# North-East CRA/RFA Project Summaries


NSW GOVERNMENT


COMMONWEALTH GOVERNMENT

# NORTH-EAST CRA/RFA

# PROJECT SUMMARIES

**New South Wales Government**
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**Commonwealth Government**
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These projects have been jointly funded by the New South Wales and Commonwealth Governments and managed through the Resource and Conservation Division, Department of Urban Affairs and Planning, and the Forests Taskforce, Department of the Prime Minister and Cabinet.

The projects were undertaken and the methodology has been developed through the Environment and Heritage, Economic and Social, ESFM and FRAMES Technical Committees which include representatives from the New South Wales and Commonwealth Governments and stakeholder groups.

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# INTRODUCTION

During 1997 and 1998 the Commonwealth and New South Wales Governments undertook comprehensive regional assessments (CRAs) of the Upper North-East and Lower North-East CRA/RFA regions. These assessments covered the range of environmental, biological, economic, social and cultural values of the North-East forests.

There are four broad assessment streams:

- environment and heritage assessments;
- economic and social assessments;
- ecologically sustainable forest management assessments; and
- Forest Resource and Management System (FRAMES) assessments.

Technical Committees managed the assessments. Over 60 separate projects were undertaken as part of the North-East CRA, for which detailed scientific and technical working papers were produced. The majority of these working papers can be viewed at the following internet address:

www.rfa.gov.au

The following project summaries provide an outline of each project undertaken including the objective of the project, the methodology applied, and the key results and products of the work.

# ENVIRONMENT AND HERITAGE

# FOREST ECOSYSTEM CLASSIFICATION AND MAPPING IN NORTH-EAST NEW SOUTH WALES (NA 35/EH, NL 02/EH, NU 06/EH)

## Project objective/s

To provide a map of the distribution of forest ecosystems occurring across all land tenures within the Upper and Lower North East CRA regions. Workshops involving the Environment and Heritage Technical Committee (EHTC) and stakeholders were conducted at various key stages in the project and the methodology was subject to independent peer review.

## Methods

Forest ecosystem classification in the north-east followed an approach recommended by a Forest Ecosystem Workshop convened by the EHTC in July 1997. Different approaches were used for three distinct biogeographic regions which are present within the north-east regions: the area south of the Hunter Valley, the area west of the New England highway, and the north-east area north of the Hunter Valley and east of the New England highway. An outline of the approach used in the area south of the Hunter River is provided in a separate report.

For the north-east area, the approach entailed:

- the derivation of a forest ecosystem classification by splitting and amalgamation of existing State Forests of New South Wales forest types based on analysis of variation between field survey plots in relation to environmental variables;
- mapping of derived ecosystems within the existing mapped extent by use of decision rules relating variation to abiotic environmental variables;
- predictive mapping of derived ecosystems across unmapped forest and cleared land based on modelling of the relationship between the mapped distribution of the ecosystem and abiotic variables.

For the western area, the approach entailed:

- the derivation of a forest ecosystem classification by subjecting floristic data from field survey plots to numerical cluster analysis;
- predictive mapping of derived ecosystems based on modelling of the relationship between the classified plots and abiotic environmental variables.

A seamless vegetation coverage across the three distinct biogeographic areas was derived by expert integration of the disparate classifications. The resultant pre-1750 data layer was refined in relation to historical data compiled from parish portion plans.

## Key results

One hundred and fifty-seven forest ecosystems were classified and mapped for the north-east area, including 141 dominated by eucalypts, and 16 dominated by non-eucalypt vegetation. Ninety-eight of the eucalypt dominated ecosystems were derived from splitting and amalgamation of forest types. The remaining 43 ecosystems comprised State Forests of New South Wales forest types on which no splitting or amalgamation was conducted. Descriptions of these ecosystems are available in a report of the Forestry Commission of New South Wales. A further 22 forest ecosystems were classified and mapped for the western area, including 21 dominated by eucalypts, and one shrubland ecosystem.

# FOREST ECOSYSTEM CLASSIFICATION AND MAPPING FOR THE HUNTER SUB-REGION OF THE LOWER NORTH EAST CRA REGION (NL 10/EH)

## Project Objective/s

This report was undertaken to classify and map forest ecosystems for the Hunter Sub Region within the Lower North East CRA Region, consistent with the specifications of nationally agreed reserve criteria (known as the JANIS criteria). Forest ecosystems are the primary surrogates for biodiversity used in CRAs.

The scope of this work was to 'provide a map of the distribution of forest ecosystems occurring across all land tenures within the Lower North East CRA south of the Hunter River'.

## Methods

To achieve this end, the project provided for the collection of new field data, compilation of existing data, and the development of a system of classification based on the multivariate analysis of field data. Data standards were substantially poorer within the Hunter sub region than for the rest of the Lower North-East region. The work developed for this project represented an initial classification system. Ecosystems were mapped using a hybrid decision tree model/expert system.

The model related the occurrence of ecosystems to spatial patterns in mapped environmental variables (parent material, terrain and climate). The resulting map of pre-1750 ecosystems was cut using a 1990 Landsat coverage of extant native vegetation cover to derive extant distributions of forest ecosystems.

## Key Results

71 forest ecosystems were classified and mapped in the Hunter Sub region, including 58 forests dominated by Eucalypts, Angophoras or Syncarpia, four rainforests, seven shrublands and heathlands, and two wetland/swamp ecosystems.

Some of the forest ecosystems are equivalent to ecosystems in the Upper and Lower North-East CRA regions to the north of the Hunter (see project NA 35/EH).

## DERIVED FOREST ECOSYSTEMS: AN EVALUATION OF SURROGACY VALUE AND INTERNAL BIOLOGICAL VARIATION (NA 44/EH)

### Project objective/s

The primary objectives of this project were to evaluate the effectiveness of forest ecosystem mapping derived for Upper North East and Lower North East CRA Regions as a surrogate for other elements of biodiversity, and to analyse the level and pattern of biological variation encompassed by each mapped ecosystem. The project also collated and prepared data on invertebrates for use in this and related CRA projects.

### Methods

The evaluation used field survey data for a number of biological groups (canopy trees, understorey plants, birds, reptiles, bats, ground-dwelling arthropods) to evaluate how well the species in each group were represented in a 'reserved' set of survey sites selected on the basis of mapped forest ecosystems. The results obtained from the evaluation of forest ecosystem mapping were compared to those obtained for a number of other potential biodiversity surrogates. Biological variation within mapped forest ecosystems was investigated by analysing the biological dissimilarity between pairs of field survey sites located within the same ecosystem in relation to the environmental and geographical separation of those sites.

### Key Results

A database containing 11,347 invertebrate locality records was established for use in this and related CRA projects. The evaluation of forest ecosystem mapping produced the following key results and recommendations:

- In terms of performance as a biodiversity surrogate, forest ecosystem mapping represents an improvement over surrogates employed in earlier assessments in north-east NSW (forest type mapping and environmental unit mapping).
- The efficacy with which biodiversity is reserved through use of forest ecosystems can be improved further by considering information on floristic similarities between ecosystems when prioritising areas for reservation and by giving due emphasis to other biodiversity criteria, including the representation of environmental and geographical gradients of biological variation within each ecosystem.
- Future conservation assessment and planning work in north-east NSW and other regions should consider seriously the potential role of biodiversity surrogates derived through alternative means such as species and assemblage modelling, which performed very favorably relative to forest ecosystem mapping in the current evaluation.

# COLLECTION OF VEGETATION DATA FROM HISTORICAL PORTION PLAN SURVEYS FOR NORTH EAST NEW SOUTH WALES (NA 34/EH)

## Project Objective/s

This project was undertaken to collect historical information on vegetation cover from a representative sample of original portion plans within parishes in the upper north east (UNE) and lower north east (LNE) CRA regions.

## Methods

Locations (in terms of easting and northing) of tree types from each corner of each portion were collected and entered into an excel spreadsheet. In addition to this information, the date the survey was carried out and general vegetation information was also recorded.

## Key results and products

The project produced a database consisting of vegetation data from 2,001 portions within a representative sample of 202 parishes across the UNE and LNE regions of NSW. The data was supplied to National Parks and Wildlife Service for use in the modelling phase of the pre-1750 extent of vegetation types/forest ecosystems.

## STATEWIDE MAPPING OF FOREST MANAGEMENT HISTORY (NA 21/EH)

### Project objective/s

To document and map the management history of public forested land in the Upper North East (UNE), Lower North East (LNE) and Southern CRA Regions of New South Wales.

### Methods

The project was established primarily as a mapping exercise to collect data for use by other CRA projects. Data were collated and digitised with regard to the following practices:

- Logging and silvicultural treatment;
- Prescribed burning and wildfire;
- Grazing; and
- Roads and other infrastructure.

The specific stages of the project were: data audit and gap analysis; establishment of data collection and validation methods; data collation and capture; validation; analysis; and reporting. Stakeholder workshops were conducted for all of the major stages in the project.

### Key results

The primary outputs of the project were attributed and validated Geographic Information Systems (GIS) layers representing particular management types. This project did not undertake analysis on the data collected.

These layers were provided to the following projects:

- Old Growth Forest Assessments;
- Response to Disturbance;
- Wilderness Assessments;
- Forest Resource and Management System (FRAMES); and
- Change Detection using Multi-Temporal LANDSAT.

## OLD-GROWTH FOREST RELATED PROJECTS IN NORTH EAST NEW SOUTH WALES (NA 28/EH)

### Project objective/s

To define, identify and map old-growth forest and the range of successional stages for the Upper North East and Lower North East CRA regions. It was composed of several different phases and involved the overlay of growth stage and disturbance information generated from Aerial Photographic Interpretation (API) with other relevant data layers to identify 'old-growth forest'.

### Methods

An expert panel was formed to review available information and advise on definition issues and ruleset development.

The project utilised a Geographic Information System (GIS) based ruleset to integrate CRA API and Management History information together with data on Forest Ecosystems to define ecological maturity and negligible disturbance as required by the old growth definition in nationally agreed reserve criteria (known as the JANIS criteria) and derive old-growth forest and other successional stages.

For the Lower North East region, due to the non-availability of CRA API data, an interim layer based on a modification of the Broad Old Growth Mapping Project old-growth layer was derived.

### Key results and products

The project:

- Derived the first quantitative site productivity index coverage for the Upper and Lower North East regions.
- Mapped interpretability classes based on expert API classification of the Upper North East forest ecosystems.
- Mapped structural maturity for the Upper North East based on integration of Interpretability and growth stage mapping from CRA API.
- Mapped disturbance levels for the Upper and Lower North East regions.
- Applied the JANIS definition and mapped candidate old-growth forest and other successional stages over 1.95 million hectares of forest across all tenures/planning units within the Upper North East.
- Revised old-growth mapping in the Lower North East over 1.6 million hectares of forest on public lands.
- Provided area statements for (where relevant) Interpretability, Structural Maturity classes, Disturbance Level and Derived Successional Stage for both the Upper and Lower North East regions.
- For the Upper North East, candidate[1] old-growth forest was mapped over 685,500 ha (35%) of the forested area, disturbed old forest over 427,500 ha (22%), mature forest over 91,500 ha (5%), disturbed mature forest over 314,000 (16%), young forest over 206,000 ha (11%), recently disturbed forest over 61,500 ha (3%) and rainforest over 160,100 ha (8%).
- For the Lower North East, candidate[1] old-growth forest was mapped over 857,000 ha (53%) of the forested area, disturbed old forest over 60,000 ha (4%), mature forest over 116,000 ha (7%), disturbed mature forest over 61,000 ha (4%), young forest over 161300 ha (10%), recently disturbed forest over 21350 ha (8%) and rainforest over 233,300 ha (15%).

[1] Old growth forest ecosystems are referred to as "candidate" old growth because time constraints and availability of datasets did not allow for the full assessment of values characteristic of old growth forest (eg some structural, compositional, functional characteristics and aesthetic values). Candidate old growth forest was identified primarily by Aerial Photographic Interpretation (API) and information on disturbance from logging and fire.

## STATEWIDE VERTEBRATE FAUNA SURVEY (NA 01/EH)

### Project objective/s

To obtain comprehensive data on fauna distributions in order to fulfill biodiversity requirements of CRAs in New South Wales. Accurate information on the distribution of vertebrate fauna is an essential component of the data required to develop a comprehensive, adequate and representative (CAR) reserve system. Such information is also integral to the development of the ecologically sustainable forest management (ESFM) practices which are to become part of the Regional Forest Agreements.

The project had four main objectives:

- collation and checking of existing data;
- identification of environmental, geographic and taxonomic gaps in existing data;
- systematic and targeted survey to fill the identified gaps; and
- entry and storage of final digital dataset.

### Methods

Both systematic and targeted surveys were conducted across the northern (Upper and Lower North East), southern (Southern and Eden) and central CRAs. Significant effort was expended in the collation and checking of existing records, and new sampling techniques were designed with reference to the major existing datasets, to enable merging of data for subsequent analysis.

### Key Results

451 sites were systematically surveyed in the northern CRA regions, 188 in the central CRA region and 387 in the southern CRA regions. These surveys have provided more than 1.2 million collected records and 145 000 new survey records to the New South Wales CRA process for the Eden, Upper and Lower North-East and Southern regions.

The data together with numerous targeted surveys and data collated from other sources were used in the CRA fauna modelling and response to disturbance projects.

## SUPPLEMENTARY GENETIC STUDY, SAMPLING AND ANALYSIS AND THE IMPLICATIONS OF GENETIC DIVERSITY FOR THE DESIGN OF A CAR RESERVE SYSTEM FOR THE UPPER NORTH EAST REGION (NA 01/EH EXT 1, NU 08/EH)

### Project objective/s:

For the Upper North East CRA Region:

- To identify ecological groupings of taxa that exist as multiple discrete evolutionary populations or cryptic species;
- To test whether major topographic and environmental barriers have affected long-term gene flow, in particular among different "genetic" subregions within the Upper North East region and between this region and South East Queensland;
- To provide insights into the historical population processes that have operated across the landscape and how these vary among major forest types;
- To determine whether genetic diversity within species is adequately represented by surrogates commonly employed in the CRA process.

### Method

Genetic diversity and geographic structure was examined in four (primarily) open-forest species and two rainforest species by mtDNA sequencing. Substantial comparative data are available for three of the species from South East Queensland and also for several rainforest-restricted species from the same region.

### Key Results

All species examined displayed extensive mtDNA sequence variation within species and the presence of discrete evolutionary lineages within the Upper North East region. There is however limited congruence in the geographical structuring of this variation across the species.

The data do not support predictions of levels of genetic diversity based on knowledge of habitat specialisation. Rainforest-restricted species did not show more evidence of historical isolation than those inhabiting drier forest types.

The available evidence from this and previous studies indicate lower levels of genetic divergence among populations of forest-dependent herpeto fauna in Upper North East New South Wales than is the case in South East Queensland.

# VASCULAR PLANTS OF CONSERVATION SIGNIFICANCE IN NORTH-EAST NEW SOUTH WALES (NA 22/EH, NU 03/EH)

## Project Objective/s

To provide accurate data on threatened vascular flora of the Upper and Lower North East CRA regions in time to contribute to the development of a comprehensive, adequate and representative reserve network in north-eastern New South Wales.

## Methods

Targeted flora surveys were initiated to provide information on the distribution, population attributes, ecology and threatening processes pertaining to priority vascular plant species in the Upper and Lower North East CRA regions. Species included within the scope of this project are those listed under the New South Wales Threatened Species Conservation Act (1995), or the Commonwealth Endangered Species Protection Act (1992), or which have been identified by expert working groups as warranting regional threatened status.

Data collation of existing records of significant plant species was also undertaken, as was a process of data checking and validation. Two hundred and fifty-two populations of 48 target plant taxa and 848 incidentally recorded populations of 342 significant plant taxa were located and assessed in the course of this project.

## Key Results

New populations were located, based on searches of areas considered potential habitat, for 34 of the target taxa. This indicates that targeted surveys utilising expert knowledge of the habitat requirements of rare plants are an effective method of increasing the knowledge base for these species.

A highlight of the field surveys was the outstanding number of populations of significant plant taxa which were recorded incidentally during this project. Populations of 26 species listed as Endangered under the New South Wales Threatened Species Conservation (TSC) Act and populations of 35 species listed as Vulnerable under the TSC Act were incidentally recorded during this project.

These results, in combination with the data validation process conducted as a part of this process, produced a very high quality dataset with which species modelling, population viability analysis and conservation requirements studies could be undertaken for the Upper and Lower North East CRAs.

# MODELLING AREAS OF HABITAT SIGNIFICANCE FOR THE VERTEBRATE FAUNA AND VASCULAR FLORA IN NORTH EAST NEW SOUTH WALES (NA 23/EH)

## Project objective/s

To identify areas of habitat significance for vertebrate fauna and vascular flora in the Upper and Lower North East CRA regions.

## Method

Species-habitat relationships were derived using known distributions of species combined with abiotic, biotic, terrain, habitat and geographic layers within a Geographic Information System (GIS). These known species-habitat relationships were then used to model predicted distributions and thus areas of significant habitat for the species of concern.

Flora and fauna experts were used to validate the models and define areas of high-quality habitat for each species.

## Key results

The key outputs from the project include:

- GIS layers derived for modelling species habitat relationships for forest flora and fauna;
- 146 habitat quality models for priority forest fauna;
- 131 habitat quality models for priority vascular flora.

## RESPONSE TO DISTURBANCE OF FOREST SPECIES IN CRA REGIONS (NA 17/EH)

### Project objective/s

This project was undertaken to identify the conservation needs of threatened flora and fauna species in the Upper North East (UNE) and Lower North East (LNE) regions. It was managed jointly by the NSW National Parks and Wildlife Service, State Forests of NSW with Environment Australia (Commonwealth), as the lead agency.

### Methods

Flora and fauna were treated in separate assessments. The work began with NSW National Parks and Wildlife Service compiling lists of forest dependant fauna and flora in the region. A number of expert workshops were then held to identify the conservation needs of the listed species. Expert ecologists were asked to provide information on the habitat and critical resource requirements, ecological attributes and the disturbances affecting the listed species. Some new analyses were developed and used to estimate the area of land needed for the conservation of species, which were rated as the highest priority.

Experts also provided information to help apply the targets in an ecologically meaningful way. This included recommendations on, distinct populations, dispersal distances and barriers.

### Key Results

The project considered 174 fauna species and 4 500 vascular plant taxa, and identified target areas for 144 fauna species and 139 flora species.

The outcomes of this project will be used, firstly, to guide the design of reserves in the UNE and LNE regions so that the habitats of the most threatened species are protected, and secondly, to help the management of forested land over both the regions.

## JANIS CONSERVATION REQUIREMENTS FOR NORTH EAST NEW SOUTH WALES (NA 59/EH)

### Project Objective/s

To identify the conservation requirements of nationally agreed reserve criteria (known as the JANIS criteria) for selected elements of biodiversity.

The project reports on the derivation of the conservation requirements of old growth forests and centres of endemism. Other selected elements of biodiversity are examined by other projects. Natural National Estate values are identified and assessed in detail by Project NA65/EH.

### Methods

The JANIS criteria guided the formulation of rule sets by expert panels and their application for the derivation of conservation requirements. Those conservation requirements identified were used to generate reservation targets configured specifically for the decision support software being used to select reserves in the New South Wales CRA process (C-Plan).

The conservation requirements for Old Growth Forest were derived and provided as a set of areal targets to drive reservation selection.

Conservation targets for each Centre of Endemism were derived and used to inform reserve selection.

### Key Results

Results for the elements of biodiversity covered by this paper are detailed in a series of tables, maps and workshop reports. Sources for results from the other components of this project are also cited in the report.

Expert workshops for deriving the conservation requirements of priority flora and fauna species were integrated with those convened for the 'Response To Disturbance' project. These workshops provided data to inform a review of Conservation Protocols for forestry activities.

## WILDERNESS ASSESSMENT FOR NORTH EAST NEW SOUTH WALES (NA 33/EH)

### Project Objective/s

The assessment and identification of wilderness is to be consistent with nationally agreed criteria and to satisfy requirements under the Commonwealth National Wilderness Inventory (NWI) and the NSW Wilderness Act.

### Methods

NWI is a customised geographic information system process which measures remote and natural values to produce a 'wilderness quality' continuum, which is produced from four(4) indicators: remoteness from access, remoteness from settlement, apparent naturalness and biophysical naturalness. JANIS 'high" quality wilderness is defined as having a minimum NWI rating of 12 and a minimum size of 8 000 hectares (or 5 000 abutting the coast).

Under the NSW Wilderness Act, provisionally identified wilderness (PIW) was derived by classifying relevant data according to a detailed set of decision rules. Three (3) categories were derived: substantially unmodified, modified and restorable and substantially modified. Those parts of the assessment area classified as substantially modified and some areas on the perimeter of the assessment area classified as modified restorable were then excluded. Resulting stand-alone areas under 15 000 hectares were rejected.

State Capable Wilderness was derived in a similar manner to PIW areas, however areas smaller than 8 000 hectares (or 5 000 hectares abutting the coast) were rejected. Areas greater than 15 000 hectares were also rejected, as these were already represented by the PIW areas.

### Key results and products

In the Upper North East (UNE) region, the NWI revealed that thirteen (13) areas meet the JANIS criteria for defining "high quality wilderness", with 59% falling into the CRA reserve system. For the Lower North East (LNE) region, the results were eleven (11) and 82% respectively.

In the UNE region, two stand-alone areas and additions to three existing identified wilderness areas were delineated as PIWs. These five areas in total comprise 55,019 hectares. Two further stand-alone areas, an area adjacent to the Queensland border and a forth area straddling the LNE/UNE CRA region boundary, were delineated as State Capable Wilderness. These four areas in total comprise 28,446 heactares.

In the LNE region, two stand-alone areas and additions to three existing identified wilderness areas were delineated as PIWs. These five areas in total comprise 143,853 hectares. Two further stand-alone areas and the area straddling the LNE/UNE CRA region boundary were delineated as State Capable Wilderness. These three areas in total comprise 27, 121 hectares.

## RESERVE DESIGN AND ADEQUACY AND THE MANAGEMENT OF BIODIVERSITY (NA 43/EH)

### Project objective/s

This project initially deals with issues relating to the spatial design or configuration of reserves. It does not address selection issues relating to which entities (or how much of each entity) should be included in reserves, nor issues relating to the type of protection (e.g. formal versus informal reservation) to be afforded to different parts of the reserve system.

The project discusses spatial design criteria against a background of the scientific literature and the resultant debates. All relevant nationally agreed reserve criteria (known as the JANIS criteria) are dealt with under the broad design principles of shape, size, connectivity and replication.

### The specific aims are to:

- Highlight JANIS criteria relating to reserve design (or spatial configuration) principles.
- Provide a literature review based on core reserve design principles; size, shape, connectivity and replication.
- Highlight existing spatial configuration tools or mechanisms being employed in the NSW CRAs.
- Provide, where needed, recommendations on how reserve design principles should be further addressed in the CRA process.

The project also aims to increase awareness of the issues regarding conservation of biodiversity from a landscape-scale perspective, and in particular, refine those reserve selection and design guidelines for those principles or criteria that cannot be effectively automated into the decision support software being used to select reserves in the New South Wales CRA process (C-plan).

### Methods

The JANIS criteria specifies spatial configuration criteria for entities as well as reserve design in general. There are many reserve design issues raised in these sections of the JANIS criteria that need to be addressed in the scope of the project. These issues were addressed under the broad design sections mentioned above.

A literature review of those threats to biodiversity within remnant vegetation in New South Wales eastern forests was undertaken to provide background information for use in the reserve selection and design process.

### Key Results

Key recommendations for reserve design investigate issues of size, shape and connectivity.

In particular, these issues address: boundaries with ecological integrity and boundary-area ratios; spread and location of reserves across environmental gradients and away from threatening processes; satisfying criteria for reserves; and corridors and linkages between reserves.

A supplementary report provides a workable set of guidelines for practitioners and managers to enable them to make reserve decisions based on clear and unambiguous objectives and a knowledge of actual and potential threats.

## DEVELOPMENT OF C-PLAN FUNCTIONALITY TO GUIDE ACHIEVEMENT OF SPATIAL CONFIGURATION OBJECTIVES (NA 60/EH)

### Project objective/s

The primary objective of the project was to develop added functionality within the decision support software being used to select reserves in the New South Wales CRA process (C-Plan). This new functionality was intended to automate derivation of measures (indices) to guide the achievement of spatial configuration objectives specified by nationally agreed criteria for the establishment of a comprehensive, adequate and representative system of forest reserves.

### Methods

Two types of measures were developed and implemented within the C-Plan software:
Measures of patch size and connectivity to facilitate improved consideration of criteria such as “reserves should be large enough to sustain the viability, quality and integrity of populations”, “protection of the largest and least fragmented areas of old-growth”, “large reserved areas are preferable to small reserved areas” and “reserves should be linked through a variety of mechanisms”.

Measures of geographical and environmental spread to facilitate improved consideration of criteria such as “reserved areas should be replicated across the geographic range of the forest ecosystem”, “the reserve system should ... sample the full range of biological variation within each forest ecosystem, by sampling the range of environmental variation typical of its geographic range” and “representation of old-growth forest across the geographic range of the forest ecosystem”.

### Key results

The software produced by this project provides a greatly enhanced capability to address spatial configuration objectives when selecting new forest reserves.

# SOIL AND REGOLITH ATTRIBUTES FOR CRA/RFA MODEL RESOLUTION (NA 31/EH)

## Project Objective/s

To expand the existing soil landscape coverage of soil attributes where little or no data was available and to develop a mapped coverage of soil attributes across the UNE and LNE CRA regions to assist with CRA modelling of individual plant and animal species distributions, modelling of extant and pre-European distribution of vegetation communities, and modelling of site quality and associated wood resource attributes.

This included:

- development of suitable algorithms and site criteria for collection and ranking of relevant parameters, including fertility, effective rooting depth and soil waterholding capacity;
- fitting of specific soil attributes to the existing soil landscape framework;
- extension of the soil and landscape map framework over the remainder of the area; and,
- potential for greater resolution of soil attributes by making provision for allocation of soil sub-landscapes that can be linked to digital elevation-derived models for outputs at scales of 1:25 000.

## Methods

Soil landscape coverage for the area was provided from 13 existing published and draft Department of Land and Water Conservation (DLWC) soil landscape maps and the undertaking of extensive reconnaissance level soil landscape mapping by nine soil surveyors and three technical assistants for the remaining 21 1:100 000 sheets.

Useful data sets including colour air photos, geological and existing soil landscape information were collected and reviewed. 1:100 000 scale base sheets showing geology, cadastre, contour and thematic mapper image were supplied by State Forests. Provisional soil landscape boundaries were drawn onto the base sheets or onto 1:100 000 topographic sheets using geological boundaries and the interpretation of both colour aerial photography and thematic mapper images. Free soil survey techniques were used to describe 1325 soil profiles, which were recorded on specially designed CRA soil observation cards. Soil landscape boundaries were revised during field work. About two weeks of field work was undertaken for each 1:100 000 map sheet. Soil data cards were collated and entered into the NSW Soil and Land Information System (SALIS). Algorithms were created to assess specific soil attributes (soil fertility, soil depth, effective rooting depth, drainage and estimated plant available waterholding capacity) from soil profile information and existing soil landscape reports for each soil sub-landscape. These were entered onto Excel tables. Field maps were traced, and along with the soil attribute tables, sent to National Parks and Wildlife Service (NPWS) for scanning on a rolling delivery basis (due to time constraints).

Soil attributes were then linked to the mapped coverage by Bureau of Rural Sciences (BRS) (Canberra). Map boundaries and soil attribute values were checked by DLWC soil survey staff and corrections undertaken by BRS.

## Key Results

Complete coverage of both UNE and LNE CRA regions of soil landscapes and associated soil attribute themes including soil fertility, effective rooting depth and estimated available waterholding capacity have been generated to assist in CRA modelling. The coverage is supplied on compact disc. Additionally, 1625 profiles were described as part of this project and are available on the NSW SALIS at DLWC (Parramatta).

## IDENTIFICATION, ASSESSMENT AND PROTECTION OF NATURAL NATIONAL ESTATE VALUES FOR NORTH EAST NEW SOUTH WALES (NA 65/EH)

As defined in the *Australian Heritage Commission Act 1975*, the National Estate comprises:

> *those places, being components of the natural environment of Australia, or the cultural environment of Australia, that have aesthetic, historic, scientific or social significance or other special value for future generations as well as for the present community*.

### Project Objective/s

This report was undertaken to document the methodology and rule-sets used to identify potential areas of natural national estate significance. The work was undertaken by Environment Australia (EA) and NSW National Parks and Wildlife Service (NPWS) in consultation with State Forests New South Wales (SFNSW).

### Methods

The process of identifying potential national estate involved asking a series of expert panels to identify species, known areas or landscape features (such as rock outcrops for example) that met the requirements for national estate criteria. The outputs from these workshops were combined with the result of literature reviews and the experience of previous CRAs to create rule-sets.

Where available, separate rule-sets were used for species based analysis and the identification of landscape features or areas. Rule-sets were then applied to data gathered during CRA assessments. The results of different rule-sets were cross-validated to generate the final set of layers. These are expressed in terms of relevant criteria.

Areas identified as having potential national estate value are indicative only and are not necessarily the delineated forested areas that will be listed in the Register of the National Estate.

### Key Results

Northern NSW was found to be a significant area in terms of natural heritage. Seventeen values were idenitified and assessed across the regions as above threshold as indicative natural national estate. These include old growth, refugia, centres of endemism, primitive, relictual and phylogenetically distinct species, species and vegetation community richness, rare species and vegetation communities, natural landscapes and undisturbed catchments. Significant areas identified included Barrington Tops, Styx River, Richmond Range, Carrai Plateau, Mount Warning Caldera and the Border Ranges.

## STATE-WIDE CULTURAL HERITAGE DATA AUDIT INTEGRATION AND ANALYSIS (NON-INDIGENOUS) (NA02/EH)

### Project objective/s

- To investigate and assess available non-indigenous cultural heritage information across the NSW CRA/RFA regions;
- To integrate the available information into datasets for ongoing use throughout the CRA process; and
- To identify gaps in information to allow targeting of future cultural heritage investigations.

### Methods

- Preparation of an annotated bibliography of sources relating to the history and non-indigenous cultural heritage of the forests of the NSW CRA regions.
- Identification of existing datasets and reports relating to non-indigenous heritage places within the forests of the NSW CRA regions.
- Development of recommendations for integrating this information into a database for ongoing use throughout the CRA process.
- Integration of information into appropriate databases and GIS coverages, focussing initially on the Eden CRA Region and then the remaining CRA regions.
- Analysis of the resulting datasets to highlight deficiencies and gaps in the data and develop recommendations for a strategic approach to future data collection and management.

### Key results and products

This project, which is statewide, has now been completed. The following results have been achieved.

- A computer database bibliography, with over 6 000 entries, of sources relating to the history and non-indigenous cultural heritage of the forests of the CRA regions.
- A report identifying existing non-indigenous heritage databases and reports relating to heritage sites and places in the NSW CRA regions.
- GIS coverages showing the location of recorded non-indigenous heritage places within the forests of the NSW CRA regions.

## ASSESSMENT OF PLACES OF AESTHETIC SIGNIFICANCE IN NSW CRAS (NA 15/EH)

### Project objective/s

The project sought to identify, assess and document forest related places of aesthetic value to the community in the Upper North East (UNE), Lower North East (LNE) and Southern NSW CRA Regions. This involved consulting with staff of the New South Wales National Parks and Wildlife Service (NPWS) and State Forests of New South Wales (SFNSW) at Forest Staff Workshops and incorporating data from NSW Community Heritage Workshops.

The definition of aesthetic value used in this project was developed for the Australian Heritage Commission: *" Aesthetic value is the response derived from the experience of the environment or of particular cultural and natural attributes within it. This response can be either to visual or non-visual elements and can embrace emotional response, sense of place, sound, smell and any other factors having a strong impact on human thoughts, feelings and attitudes"*

### Methods

Work was carried out within the Technical Framework for Environment and Heritage Assessments in the NSW CRA/RFA process that was developed by the NSW CRA/RFA Environment and Heritage Technical Committee. Table 1e of this framework identified *Assessment of Places of Aesthetic Significance within the forested areas of NSW CRA Regions* as linked to other non-indigenous cultural heritage projects:

- *NSW Community Heritage Values Identification and Assessment Project for the Upper and Lower North East Regions Vol. 2, Social Value Assessment ;*and the
- *NSW Thematic Forest History and Assessment;*

and the projects for:

- *National Estate Biodiversity;*
- *National Estate Old Growth;*
- *National Estate Wilderness;*
- *Landscape Scale National Estate Values.*

Selection of a representative sample of sites for documentation of aesthetic significance was then carried out. Forest Staff Workshops were held at Casino, Coffs Harbour, Gloucester, Port Macquarie and Raymond Terrace in April 1998. Places considered to be of aesthetic value within forested areas were identified at these workshops. These workshops and the Community Heritage Workshops were the primary sources of data on places of potential national estate aesthetic and social value. Twenty-seven people attended the five Forest Staff Workshops held in the UNE and LNE CRA Regions, with a further nineteen people forwarding responses after the workshops.

107 named sites were identified from the Forest Staff Workshops in the UNE CRA Region with 188 sites identified in the LNE CRA Region. These places were later cross-referenced with Community Heritage Workshop places identified by the community as important to them and as having a component of aesthetic value. 55 of the UNE 107 sites and 66 of the LNE 188 sites identified at Forest Staff Workshops were also identified at Community Heritage Workshops.

These sites are considered to be a reasonable representation of the symbolic landmark and outstanding landform components of the study subject. Further work would be required to fully represent the attribute, compositional, meaning and evocative aesthetic components of the study subject.

A number of sites were initially selected for inspection and assessment against State and National Estate cultural heritage criteria. These sites were selected by applying the three triggers developed by the Cultural Heritage Working Group (CHWG) of the NSW Environment and Heritage Technical Committee, as well as incorporating additional criteria. These criteria were applied to obtain a representative sampling of the reasons why sites had been identified as being of aesthetic value at Forest Staff Workshops. After inspection of sites and initial assessment of aesthetic significance had been carried out, the Project Manager reviewed financial and time restraints of the project. As a result, 11 sites in the UNE Region and 15 sites in the LNE Region were formally assessed for State and National Estate heritage significance.

The CHWG and a selected panel of experts reviewed the documentation and amendments were incorporated into the final report.

### Key results

Sites identified at Community Heritage Workshops and sites assessed as being above National Estate threshold are listed in the project reports. Documentation of the assessed sites is contained in the Heritage Inventory Forms available as appendices to the reports.

The places identified at Forest Staff and Community Heritage Workshops were entered into the NSW NPWS Cultural Heritage Database with assigned Heritage Inventory Numbers.

## FOREST HISTORY AND HERITAGE ASSESSMENT (NON-INDIGENOUS) FOR THE UPPER NORTH-EAST AND LOWER NORTH-EAST CRA/RFA REGIONS (NA 29/EH)

### Project Objective/s

This report was undertaken to document past human interaction with and current social attachment to forested environments. The project aimed to identify areas of State significance and national estate value and to place these within an historical framework. The project outcomes then will :

- contribute to the sound management of forests by helping to prioritise, guide, inform and stimulate research design and questions for investigative research and field work;
- assist forest managers to understand and manage the cultural heritage values of their forests;
- identify forested places of particular significance to the community.

### Methods

The project consisted of 4 components:

1. ***The historic framework of the CRA region.***
   The history of these forests over the last two hundred years was traced in a series of thematic frameworks. The report describes the landscape and topography of the forests, the influence of land tenure and the pivotal role of towns, along with a discussion of the philosophies that served to shape the forests. Seminal periods of convicts and timber-getting, contact and continuity among the Aborigines, the presence of mining in the forests in the late 19th century and women and children and their lives which complemented the more 'heroic' figures of the early timber-getters.
2. ***The identification of places of particular significance to the community, national estate value and/or State significance through a series of community workshops.***
   Thirteen workshops were held across the two regions, targeting a range of interest groups including natural environment; history; timber and forest related industries; tourism and recreation; primary industry (grazing, bee keeping etc); mining; township commerce and business; community services and schools. Local community workshops were held in the Upper North East Region at Dorrigo, Glen Innes, Grafton, Lismore, Murwillumbah, Tenterfield, Woodenbong. In the Lower North-East Region workshops were held at Cessnock, Dungog, Kempsey, Taree, Walcha, and Wauchope. All information was a entered into the CRA Heritage Inventory database, and this information and a short report on the workshop was returned to workshop invitees for comment. Social value research was then conducted by means of a questionnaire in each workshop locality, followed by field inspection and documentation of a range of sites.
3. ***The identification of places of historical significance***
   This stage was based on the results of a previous data audit project (project no. NA 02/EH) and a consideration of the history of the CRA region. From the identified sites a selection was chosen for further research and field validation on the basis of likely significance given the early desk top study and an understanding of the history of the area. It was only possible to sample the range of sites within the time frames of this project. All information was entered into the CRA Heritage Inventory database which was based on a modified version of the NSW State Heritage Inventory. The modifications were to included the assessment of National Estate Values as well as the State significance assessment criteria.
4. ***Mapping of the places of high conservation value on a Geographic Information System***
   This enabled the information to be available during the integration phase of the CRA process so that the impact of decisions on the known cultural heritage could be considered in the decisions regarding boundaries and land tenure.

### Key Results and Products:

1. A thematic report which is a valuable starting point to understanding the heritage of the region.
2. Community workshop reports for each workshop undertaken which listed the places identified at that workshop and was sent back to each person or organisation who had been invited to the workshop.
3. A Social Values Assessment Report documenting the workshop process and the outcomes of the field assessment stage.
4. An inventory of places and their assessment which was entered into a CRA database, for use in assessments for the Register of the National Estate, the NSW State Heritage Register and by land management agencies to plan forest activities as well as listing on their own heritage registers.
5. GIS layers which map the places of high conservation value which were subject to field investigation.

## PLACES OF NATURAL HISTORY SIGNIFICANCE IN NSW FOREST REGIONS (NA 24/EH)

### Project Objective/s

This project was undertaken to identify and assess sites of indicative national estate natural history significance in the Upper North East, Lower North East, Southern and Eden CRA Forest Regions in New South Wales. These four CRA Regions were assessed on the basis of National Estate Criteria C1, being

> *"Importance for information contributing to a wider understanding of Australian natural history, by virtue of its use as a research site, teaching site, Type locality, reference or benchmark site".*

### Methods

Data sources included literature searches of established journals, conference proceedings, contact with various institutions including natural history societies, and contact with numerous experts. The national estate values of identified places were assessed against the national estate criteria by ranking the importance of each site, in terms of its contribution to Australian Natural History. The sites were ranked as having High, Moderate or Low value as a C1 site of national estate importance.

### Key Results

A total of 247 sites were ranked as having High or Moderate value and have the potential of nomination onto the Register of the National Estate.

## OVERVIEW OF ARCHAEOLOGICAL RESOURCE ON FORESTS (NA 16/EH)

### Project Objective/s

The two main aims of the project were to give a clear indication of the nature of the forest archaeological resource and to stimulate discussion between natural resource and cultural heritage managers on archaeological identification and management issues for the CRA/RFAs.

The project dealt with the scientific values of the resource as opposed to the cultural values held by Aboriginal people, which were assessed through the Indigenous Consultation Project NA 10/EH.

### Methods

A report was produced which collated and synthesised existing archaeological forest studies. Qualitative assessment of methods and outcomes was undertaken. Issues discussed include:

- the nature and extent of research undertaken;
- possible future data requirements;
- the analytical potential of the resource and its implications for management;
- technical issues pertaining specifically to defining the empirical nature of the resource;
- the range of natural and cultural impacts to the resource and implications for the management of minimally disturbed areas;
- different models of management in terms of their operational viability and effectiveness to maintain a 'representative' sample of the resource; and
- options for the management of archaeological values in NSW forests.

### Key Results

- A report providing an overview of the extent and nature of forest archaeological research and implications for future data and research requirements.
- Increased awareness of management issues based on adequate understanding of the empirical nature of the resource.

The report will provide background information to be used as a basis for technical discussions during the Protecting Cultural Heritage Values and Places in the NSW Forest Estate CRA project (Project NA03/EH) and to assist the ESFM project management group in their assessment of management issues regarding the archaeological resource in forests.

## PLACES OF GEOHERITAGE SIGNIFICANCE IN NSW FOREST REGIONS (NA 25/EH)

### Project Objective/s

This project was undertaken to identify and document places of geoheritage significance in the Upper North East, Lower North East, Southern and Eden CRA Forest Regions in New South Wales.

Places of geoheritage significance in this report are defined as places containing:

> *"Those components of natural geodiversity which are of significant value to humans for purposes which do not decrease their intrinsic or ecological value: such purposes may include scientific research, education, aesthetics and inspiration, cultural development and contribution to a sense of place experience by human communities"* (Dixon, 1996).

Areas that may be identified as having geoheritage value include places important:

- in the evolution of Australian landscapes or climate;
- in maintaining existing processes or natural systems at the regional or national scale;
- in exhibiting unusual richness or diversity of landscapes;
- for rare, endangered or uncommon natural landscapes or phenomena;
- for information contributing to a wider understanding of Australian natural history by virtue of its use as a research site, teaching site, type locality, reference or benchmark site;
- in demonstrating the principal characteristics of the range of landscapes, environments or ecosystems, the attributes of which identify them as being characteristic of their class.

### Methods

The methodology being undertaken for the project includes:

- the development and application of thresholds for national estate assessment purposes based on a review of the significance of the identified sites;
- documentation of potential national estate geoheritage sites;
- sensitivity analysis of all potential national estate geoheritage sites; and
- development of conservation management guidelines for those sites identified

The project has been undertaken over a period of three months entirely as a desktop survey. Data was obtained from scientific journals and other published material for place-related information that was likely to identify potential places of geoheritage significance. Published geological maps and topographic maps were examined and potential features of geological significance identified. Other sources of data included contact with various institutions, and contact with numerous experts.

### Results

- Project report produced identifying places of geoheritage significance in the Upper North East, Lower North East, Southern and Eden CRA Forest Regions in New South Wales; and
- data produced in spreadsheet and table format listing geoheritage places identified in each NSW RFA region.

## INDIGENOUS CONSULTATION PROCESS FOR THE CRA/RFA PROCESS (NA 10/EH, NU 10/EH, NL 11/EH)

### Project objective/s

As a statewide project, to ensure a co-ordinated approach across the NSW CRA/RFA regions to the management of consultation with Aboriginal people and the preparation of assessment projects relating to Aboriginal communties' values within forested areas.

For the UNE region, a further project (NU 10/EH) was carried out to document and map the boundaries of Aboriginal nations, clans and Local Aboriginal Land Councils (LALC), for subsequent consultation and dialogue.

For the LNE region, a further project (NL 11/EH) to develop and finalise a protocol for negotiation between the Aboriginal communities of the region and governments related to RFA issues.

### Methods

- Appointment of two project officers to co-ordinate and manage the Aboriginal consultation process.
- The formation of Aboriginal Management Committees in each region.

Dissemination of information to Aboriginal communities on the CRA process in each CRA/RFA Region.

Oversight of management of the consultation process, consultants and the preparation of reports and documents for the projects.

Oversight of the presentation of final reports and documents to the Aboriginal Management Committee for approval.

### Key results

The consultation process in the UNE/LNE Regions were implemented through:

- Formation and operation of Aboriginal Forest Management Committees in each region
- Aboriginal community involvement in the development and undertaking of assessment projects
- Completion and submission of a protocol for negotiation with governments for the development of an RFA for the LNE region.

# ECONOMIC AND SOCIAL

## SAWMILL SURVEY AND FORUM ANALYSIS (NA 36/ES, NA 38/ES)

### Project objective/s

- survey mill owners or managers to provide information on the current econonomic structure and performance of business enterprises comprising the hardwood based industriees of the Northern CRA regions;
- to assess the economic, employment and social impacts associated with changes in resource availablity.

### Method

The survey of wood processing mills in the Upper and Lower North-East NSW RFA regions was conducted in May 1998. The survey involved face to face interviews with mill owners or managers to collect data on mill input, recovery rates, sales, processing costs, employment and overheads for the 1996-97 financial year. Data from the mill survey is used to configure the Forest Resource and Use Model (FORUM).

FORUM tracks the flow of wood resources from the forest to the mill and then from the mill to the market over a twenty year period. The model identifies the optimal allocation of logs to achieve the highest net return for each resource configuration. In the process FORUM considers harvesting costs, the transport cost between each of the three locations (forest-mill, mill-mill, mill-market), as well as recovery rates, processing costs and product prices. Labour requirements across the forest industry are also calculated.

### Key results

FORUM has been configured for the North-East regions to provide log flow data, employment changes and economic data, such as the gross value of production (GVP), total costs and the net value of production (NVP). These are provided at an aggregate industry level and at a regional level. The model has produced information which will be used in finalising the North-East RFA.

## REGIONAL ECONOMIC IMPACT ASSESSMENT (NU12/ES, NL 08/ES & NA 39/ES)

### Project objective/s

This project:

- provides an economic profile of the Upper and Lower North-East Comprehensive Regional Assessment (CRA) regions and the forestry industry in that region;
- provides a social profile of the communities that make up the Northern CRA regions;
- estimates the likely impact on the regions of changes in the current forest land tenure configuration.

### Method

A model of the regions' forestry industry was constructed to indicate how the various forest industry activities relate to each other and how changes in the amount of wood available from State Forests impact on other forestry activities. A database of key economic variables was also developed and interpreted.

Input-output models for the Upper and Lower North East CRA regions were also constructed. These models were used to estimate the multipliers and flow-on effects associated with the direct effects of forestry activities. A base case for each region was constructed around the actual level of forest industry activity in 1997-98. These models were then used to estimate the potential economic impacts associated with a change in land tenure away from the base case.

The social characteristics of the regions' communities were examined using information from the 1996 Population Census. The communities where there was a high dependence on forestry activities were examined in terms of indexes reflecting unemployment and household income, education and occupation, family and housing conditions and age dependency.

### Key results

The Upper and Lower North East CRA regions have experienced high growth in terms of population and employment, especially in the areas near to Sydney and the coast. Unemployment however, remains high in each region and the number of dependents in each region is well above the average for NSW. Employment in the Upper North East region in 1996 totaled approximately 110,000 people and Gross Regional Product was $4,948m. Employment in the Lower North East region in 1996 totaled approximately 370,000 people and Gross Regional Product was $21,878m.

The timber industry in the Upper North East region in 1997-98 processed approximately 445,000 $m^3$ of wood, while all forestry-based activities contributed, directly and indirectly, $250m to Gross Regional Product (accounting for 4.2 per cent of the economy) and 5,000 jobs (approximately 4.5 per cent of total employment). One-half of this contribution was associated with the growing, harvesting and processing of native hardwood.

The timber industry in the Lower North East in 1997-98 processed approximately 708,000 $m^3$ of wood while all forestry-based activities contributed, directly and indirectly, $356m to Gross Regional Product (1.6 per cent of the economy) and almost 7,200 jobs (1.9 per cent of total employment). About 40 per cent of this contribution was associated with the growing, harvesting and processing of native hardwood.

Social profiles for the Upper North East region identified a number of communities where forestry provided a significant level of employment. There was however considerable variation among those communities in terms of other social characteristics that were used as indicators of the capacity of that community to adapt to changes in key industries and their economy.

While most forestry employment was found in the medium-sized centres of Grafton, Kyogle and Coffs Harbour, the dependence on forestry was most important in Grafton and Kyogle. The smaller centres of Tenterfield, Dorrigo and Urbenville also appeared susceptible to change because of a high proportion of employment in the forestry industry and low education levels and occupational skills. Those results indicate that the local impact of changes in forestry will be variable among the centres in the CRA region.

Social profiles for the Lower North East region identified a number of communities where forestry provided a significant level of employment. Again however, there was considerable variation among those communities in terms of other social characteristics that were used as indicators of the capacity of that community to adapt to changes in key industries and their economy.

Most forestry employment in the Lower North East local government areas (LGAs) was found near the coast especially Bellingen, Hastings, Greater Taree, Nambucca, Kempsey and Great Lakes. The particular communities that appear to be most susceptible to change are those hinterland centres including, Dorrigo, Bulahdelah, Dungog and Gloucester, where there is a high proportion of employment in the timber industry. Other coastal, such as Taree, The Entrance, Gosford and Port Macquarie may also be susceptible to change because of the high absolute numbers employed in the timber industry. Results indicate that the local impact of changes in forestry will be variable among the centres in the CRA region.

## PRIVATE FOREST MANAGEMENT INTENT SURVEY (NA 47/ES)

### Project objective/s

The aim of this project was to conduct a survey of private forest owners to obtain information on the private forest resources within the northern NSW CRA regions and gain a better understanding of management intentions on private forested land, including assessing the level of interest private managers have in commercial plantations.

### Method

Written surveys were sent out to 2128 landowners with properties in excess of 100 hectares in the Upper and Lower North East regions. This represents a 21% sample population of out of a potential target population of 10,160 landowners in 35 local government areas. The survey response rate was 11.9% (or 254 responses). The survey sought information about:

- Private native forest area and logging history.
- Private forest management intent, including timber production and conservation, factors impacting on management, inventory and flora and fauna assessment, the importance of forestry as an agricultural enterprise and potential markets for forest products.
- The level of interest from private landowners in establishing commercial plantations.

### Key Results

Private forests make up approximately 46% of the 3.9 million hectares of commercial forest types in the northern CRA regions. In 1997, these private forests contributed 35% of the region's roundwood production. While no statistical analysis was undertaken as part of the survey, the responses still indicate some important results for landowner management intent.

Ninety-three percent of respondents in UNE indicated they had native forests and 75% in LNE.

Fifty-one per cent of survey respondents reported that logging had occurred on their properties and 62% intended to undertake logging.

More than 35% of total respondents indicated that they currently managed their forests for both timber production and conservation and would continue do so. Fifteen per cent managed for conservation only (including potential Voluntary Conservation Agreements); 5% managed for timber production alone, and the remainder (45%) managed for other uses, did not actively manage, or were non-committal.

In relation to important factors affecting forest management, 69% of respondents identified concern or confusion over regulatory and legislative requirements, 40% referred to problems in negotiating environmental controls, 43% to the need for good financial returns, and 49% to the need for professional management advice.

Almost 50% of landowners indicated an interest in having formal timber inventories undertaken and about 30% were interested in fauna/flora surveys.

Although more than 50% of respondents have been or will be involved in some form of forest management, they rated their forestry activities low relative to grazing and dairying, the two most common forms of land use. For more than 80% of respondents, their income from forestry amounted to less than 10% of total farm income.

Extrapolation of the survey results showed landowner interest in commercial plantations over an approximate gross area of 275,000 hectares. This is a gross area that has not been statistically tested and takes no account of potential land capability or suitability for plantation purpose therefore must be treated with caution. Additionally, conversion from landowner interest into establishment is estimated at approximately 10%.

## FOREST BASED TOURISM AND RECREATION (NA48/ES)

### Project objective/s

This project:

- identifies the nature and size of the tourism and recreation industry in the Upper and Lower North East Comprehensive Regional Assessment (CRA) regions and provides quantitative and qualitative information on existing, proposed and likely levels of tourism activity in these areas;
- estimates the proportion of the tourism and recreation industry that depends on the use of public forested areas managed by NSW National Parks and Wildlife Service and State Forests of NSW;
- identifies the value of biodiversity protection to the tourism industry of the Upper and Lower North East regions;
- estimates the potential impacts of a change in forest land tenure configuration on the regions' tourism and recreation industry

### Method

A number of methods were used to gather data for this study. A literature review was undertaken to collect information on various aspects of the tourism and recreation industry in both the Upper and Lower North East regions and more generally throughout Australia. Various government and non-government organisations, businesses and individuals were consulted to assist in profiling the tourism and recreation industries in the regions and to help in the assessment of potential impacts associated with a change in forest land tenure configuration. A survey of commercial tourist operators was also undertaken to gain an understanding of tourism and recreation industries dependence on forests in the Upper and Lower North East regions. This survey provided important background information on the regions' direct forest users.

### Key results

In 1997, there were approximately 2.8 million forest-based visits in the Upper North East region and 2.1 million forest-based visits in the Lower North East region.

Growth in the tourism and recreation industry in north east NSW varies, with some areas experiencing higher growth rates than other areas. Generally, it was found that tourism is growing at between two and three percent per annum throughout the UNE and LNE regions.

The project found that forest areas were very important to the businesses surveyed, with respondents rating their importance to their business at above 8 out of a possible 10. According to operators, it was more difficult for businesses using State forest areas to find alternative areas for their activities than it was for businesses using National Parks. It was found that respondents using State forest areas were more concerned with land tenure changes than were respondents using National Parks, however, as many of the recreational activities carried out in State forests are compatible with NPWS, it is likely that most commercial tourism and recreation business operations would be unaffected by a change in forest land tenure configuration.

## A REPORT ON FOREST WOOD RESOURCES (NA 52/ES)

### Project Objective/s

This project provides an overview of the wood resources, including timber supply priority areas, and information related to products, species, supply commitments and methods of assigning royalty for the two North Eastern CRA regions. The project also provides a description of forest harvesting, the hardwood resource, and management.

### Method

A review of data concerning the forest resource, wood produce and management regimes was undertaken.

### Key Results

**Volume by Product Information for the Period 1994-1998**
There has been a considerable reduction in the yields of all products cut over the last four years. In overall terms there has been a reduction of about 40 percent over the last four years.

**End Use for Timber Products, Including Volume By Species Information for the Period Jan 95 to Jul 98**
The timber industry bases its sawn markets in the following species; tallowwood, ironbark, blackbutt, spotted gum, brush box, turpentine, Sydney blue gum, flooded gum, various stringybarks, New England blackbutt and messmate. The main species on the coast are blackbutt, spotted gum and Sydney blue gum, with messmate and New England blackbutt from the tablelands.

**Softwood Plantations in the Upper and Lower North East**
The UNE softwood plantations cover approximately 13,600 ha and over the next 10 years are expected to yield 170,000 $m^3$/yr of sawlog and veneer logs distributed amongst six main customers. The 10,000 ha of plantation in the LNE could potentially yield 80,000 $m^3$/yr of sawlog in the same period, however market development is needed for this resource.

**Non-Quota Products**
Non-quota products refers to logs other than quota quality sawlogs. The non-quota products represent logs at both ends of the quality spectrum including the high quality, specialty logs such as girders, poles, piles and veneer logs and the lower grade logs such as salvage sawlogs. Non-quota products along with quota sawlogs, are produced as part of integrated harvesting operations in native forests and plantations.

## LOCATIONAL IMPACTS OF FOREST INDUSTRY EXPENDITURE (NA 58/ES, NU 05/ES AND NL 05/ES)

### Project objective/s

To explore the potential effects of a change in the native hardwood timber industry on industries that supply goods and services to the regions' timber industry, on a location basis.

### Methods

The project adopted a cascade principle whereby the potential effects of change on the timber industry business (mills, contractors, hauliers) were examined together with the consequent effects on those businesses that supply the timber industry in the local area. Twenty-three businesses were selected, based on their size and location, for face-to-face interviews. A mail survey was conducted of the remaining mills and contractors.

### Key results

#### Upper North East

- The majority of the activity in the Upper North East region is concentrated in the Grafton area, which draws over one-third of activity (measured as employment). Lismore and Casino are also significant centres followed by a range of secondary centres, including Coffs Harbour, Woodenbong, Kyogle and Murwillumbah/Mullumbimby;
- The average annual wage for a mill worker in the region is about $26 690 (range $15 000 - $31 000). The average annual wage for a mill contractor and haulier employees is about $24 500 (range $15 000 - $31 000);
- About two-thirds of workers live within ten kilometres to their place of work, and over 90 % live within 40 kilometres;
- Individual mills spend about $12 810 per employee per annum in the local economy
- Local businesses supplying the timber industry were also concentrated in Grafton, Coffs Harbour, Lismore, and Casino with representation at lower levels in 10 other centres. On average these businesses employed eight people full-time, about two people part-time, and about 3 people on a casual basis.
- About one-quarter of the sample businesses had a gross income of up to $100 000 for the year ending June 30 1997, compared to approximately 18 % with a high gross income of $1million or more. Most businesses had 50 or more customers, some however concentrated a large proportion of their sales on the 'top five' customers. These included transport/storage, finance/insurance, and construction sectors. Those with a high proportion of income (sales) from the timber industry were transport/storage, construction, auto repairs/tyres/service, manufacturing, and wholesale trade.
- On average 58.9 % of income was spent locally by the 70 businesses completing this section of the questionnaire. Highest local spend was by finance/insurance (96.7%) and property/business services (82.2%) and lowest in the manufacturing (29.4%) and wholesale sectors (33.3%).

#### Lower North East

- The Newcastle region is the most significant focus for timber industry activity in the Lower North East region, followed by a range of secondary centres including Coffs Harbour, Kempsey, Walcha, Wauchope and Bulahdelah. Macksville, Gloucester and Gosford function as local centres.
- Local businesses supplying the timber industry were concentrated in Walcha, Port Macquarie, Taree, Wauchope, Kempsey, Wingham and Gloucester, although other communities were also represented. On average these businesses employed four people full-time, about four people part-time, and 3 casual.

- The average annual wage for a mill worker in the region is about $25 300 per annum (range $12 000 - $30 000). The average annual wage for contractor employees is about $28,000 per annum with a range over individual sites of $15 000 - $31 000.
- Just over half of mill employees live within a ten kilometre radius from their place of work, and just over three quarters (77%) live within 20 kilometres. Almost all live within 60 kilometres.
- Individual mills spend about $12 200 per employee per annum in the local economy.
- Mill owners in face-to-face interviews stated that timber industry businesses contribute in case or kind to their local communities, recognising that '*it is important to put money back into the community'*.
- Eleven per cent of the sample businesses had a gross income of up to $100 000 for the year ending June 30 1997. This decreased to eight percent by June 1998. The proportion of businesses in the $100 000 - $200 000 bracket rose by four percent. The median gross wages recorded by 72 businesses as going into the community was $75 000 - $100 000. The median amount spent on good and services by suppliers to the timber industry was $50 000. Thirteen percent spent $500 000 or more and three per cent spent over $2M. One in four were at the lowest end of the scale ($1 000 - $20 000), with a further 28 per cent spending between $20 000 and $50 000. Three sectors, general retail, wholesale machinery, and construction, appeared to spend a larger amount on good and services than others do.
- On average 61% of income was spent locally by the suppliers who responded to the survey. Three sectors were more likely than others to record a high local spend – petrol/fuel, finance/insurance, and property/business services. All three have a low dependence on the timber industry.

## BENEFIT TRANSFER AND THRESHOLD VALUE ANALYSIS OF NON-USE VALUES OF FOREST PRESERVATION (NA 62/ES)

### Project objective/s

The aim of the Threshold Value Analysis (TVA) project is to provide information on the non-use values of forest preservation for the Upper and Lower North East CRA regions by estimating the value of benefits, resulting from protecting a forest area, that would need to be achieved for the establishment of a reserve in that area to be in the communities best interests.

### Method

Threshold Value Analysis estimates the foregone extractive benefits associated with a proposed forest reserve area, and provides the decision maker with information to help address the quesiton “are the benefits of protecting the forests greater than the value of the extractive benefits that will be given up if the reserves are established?”

Values are determined by estimating the opportunity costs of timber production forgone, that is, non-use values are estimated in terms of the “price” that the community would have to pay to generate the same level of economic benefit from forest preservation as derived from timber production forgone. These non-use values represent threshold values for each category of non-use value. Opportunity costs are assessed as changes relative to a base situation, in terms of the direct costs and as direct-plus-nonmarket costs of timber production forgone.

This project utilises two modelling approaches, a “static” threshold value analysis and a “dynamic” threshold value analysis. Under the static analysis, the foregone extractive benefits of the forest areas being considered for reservation are estimated at a point in time. The fundamentals of the dynamic analysis are the same however, the dynamic analysis takes into account potential changes over time in the streams of benefits from forest protection and extraction.

### Key results

The study provided information on the opportunity costs associated with land tenure configurations for the Upper and Lower North East regions’ Comprehensive Regional Assessments. An analysis of the extent and composition of forest protection benefits associated with the Upper and Lower North East reserve configurations indicates that only moderate increases in visitation numbers in the CRA regions are required for these non-use threshold values to be exceeded.

## ECONOMIC ASSESSMENT OF WATER VALUES (NA 64/ES)

### Project objective/s

This project estimates the potential economic impacts of changes in water quantity and quality from forest catchments, focusing on a selection of forest catchments within the Upper and Lower North East regions and draws inferences for the economic impacts associated with the adoption of different forest management practices more generally throughout these regions.

### Method

This study examined a number of representative catchments in the Upper and Lower North East regions and utilised the findings from the Ecologically Sustainable Forest Management Water Quality and Quantity project in assessing the economic impacts associated with different forest management regimes.

The catchments were examined over three different timeframes and a relationship was determined between the change in water yield due to logging operations and the State Forest area contained within each catchment. This relationship allowed changes in water yield to be expressed in terms of changes in mean streamflow at defined locations. Once this change in streamflow was determined, the economic impacts arising from this change in streamflow were estimated. Economic impacts were then estimated for a variety of activities that utilise water in the downstream section of each catchment.

### Key results[2]

The following key results are based on an assessment of the impacts associated with a "logging scenario" as compared to a "no logging" base case for each catchment. Logging scenarios were developed to assist in the assessment of economic impacts attributable to different forest land tenure configurations and generally led to an increase in the catchment's mean annual stream flows in the medium to long term.

Results in the UNE indicated that, for an increase in stream flows:

- the largest economic benefits arise when logging occurred in a forest of current age, rather than an old growth forest;
- the longer the timeframe of the economic analysis, the larger the potential annual gains to downstream water users; and
- the potential trends in impacts on mean streamflow change when analysed over the very long-term (more than 50 years).

Results in the LNE indicated that, for an increase in stream flows:

- there was a greater divergence in the estimated impacts on mean streamflow across the region's catchments; and
- the economic impacts on downstream water users across catchments under different scenarios and timeframes vary significantly.

The agricultural sector is best placed to capture the economic benefits associated with a marginal increase in water supply. If policy prevents this capture, incremental gains or losses can be expected to accrue to the environment, manufacturing (for LNE), drinking water supplies and recreation and tourism activities.

[2] When interpreting the economic impacts of alternative logging scenarios, it must be noted that economic impacts were not estimated for periods greater than 20 years. Changes to the forest age profile in subsequent decades will alter the impact that alternative logging scenarios have upon both mean streamflow and downstream water users. Therefore, the potential exists for the economic impacts estimated as part of this study to be reversed (or at least change) if analysis is undertaken over longer time periods.

## ASSESSMENT OF MINERAL RESOURCES (NU 04/ES AND NL 01/ES)

### Project objective/s

The project provides an assessment of mineral resource potential of the Upper and Lower North East CRA regions by compiling information on the known mineral resources of the regions and by estimating the mineral potential, or undiscovered mineral resources, of the regions.

### Method

The assessment is based on the known mineral occurrences and resources of the region and on the potential for undiscovered mineral resources, based on mineral exploration, geology and other geoscientific information for the area.

The Project used the United States Geological Survey methodology to identify geological units (referred to as tracts) which may contain particular types of mineral deposits. An assessment of the likelihood of these mineral deposits occurring in a sufficient size and grade to constitute a mineral resource is then made.

Deposit types studied include those for gold, antimony, copper, nickel, cobalt and chromium, a range of industrial minerals including gemstones, sapphire and diamonds.

The identified mineral tracts were combined to present a weighted composite mineral potential for the Upper and Lower North East regions. This weighting provided a simple ranking of relative economic significance between different types of mineral deposits. Maps were then prepared, in conjunction with other indicators of mineral interest, to assist in the decision-making process.

### Key results

#### Upper North East CRA region

In the Upper North East region mineral potential tracts were identified for thirty types of mineral deposits. The study indicated known and high potential for construction material deposits, high potential for coal seam methane, gold in several settings and high potential for a large range of other commodities, including tin, antimony, sapphires and topaz.

In 1996/97, the value of production from mining and quarrying operations in the region totaled over $29 million, with construction material deposits accounting for the majority of this value.

#### Lower North East CRA region

In the Lower North East region mineral potential tracts were identified for seventeen types of mineral deposits. The study indicated known and high potential for coal deposits, gold and copper in several areas and for continuing industrial and construction material extraction. There is also potential for a broad range of other mineral commodities throughout the region, including tin, antimony, nickel, cobalt and gemstones.

In 1996/97, the most valuable resource in the Lower North region was the high quality coal mined in the Newcastle and Hunter areas. The value of operations from the collieries, mining and quarrying operations was more than $2.6 billion for coal and approximately $105 million for construction materials and metallic mineral deposits.

## REPORT ON APIARY IN NSW – UPPER NORTH EAST AND LOWER NORTH EAST RFA REGIONS (NA 06/ES)

### Project Objective/s

To provide a profile of the apiary industry and evaluate the apiary industry within the framework of the forest assessment process.

### Methods

This is a consultancy project which involved desktop and interview techniques to profile the apiculture industry in the UNE and LNE RFA regions. Profiling includes a summary of the nature, location, size and characteristics of the industry in each CRA region. Economic analysis is then used to identify the values of the industry (in both direct monetary and descriptive terms). An outline of the relationship to other forest uses and users, and the sensitivity and capacity of the industry to changes in land tenure are also canvassed.

### Key Results

The Upper North East (UNE) and Lower North East (LNE) sections of the "Report on Apiary in New South Wales" report identifies:

- that the apiary industry in both the UNE and LNE is characterised by its mobility, its eucalypt and understorey dependency and the variability of production.
- opportunities for the apiary industry to relocate to alternative areas are limited in both regions.
- the UNE apiary industry produces 29% of the NSW production of honey from an estimated 4,000 sites carrying up to 300,000 hives. Approximately 29% of the industry is located on State Forest sites inside the RFA region boundaries On average, supplying approximately 4,300 tonnes of honey with a wholesale value of $7.1 million. Wax and other product sales add another $360,000.
- the LNE apiary industry produces 12% of the NSW production of honey from an estimated 1,400 sites carrying up to 147,000 hives. Approximately 30% of the industry is located on State Forest sites inside the RFA region boundaries. On average, supplying approximately 1,800 tonnes of honey with a wholesale value of $3.0 million. Wax and other product sales add another $150,000.
- that both the UNE and LNE regions value to the NSW apiary industry lies not only in the value of products generated, but also in its value, over wintering bees and spring build up in queen bee breeding enterprises and in the UNE for pollination.
- the relationship of apiary to other forest uses and users, and the recent changes to NPWS access policy that addresses the issue of the apiary industry's sensitivity to tenure change are discussed in detail in the report.

## PROFILE AND ECONOMIC EVALUATION OF GRAZING IN STATE FORESTS (NA51/ES)

### Project Objective/s

To provide a report on the use of State forests for grazing and the contribution of this forest based activity to the regional economies of the Upper North East and Lower North East regions.

### Method

This project involved the collection of data to quantify the extent of grazing within State Forests in each region and the preparation of a profile report on State Forest grazing through; a review of State Forests Environmental Impact Studies and contacting graziers who submitted comments during the public exhibition of EIS documents; liaison with relevant Departments and Industry bodies, and a sample population of graziers using State forests; and an assessment of the economic value of State forest based grazing.

### Key Results

A detailed report has been prepared covering both regions and identifying:

- graziers hold permit and lease entitlements to State Forest land in excess of 385,000 hectares in the UNE and 141,000 hectares in the LNE; forest lease and permit areas are used almost solely for beef cattle grazing;
- average carrying capacities of State Forest land utilised for grazing is one dry beast per twenty hectares (1:20), with land area utilised for 6 months annually;
- grazing purposes range from seeking short-term relief feed to using such areas as an integrated part of established farming systems;
- the contribution of forest based grazing to total farm business performance ranges from 0% to 50%, reflecting the wide variation in dependence upon this resource amongst graziers who hold lease and permit entitlements;
- based on the area of permit and lease entitlement in State Forests in each region and an assumed carrying capacity of 1:20 for six months per year, an estimated 19,200 cattle could be grazed in the UNE and 7,050 in the LNE;
- gross value of production from State Forest based grazing in the UNE is $1.26 million and in the LNE is $462,000; this grazing generates 7 full time job equivalents in the UNE and 2.5 in the LNE;
- the contribution of State Forest based grazing to the wider grazing industry is not large. State Forest based grazing represents 1.2% of the gross value of cattle and calf production in the UNE CRA region and 0.4% in the LNE CRA region; and
- despite this small contribution to the wider industry, the importance of the industry, measured in both economic and social terms, to those graziers who are stakeholders in forest based grazing enterprises is significant.

## FOREST INDUSTRY DEVELOPMENT OPTIONS IN NORTHEAST NSW (NA 37/ES)

### Project objective/s

To provide an initial assessment of industry development options available in both the Upper and Lower North East CRA regions in NSW. The new industry development options identified in this study will be included in the FORUM economic analysis of the region.

### Method

A profile of the industry was developed using current industry structure and competitiveness together with identified market opportunities for the forest industries in the two regions. This was used to identify potential development options based on possible future resource scenarios. The scenarios assumed were 50%, 100%, 150%, and 200% of 1996/97 resource allocations. The development options that are identified will also be assessed in the FORUM economic analysis of the region, using the future resource availability scenarios generated by SPECTRUM.

### Key results and products

A three volume report was produced, one providing background and two addressing specific development options in the respective regions.

Key industry development options identified by the consultants include:

- increased proportions of hardwood logs being directed to value added processing - it is envisaged that value adding processing will be based on industry nodes across a number of centres in the region;
- increased utilisation of low grade logs, primarily through increased recovery from existing pulpwood resources;
- expanding production of high quality hardwood and softwood plywood and veneer, and potential production of hardwood LVL;
- potential establishment of a world scale softwood LVL plant based on available plantation resources at Walcha;
- increased woodchip exports, with possible construction of a new world scale chip mill; and
- utilisation of the current waste material through biomass energy production both in a specific mill as well as through smaller scale co-generation at specific mill sites.

There are potential synergies between these options. For instance, increased utilisation of residues would enable increased production of sawlog resources through more intensive forest management regimes. The analysis also identifies the significant role of private property forests in current and future development of the industry.

## MODELLING AND SOCIAL IMPACT ASSESSMENT (NU 09/ES AND NL 09/ES)

### Project objective

To model potential social impacts of land use scenarios on communities in the Upper and Lower North East regions.

### Methods

A stand alone social impact assessment model, "I think' (High Performance Systems Inc), developed for the Eden Forest Agreement, was used to inform possible social impacts related to changes in land use and tenure based on qualitative and quantitative data collected in social projects.

"I think" responds to employment changes and indicates the likely impacts on a community. The model utilises a number of key variables (eg industry employment by type, community of residence). Key variables are able to be adjusted by an estimate of the number of timber jobs lost or gained from changes in resource availability and its impact on community employment of a town. Any changes to employment resulting from reserve design scenarios can then be modelled to produce a summary of impacts categorised by the identified list of social indicators.

Mitigation and industry development data can be incorporated into the model along with accompanying employment predictions.

A variety of simulations have been undertaken to test the confidence of the model and ground-truthed against other primary and secondary data sources.

### Key results and products

A 'base flow' of timber jobs in each community was established from survey results, with any changes in hardwood timber jobs by township of residence to be used as the primary impact variable. The model used historical change, adaptive responses, and vulnerability to predict community wellbeing to provide a visual 'snapshot' display of the current social conditions of case study communities.

## POST IMPACT STUDIES ANALYSIS AND REGIONAL PROFILE (UNE) (NU 01/ES)

### Project objective/s

- To provide a review of social impact studies conducted within the Upper North East CRA/RFA region
- To provide a review of national and international studies relating to social impacts in resource-based communities
- To develop a regional population profile for the region and of selected service sectors within it.

### Method

A literature search was undertaken to identify any precious social assessment work within the CRA/RFA Region or studies of communities that resemble the current impact context.

The profiling project involved the collection of statistical and historical data for communities within the Upper North East Region. Existing databases including the Australian Bureau of Statistics and the IRDB (Integrated regional database), local shire histories, and statistical data based on the 1991 and 1996 ABS Census of Population and Housing were used. Statistical data was presented at the local government area (LGA) level.

Data was also obtained from relevant State agencies and local government authorities regarding the provision of infrastructure services throughout the CRA/RFA Region

### Key results and products

An assessment report was produced and is publicly available through the "Post Impact Analysis and Regional Profile"project.
The following is a very brief regional community profile of the Upper North East CRA/RFA Region:

- The Region covers 17 local government areas (LGAs) including Ballina, Byron, Casino, Coffs Harbour, Copmanhurst, Glen Innes, Grafton, Guyra, Kyogle, Lismore, Maclean, Nymboida, Richmond River, Severn, Tenterfield, Tweed and Ulmarra;
- The region has a rapidly growing population. In 1996 the population was 327 411. Between 1991 and 1996 the population change was 10.72%, double that of NSW. The fastest growth occurred in the northern coastal fringe with Byron LGA (21.06%) and Tweed LGA (19.5%) experiencing the highest growth rates. Population decline occurred in the Severn (-6.6%), Glen Innes (-0.54%), and Guyra (-9.63%) local government areas;
- In 1996 the unemployment rate in the region was 15.38%. This ranged from 11.3% in Glen Innes and Tenterfield to 20.6% in Ulmarra;
- In 1996 approximately 1 928 persons were employed in the timber industry, including both hardwood and softwood sectors in the region. Of these 75% were employed in timber processing, including sawmilling, timber dressing and other wood manufacturing.The largest proportion of persons working in forestry and logging (26.7%) were employed in the Coffs Harbour LGA. The highest concentration of people employed in sawmilling and timber dressing (17.7%) was in the LGA. Other wood production and manufacturing was focused in Coffs Harbour and Grafton local governement areas, both employing 111 persons (15.8%) each.

Significant environmental, economic and social studies have been conducted in the Upper North East Region since the early 1970s:

- The most significant studies regarding the social context have been the numerous Environmental Impact Statements between 1992 and the NSW Interim Forest Assessment Process in 1996. These studies show a decline in employment in the native timber industry over the last ten years. Current service provision in health, transport, education and regional population baselines is also documented.

## POST IMPACT STUDIES ANALYSIS AND REGIONAL PROFILE (LNE) (NL06/ES)

### Project objective/s

- To provide a review of social impact studies conducted within the Lower North East CRA/RFA region
- To provide a review of national and international studies relating to social impacts in resource-based communities
- To develop a regional population profile for the region and selected service sectors within it.

### Method

A literature search was employed to identify any precious social assessment work within the CRA/RFA Region or studies of communities that resemble the current impact context.

The profiling project involved the collection of statistical and historical data for communities within the Lower North East study area. Existing databases including the Australian Bureau of Statistics and the IRDB (Integrated regional database), local shire histories, and statistical data based on the 1991 and 1996 ABS Census of Population and Housing were used. . Statistical data was presented at the local government area (LGA) level.

Data was also obtained from relevant State agencies and local government authorities regarding the provision of infrastructure services throughout the CRA/RFA Region.

### Key results and products

An assessment report was produced and is publicly available through the "Post Impact Analysis and Regional Profile" project report undertaken for the NSW CRA/RFA Steering Committee. The following is a very brief regional community profile of the Lower North East CRA/RFA Region:

- The region covers 24 local government areas (LGAs) and includes Armidale, Bellingen, Cessnock, Dumaresq, Dungog, Gloucester, Gosford, Great Lakes, Greater Taree, Hastings, Hawkesbury, Kempsey, Lake Macquarie, Maitland, Muswellbrook, Nambucca, Newcastle, Nundle, Port Stephens, Scone, Singleton, Uralla, Walcha, and Wyong. Hawkesbury LGA was not covered in this regional profile;
- The Lower North East study area has a steadily growing population. In 1996 it was 418 577, an increase 5.10 % from 1991, similar to that of NSW. The fastest growth occurred in Port Stephens (17.35%), Hastings (15.92%), Wyong (15.47%), Gosford (12.33%) and Great Lakes (10.15%) LGAs. Declines were experienced in Walcha (-10.01%) and Armidale (-1.14%), LGAs;
- In 1996 the unemployment rate in the region was 11.84%, higher than NSW (8.8%). Unemployment levels ranged from 19.6 % in Kempsey to 5.4% in Dumaresq;
- In 1996 approximately 3 312 persons were employed in the hardwood and softwood timber industry sectors in the Lower North East study area. Of these 681 were employed in foresting and logging, 1 015 in sawmilling and timber dressing, and 1 616 in other wood product manufacture. (This does not include employment in the Newcastle and Nundle LGAs). The highest concentration of workers employed in forestry and logging (12.77 %) was in Greater Taree and Walcha LGAs. The highest concentration of people employed in sawmilling and timber dressing (15.96 %) was in the Great Lakes LGA. Other wood production and manufacturing was focused in Gosford (20.73 %) and Wyong (20.42%).

Significant environmental, economic and social studies have been conducted in the Lower North East Region since the early 1970s:

- The most significant studies regarding the social context in the Region have been the numerous Environmental Impact Statements between 1992 and the NSW Interim Forest Assessment Process in 1996. These studies show a decline in employment in the native timber industry over the last ten years.

Current service provision in health, transport, education and regional population baselines is also documented.

## SOCIAL VALUES OF FORESTS (UNE) (NU 02/ES)

### Project objective/s:

- To document the mains issues of concern of stakeholders in the RFA process regarding the social values of forests;
- To conduct a random telephone survey in the Region to identify broader community social values regarding forested land use;
- To select a diverse range of communities within the Region, and construct comprehensive baseline profiles of the social conditions within case study areas;
- To identify and survey forest-based industry groups to link community dependence to forested areas, the social values of forests held by these groups, establish the impact felt by these groups.

### Methods

A number of methods were employed at the regional and local level. These included networking and participant observation, community workshops and focus groups, an action research method to collect localised community infrastructure data for case study areas; surveys of occupational communities, and a random community attitude telephone survey.

### Key results and products

A draft report was publicly available in December 1998 through the "Draft Social Values of Forests" project report. A final report will be available with other CRA/RFA Northern NSW reports.

Comprehensive studies were undertaken for 12 communities in the Upper North East study area. These included community workshops and the collection of statistical and other data. The table below summaries some key findings on townships selected as selected as case study communities.

| Case study community | Town population 1996 | Town population 1991 | % Population change since 1991 | No. employed in town 1996 | % Unemployed in town 1996 | % Hardwood* jobs relative to no. employed in town 1996 |
|---|---|---|---|---|---|---|
| Byron Bay | 6130 | 5007 | 22.4 | 2093 | 21.3 | 0 |
| Casino | 9990 | 10856 | 7.9 | 3398 | 12.5 | 1.0 |
| Coffs Harbour | 22177 | 20315 | 9.1 | 8058 | 15.8 | 0.73 |
| Coutts Crossing | 510 | 446 | 14.3 | 183 | 13.3 | 5.5 |
| Dorrigo | 1013 | 1132 | -10.5 | 354 | 12.6 | 10.5 |
| Grafton | 16562 | 16637 | -0.5 | 5800 | 13.6 | 3.7 |
| Guyra | 1801 | 1937 | -7.0 | 586 | 21 | 0.0 |
| Lismore | 28380 | 27245 | 4.1 | 10580 | 13.9 | 0.2 |
| Pottsville | 1987 | 1289 | 54.1 | 1118 | 18.3 | 0.17 |
| Rappville | 113 | 109 | 3.7 | 544 | 35.7 | 1.10 |
| Tenterfield | 3205 | 3310 | -3.2 | 1118 | 8.7 | 0.98 |
| Woodenbong | 377 | 348 | 8.0 | 135 | 5.6 | 42.2 |

* the percentage of hardwood jobs denotes workers in mills that are primarily dependent on resource from public forests and does not include workers in mills that access resource solelyfrom private property

Timber workers in hardwood mills principally dependent of State forests are predominantly male. Forty-five percent 30-45 years of age and earn $12 000-$25 000 per annum. Fifty percent left school before year 10. Sixty percent of contractors and subcontractors are between 40-50 years of age. Thirty percent earn $25 000- $40 000 per annum. Contractor employees are, on average, aged 39 years and have an annual salary of $25 000-$40 000. A survey of the broader community identified a diversity of attitudes and values.

## SOCIAL VALUES OF FORESTS (LNE) NA 07/ES

### Project objective/s:

- To document the mains issues of concern of stakeholders in the RFA process regarding the social values of forests;
- To conduct a random telephone survey in the Region to identify broader community social values regarding forested land use;
- To select a diverse range of communities within the Region, and construct comprehensive baseline profiles of the social conditions within case study areas;
- To identify and survey forest-based industry groups to link community dependence to forested areas, the social values of forests held by these groups, establish the impact felt by these groups.

### Methods

A number of methods were employed at the regional and local level. These included networking and participant observation, community workshops and focus groups, an action research method to collect localised community infrastructure data for case study areas, surveys of occupational communities, and a random community attitude telephone survey.

### Key results and products

A draft report was publicly available in December 1998 through the "Draft Social Values of Forests" project report. A final report will be available with other CRA/RFA Northern NSW reports.

Community workshops were undertaken for six communities in the Lower North East study area. Statistical and other data from primary and secondary sources was obtained for 11 communities. The table below summaries some key findings.

| Case study community | Town population 1996 | Town population 1991 | % Population change since 1991 | No employed in town 1996 | % Unemployed in town 1996 | % hardwood jobs* relative to no. employed in town 1996 |
|---|---|---|---|---|---|---|
| Bellingen | 2690 | 2301 | 17.0 | 814 | 17.6 | 2.1 |
| Bulahdelah | 1113 | 1092 | 1.9 | 409 | 6 | 10.5 |
| Bowraville | 884 | 969 | -8.7 | 234 | 20.7 | 4.7 |
| Dungog | 2181 | 2187 | 0.3 | 758 | 10.6 | 1.6 |
| Gloucester | 2634 | 2468 | 6.7 | 889 | 9.1 | 1.5 |
| Kempsey | 8630 | 9039 | -4.5 | 2482 | 18 | 1.9 |
| Kendall | 715 | 714 | 0.1 | 218 | 23.5 | 4.6 |
| Millfield | 468 | 391 | 19.7 | 130 | 24.4 | 3.1 |
| Stroud | 598 | 558 | 7.2 | 186 | 13.9 | 8.1 |
| Walcha | 1623 | 1786 | -9.1 | 631 | 9.3 | 10.4 |
| Wauchope | 4963 | 4305 | 15.3 | 1483 | 16.6 | 2.4 |

* the percentage of hardwood jobs denotes workers in mills that are primarily dependent on resource from public forests and does not include workers in mills that access resource solelyfrom private property

Timber workers in sawmills and processing operations (principally dependent of State forests) are predominantly male. Over 4% of workers in hardwood mills and 2% in processing plants identify as Aboriginal or Torres Strait Islander. The majority earns between $12 000 and $25 000 per annum with almost 50% either owning their own homes or paying off a mortgage. Less than one half of workers completed year 10. Approximately half have school aged children who attend local schools. Six percent of bush crew workers identify as Aboriginal or Torres Strait Islander. A survey of the broader community identified a range of attitudes and values.

## REVIEW OF FOREST INDUSTRY MITIGATION MEASURES – UPPER NORTH EAST AND LOWER NORTH EAST RFA REGIONS (NA63/ES)

### Project Objective/s

- To provide baseline data for a longer-term longitudinal analysis of some of the social impacts of recent structural adjustment and mitigative processes in the Upper North East and Lower North East regions.
- To provide an analysis of the numbers of people who have accessed structural adjustment funds January 1996 to July 1998, and to describe the current status of workers and business owners in the timber industry, including all those who have exited the industry in the Upper North East and Lower North East regions January 1996 - June 1998.
- To provide a situation report on the quantum and nature of mitigative measures accessed by workers and businesses across each FISAP program area in the native hardwood industry in the UNE and LNE regions.
- To undertake case studies to understand the individual experiences both of the social impacts of recent structural change and of the mitigation measures that have been implemented in the native hardwood industry in the UNE & LNE CRA regions.

### Methods

A case study approach was used to determine the impacts of structural change and mitigative measures on a study group consisting of mill workers, logging contractors and bush crews and lorry owner-drivers in the UNE & LNE CRA regions. Qualitative and quantitative data collection techniques were employed to identify not only the extent of the impacts experienced, but also to obtain an understanding of individual experiences of these impacts.

Techniques included survey of workers and business owners to obtain direct evidence of the impacts experienced and in depth face to face interviews to understand the individual reactions and the social significance and meanings attributed by the affected people to the impacts they have experienced. The qualitative data was analysed using a variety of analytical techniques such as content/theme analysis and analytic induction.

### Key results

A detailed report has been prepared for each region which addresses the project objectives and identifies:

- the current level of timber industry employment and the employment changes during the period January 1996 to August 1998.
- the level of Commonwealth and NSW State Government Forest Industry Structural Adjustment Package (FISAP) assistance approved from December 1995 - 30 August 1998 in both regions – totalling $13.1 million in the Upper North East and $11.36 million in the Lower North East.
- the personal experience of redundancy – reporting that the mitigative measures provided to the laid off timber workers have not been such as to significantly alter the negative experiences - economic, personal and social - of redundancy in the lives of those experiencing it.
- that the findings of this study are in agreement with earlier studies in forest communities in the Eden region (1996), and in general agreement with experiences elsewhere (e.g. forest communities in the USA).

# ECOLOGICALLY SUSTAINABLE FOREST MANAGEMENT

## STATE-WIDE AND REGIONAL ASSESSMENT OF NSW MANAGEMENT SYSTEMS AND PROCESSES FOR DELIVERY OF ESFM (NA 18/ESFM)

### Project objective/s

To provide the basis for joint Commonwealth/ State development and Commonwealth accreditation of statewide NSW forest management systems and processes, including those for the Upper and Lower North East CRA/RFA Region, for delivery of ecologically sustainable forest management.

### Methods

- Develop a framework for the assessment of the state-wide management system based on (a) NSW ESFM Principles adapted by the NSW ESFM Group from the national guidelines of the Comprehensive Regional Assessment Implementation Forum, and (b) the guiding principles of ISO 14004 Environmental Management Systems (EMS)
- Describe existing forest management systems and processes for NSW in relation to the agreed assessment framework based on individual EMS components of commitment, legislative and policy framework, planning, implementation, monitoring and evaluation, and review and improvement.
- Appoint experts to form a working group to undertake an assessment of NSW forest management systems and processes according to Terms of Reference developed by the NSW ESFM Group.
- Provide opportunities for stakeholder comment on drafts of the report for incorporation by the expert working group into a final report.
- Use recommendations from the independent report as a basis for improving NSW forest management systems and processes for Commonwealth accreditation and the delivery of ESFM in the Upper and Lower North East CRA/RFA regions.

### Key results and products

- Independent report on the assessment of NSW management systems and processes with recommendations for change where weaknesses and deficiencies are identified.
- Recommendations for improvement of the forest management systems and processes which achieve ecological sustainable forest management for NSW on a statewide basis, including the Upper and Lower North East CRA/RFA Region.

## CRITERIA AND INDICATORS, TARGETS AND MONITORING PROCESSES OF ECOLOGICALLY SUSTAINBLE FOREST MANAGEMENT FOR THE UNE AND LNE RFA REGIONS (NA 41/ESFM)

### Project Objective/s

This document recommends Criteria, Indicators Objectives and Indicative Targets for the Upper North East and Lower North East RFA regions for use in guiding and measuring ecological sustainable forest management (ESFM). ESFM aims to maintain, in perpetuity, a full range of forest values.

### Methods

The Criteria and Indicators recommended here were developed from "A Framework of Regional (Sub-National) Level Criteria and Indicators of Sustainable Forest Management in Australia" (Montreal Implementation Group 1998), and tailored to the UNE and LNE RFA regions by consultation with independent experts, relevant government agencies and stakeholders through the UNE and LNE Regional Forest Forums.

### Key results and products

In this project, forest values are represented by 7 Criteria. Each Criterion is characterised by a set of related Indicators, which are measured in quantitative or narrative terms, and are monitored periodically to assess change. Twenty-one Indicators that are immediately implementable (Category A), supplemented by 3 Indicators that require research and development before implementation immediately after the first 5 year review of the RFAs (Category B), have been identified. Short-term interim Indicators or reporting mechanisms for some Category A Indicators have also been included until mechanisms for their full implementation have been determined.

For each Indicator, indicative targets have been set at the levels required to achieve ESFM. Details of data availability, monitoring methodology, reporting requirements and research and development requirements are also provided. Systematic measurement and assessment of each Indicator will show if indicative targets for ESFM are being met. If necessary, our forest management practices can then be adapted to better meet goals. The indicators for ESFM in the UNE and LNE regions are listed below:

**INDICATORS OF EFSM FOR THE UNE AND LNE RFA REGIONS**
**ALL INDICATORS ARE CATEGORY A (IMPLEMENTABLE IMMEDIATELY) UNLESS OTHERWISE SPECIFIED.**

CRITERIA 1: BIODIVERSITY

1.1.a Extent of area by forest type and tenure.
1.1.a.1 Understorey vegetation layer (Category B).
1.1.b Area of forest type by growth stage distribution by tenure.
1.1.e Fragmentation of forest types.
1.2.a A list of forest dwelling species
1.2.b The status (threatened, rare, vulnerable, endangered, or extinct) of forest dwelling species at risk of not maintaining viable breeding populations, as determined by legislation or scientific assessment.
1.2.b.1 The status of endangered populations and ecosystems as determined by legislation or scientific assessment (sub-indicator of 1.2.b).

**INDICATORS OF EFSM FOR THE UNE AND LNE RFA REGIONS**
**ALL INDICATORS ARE CATEGORY A (IMPLEMENTABLE IMMEDIATELY) UNLESS OTHERWISE SPECIFIED (CONTINUED).**

## CRITERIA 2: PRODUCTIVE CAPACITY OF FOREST ECOSYSTEMS

2.1.a Area of forest land and net area of forest land available for timber production.
2.1.b Total growing stock of both merchantable and non-merchantable tree species on native forest land available for timber production.
2.1.d Annual removal of wood products compared to sustainable volume.
2.1.f Area and percent of plantation established meeting effective stocking one year after planting.
2.1.g Area and percent of harvested area of native forest effectively regenerated.

## CRITERIA 3: ECOSYSTEM HEALTH AND VITALITY

3.1.a Area and percent of forest affected by processes or agents that may change ecosystem health and vitality (narrative as interim)

## CRITERIA 4: SOIL AND WATER RESOURCES

4.1.a Area and percent of forest land covered by comprehensive Road Management Plans, which include;

- an assessment of the extent of existing road infrastructure,
- processes for ongoing improvement,
- targets and milestones.

4.1.a Area and percent of forest land systematically assessed for soil erosion hazard, and for which site-varying scientifically-based measures to protect soil and water values are implemented (Interim).

## CRITERIA 5: GLOBAL CARBON CYCLES

5.1a Total forest ecosystem biomass and carbon pool, and if appropriate, by forest type, age class, and successional stages (Category B).
5.1c Contribution of forest products to the global carbon budget (Category B).

## CRITERIA 6: SOCIAL AND ECONOMIC BENEFITS

6.2.c Number of visits per annum.
6.4.c Change in condition and number of recorded places, artefacts, sites, buildings or other structures.
6.5.a Direct and indirect employment in the forest sector and forest sector employment as a proportion of total employment.

## CRITERIA 7: LEGAL, INSTITUTIONAL AND ECONOMIC FRAMEWORK

7.1 Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests (Narrative).
7.2 Extent to which the institutional framework supports the conservation and sustainable management of forests (Narrative).
7.4 Capacity to measure and monitor changes in the conservation and sustainable management of forests (Narrative).
7.5 Capacity to conduct and apply research and development aimed at improving forest management and delivery of forest goods and services (Narrative).

## REVIEW OF PROTECTIVE MEASURES AND FOREST PRACTICES AND EXPRESSION OF THESE INTO LANGUAGE FOR INFORMATION SYSTEMS FOR THE UPPER NORTH EAST AND LOWER NORTH EAST CRA/RFA REGIONS (NA 45/ESFM)

### Project objective/s

The objective of this project was to describe, review and assess current protective measures and practices applied to forests in the Upper and Lower North East CRA/RFA regions. It considered the effectiveness of the protective measures and forest practices in achieving the ESFM principles, how they effect forest values, and their scientific basis. The project aimed to recommend improvements and variations to protective measures and forest practices. It also aimed to compile into one document, all the major protective measures and forest practices involved in forest conservation and management in NSW, and this document was called a Code System.

When the project was formulated it had as an objective: 'Expression of the protective measures/forest practices and variations, in language compatible with their representation in an information system.' This part of the project was subsequently undertaken by another project and is covered by a separate ESFM project summary and report titled 'ESFM PA 4/2/2 – Application of the protective measures and forest practices into a quantitative database' (NA57/ESFM).

### Methods

The project was carried out by agencies involved in forest conservation and management. They, collated, identified and described their existing protective measures and forest practices and assessed how they achieved the ESFM principles and protected specific values, and suggested improvements and variations. The agencies involved included Environment Protection Agency (EPA), State Forest of NSW (SFNSW), Department of Urban Affairs and Planning (DUAP), National Parks and Wildlife Service (NPWS), and Department of Bushfire Services.

The protective measures and forest forests were independently reviewed at a series of expert workshops which focussed on specific areas: soil and water; biodiversity; forest uses (including fire management). A workshop reviewing economic and social aspects did not happen. The review assessed the overall effectiveness of protective measures and forest practices in protecting forest values and identified improvements and variations.

Finally the existing protective measures and forest practices involved in forest conservation and management in NSW, were compiled into one document and called a Code System.

### Key Results

- Description of existing or proposed protective measures and forest practices involved in forest conservation and management in NSW, including:
  - EPA – Pollution control licence issues to SFNSW
  - SFNSW – Protective measures and forest practices used on State forests
  - NPWS – Conservation protocols, state-wide biodiversity measures and reserve management
  - DUAP – EIS approvals and timber plantation accreditation process
  - Various agencies involved protecting cultural heritage values (indigenous and non-indigenous)
  - Department of Bushfire Services
- Review of the protective measures and forest practices including suggested improvements at three workshops covering biodiversity, forerst uses and soil and water.
- Compilation of the protective measures and forest practices into a Code System.

- Variations to the protective measures/forest practices identified by stakeholders, experts and agencies.

## APPLICATION OF PROTECTIVE MEASURES AND FOREST PRACTICES INTO A QUANTATIVE DATABASE FOR THE UNE AND LNE REGIONS (NA 57/ESFM)

### Project objective/s

The project was conducted to develop a quantitative database describing current and proposed protective measures, operational factors and management practices and the restrictions they place on the area available for harvesting and the timber yield from State forests of the Upper North East and Lower North East regions. The specific objectives of the project were to:

- Build a geographic information system (mapped based system) that clearly and accurately identifies State forest land that would be unavailable for logging due to operational reasons, conservation outcomes or regulatory requirements.
- Identify how other factors affect the area available for harvesting or timber yield.
- Determine what State forest lands are covered by particular management categories.

### Methods

The factors that cause a reduction in the area available for harvesting and a lower timber yield were identified and they included:

- Agreed management practices contained in the Pollution Control Licence issued by the Environment Protection Authority (EPA) such as filter strips and inherent soil hazard class 4;
- General conservation requirements issued by the National Parks and Wildlife Service (NPWS) such as protection of heath, rocky outcrops, wetlands, rare non-commercial forest types, rainforest, habitat tree and feed tree retention;
- Terrain factors such as steep slopes and rockiness;
- Non-native forest such as purchased land, hardwood and softwood plantations;
- Accessibility factors for example road and extraction access;
- Leasehold conditions that may affect timber availability;
- State Forest of NSW (SFNSW) management practices such as silvicultural methods;
- SFNSW management priorities (e.g Preferred Management Priorities such as preserved native forest, unavailable native forest including to protect visual quality, flora, fauna or special catchments);
- Operational factors (eg proximity to exclusion zones, haulage impediments);
- Economic factors;
- Merchantability factors;
- Nomination for inclusion in a formal or informal reserve such as wilderness areas and flora reserves;
- NPWS species specific management requirements.

Some of these factors were identified as known and locatable areas such as EPA filter strips, rocky areas and NPWS riparian buffers. These factors caused harvesting to be excluded and so reduced the area available for harvesting (defined as the net harvest area). These were described as Type “A” exclusion features. These features could be mapped.

Other factors caused altered practices to protect identified features such as habitat and feed tree retention. For modelling purposes these practices affect the timber yield (or net harvest volume) and these factors are

incorporated in the FRAMES Yield Simulator. The FRAMES Yield Simulator prepared estimates of yield and residual stand volumes under various silvicultural operations (For further information see FRAMES project called Yield Simulator NA/14FRA). These were described as Type “B” factors.

The third group of factors can not be located on the ground until the harvest planning and harvesting stages are undertaken. These reduce the area available for harvesting as typically the protective measure is a 100% harvest exclusion zone around the feature of interest. The impact of these factors was determined by calculating how often the feature to be protected was encountered during planning and harvesting (i.e how often a strike occurred) and then allowing for the pattern of where these features tended to occur within the matrix of the area that is available or unavailable for harvesting. These were defined as a Type “C” factor. These were calculated to reduce the potential timber harvest that has been determined from mapping Type “A” features.

### Key results and products

In the Upper North  East Region accounting for the Type “A” factors caused the gross harvest area of 624 032 hectares to be reduced to a net harvest area of 190 639 hectares (ie 30% of the gross area). Additionally it was determined that the Type “C” factors caused 6.7% reduction in the net harvest area.

In the Lower North  East Region the Type “A” factors caused the gross harvest area of 813 782 hectares to be reduced to a net harvest area of 222 758 hectares (ie 27% of the gross area). Additionally it was determined that the Type “C” factors caused 6.7% reduction in the net harvest area.

## KNOWLEDGE AND INFORMATION GAPS FOR THE UPPER NORTH EAST, LOWER NORTH EAST AND SOUTHERN CRA/RFA REGIONS – STAGE 1 (NA 30/ESFM)

### Project objective/s

The aim of this project was to review and analyse the knowledge and information needed to ensure the delivery of ecologically sustainable forest management (ESFM) in New South Wales. The project undertook a review of knowledge and information, in line with the principles of ESFM. The project aimed to identify the current availability or gaps in information; identify critical questions and important areas requiring further research and development; what action was required to undertake the research or investigation; and to provide an indication of their priority.

### Methods

The ESFM Group identified the key subject areas and questions involved in delivering ecologically sustainable forest management in NSW. The key subject areas and questions were compared to projects being undertaken by other Technical Committees in the CRA/RFA process to determine what subject areas and questions were already being addressed. This then provided a list of key subject areas and questions areas that were given priority by the ESFM Group.

The list of key subject areas and questions were compiled and discussed at the Regional Forest Forums to clarify which areas were of most importance from a regional perspective and to have priority in the review.

The key subject areas and questions identified from this process were grouped together to form a series of nine workshops:

- Biodiversity/Forest ecosystem health and vitality (held on the 23 April 1998)
- Global geochemical cycles (held on the 21 May 1998)
- Indigenous heritage (held on the 25 June 1998)
- Indigenous values - other than heritage (held on the 26 June 1998)
- Non-indigenous cultural heritage (held on the 24 June 1998)
- Natural heritage (held on the 22 June 1998)
- Soil and water (held on the 17 Feburary1998)
- Productive capacity and sustainbility of forest ecosystems (held on the 24 April 1998)
- Economic and social (held on the 29 June 1998)

At the workshops, experts were asked to review the list of subject areas and critical questions that were compiled by the ESFM Group to determine their importance and how they could be answered (eg literature review, field research, desktop study). The workshop then provided an indication of priorities for further research and investigation.

### Key Results

For each of the nine subject areas, the workshop provided:

- Identification and review of key subject areas and questions.
- Identification of other important areas or questions for research and development.
- Identification of actions to undertake the research or development (eg literature review, field research, desktop study).
- Prioritise subject areas and questions.

## WATER QUALITY AND QUANTITY FOR THE UPPER AND LOWER NORTH EAST AND SOUTHERN CRA/RFA REGIONS (NA 61/ESFM)

### Project objective/s

The objectives of this project were to review the available literature on the impacts of logging upon water quality and quantity, to collate relevant baseline resource information, and to develop and apply a methodology for modelling the impact of possible logging activities on water quality and quantity.

### Methods

A literature review was undertaken to provide a thorough summary of our current understanding of the potential impacts of logging on water quantity and quality. A wide range of topographic, climatic and hydrologic data was collected and used to develop a methodology for assessing the impact of logging on water quality and quantity.

The modelling framework was developed specifically to suit the project objectives at a level of complexity commensurate with the available data. Results were obtained for seven trial catchments, the developed methodology is applicable to all forested catchments in the NSW CRA regions. The models were used to assess the impact of logging activities for a site immediately downstream of each forest as well as for a site further downstream that included a mixture of land uses.

**Water quantity**

The overall form of the relationship adopted for modelling changes in water quantity was based on the response observed in the Melbourne water supply catchments (the "Kuczera" curve). However it was modified to incorporate an initial increase in yield for a short period immediately following forest disturbance and to be consistent with the limited evidence available from NSW forests. The initial increase in yield and return to pre-treatment levels between 4 and 10 years after disturbance is well established in the literature. Following the increase in yield, streamflows decreased to a minimum after about 30 years of age. This was followed by a gradual recovery back to old-growth conditions over the next 50 to 150 years (the exact timing and magnitude of this deficit and recovery are speculative).

**Water Quality**

Logging activities can impact on water quality in a number of ways, though the greatest impact (and hence focus of this study) was the increased level of suspended solids in streamflows. For the purposes of quantifying impacts, the main causes of disturbance that impact upon sediment production are logging activities within the general harvest and snig track area, and the maintenance and use of permanent access roads.

Based upon published and unpublished literature, probabilistic event-based *sediment generation rates* were derived for both the general harvest and snig track area, as well as the permanent access roads. Information on rainfall characteristics was then used to convert the event-based rates to site specific annual loads. For the general harvest and snig track area relationship was also established to define the decline in sediment production as a function of time since disturbance.

Spatial information on drainage lines, roads, soil erodibility and forested catchment boundaries were imported into a GIS and analysed to provide site-specific relationships for the *proportion of the mobilised sediment that reaches the stream* from both the general harvest and snig track area, as well as the permanent access roads. The annual generation rates were combined with the site-specific delivery ratios to determine the annual sediment load reaching the drainage lines. The difference in sediment loads due to logging activities were then identified.

## Key Results

### Water Quantity

The following conclusions can be made on the basis of the results of the water quantity modelling:

- The impact of logging on water quantity varies over the timeframe considered in the modelling. There tends to be an increase in flows followed by a decrease. The timimg of these changes is dependent upon the age profile of the forest and the adopted logging scenario;
- For the range of catchments considered, the expected effects due to logging and tree growth are:
  - ? initial increase in annual flow ranges between 2% and 60%
  - ? no subsequent decrease in annual flow;
- For the range of catchments considered, the expected effects due just to logging are:
  - ? initial increase in annual flow ranges between 0% and 10%
  - ? subsequent decrease in annual flow ranges between 5% and 50%;
- The timing of these expected decreases and increases is dependent upon the current age of the forest and the adopted logging scenario; in general however, it is expected that the streamflow increases solely attributable to logging will peak within the next 10 years, and the maximum decreases will occur within the next 40 to 80 years.
- The impacts attributable solely to logging are not sensitive to the initial age profile adopted;
- The total expected impact on yield due to both logging and growth will vary depending on the initial age profile adopted.

### Water Quality

The following conclusions can be made on the basis of the results of the water quality modelling:

- The total estimated increase in sediment loads due to logging activities range between 10% and 70% of the current estimated loads;
- The majority of the increase in sediment load is generated by increased road traffic;
- The contribution from the general harvest and snig track area represents between 10% to 40% of the total increase in sediment load to logging.

# FOREST RESOURCE AND MANAGEMENT SYSTEM

## STATEWIDE STRATEGIC INVENTORY (NA 04/FRA)

This project is one of four 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.

### Project Objective/s

The objectives of the FRAMES Strategic Inventory were to:

- provide stratum-level statistics for timber volumes by product class;
- provide data for the prediction of long-term wood flows;
- assign volumes at the sub-compartment level; and
- provide spatial linkages between the inventory and attribute data.

Unit total volumes and unit volume of high value wood were to be estimated with a target accuracy of ±30% of the true value, at the 95% confidence level.

### Methods

The native forest population to be sampled was defined as the net State forest area within the Upper and Lower North East CRA Regions. The plantation population to be sampled was the category A and B plantations within UNE and LNE. The sample design for both populations was a stratified design. Strata in the native forests were based on a yield association (amalgamations of forest type) by stand structure matrix. In plantations, the strata were based on species, thinning history, stocking density and age class. Sample points were selected with a random-start grid. At each point, a range of standard mensurational parameters were measured. All inventory data were processed with the MARVL software package.

### Key Results

Results for native forests showed that the accuracy target for total volume could be met with a sample of around 20 plots per strata; and that the accuracy target for the volume of high quality log volume could be met with a sample of 40 - 45 plots. In UNE, accuracy targets for total volume were met in 25 out of the 31 strata, which contained 92% of all volume estimated in the inventory; accuracy targets for high value volume were met in 8 out of 31 strata, for 42% of all high value volume measured in the inventory. In LNE, accuracy targets for total volume were met in 25 out of the 31 strata, which contained 95% of all volume estimated in the inventory; accuracy targets for high value volume were met in 11 out of 31 strata, for 69% of all high value volume measured in the inventory. The conclusion to be drawn from these data is that the forests of LNE are more uniform than the forests of UNE. Although the target confidence limits were not met for all strata, the data were considered to be sufficiently close to the confidence limits for the more important strata to effectively underpin long term yield estimates.

Strategic Inventory data is passed to the FRAMES Yield Simulator for calculation of the range of future yields that then underpin the sustainable yield calculations performed by the FRAMES Strategic Yield Schelduler.

All plot locations and associated strata are stored in a GIS database.

## STATEWIDE BIOMETRICS MODELS (NA 13/FRA)

This project is one of four 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.

### Project Objective/s

- To develop diameter and height increment functions for building a native eucalypt forest growth model.
- To develop mortality and recruitment functions for the growth model.
- To develop volume and taper functions for key commercial tree species.
- To develop growth functions for eucalypt plantation species.

### Methods

For native forest biometrics, a database of growth information was collated from State Forests' Permanent Growth Plot (PGP) System. A total of 550 plots with over 40,000 individual tree growth measurements were used for the biometrics processes.

For the eucalypt plantation resource, data was collated from recent plantation inventory programs as well as appropriate permanent growth plot data both within and outside NSW.

Tree shape data was collected independently from the direct measurement of over 800 native and plantation trees.

Statistical analysis and modelling work was undertaken with the SAS statistical analysis software.

### Key Results

The project provided taper and volume equations for estimating timber volumes in the FRAMES Strategic Inventory and Yield Simulator, and growth functions (diameter increment, stand increment, height prediction, mortality and recruitment) for predicting future yield and woodflow through the FRAMES Yield Simulator and Strategic Yield Scheduler.

## STATEWIDE YIELD SIMULATOR (NA 14/FRA)

This project is one of four 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.

### Project objective/s

The FRAMES Yield Simulator was developed to provide a computerised system that would predict future growth and timber yields for native forest areas. The system uses quantitative inventory data (from the strategic inventory) as the primary input to the simulation process. The system was also designed to incorporate and be responsive to a range of silvicultural prescriptions and management strategies.

### Methods

The simulator project involved the combination of field based harvesting studies and computer software programming. The primary tasks included in the development are:

- Net harvest area modifiers (determining the physical impediments to harvesting not already captured in GIS data);
- Tree Availability modifiers (determining the level of damage and mortality caused by harvesting events);
- Tree defect modifiers (determining the difference between standing tree quality and actual harvested log quality);
- Standardised silvicultural prescriptions (defining the parameters used to model the silvicultural options used in forest management);
- Computer software development (developing a system to apply the models and prescriptions to data captured in the strategic inventory project - NA04/FRA, summarising the results in a form useable by the strategic scheduling project – NA54/FRA).

Models developed from the above were combined with the Biometrics models (NA13/FRA) to produce the Yield Simulator System.

### Key Results

The Yield Simulator provides estimates of future timber volumes from strategic inventory data in response to a range of silvicultural prescriptions and management strategies. The Yield Simulator incorporates many user-defined variables, which can be used to model a large number of silvicultural and management options, and assess the impact of those options on environmental values over time. Once an acceptable mix of future yield options is obtained for each stratum of the forest, the yield estimates are then combined with area calculations to produce sustainable wood flow projections over time in the Strategic Yield Scheduler.

## STATEWIDE STRATEGIC YIELD SCHEDULER (NA 54/FRA)

This project is one of four 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.

### Project objective/s

- To provide a tool to select from among a range of yields by management strategy (from the FRAMES Yield Simulator) the set of yields that produce sustainable wood flow volumes by quality class, size and species group for a range of management options and a varying resource base. These yields are responsive to the set of environmental protocols applying to the management strategies chosen.
- To track over time forest values such as proportion by growth stage, to enable assessment of the long term implications of particular silvicultural practices.
- To develop an effective system that is easy to use, interactive and sufficiently responsive for RFA negotiations.

### Methods

A yield scheduling framework was developed to integrate the net harvestable area and predicted yields under alternative management strategies to determine future wood supply forecasts. The framework was built around the linear programming forest yield scheduling model SPECTRUM.

Development of the framework involved 5 broad stages:

- SPECTRUM model set up and design
- Development of area and yield input databases
- Model template construction. This included definition of objectives, management actions and constraints; importing databases, and custom report development.
- Model testing and validation
- Development of model input and output linkages and reports. This included the definition, design, formatting, construction of electronic linkages (data flows) between:
  - C-PLAN, ESFM tools, GIS spatial analysis units and net area inputs
  - Net area and yield simulator models and FRAMES and various outputs
  - FRAMES and FRAMES reports
  - FRAMES and the economic and social model data

### Key results and products

Development of a semi-automated and integrated yield scheduling framework and modelling approach centred on SPECTRUM, which enables the rapid and repeated determination of sustainable wood flows and wood supply capacity under a range of silvicultural options and for varying resource bases.