE FOR UPPER AND LOWER NORTH EAST**

Species	Average area effect (records per 1000 ha)
<i>Mixophyes balbus</i>	0.00
<i>Mixophyes iteratus</i>	0.02
<i>Phyloria kudagungan</i>	0.00
<i>Phyloria loveridgei</i>	0.00
<i>Phyloria sphagniclois</i>	0.00
Rufous Scrub-bird	11.76
Brush-tailed Phascogale	2.32
Hastings River Mouse	9.69
Koala high use areas	3.47
Squirrel Glider	2.94
Gold-tipped Bat	1.49
Large-footed Myotis	0.32
Threatened Flora prescription A	0.01
Threatened Flora prescription B	0.00
Threatened Flora prescription C	2.66
Connection corridors	7.87
Mines	0.15
Large forest owls	26.21
Other prescriptions	7.38
Total of all C type prescriptions	76.30

**FIGURE 3: FREQUENCY DISTRIBUTION OF STRIKE RATE DATA**



### 3.4.3.3. Limitations of the study

The study cannot be considered definitive given the limited time and information available. While it is important to recognise the limitations of the study the authors believe the study represents the best estimate of the effect of type “C” prescriptions available. Further work would improve the estimate of the effect of type “C” prescriptions.

The limitations of the study include:

1. Some species with type “C” prescriptions were not encountered in this study, including *Philoria* spp. and prescription B flora. Consequently the effect of these prescriptions has not been estimated.
2. The comparatively small sample size resulted in the average effect of some species specific prescriptions being over estimated. This over estimation was due to some prescriptions having an unusually large effect, examples of this are Hastings River Mouse in Girrard and Boorook State Forests and Rufous Scrub-birds in Thumb Creek State Forest, and the relatively small sample size not being able to “dilute” the effect.
3. Some compartments were unusual in that they were Interim Deferred Forest Areas: Yabbra 286, Yabbra 196 and 199 and as such had special conditions apply, or they had unusually high prescriptive load: Yabbra 286, Ewingar 604-608, Gibberagee compartments, Thumb Creek 415 and 416. These compartments should not be seen as the normal situation. Indeed, where these situations arise it was open to State Forests of NSW to seek a review of the prescriptions, which State Forests of NSW chose not to do.

The effect of these limitations is to under-estimate the effect in point 1 and over-estimate the effect in points 2 and 3. The overall effect of these limitations is to over-estimate the effect as evidenced by the median value being 3.10% and the effect for 57% of areas assessed being 5% or less (Figure 3).

## 3.5. METHODOLOGY FOR FRAMES NET HARVEST AREA MODIFIER

The FRAMES Unmapped NHA modifier methodology has been described in the FRAMES project documentation (SFNSW, 2000). A summary of the methodology follows.

Detailed sampling of pre- and post-harvest conditions was carried out in a number of compartments to compare planned versus actual timber removals. 74 compartments were used in the study, clustered into approximately 30 groups (adjacent compartments were grouped). These groups were selected at random from all areas harvested between the 1<sup>st</sup> January 1995 and 30<sup>th</sup> December 1996.

All areas within the eligible harvest area that were not harvested were identified, mapped, digitised and coded with the reason for why they were bypassed (areas not harvested in harvesting operation). Post harvest conditions were mapped and assessed using a combination of air photo interpretation and detailed site inspections. Areas within the study sites that were not harvested were assigned reason codes from the following tables. Combinations of codes were used where several reasons might apply.



**TABLE 3F: CODES FOR NET HARVEST AREA MODIFIER**

Reason for harvest bypass	Codes used in GIS
Harvested Areas	H
<i>PMP Exclusion</i>	<i>P</i>
<i>Rainforest and non-harvestable forest types</i>	<i>R</i>
<i>Steep</i>	<i>S</i>
<b>Rock and/or Inaccessible</b>	<b>I</b>
<i>Old Growth</i>	<i>O</i>
<i>Flora Protection</i>	<i>F</i>
<i>Fauna Protection (Animals)</i>	<i>A</i>
<i>Filter Strip Extensions (Creeks)</i>	<i>C</i>
<b>Pre-merchantable (Tiddlers)</b>	<b>T</b>
<b>Unmerchantable</b>	<b>U</b>
<b>Harvesting Logistics</b>	<b>L</b>
<b>Supervisor Error</b>	<b>E</b>
<b>Unsure – no reason</b>	<b>?</b>

The codes shown in italics represent factors that were accounted by the ESFM NHA database as complete exclusions. Reason codes in bold-faced type represent factors that were in addition to the ESFM protocols. In order to get a reliable estimate of wood supply the incremental factors must be considered, but the already estimated ESFM factors must not be double counted. Point 4 of this methodology separates the contributions of factors to ensure that double counting did not occur.

1. A stratification layer was created from physical characteristics that account for the reasons why lands eligible for harvest were bypassed. The following variables were the explanatory variables used to stratify the eligible land base:

**TABLE 3G: STRATIFICATION CATERGORIES FOR NET HARVEST AREA MODIFIER**

Stratum Category	Category Values
Soil Regolith Class	1
	2
	3
	4
Rainfall Erosivity Isopleth	0-2000
	2000-4000
	4000-6000
	6000 +
Slope	0° - 10°
	10° - 20°
	20° - 25°
	25° - 30°
	30°+
Yield Association	0, 13 – 17
	1 – 8, 10, 18
	9, 11, 12
Distance to Filter Strip	< 25m
	25 – 50m
	>50m

2. The above five layers were classified into categories, rasterized at a 25m resolution and overlaid in order to generate the stratification layer.

3. The detailed survey records were overlaid onto the stratification, and the empirical data was used to develop probability of harvest factors for each stratum. Harvest probabilities were derived for each strata from the ratio of actual harvested area to the eligible area within each

stratum.

$$P_s = \frac{\textit{Harvested Area}_s}{\textit{Eligible Area}_s}$$

4. The eligible area was equivalent to the ESFM net harvest area, and is that part of the land base outside of the protocol exclusion zones. In order to avoid double counting of areas, it was essential to factor out bypasses that had already been accounted for by the type “A” filter strips. Therefore only bypasses that occurred due to factors that are *in addition* to the general protocols were counted. For example,

- Land Information Centre mapped filter strip bypasses were estimated more accurately from the type “A” filter strip layer and were not counted as part of the eligible land base,
- Best management practice buffers around filter strips (that were left to avoid felling trees into the filter strips) were not accounted for by the ESFM net harvest area, and will be counted as part of the eligible land base.

5. From the reason code table, the codes shown in italics corresponded to the ESFM net harvest area layer and were assessed as ineligible for harvesting (the area has already been accounted by the ESFM net harvest area project and did not contribute to the calculation). The codes in bold face type were assessed as eligible and the areas did contribute to the calculation. The harvest probability was computed as a ratio of harvested areas (type “H”) to the eligible land base within each stratum.

6. The probability of harvest factors were then applied across all strata to derive a forest-wide mapping of harvest probability (likelihood that a site eligible for harvest could actually be harvested). This resulted in a 25m-raster database; each cell containing a ‘net harvestable area’ factor that could be applied to the eligible land base.

7. The harvest probability stratification was overlaid onto the FRAMES strategic inventory. All sites within the ESFM net harvest area (those sites that are eligible for harvest) were then assigned an assessment of their likelihood of harvest (FRAMES NHAM). This step used a GIS operation to sum up the net harvest area for all raster cells that fall within each planning unit (a combination of strategic inventory strata and compartment). The resulting value was stored as an additional area attribute for each FRAMES planning unit.



# 4. PRODUCTS

## 4.1. DATA SETS

The primary product was the development of data sets for the Upper and Lower North East CRA regions.

### 4.1.1. Upper North East

The UNE data set had the following characteristics:

Feature Class	Subclass	Number of features	
ARCS		1,957,728	
POLYGONS		771,188	
NODES		1,206,349	
REGIONS	CRAFTI_RF	2,777	Rainforest (all codes starting with R)
	CRAFTI_RF2	2,149	Rainforest (all R codes R except RE)
	CRAFTI_RF3	1,188	Rainforest (all codes starting with R8)
	CRAFTI_RF4	1,291	Rainforest (all R codes except RE, RB, RM)
	EPAFILTER0	88,920	PCL filter strips on unmapped drainage
	EPAFILTER1	8,082	PCL filter strips on mapped drainage
	HAZ4	19,825	PCL inherent hazard class 4
	HWD_PL	572	Hardwood plantations
	IDWILD	205	Identified wilderness
	PEI	872	Physically and economically inaccessible
	PMP13	77	Preserved native forest
	PMPUNAV	941	Unavailable native forest
	PURCH	116	Purchased land
	RECENT_LOG	317	Recently logged area
	RN17_HEATH	2	Heaths
	RN17_RF	3,722	Rainforest types
	RN17_RNC	297	Rare non-commercial forest types
	RN17_ROCK	985	Rocky outcrops
	RN17_WET	286	Wetlands
	STRATA	93,081	FRAMES strata
	STRUCT	15,757	CRAFTI structure types
	SWD_PL	40	Softwood plantations
	TYPES	33,528	RN17 forest types
	UNITS	4,965	Planning unit identification
	UNMERCH	22,286	Unmerchantable types
	WILDCAP	81	State capable wilderness
COVERAGE BOUNDARY			
Xmin =	327165.905	Xmax =	547862.500
Ymin =	6631626.623	Ymax =	6874902.662

#### 4.1.2. Lower North East

The LNE data set had the following characteristics:

Feature Class	Subclass	Number of features	
-----	-----	-----	
ARCS		2,849,763	
POLYGONS		1,070,512	
NODES		1,803,448	
REGIONS	BOGM	14,469	Broad old growth mapping
	BOGM_RF1	1,060	BOGM Rainforest type 'r'
	BOGM_RF2	6	BOGM Rainforest types 'ry' and 'rd'
	BOGM_RF3	1,008	BOGM Rainforest (all types with embedded 'r')
	EPAFILTER	121,495	all EPA filter strips
	EPAFILTER0	111,834	PCL filter strips on unmapped drainage
	EPAFILTER1	10,149	PCL filter strips on mapped drainage
	HAZ4	46,970	PCL inherent hazard class 4
	HWD_PL	1,269	Hardwood plantations
	IDWILD	27	Identified wilderness
	PART_E	1,593	Unproductive non-eucalypt forest
	PEI	930	Physically and economically inaccessible
	PMP13	291	Preserved native forest
	PMPUNAV	863	Unavailable native forest
	PURCH	33	Purchased land
	RN17_HEATH	76	Heaths
	RN17_RF	8,761	Rainforest types
	RN17_RNC	332	Rare non-commercial forest types
	RN17_ROCK	997	Rocky outcrops
	RN17_WET	67	Wetlands
	STRATA	165,370	FRAMES strata
	SWD_PL	10	Softwood plantations
	TYPES	56,475	RN17 forest types
	UNITS	6,915	Planning unit identification
	UNMERCH	36,482	Unmerchantable types
	WILDCAP	8	State capable wilderness

#### COVERAGE BOUNDARY

Xmin =	250937.500	Xmax =	505612.313
Ymin =	6299455.441	Ymax =	6660968.371

## **4.2. NET HARVEST AREA CALCULATIONS**

### **4.2.1. Net harvest area query**

A computer program ('NHAQUERY') was developed to allow calculation of the Net Harvest Area.

The NHAQUERY program accepted a specification of the protocol exclusion categories to apply in the calculation, the name of the C-PLAN reserve design, and the variation of the FRAMES Net Harvest Area modifier to be used. In operation the program performed the following actions:

- read through the C-PLAN design file and mark for exclusion all planning units with status codes of Initial Reserved ("IR"), Mandatory Reserved ("MR"), Negotiated Reserved ("NR"), or Flagged ("FI") (Refer Appendix 3);
- read through the NHA mapped exclusion themes and mark for exclusion all areas that match the mapped exclusion specification;
- read through the NHA polygon file and apply the FRAMES Net Harvest Area modifier to land unit;
- sum and print out the net harvestable area within each combination of FRAMES strata and Timber Supply Zone. This information is directly used as the SPECTRUM analysis unit input file.
- Sum and print out a statement of the area removed in each exclusion class.

See Chapter 5 for a copy of the NHAQUERY output generated for the Forest Agreements.

### **4.2.2. Mechanism for analysis**

To facilitate users of NHAQUERY generating net harvestable area datafiles based on different criteria, a check form was developed for use by participants in the negotiation process. The check form allowed participants to nominate their preferences of Type "A", Type "B" and other operational protective measures. Essentially the participants could nominate which reservation types, operational area reductions and silvicultural system they required for production of net harvest area and analysis by SPECTRUM.

See Appendix 1 for a net harvest area and SPECTRUM scenario check form.



# 5. FINAL NET AREA

## **5.1. NET HARVESTABLE AREA STATEMENTS**

The following tables show the Net Harvestable generated for the Final State Position. The NHAQUERY model was used for the production of the preliminary net harvestable area, but a further reduction of 6.71 % was applied to the preliminary net harvest area to account for the Type “C” protective measures.

The preliminary net harvestable area equates to the Gross area of State Forest less Type “A” protective measures, non native forest land, operational restrictions and Reserves in the final State position. The Type “B” protective measures are implicitly accounted for in the yield simulation.



**TABLE 5A: NET HARVESTABLE AREA STATEMENT FOR THE UPPER NORTH EAST  
FINAL STATE POSITION**

Land Category	Area (hectares)		
	Gross	Marginal Impact	
<b>Gross Area of Existing State Forest</b>	624,032		<b>624,032</b>
<i>Less</i>			
Plantations and Purchased Land			
Purchased land	22,315	22,315	
Softwood plantations	13,999	13,999	
Hardwood plantations	6,727	6,727	-43,041
Type "A" Protective Measures & Operational Restrictions			
Physically and economically inaccessible	137,043	137,041	
Preserved native forest	10,591	190	
Unavailable native forest	33,443	201	
Wetlands	2,805	1,314	
Rocky outcrops	10,624	3,858	
Heaths	102	46	
PCL inherent hazard level 4	28,723	8,084	
Rainforest types – Research Note 17	39,286	13,892	
Rare non-commercial forest types	2,627	1,777	
Rainforest type CRAFTI	50,283	13,881	
Filter strips on mapped drainage	71,883	39,401	
Filter strips on unmapped drainage	19,191	11,783	
Unmerchantable types	140,372	37,036	-268,504
Formal and Informal Reserves	156,873	62,222	-62,222
<b>Net Mapped Area</b>			<b>250,265</b>
<i>Less</i>			
Net area modifier (incl. High Conservation Value Old Growth)*			-59,625
<b>Preliminary Net Harvest Area</b>			<b>190,640</b>
<i>Less</i>			
Type "C" Protective Measures (strike rate)			-12,792
<b>Net Harvestable Area</b>			<b>177,848</b>

\* Operational restriction and Type "A" protective measure for Old Growth

**TABLE 5B: NET HARVESTABLE AREA STATEMENT FOR THE LOWER NORTH EAST  
FINAL STATE POSITION**

Land Category	Area (hectares)		
	Gross	Marginal Impact	
<b>Gross Area of Existing State Forest</b>			<b>813,782</b>
<i>Less</i>			
Plantations and Purchased Land			
Purchased land	2,146	2,146	
Softwood plantations	19,633	19,633	
Hardwood plantations	19,407	19,387	41,166
Type "A" Protective Measures & Operational Restrictions			
Physically and economically inaccessible	167,401	167,381	
Preserved native forest	21,856	1,387	
Unavailable native forest	47,962	99	
Wetlands	531	327	
Rocky outcrops	10,230	3,846	
Heaths	743	616	
PCL inherent hazard level 4	70,833	29,419	
Rainforest types – Research Note 17	74,208	38,224	
Rainforest type r BOGM	47,552	9,274	
Rainforest type ry & rd BOGM	180	109	
Rainforest with embedded type r BOGM	44,008	22,671	
Filter strips on mapped drainage	98,214	48,468	
Filter strips on unmapped drainage	24,201	13,522	
Rare non-commercial forest types	2,968	978	
Unmerchantable types	192,198	29,718	-
Formal and Informal Reserves	274,496		366,039
			-
			123,425
<b>Net Mapped Area</b>			<b>283,153</b>
<i>Less</i>			
Net area modifier (incl High Conservation Value Old Growth)*			-60,395
<b>Preliminary Net Harvest Area</b>			<b>222,758</b>
<i>Less</i>			
Type "C" Protective Measures (strike rate)			-14,947
<b>Net Harvestable Area</b>			<b>207,811</b>

\* Operational restriction and Type "A" protective measure for Old Growth

## 5.2. STATE FOREST LAND ALLOCATION FROM FINAL STATE POSITION

The allocation of State forest area by general land use category for the Final State Position is shown in the following Tables:

### 5.2.1.1. Upper North East

**TABLE 5C: AREA OF STATE FOREST BY CATEGORY IN THE FINAL STATE POSITION, UNE**

Land Category	Area (hectares)	Percentage of Gross State Forest area
Final net harvestable area	177,847	29%
Plantations and Purchased land	43,041	7%
Formal and Informal Reserves	62,222	10%
Type "A" protective measures	94,428	15%
Type "C" protective measures	12,792	2%
Operational restrictions	233,702	37%
<b>Total (Gross Area)</b>	<b>624,032</b>	<b>100%</b>

### 5.2.1.2. Lower North East

**TABLE 5D: AREA OF STATE FOREST BY CATEGORY IN THE FINAL STATE POSITION, LNE**

Land Category	Area (hectares)	Percentage of Gross State forest area
Final net harvest area	207,811	26%
Plantations and Purchased land	41,166	5%
Formal and Informal Reserves	123,425	15%
Type "A" protective measures	168,939	21%
Type "C" protective measures	14,947	2%
Operational restrictions	257,494	31%
<b>Total (Gross Area)</b>	<b>813,782</b>	<b>100%</b>

# TERMINOLOGY

## **Net Harvestable Area**

Total actual area available for harvesting, being the gross area minus all mapped and unmapped exclusions for conservation protocols, pollution control license conditions, operational restrictions, threatened fauna & fauna strikes, and reservation for JANIS criteria.

## **Exclusions**

Areas of SFNSW gross forest area not available for harvesting. Includes both areas which are unavailable and unsuitable for harvesting. Mapped exclusions are those areas which are clearly demarcated and mapped. The modelled polygons are removed directly from the Gross forest area to provide the Net Mapped Area. Unmapped operational exclusions are accounted for through a net harvest area modifier to provide a Preliminary Net Harvest Area. Old Growth forest exclusions were mapped, but due to complexity of the datasets (extremely fragmented forest areas), were transformed to net area modifiers. Unmapped threatened flora and fauna are accounted for by strike rate reductions to the preliminary net harvest area to provide the actual Net Harvestable Area

## **Bypasses**

Areas not harvested in harvesting operation

## **Type “A” Protective Measures**

100% exclusion areas e.g. rainforest (CRAFTI & RN17), rare forest types, PMP 1.3, EPA filter strips, heath, rocky outcrops, and wetlands. Exclusion of areas of SFNSW estate (both forested and non-forested natural areas) from harvesting as detailed in NPWS conservation protocols and EPA Pollution Control Licences. These are areas defined on existing datasets (RN17 forest typing, CRAFTI and BOGM) (Refer Section 2.1).

## **Type “B” Protective Measures**

Modified exclusion areas e.g. habitat tree retention, light selective logging. Requirement for habitat tree and feed tree retention within areas where harvesting is permitted. These are accounted for through the native forest yield simulations. Habitat and feed trees are retained when the forest growth and forest management is simulated. These are effectively restrictions on net harvestable volume, not net harvestable area.

## **Type “C” Protective Measures**

Percentage fauna strike rates i.e. rare fauna occupancy probabilities. Conservation protocols implemented to protect unmapped threatened flora and fauna. As the area impact over the landscape could not be calculated in advance, a proportion reduction to the net harvestable area.

**Timber Catchment**

Timber (or Wood Supply) Catchments are broad timber supply zones. The supply zones are distinct geographical areas and represent broad management zones. The timber catchments reflect one or more of the following:

- large forest areas which supply current industry because of existing contracts;
- large contiguous areas worked by specific industries;
- physical or economic catchment areas in which the wood flows are similar due to geographical factors which do not favour inter-catchment wood movement, and possibly reflect economic distances to specific ports and/or industrial facilities;
- forest management and administrative boundaries.
- distinct biophysical area with distinct species types (coastal, tableland); and
- amalgamations of timber price zones and timber supply priority zones.

**Timber Price Zone**

Timber price (royalty) zones are geographical groupings of forest areas grouped on the basis of similar relative commercial timber value, harvesting terrain, and haulage distance to markets.

**Timber Supply Zone**

Timber Supply Zones (TSZs) are groupings of compartments with common geographical boundaries which are self contained production units in terms of harvesting and transport infrastructure.

**Area Definition****Gross Area**

less **Mapped exclusions:**

- Purchased land
- Softwood plantations
- Hardwood plantations
- Heath
- Rocky Outcrops
- Wetlands
- Rare non-commercial forest types
- Rainforest
  - RN17
  - r BOGM
  - ry & rd BOGM
  - embedded type r BOGM
  - CRAFTI
- Preserved native forest (PMP 1.3)
- Unavailable native forest (PMP 1.2, 1.1.5, 1.1.6, 1.1.7)
- PCL Inherent Hazard Level 4
- Filter strips on mapped drainage
- Filter strips on unmapped drainage
- Wilderness
  - State Capable
  - Identified
- Unmerchantable types
- Slopes >30 degrees
- Physically & Economically Inaccessible
- Formal & informal reserves (C-PLAN)

= **Net Mapped Area**

less **Net Area Modifier**

-unmapped operational restrictions

-Old Growth - Candidate

-Old Growth - High Quality Habitat excl. sA & tA

-Old Growth - all High Quality Habitat

-Old Growth - High Conservation Value

= **Preliminary Net Harvest Area**

less Unmapped threatened flora & fauna strike rate

= **Net Harvestable Area**



# APPENDIX 1 – NET HARVESTABLE AREA AND SPECTRUM CHECK FORM



## Spectrum Scenario

Title \_\_\_\_\_

*CRA Region, Date, Scenario name*  UNE  LNE

*C-PLAN name*

Standard Native Forest Net Harvest Area (NHA) Exclusions

<input type="checkbox"/> PMP 1.3	<input type="checkbox"/> RN17 RF
<input type="checkbox"/> PMP 1.2, non-harvestable PMP 1.1.5/6/7	<input type="checkbox"/> Unmerchantable forest types
<input type="checkbox"/> EPA Hazard Class 4	<input type="checkbox"/> Rare non-commercial forest types
<input type="checkbox"/> Physically/economically Inaccessible	<input type="checkbox"/> Wetlands
<input type="checkbox"/> EPA filter 1 (mapped drainage lines)	<input type="checkbox"/> Heaths
	<input type="checkbox"/> Rocky outcrop
<input type="checkbox"/> Base Net Harvest Area Modifier (NHAM) other than "buffers on buffers"	

Additional NHA Exclusions for this scenario (IF TICKED THEN NOT AVAILABLE FOR HARVESTING)

<input type="checkbox"/> Identified Wilderness	<input type="checkbox"/> Crafti RE tags (UNE)	<input type="checkbox"/> NHAM "Buffers on buffers"
<input type="checkbox"/> State Capable Wilderness	<input type="checkbox"/> Crafti RM and RB tags (UNE)	
<input type="checkbox"/> Candidate Old Growth	<input type="checkbox"/> All other Crafti R tags (UNE)	
<input type="checkbox"/> HQ Habitat Old Growth	<input type="checkbox"/> All BOG R rainforest (LNE)	<input type="checkbox"/> EPA filter 0 (unmapped drainage lines)
<input type="checkbox"/> High Conservation Value OG		

Objective function

<input type="checkbox"/> Maximum 20 year HQ Large volumes	<input type="checkbox"/> X,000/yr Periods 1 -4, Period 5 x,000m3/yr, Periods 6-20 smoothed
<input type="checkbox"/> 100 year non-declining HQ Large volumes	<input type="checkbox"/> (+/- x %) at minimum x,000 m3/yr

NHA = x ha  
 HQL Vol x,000/yr Periods 1-4

Silvicultural Prescriptions

Trigger volumes (HQ large) for harvesting are: STS 7 m3/ha AGS 7 m3/ha  
 for trees with at least the following diameters (breast height over bark):  
 Moist BBT: 65cm Moist Coastal: 55cm All Other Moist: 50cm All Dry: 50cm  
 High Quality large specifications: 40 cm cdub (34 cm sedub) and 3.6 m in length.  
 High Quality small specifications: 20 cm sedub and 3.6 m in length.

<input type="checkbox"/>	STS Light is applied and uses maximum BA removed of 20%
<input type="checkbox"/>	STS Medium is applied and uses maximum BA removed of 30%
<input type="checkbox"/>	STS Heavy is applied and uses maximum BA removed of 40%
<input type="checkbox"/>	AGS Light is applied and uses ~40 m gaps, 20% net area retained, a return time between harvests of 10 years and 10% gapped in each gapping event.
<input type="checkbox"/>	AGS Medium is applied and uses ~70 m gaps, 20% net area retained, a return time between harvests of 10 years and 20% gapped in each gapping event.
<input type="checkbox"/>	AGS Heavy is applied and uses ~100 m gaps, 10% net area retained, a return time between harvests of 10 years and 30% gapped in each gapping event.

# APPENDIX 2 – STRIKE RATE DATA



	Sample number	26	27	28	average strike rates	strike rates / 1000ha
	MA SF CPT	Chichester Chichester 53,54	Chichester Masseys Ck 115,116, 118	Bulahdelah Myall River 30,40		
	gross area (ha)	611	970	578		
M. balbus	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0.001	0.85
M. iteratus	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0.000	0.11
P. kundagungan	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0	0.00
P. loveridgei	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0	0.00
P. sphagnicolis	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0	0.00
Rufous Scrub-bird	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0.000	0.21
Brush-tailed Phascogale recorded wi. 3km only	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0.000	0.46
Hastings River Mouse	existing records	0	0	0		
	new records	0	0	0		
	habitat P/A	0	0	0	0.107	0.11
	strike rate	0	0	0	0	0.00
Koala	existing records wi. 2km	1	0	0		
	new records	0	0	0		
	record strike rate	0.002	0	0	0.005	5.38
	high use areas	0	0	0		0.32
	high use area SR	0	0	0	0.000	0.46
	intermediate areas/cpts intermediate use SR	0	0	0	0.000	0.41
Squirrel Glider	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0.000	0.44
Gold-tipped Bat	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0.001	1.20
Large-footed Myotis	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0.000	0.13
Flora prescription 1	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0.000	0.48
Flora prescription 2	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0	0.00
Flora prescription 3	existing records	0	0	0		
	new records	0	0	0		
	strike rate	0	0	0	0.005	4.97
Connection Corridors	number per block	2	4	2		
	strike rate (no/ha)	0.003	0.004	0.003	0.004	3.69
Mines	number per block	0	0	0		
	strike rate (no/ha)	0	0	0	0.000	0.10

# APPENDIX 3 – C PLAN

C-PLAN (**C**onservation **P**lanning Software) is NSW NPWS' decision support system designed to identify options for achieving a conservation goal in an area of land of water at a regional level. In a given region the **features** (physical e.g. geology, terrain; biological vegetation types, species, assemblages; cultural; and / or visual) are defined for each **site** (e.g. logging compartments, pastoral holding) in terms of conservation measures. C-Plan is then run with conservation targets (e.g area, number of localities of each species, forest ecosystem or other feature) to identify which combination of sites should be allocated to conservation management. C-Plan calculates and displays the irreplaceability of each of the sites in a region as a guide to their importance for the regional conservation goal.

In C-PLAN all sites are classified in terms of site tenures and site classes:

**Site Tenures:**

**IR** - Initial reserved (tenure assigned to sites which are already in a reserve system or are protected in some way)

**IA** - Initial available (sites which are available for reservation into a new or hypothetical reserve system)

**IE** - Initial excluded (sites which are totally ignored in all respects including target calculation)

**Site Classes:**

**MR** - Mandatory reserved (Form of reservation for sites which have a very high conservation value, or for some other reason have to be reserved)

**NR** - Negotiated reserved (Area selected into a hypothetical reserve system. Areas of negotiated reserve sites will contribute to satisfying feature targets. There is no functional difference between this class and the mandatory reserved class)

**PR** - Partially reserved (Only one or more features in the site are tagged for reservation (or some form of protection), for example this could include special management of an endangered species. The amount of that feature in the site will be considered reserved and subtracted from the feature target, the remaining unreserved features will not contribute to satisfying targets)

**FI** - Flagged (Flagged sites are a subset of available sites which have been flagged for a given reason, which can be recorded in the selection log. This class is for display purposes only)

**Ex** - Excluded (Sites which are totally ignored, and are excluded from all calculations)

In the NSW Forest CRA negotiation process, planning units (whole or partial logging compartments – a combination of strategic inventory strata and compartment) were defined as Reserved (initially reserved, negotiated, mandatory, partially & flagged) or Excluded (i.e. are available for logging). The proposed reserve design is imported into the Net Harvest Area Query model and these compartments were excluded from the Net Harvest Area database imported into the yield scheduler SPECTRUM.

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