Private Native Forest Resource Inventory and Mapping

NSW Mid North Coast



Looking NW over Port Macquarie

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Sections of this were originally supplied in **August 2007** to the Principals. Mid North Coast Private Forestry Development Committee and Mid North Coast Regional Development Board. This update has amended and edited text for clarity and confidentiality, and confidential data and results have been removed. Some links may no longer be active.

1. Project Details

The aim of this project was to provide a reliable and detailed regional inventory on the current and potential timber resource in the NSW Mid North Coast region to guide strategic planning and investment decisions.

The MNC Regional Inventory Project 2007 has

- a. identified, quantified, and presented as accurately as possible the;
 - Current and potential commercial timber resource available on private land in each local government area. This included location, species or broad forest type, site quality, total resource and estimated commercially available volumes. Data is presented by area (Ha) and volume (M³).
 - Cleared land suitable for plantations.
- b. summarised the information in the following concise report, with detailed appendices in electronic form (MS-Excel file and maps). The maps show local government area (LGA), towns, rivers, roads, Forests NSW and National Parks estates, and the location, type and site quality of privately owned commercial native forests resource.

The study covered 9 main local government areas (LGA) in the lower northeast (LNE) NSW RFA area, plus 2 additional LGAs from upper northeast (UNE). Mapping and data for 4 Tableland LGAs is also reported here, although funded from another source (NIRDB, Armidale NSW).

Table 1. LGA data coverage

Bellingen	*	Port Stephens	*
Nambucca	*	Pristine Waters	UNE
Kempsey	*	Coffs Harbour	UNE
Port Macquarie-Hastings	**	Walcha	TBL
Greater Taree	**	Nundle	TBL
Gloucester	**	Armidale/Dumaresq	TBL#
Great Lakes	**	Uralla	TBL#
Dungog	**		

* Full coverage of forest type and site quality ; ** included in 1996 study

UNE Additional upper northeast areas included in full coverage report and maps only

TBL Data additional to this report, sourced from other studies (NIRDB); # partial coverage only

The following 9 LGAs comprise part of the LNE NSW RFA region, but had insufficient data for private land to map either or both of site quality and forest type. Inspection of satellite and aerial photos on Google Earth indicates there is minimal private forest land with commercial potential in these LGAs

Newcastle	Upper Hunter	Maitland
Cessnock	Singleton	Wyong
Lake Macquarie	Muswellbrook	Gosford

This information produced by this project is intended to be used as a baseline to record the current status of this region's commercial private forestry industry for program evaluation and future program/policy development purposes and to assist planning and infrastructure provision; and to provide reputable data on the region's current and future capability to support investment in forestry and timber processing.

The report has not set out to evaluate the full range of forestry values at the farm scale such as on-farm timber use, shelter belts and environmental amenity, and it should be noted that these values can be generated on sites with lower growth potential (SQ<30, see p.7) even though they have not been included in the analysis. The primary focus is commercial timber production potential from native forests. The target audience includes landholders, mills and processors, potential investors, industry associations and the three levels of government.

The primary purpose and outputs of the project are the database and maps on the CD. This report is intended to serve only as a concise overview and summary.

2. Sources and Data

The project was undertaken as a desktop (GIS) mapping exercise using vegetation type and environmental attribute data available from the Lower North East (LNE) Comprehensive Regional Assessments (CRA) (March 2000 Regional Forest Agreement for North East NSW. http://www.daff.gov.au/rfa/regions/nsw-northeast).

It complements and updates an existing study (NorFor & SFNSW 1996, http://www.privateforestry.org.au/pri_hdw.htm) which estimated yields and areas available for timber harvesting on private land in five Local Government Areas (LGAs) of the Mid North Coast.

The consultant generated Forest Type and Site Quality maps for 9 complete and 6 partial local government areas. The intersection of these maps provided the basic area estimates for Yield Tables in the results using the 9 completely mapped LGAs.

The high resolution version of the maps (and the scale of GIS aggregation) is at ~25m pixel resolution. which is sufficient to support and facilitate farm and catchment-scale planning.

Some data limitations in the maps and yield estimates arise from

- Acquisition of private land since 1999 by State Forests and National Parks.
- Accuracy of vegetation type mapping from aerial photographs
- Accuracy of land attribute mapping such as soil depth and fertility used to derive Site Quality (growth potential)
- Insufficient information regarding forest structure, and thus coarse estimates only for potential gross yields and product proportions
- Variation in rate of landowner participation in private native forestry harvesting. (surveys for upper north east NSW indicate about 50% of landholders with potentially productive forest may be engaged in PNF)
- Uncertain impacts of the Aug 2007 PNF Code on available area, yield and landholder participation rate.
- inset: Location map NSW : local government areas LGAs : UNE blue, LNE purple, Tablelands areas as darker shades. Note northern end of mapped area below includes 2 LGAs from UNE and partial coverage (eastern fall) areas of Tablelands, both of which are excluded from volume and area totals reported in summary for 9 LGAs.





MNC Forest Resource Inventory & Mapping : as amended

3. Methods

a. Forest Type

The LNE RFA dataset contained some 1865 floristic associations mapped from aerial photographs. These were condensed into the following 17 broad forest types. Types 1-12 only are considered to be of commercial forestry interest and are mapped and tabulated in this report. A more detailed description of the types and a cross-referencing of LNE RFA associations and the broad types is found on the accompanying CD. (ForestType.xls)

1	mBBT	moist Blackbutt
2	dBBT	dry Blackbutt
3	BBX	Brushbox
4	FLG	Flooded Gum
5	MCE	Moist Coastal Eucalypt
6	smTDE	semi-moist and Tall Dry Eucalypt
7	mSPG	moist Spotted Gum
8	dSPG	dry Spotted Gum
9	dSW	dry Sclerophyll and Woodland
10	TEM	Tableland Eucalypt (moist) incl New England BBT types
11	TEd	Tableland Eucalypt (dry)
12	TSB	Tableland Stringybark
13	NonC	Non Commercial eucalypt species predominant
14	RF	Rain Forest
15	Sftwd	Softwood (Coniferous) plantations
16	Hdwd	Hardwood (Broadleaved) plantations
17	NonEuc	Non-Eucalypt sclerophyll forests
		(eg dominant species Acacia, Melaleuca, Casuarina)

The forest type mapping covers only private land tenures. Plantation types were excluded from the mapping and yield forecasts since the data is substantially out of date.

1	moist BBT	5	MCE	9	Dry Scier & Wdiand
2	dry BBT	6	smTDE	10	ТЕМ
3	BBX	7	mSPG	11	TEd
4	FLG	8	dSPG	12	T5B

The main commercial forest type mapping colours are .. (see also map key)

b. Site Quality

During the course of other private research in 2005, the author developed an algorithm for estimating the basal area of fully stocked native forest at healthy maturity. This figure is described as Site Quality (SQ) and used as an indicator of the potential net primary productivity of the forest. For sites with identical SQ, actual productivity of commercial timber may vary because of stand structure, species composition, and management factors which affect log grades.

The SQ formula uses 41 environmental attribute GIS layers. These are average monthly rainfall (12), minimum and maximum temperatures (24), the annual total solar radiation divided into monthly factors based on a weighted composite of Brisbane (2/3) and Sydney (1/3), and 4 soil-related attributes. The latter are soil fertility (integer scale 1:Low to 5:High), potential soil rooting depth (mm), topographic position (scale 0:gully to 100 ridgetop), and monthly average of available moisture¹. Some GIS layers are interpolated or modelled from other information and may have resolution as coarse as 200m (eg soil fertility).

Site Quality Index (asymptoital Basal Area for mature forest in healthy condition) is calculated as

$$SQ = \left[\sum_{month=1}^{12} \left(\frac{RainSol_{month}}{12} \times \sqrt{DayNightTemp_{month}}\right)\right] \times \sqrt{Moisture \times Rooting \times Fertility \times Position}$$

The maximum SQ for the study area is about $60m^2/ha$. Sites with SQ <30 are considered to have insufficient growth for commercial forestry. SQ is mapped in 8 classes, being

Class	Map colour		SQ range
<25	light grey	<25	0-24
25	grey	25-29	25-29
30	red	30-34	30-34
35	orange	35-39	35-39
40	yellow	40-44	40-44
45	green	45-49	45-49
50	blue	50-54	50-54
55	crimson	55-60	55-60

The SQ mapping covers all tenures and forest types.

¹ Prescotts Soil Moisture Index PSMI is an index of available moisture based on rainfall R and Evaporation E such that PSMI = $0.445 \text{ R} / \text{E}^{0.75}$. E can be calculated from mean maximum temperature and solar radiation.

source: McKenzie & Ryan 1999 "Spatial prediction of soil properties using environmental correlation" Geoderma 89(1):67-94 p.72.

c. Plantation suitability

All public land and private forest was rendered transparent on the SQ map. This left a map which shows SQ only on cleared private land. As a Google Earth overlay, this may be used to identify areas initially suitable for plantation. Factors such as slope, high water table or soil impediments were not able to be excluded. No area data is available.

d. Stream buffers

A GIS layer for watercourses and stream order was required to calculate net available harvest area after deducting regulatory buffer zones. The calculations were completed before the finalization of the August 2007 NSW Private Native Forestry Code of Practice. Streams are represented as lines within the GIS layer, so the calculated buffers are based on distance from centre line of stream. This may be somewhat less than the actual field area which is measured as distance from top of bank. The buffer widths either side of the stream are assumed in the analysis to be SSO1=10m, SSO2=20m SSO3=30m, SSO4=40m, where SSO =Strahler stream order.

The August 2007 PNF Code added a 5m exclusion strip to all streams, in addition to the buffers above. The effect has not been deducted from the table of potential yields, however the additional area is an outer strip in which partial harvesting is permitted.

e. Timber Yields Calculation

Annual yields of various log grades (products) were calculated for the net available private native forest estate.

Area calculations proceeded as follows

Gross PNF estate = all private forested land Net productive PNF = [Gross PNF estate] – [low SQ (<30) + steep land (>18 degrees)] Net available PNF = [Net productive PNF] – [stream buffers.] O'Neill (NorFor & SFNSW 1996) applied a final area reduction factor to their initial calculation of productive forest area. The purpose was to account for small scattered non-commercial or unproductive types, inaccessible, steep, rocky or wet areas, rainforests, watercourse filter zones, zoning exclusions. The reduction was very close to one third (33%) of the initial estimate. However, since the GIS excluded low SQ and steep land, and the forest typing identified non-productive types and visible exclusions such as rock or wetland, most of the factors should already be accounted for in the final area figure provided here, except for LGA zoning exclusions. No attempt has been made to quantify these.

The two most significant factors which could cause a variation in the estimated annual yields from the private estate are (i) the landholder participation rate and (ii) current forest structure or condition. Since these are unknown, the estate net area figure and yields are presented without any reduction factor. Future analysis can refine the figures further as better information becomes available.

Information is not available to calculate area effects of old-growth forest and listed species logging exclusion zones required under the PNF Code. Other yield impacts may arise from silvicultural rules under the PNF Code; Jay et al (2007) investigated the effects of basal area and habitat tree retention for UNE NSW, and found that silvicultural impacts for landholders and industry may be substantial (see CD). These factors are likely to reduce the yields below the estimates made in this report, but the reduction is not yet readily quantifiable.

Yield Estimation Methods

The method of estimating total annual yield is based on that used by NorFor & SFNSW (1996). A "forest unit" is created by overlaying two maps ; forest type and site quality, or "FTxSQ". An estimate of Mean Annual Increments (MAI) or average volume growth in m3/ha/yr is applied for each FTxSQ unit in the overlays, and the land area and volume are summed over the Net Available forest area. The average estimated growth of harvestable bole volume used here was guided by EUCAMIX model estimates for stands in fair to good structural condition. The actual growth and yield will on FTxSQ units will vary according to stand structure. A pulpwood¹ proportion varying by FTxSQ unit was applied to the total bole volume, and then an estimate of proportion of higher value log grades (products such as sawlogs, veneer and poles) was applied to the balance of [total bole] – [pulpwood].

¹ there are presently no markets available for pulpwood produced by private native forest growers on the mid north coast. The purpose of including "pulp" was to (i) to make the estimates more easily comparable with the 1996 report (ii) identify potential for any product based on fibre, including chipboard, biofuels, carbon etc, and (iii) to indicate that, with a modicum of better silviculture, there is great scope for improving yields of higher quality products from sites with a given biological growth potential.

The higher value log proportions vary according to SQ, but are assumed similar (ie constant) for all forest types. This provided an estimate of potential product yield for all FTxSQ units, which was multiplied by Net Available Harvest area to give a total potential annual yield of log grades for each LGA in the study area.

$$Y = \sum_{s,f,g,LGA=1}^{n} MAI_{s,f} * pulp\%_{s,f} + [MAI_{s,f} - pulp\%_{s,f}] * HV\%_{s,g}$$

$$Y= Annual Regional Yield, \qquad MAI = average annual growth (m3/ha/ann)$$

$$pulp = pulpwood \qquad HV = high value logs$$

$$s= SQ class, \qquad f = forest type, \qquad g= log grade ,$$

$$n_s=5, \qquad n_f=12, \qquad n_g=4 \qquad n_{LGA}=9+2+4$$

Yield calculation is now illustrated using forest type 6, smTDE.

To simplify, each forest type was divided into 5 site quality classes based on the distribution of the type across the whole region. In LNE and UNE NSW, there are 205,000 ha of forest type 6 (smTDE) distributed as follows.



SQ class boundaries are defined using the percentile distributions, as illustrated in lower left of the above diagram. Any occurrence on SQ class which is less than the lowest 10% of the total distribution, is defined as "very low". Occurrence on SQ which is \pm 20% of the median (ie between percentiles 30-70) is defined as medium SQ. Hence for all Forest Types, 40% of the total area will be medium SQ. For smTDE, this will be SQ between 40 and 45.

Next, for each FTxSQ class, MAI and pulp % are defined. For smTDE for example, these are

	v.low	low	med	high	v.high				
MAI	0.9	2.1	3.2	3.9	4.3				
pulp%	72%	67%	60%	50%	45%				
MAI = average annual log volume production or growth (m3/ha/ann)									

Finally the Higher Value logs grades are the residual volume after deducting pulpwood, which is allocated for the SQ class (assumed constant for all forest types) as follows.

Product	uct v.low low		med high		v.high	Log Grade Description
V	5%	10%	15%	15%	15%	Veneer
Ρ	10%	10%	10%	12%	15%	Poles Piles and Girders
Q	50%	55%	60%	60%	60%	Small and large sawlogs
Z	35%	25%	15%	13%	10%	Salvage grade sawlogs
	100%	100%	100%	100%	100%	

Full details for all Forest Types is on the CD supplied to the principals.

4. Results

The assumptions made for Timber Yield Parameters (gross MAI, pulpwood proportion, HV log grade recovery) in forest units were similar to those in NorFor & SFNSW 1996. Hence this study found a somewhat similar yield to NorFor & SFNSW 1996 for the 5 complete LGAs that were common to both studies.

Yields and area of net productive forest are now reported here for 9 complete LGAs. (local government areas).

Results summary table :- LNE NSW :

Area of Net available PNF, and estimated total annual volume yield potential with 100% PNF timber production participation by landowners.

this report 9 LGAs	289,965	hectares
	m3/ann	m3/ha/ann
pulp	465,442	1.61 50%
millable and HV	460,171	1.59 50%
gross	925,613	3.19

Detailed breakdown of results is on the accompanying CD in the file "PNF FTxSQ UNE&LNE.xls" . The following tables are a summary.

a. Forest Type area sum in 9 main LGAs

Hectares x site quality (Net Prod PNF only)

SQ class	30	35	40	45	50	55	TOTAL
bellingen	1,226	1,253	1,182	7,135	3,584	649	15,028
dungog	2,724	5,155	12,532	5,594	747		26,751
gloucester	3,345	5,907	10,931	2,546	2		22,730
great_lakes	6,979	1,732	25,888	38,411	534		73,543
greater_taree	6,347	5,748	25,390	16,772	1,285	20	55,563
hastings	5,452	1,663	9,808	28,209	4,019	173	49,323
kempsey	6,237	2,252	25,138	20,953	208		54,788
nambucca	3,049	450	4,236	12,142	357		20,235
port_stephens	562	3,497	11,144	1,045	0		16,248
LNE Total	35,921	27,656	126,248	132,806	10,735	842	334,209

hectares

Hectares x forest type

			excl low SQ			
		all PNF	and steep	Net Prod	Stream	Buffer
Fores	t Type	Gross	Net Prod	% Gross	Buffers	%Net
1	mBBT	8,129	5,303	65%	747	14.1%
2	dBBT	46,055	37,883	82%	2,706	7.1%
3	BBX	918	699	76%	172	24.6%
4	FLG	3,148	1,786	57%	521	29.2%
5	MCE	88,319	53,356	60%	9,960	18.7%
6	smTDE	268,546	160,324	60%	20,662	12.9%
7	mSPG	56,631	42,828	76%	4,957	11.6%
8	dSPG	11,559	7,186	62%	1,229	17.1%
9	dSW	21,005	11,880	57%	1,755	14.8%
10	TEM	34,728	12,877	37%	1,518	11.8%
11	TEd	143	31	22%	7	22.9%
12	TSB	232	56	24%	10	17.5%
	Total HA	539,412	334,209	62%	44,244	13.2%
		nectares				

b. Timber Yield Potential (cubic metres of logs per year) in 9 main LGAs

	mBBT	dBBT	BBX	FLG	MCE	smTDE	mSPG	dSPG	dSW	TEM	TEd	TSB	
Millable & H	igh Valu	e Logs											
bellingen dungog gloucester great_lakes greater_taree hastings kempsey nambucca port stephens	Details	removed	for conf	identiali	ty and cop	yright reas	ons and/or	market s	ensitivity				
SUBTOTAL	9,855	75,783	714	2,521	80,071	200,027	54,165	8,052	13,657	15,251	23	54	460,171
V P Q Z	Details	removed	for conf	identiali	ty and cop	yright reas	ons and/or	market s	ensitivity				
SUBTOTAL	9,855	75,783	714	2,521	80,071	200,027	54,165	8,052	13,657	15,251	23	54	460,171
Low Quality	Logs (P	ulpwood	l or Bio	mass)						Cubi	c metres	of logs	oer year
bellingen dungog gloucester great_lakes greater_taree hastings kempsey nambucca port_stephens	Details	removed	for conf	identiali	ty and cop	yright reas	ons and/or	market s	ensitivity.	15.220	20		
	6,339	49,561	759	1,776	67,553	244,518	56,533	8,495	14,443	15,379	29	57	465,442
TOTAL	16,194	125,345	1,473	4,297	147,624	444,545	110,697	16,546	28,099	30,630	52	110	925,613