FLORA AND FAUNA ASSESSMENT IN NSW STATE FORESTS

SURVEY GUIDELINES

Procedures for Sampling Flora & Fauna
for Environmental Impact Statements

Version 1.0

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TABLE OF CONTENTS

TABLE OF CONTENTS cont..

page

INTRODUCTION

The information provided by flora and fauna assessment is fundamental to effective, scientifically based forest management. At the most basic level the information collected consists of a simple *inventory* of species for a particular area, on scales varying from a few hectares to a management area or regional basis. *Survey*, which is usually regarded as providing more site specific data, is the next level. Survey data obviously may vary greatly in quality and detail. Ultimately, survey information should provide a basis for *monitoring* (i.e. repeated assessment) where changes in plant and animal community composition are recorded over time, particularly in relation to forest management practices, and to examine individual species responses to management. Monitoring is especially important for assessing long term trends, and complements intensive research studies. It requires detailed site-specific data, and preferably relocatable datum points (e.g. permanent plots or individually marked plants and animals).

These notes aim to provide standardised guide-lines for flora and fauna survey within the Commission. Such surveys may provide data for specific purposes, such as Flora Reserve description, environmental impact assessment, particular research purposes or fauna habitat description. Although particular surveys may have specific requirements and emphases depending on the purpose and resources available, it is essential that data be collected as far as possible in a standardised form, so that data from various types of surveys are compatible to the greatest extent possible. This is particularly so because survey information is often used in a comparative sense and its value for this purpose increases as the database accumulates. The collection of data in this way will also allow the interrelationship between habitat structure and faunal composition to be explored more fully, potentially elucidating the particular requirements of selected species.

Monitoring requirements are not further considered in these notes. A comprehensive set of guide-lines for monitoring in Flora Reserves has been presented by G.N. Baur (H.O. 5400 of 21.1.1988) and general guide-lines will be developed in due course.

Survey Strategies

For vegetation assessment, broad area, "rapid" survey (where little or no site specific data are collected and survey areas are defined in only a very general sense) has the advantage of usually yielding more comprehensive floristic inventory data for a given resource input. Similarly, extensive lists of fauna can often be generated from foot and vehicle traverses in particular habitats. The value of the information

collected in this manner is however relatively limited compared to data from more site specific survey. Broad area assessment (termed *general survey* in these notes) is usually an implicit part of any survey, but specifically may be of particular value for:

- subjectively identifying sites or locating species of particular interest (e.g. in a conservation sense), such as for pre-harvesting survey if time and resources are very limited,
- choosing locations of monitoring or survey plots.

Site-specific survey (termed *plot-based survey* in these notes) usually produces less comprehensive lists of flora and fauna (per unit time), but permits collection of specific habitat data and has the following advantages:

- it allows more quantitative examination of species distribution and abundance, and of community relationships, and greater flexibility of future analyses,
- it allows examination of important species/environment relationships and interpolation and predictions based on habitat or geographic data,
- inconspicuous or rare species are less likely to be overlooked due to a smaller search area,
- it provides a sound basis for subsequent monitoring and any other more detailed research work.

These advantages become more pronounced as data accumulates, and are thus of particular benefit in the longer term. For these reasons *plot-based survey* is preferred to simple inventory, and research staff should generally be discouraged from carrying out general broad area assessment, except where specific circumstances exist for doing so.

A third form of survey may be required (particularly for fauna) to assess localised environments/communities of high conservation significance or fauna "of special interest". This is termed *specialised survey* and usually requires specific skills and techniques and independently installed and monitored study sites.

> The remainder of this document deals primarily with *plot-based* survey techniques. For specific purposes data collected by *general* and *specialized* survey complement this approach, and suitable techniques are discussed in the appropriate sections.

PART A. VEGETATION SURVEY

The primary components of a *plot-based* vegetation survey involve the overall design, the collection of data, and the subsequent analysis and reporting.

1.0 SURVEY DESIGN

The design and implementation of a vegetation survey involves the following considerations: plot location, plot size, plot numbering and marking.

1.1 Plot Location

The selection of study plots will involve the following:

1. A consideration of the specific purpose of the survey. In most surveys, the aim will be to adequately sample the range of variation of vegetation, habitat and management history in the survey area. For other purposes (eg. *specialised survey*) a particular vegetation unit may be of most interest, e.g. because of likelihood of being affected by some management practice, because it is extensive, or because of particular conservation interest.

2. Stratification will usually be important. Where forest type or vegetation maps are available, these offer the most convenient and appropriate means. In addition, important habitat parameters, such as geology, altitude and topography, should be considered. If the survey area is over about 5,000 hectares, it may also be worthwhile to stratify geographically to ensure that the area is broadly covered by the survey, although this will normally be achieved in any case through stratification on the other factors. The future availability of Geographic Information Systems (GIS) and computerised mapping systems within the Commission should facilitate survey planning and ensure appropriate stratification.

3. Ideally, plots should normally be <u>randomly</u> located within strata, and their locations determined on a map before field survey, to ensure a high level of objectivity. This may not be practical if survey intensity is very low, in which case subjective sampling may be more appropriate to survey objectives. For regional scale surveys where random plot location is impractical (eg. due to cost constraints), gradsect sampling (Gillison and Brewer 1985, Austin and Heyligers 1991) is an efficient, cost-effective alternative.

4. Accessibility will be an important criterion in plot location, particularly for plots which are to be used as a basis for fauna survey. In general, plots nearer to roads may be preferred over more remote plots in similar habitat, simply due to cost and resource constraints. However, more remote plots may have some sampling advantages: e.g. allow strict adherence to random sampling and more extensive traverse of the survey area.

5. There is obviously an inverse relationship between the survey intensity and the area covered by the survey. In most cases, resources will be inadequate to survey to the desired intensity, and the relative importance of each of the above factors will need to be carefully considered. For a general descriptive survey of a large survey area using limited survey resources, the priority would usually be to sample the widest possible range of habitats and vegetation types, including the extremes. Replication within extensive habitat/environment strata would be desirable. As a very rough guide, minimum desirable intensity would range from 1 plot/1,000ha to 1 plot/100ha for a general survey.

   For a *plot-based* survey with accompanying fauna assessment, a minimum of 4 replicate sites per habitat category is required (site selection based on broad forest type and management history - see Part B, Section 1.0).

1.2 Plot Size

It is important that a plot samples an homogeneous area of vegetation and habitat. Perception of homogeneity is obviously subjective and dependent on scale. For example, a homogeneous area at the forest canopy scale may extend over several hectares, while ground cover may be homogeneous only at a scale of metres. In forests, the forest canopy is the most convenient scale to consider, and it is suggested that an arbitrary plot size of 0.1 hectare (1000 m^2) could be used as a standard for most purposes. For comparison, 700 m^2 is used for flora surveys in Victoria, 400 m^2 is used by the National Herbarium and the National Parks and Wildlife Service of NSW and 0.1 ha is used for sampling overstorey by CSIRO Division of Wildlife and Ecology. For most forest areas, 400 m^2 seems too small to adequately sample the overstorey, but would be adequate for lower strata.

The use of 0.1 ha is suggested as an attempt to include the range of floristic diversity in a stand while not unduly compromising the need to ensure relative homogeneity of lower strata. It is obviously difficult to suggest a single plot size which is appropriate to all situations, but a uniform plot size is important for the validity of comparisons among surveys. Plots smaller than 0.1ha may be unavoidable for localised habitat or vegetation of limited extent. Plot shape may be varied to suit the type of vegetation. A 50m x 20m rectangle would be appropriate for most

purposes, although longer, narrower plots would be preferable for "linear" habitats such as riparian vegetation. In order to allow direct comparison with data from the NPWS and NSW Herbarium, a 20x20m plot should be nested within the 0.1ha plot, with the data being recorded simultaneously.

1.3 Plot Numbering and Marking

The only essential requirement for field numbering is to ensure that each plot is uniquely identified for a particular survey. This may be accomplished with a simple sequential numbering, or preferably, including a prefix which identifies the survey. For long term data storage, it is necessary to ensure overall unique identification. A statewide standard will be developed for data storage within the Commission, controlled from W.T.F.R.D.. Possibly the most appropriate form of such a standard would be a 3-character Management Area code as a prefix to sequential numbers for each Management Area, as currently used for numbering Commission Permanent Growth Plots. In the unlikely event of possible confusion with PGP numbers, an additional prefix could be allocated (e.g. FS for flora survey).

All plots should be marked as accurately as possible on 1:25,000 topographic maps, to at least an accuracy of 100 metres (4mm on the map). A copy of the relevant part of the map should accompany the field data sheets for each survey. In addition, where staff have appropriate experience and resources, air photos may be pinned with the plot location, and the photo number and location recorded.

Marking in the field is problematical. There is probably some value in temporary marking, for example with plastic flagging tape, provided the tape is marked to indicate its purpose and avoid confusion with tape placed for management purposes. Temporary marking is an advantage where concurrent or future fauna survey, or a system of permanent vegetation monitoring plots is planned, based on flora survey plots. Routine permanent marking of floristic survey plots, using blazed trees or steel pegs, requires considerably extra time and effort and would rarely be justified for most surveys.

2.0 DATA COLLECTION

Data collection should be standardised as far as possible, for ease of collection, collation and analysis and for maximum compatibility among data sets. Computer based data storage and retrieval is obviously essential for effective use of the data, especially as the data base accumulates. Appropriately coded data facilitates standardisation but may sometimes result in a loss of information. A balance is necessary between coding and information loss. In some cases it is advisable to record both descriptive and coded information. Data entry on hand-held field computers, with verification from standard computerised floristic reference lists, is desirable in the longer term, but probably beyond the Commission's current resources.

Some aspects of data collection are discussed below. A compromise is necessary between the amount of data collected at each plot and the number of plots surveyed, also recognizing that travel to and between plots may be a substantial component of the total survey time. In considering data collection, an attempt has been made to include all data which is likely to be relevant to use and analysis of vegetation survey information, while taking account of ease of data collection in the field and avoiding unnecessary complexities. Appendix 1 includes suggested field data sheet formats and details of those parameters which should be recorded.

2.1 Plot Physical Data

A range of plot data should be recorded to adequately describe the plot location and those physical attributes likely to influence vegetation patterns. Appendix 1 includes a suggested format for data recording and details suggested parameters which should be recorded for all plots. Ideally, all relevant physical attributes should be recorded, but in practice it is normally feasible to record only those attributes which are readily recorded in the field using a minimum of equipment. Most of the important factors have been included, at least in a broad sense. The most obvious omission is a measure of soil nutrient status. Provision has been made to note whether a soil sample has been collected, but it is likely that soil nutrient analyses will be undertaken for only a selected small proportion of survey plots, and details are best recorded separately.

2.2 Vegetation Structure

Four descriptive elements may be considered important in recording vegetation structure: vertical stratification, a measure of abundance (e.g. biomass, cover, density), structural floristics and growth form. Growth form tends to be closely related to floristics and for most forest

vegetation it would not be necessary to record both. Floristics would normally be preferred. Cover is the most readily estimated field measure of abundance. Coded data is necessary for ease of data storage, retrieval and analysis, but usually results in some loss of information due to the difficulty of adequately representing the diversity of vegetation structural arrangements with simplified codes. It would be desirable to record both coded and descriptive information on field sheets, even though the latter is unlikely to be used in computer analyses.

2.2.1 Vertical Stratification

In most stands of vegetation some vertical layering is discernible, even though it may be obscure and layers may overlap. The following height classes are suggested to code vertical structure. These are essentially arbitrary, but broadly correspond to commonly perceived vegetation layers in forests.

Class	Height range	Vegetation layer
1	>35 m	tall forest canopy or emergents
2	20.1-35 m	forest canopy
3	6.1-20 m	sub-canopy or tall understorey
4	1.1-6 m	understorey or shrub layer
5	0-1 m	ground layer

The above limits are approximate and intended to indicate the general height range. A layer should be recorded in the most appropriate class. Where it overlaps several classes, it should be recorded in the class which includes most of the height range. In any case, the actual height range of each layer should also be recorded. In some cases, such as for heath vegetation with more complex layering at lower levels, the above limits may be too broad to accurately describe vertical structure. The classes may then be subdivided.

It is suggested that provision be made for a maximum of five strata to be recorded, even if some of the above are subdivided, and that overall cover-abundance codes be recorded for each species in each of the above broad strata as appropriate. Where vertical layering is very obscure or not evident, the vegetation should be recorded as far as possible in the most appropriate classes but an additional code entered to denote that condition.

2.2.2 Cover

Vegetation cover may be described in several ways. The two most common are crown cover, which is the percentage of the sample area within the projection of the crown perimeters (i.e. crowns are assumed opaque), and foliage cover (or canopy cover), which is the percentage occupied by the vertical projection of foliage and branches. Both are useful measures, although neither is simply correlated with leaf area. The advantages of crown cover are that it is independent of seasonal changes in foliage density (e.g. deciduousness) and leaf orientation, and is probably easier to estimate in the field. The advantages of foliage cover are that it more accurately reflects variations in foliage density among species (e.g. rainforest trees vs eucalypts) and it is the only simple measure available for herbaceous species which do not form crowns or analogous structures. It is suggested that a visual estimate of both measures be recorded for the tallest stratum, and at least foliage cover for lower strata. Estimates should be to the nearest 5% or 10%.

2.2.3 Floristics

Up to three major species in each stratum may be recorded, in order of abundance. If there are no clearly predominant species in a stratum, a code to denote a mixed composition should be added, and either no species recorded, or those species considered most abundant recorded. The suggested method of recording this information is given in Appendix 1.

2.2.4 Tree Size

Optionally, the DBHOB (over-bark diameter at 1.3 metres) of the largest individual of each canopy tree species, or at least the major species, and possibly major subcanopy or tall understorey species, may be recorded. Preferably the diameter and species of all stems >50cm should be recorded. A tally of all stems >10cm DBHOB should be made in 10cm size classes (by species). For logged plots, it is essential to record diameters (mean of 2 perpendicular diameters) of all stumps.

2.3 Floristic Data

All species which can be distinguished at a site should be recorded and identified as far as possible to the species level, or subspecies level if appropriate. Where it is not possible to assign a species name, the lowest identifiable taxonomic level should be recorded (e.g. genus or family), and preferably, a herbarium voucher specimen should be collected for possible later determination.

Species names should be coded for ease of field recording and data computerisation. A standard eight letter code, consisting of the first four letters of the generic name plus the first four letters of the specific epithet is suggested. A genus of less than four letters (e.g. *Poa*) should still be allocated four letters for genus and padded with blanks. The eight letter code is not unique for every species, and where duplicates are likely, or for infrequently encountered species, it is desirable to record full species names on field data sheets. Full names should always be included in the computerised database. These would normally be derived from the codes and added to the data file from a computer reference file using an appropriate program. Infra-specific taxa may be coded as for species but using the first two letters of the subspecific or varietal name in place of the last two letters of the species code. The codes for taxa which are not determined to species level could consist of the first four letters of the lowest identifiable level followed by a collection number (or the last 4 digits thereof) or a number prefixed by "SP". For these taxa voucher specimen collection numbers should be recorded on field sheets and used in place of specific names on computer data files. For example, an unidentified member of the Myrtaceae represented by specimen number DLB678 could be coded as MYRTSP1 or MYRT678 and stored as Myrtaceae DLB678.

A measure of abundance or importance is desirable for each species. Projected foliage cover is a convenient measure which combines elements of both plant size and density and which is readily visually estimated in the field, at least broadly. Cover-abundance codes are suggested which are based on broad but useful limits for cover classes, reflecting the degree of accuracy expected from visual cover estimates, with the lowest class subdivided to refine estimates for species with low cover values. These codes are defined below and are consistent with codes commonly used by other organisations in NSW and elsewhere in Australia.

Code	Cover-abundance
1	$\leq$5% cover, few individuals or sparse occurrence
2	$\leq$5%, any number of individuals
3	6-25%, any number
4	26-50%
5	51-75%
6	>75%

A code should be recorded for each species as it occurs in each of the coded height strata (as described above) defined for the plot. Where a stratum has been subdivided, codes for occurrence in each of sub-classes should be added. For species which occur in more than one stratum, an overall code for the species over the plot as a whole should be recorded in

addition to the codes for each stratum. Otherwise, the individual stratum code will be assumed to apply to the plot and it is not necessary to record an overall code. In practice, few species occur in more than one stratum. Other items which should be recorded are: an annotation if a specimen is collected from the site; a code for tentative identifications. These are detailed in Appendix 1.

2.4 Other Considerations

2.4.1 Rare or Otherwise Difficult Species

Rare or highly localized species present obvious difficulties in survey, simply due to the nature of their distribution, and yet may be of great conservation significance. Those which are rare because they are localized and restricted to specific habitats may be effectively surveyed by giving particular attention to those habitats (e.g. swamps, rocky sites) which often support such species.

Species with a more general distribution which occur at very low frequency through a range of habitats, or those for which preferred habitat is less obvious, are less tractable. They are difficult to survey specifically and the probability of detecting such species is low regardless of survey method, unless sampling intensity is high.

Highly seasonal (e.g. geophytic monocotyledons) or ephemeral species may also present problems, and if such species are of particular interest or expected to be an important component of the flora, the timing of the survey will need careful consideration. Species which are both rare and seasonal obviously are particularly difficult subjects.

Information on rare species should be collected opportunistically during survey, in addition to any information from survey plots. Any populations detected should be mapped on 1:25,000 maps and preferably, information on population size, size or age structure and regeneration collected.

2.4.2 Herbaria

Floristic data should be supported by herbarium specimens as far as practicable. Of particular importance are rare species, specimens representing unusual geographic records or unusual morphological types, and taxonomically difficult species, though common species should not be neglected. Retention of sterile material of species not identifiable at the time of the survey may also be worthwhile, for later determination when fertile material becomes available. Specimen collector's numbers or herbarium accession numbers should be recorded on floristic data sheets to

allow cross-referencing. Very brief guide-lines for collection and maintenance of herbarium material are given in Appendix 2. Details of an herbarium database have been previously circulated (WIFRD 11748 of 30/5/89).

2.4.3 Photographs

Photographs (especially colour transparencies) of survey plots provide a valuable record of vegetation appearance which supplements the data record. They obviously need to be adequately catalogued and referenced to the survey plots. It would not normally be essential to photograph every survey plot, but a photographic record of a representative selection of plots for each survey area would be worthwhile.

3.0 DATA ANALYSIS AND REPORTING

Regional research centres should hold copies of all computerised flora survey data and preferably all field data sheets from surveys carried out under the Commission's direction, relevant to Regions in which they operate. This includes any data from consultants contracted by the Commission. Copies of all field data sheets and all data in computer files should also be forwarded to Forest Ecology and Silviculture Section, W.T.F.R.D. This has obvious security benefits, allows centralised accumulation of a statewide floristic database and allows possible further analysis by W.T.F.R.D. staff in consultation with field staff, as appropriate. Any subsequent modifications, such as those due to identification of previously unidentified material, or previously incorrectly identified specimens, should also be made to all copies of the data.

Information from minor surveys, or a small amount of data, is normally only presented as internal file reports. It may be appropriate to combine such information on a Management Area basis and present it in the Commission's "Forest Resources Series". More extensive survey results may be submitted to this series on an individual survey basis. Format guide-lines for reporting flora survey data appear in Appendix 3.

References cited:

Austin,M.P. and Heyligers,P.C. (1991) New approach to vegetation survey design : Gradsect sampling. In *Nature Conservation : Cost Effective Biological Surveys and Data Analysis.* C.R. Margules and M.P. Austin (eds.) CSIRO Australia.

Gillison,A.N. and Brewer,K.R.W. (1985) The use of gradient directed transects or gradsects in natural resource survey. *J.Environ. Manage.* 20:103-127.

PART B. FAUNA SURVEY

1.0 SELECTION OF STUDY SITES

The experimental design for *plot-based* fauna survey should be based upon the variability of vegetation types and forest management operations (see Part A, Section 1.0). Each broad vegetation category (as opposed to Baur's forest types or similarly defined plant community or association) can be considered as a "category" in the unlogged state (eg. dry sclerophyll, wet sclerophyll, rainforest etc). A logged example of each broad vegetation type would be another category to be surveyed. Thus the number of categories would depend on the number of major forest types and the number of different types of forest operations in the area of reference. These categories are therefore the *class variables* that will be used to analyze the data. ie. are there more/less bird species in "unlogged" or "logged dry sclerophyll forest"?

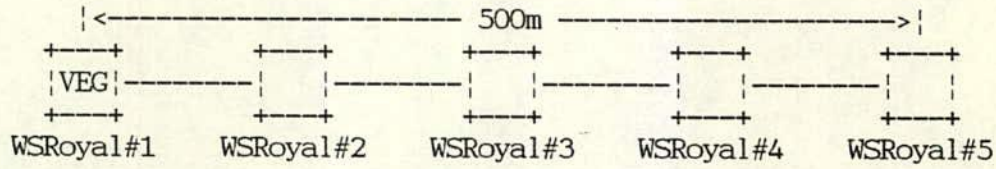
From the general information at hand, it does not appear that the size of the study area will be a determining factor with respect to the number of categories. This would only become a factor if there were some *a priori* reasons to indicate that there was variation caused by the geographical distribution of animal species within the reference area.

"Broad vegetation type" is used here to indicate forest types or plant communities that are real entities on the operational scale of management and at the level of species distribution in ecological terms. That is, vegetation types that correspond to features of the environment at the landscape/ecosystem level, or which have different prescriptions for harvest, and which are therefore significant for the conservation of fauna. These two factors often coincide. For example, rainforest, coastal heath and mixed moist hardwood forest often occur in the same general area, but are separated by differences in ecosystem requirements for establishment and maintainence, and both have different scales of harvest (in that rainforest is seldom logged at all, and heath is mainly affected by fire).

Within these broad vegetation types there may occur many different plant communities or associations. These are of interest in botanical terms, but it may not necessary or particularly useful to sample fauna on this scale for the purposes of environmental impact statements. However, to allow for critical decisions about the value of vegetation types for the conservation of fauna, differences in soil productivity, ground moisture, topography, and the resultant floristic differences in forests, should be taken into account in determining these broad vegetation categories. Where these are widely different, another broad vegetation category should be defined.

The location of study sites for wildlife surveys will be based on randomly located vegetation plots within each forest type and treatment (see Part A, Section 1.1). There should be **four** replicates within each major forest type and each treatment. (Actually, there should be as many replicates as possible; four, however, is the minimum meaningful number that can be sampled for fauna. If, by great good fortune, it is possible to sample more replicates, it is important that these be balanced. That is, it is highly desirable to maintain equal sample intensity across the entire project. Any gain in information from increased sampling in any one broad vegetation community would be countered by the loss of statistical power in analysis due to unequal replication).

The following configuration of study sites has been used in the past to good effect. A 500m transect running through the study site is established in such a way that it bisects the plot on which vegetation was quantitatively assessed. A fauna count station "point" is established at each 100m mark along the transect with flagging tape that denotes the plot name and the number of the point. For example: *WSRoyal #1*, might denote point number one on a wet sclerophyll plot at Mt. Royal. Each study plot (but not each "point") should clearly be marked on a map and the grid references recorded. To aid in distance estimation as part of the bird count procedure (see below), flagging is placed conspicuously along the transect at points 30m and 50m distant from each station.



(note: transects do not need to be in a straight line,
VEG=vegetation plot)

It takes between one and two hours to set up these transects, depending on terrain. This can be done in advance of the actual bird counts by local Forestry Commission staff. This would save considerable time that would otherwise be a billable hour by the consultant or W.T.F.R.D. wildlife officers.

It should be noted that if "fauna of special interest" are also to be sampled, separate specialized techniques may be involved which require independently installed and surveyed study sites.

2.0 PROCEDURES FOR SAMPLING FOREST BIRDS

2.1 Introduction

The experimental design for sampling bird populations as part of the Environmental Impact Statement process requires replication within unlogged examples of major forest types. Logged forest, preferably 20 - 40 years old, should also be sampled to allow an assessment of the impact of proposed operations. From these data, a model can be constructed to explain the nature of the relationship between bird populations, forest type and management history. By stratifying the bird species present in terms of use of forest resources for breeding and foraging, a rational assessment of the impact of operations on all species can be made. Thus, the species present are recorded, and information on how they are distributed is obtained.

A second set of data will be generated by this process. The person collecting data for the environmental impact statement will maintain a species list across forest types. With records from local observers (which are usually incorporated into the Management Plan for the area of reference), this should allow us to provide a comprehensive statement as to the nature of the avian community. In combination with the special studies for impacted species or rare and endangered species, the impact of management should be well defined.

2.2 Methodology

The location of study sites for bird counts will be based on randomly located vegetation plots within each forest type and treatment (see Section 1.0). To ensure that the entire complement of forest birds are present, general avifauna studies should be carried out in the summer, when migrants from the Oriental tropics are present.

The method proposed is one that has been used extensively throughout the state by Commission staff and consultants. It is designed for use in a variety of forest types, and allows for variable degrees of precision, depending on the nature of the experiment and ambient environmental conditions (Eg, thick scrub).

Basically, all birds seen and heard at each station ("point") are recorded for a ten minute period. The distance from the point to the bird is estimated, and recorded in pre-set distance categories (0-5 m, 5-10 m, 10-20 m, 20-30 m, 30-50 m, and > 50 m) in corresponding columns on the data sheet (example attached).

To envision this graphically, imagine a target or bull's-eye, with the station at the centre. Birds are recorded in each of the expanding rings of the target area in the appropriate columns on the data sheet. All those entirely outside the target areas, but within the habitat, are recorded in one column (the " > 50 m" column). Data for each bird species are recorded on a separate line on the data sheet.

Four counts are made on each study plot on four different days (more than one count can be made on a plot on a given day, but this reduces the value of the experimental design and is highly discouraged.) The plots are censused from alternate ends to avoid temporal bias. That is, if a count begins at station 1 the first day, it should be started from station 5 the following day. A balanced number of early and late counts is achieved in this manner. As noted previously, a running list of the species encountered in each forest type should be kept by the researcher doing the field work, as all species encountered during the census procedure may not be recorded as part of the formal censuses.

Regular standardization procedures should be followed to reduce observer bias. This should take the form of a work shop between the field worker(s) and research staff from WIFRD.

2.3 Data Management and Results

Each study site will be censused four times over five stations, resulting in 20 data sheets per site. Standardized data forms are available from the Forest Ecology section at W.T.F.R.D. A copy of the data sheets should be kept in the Region where the EIS is conducted. It is essential to have the data transcribed as soon as possible to electronic format; it can then be copied and distributed to the appropriate division for analysis and production of the final report. This will be done either by the consultant or the Commission, depending on the circumstances for the individual EIS involved. It is recommended that data processing be done in the Region of origin, possibly by the Research Centre office staff, wherever possible.

Results are amenable to analysis of variance (either parametric or non-parametric). Tests should be conducted for difference between forest types (one-way analysis) and forest types and treatments (two-way analysis).

The results of the general survey for bird species occurrence should be presented in a table of bird species by forest type.

2.4 Administration

Censusing birds is a skill which requires considerable experience and practice. Therefore, it may be necessary to use consultants with appropriate expertise to achieve the goals set out for EIS completion.

The procedure described above has been used by the Forest Ecology Section on several projects which required the use of consultants. Consequently, there are contracts already in existence which can be used as a template for further work. Basically, the data sheets described above are the units by which consultants are contracted and funded. The contract states that a specified number of bird counts are to be completed for a certain cost.

In cases where the consultant will prepare a final report, the report itself should be the contractual objective.

3.0 LARGE ARBOREAL MAMMAL AND OWL SURVEY

3.1 Introduction

Section 2 dealt with a research design for sampling diurnal birds. It is proposed that the same general research design be employed for determining relative population density of both large arboreal mammals and owls. Different sampling techniques, of course, will be required. Further, a more elaborate scheme will be necessary to document general distribution across the spectrum of habitats covered in the impact assessment procedure.

It was previously stated that the general distribution patterns can be determined for diurnal birds through a combination of literature survey, interviewing local naturalists, review of current Management Plans, and the opportunistic compilation of lists during the experimental part of the impact assessment procedure. This is possible because: 1) the R.A.O.U. carried out an extensive program to record bird distribution objectively and published the results, 2) bird watching is a popular avocation, and 3) diurnal birds are easy to observe and identify.

No such atlas program has been undertaken for mammals in New South Wales (although the Victorians have made some attempt in recent years). Arboreal mammal watching has never caught on with the general public, mostly because it requires going out into the dark scary forest at night. There are serious problems of identification with the records that do exist, once again due to the nocturnal conditions under which these records were gathered. It should be pointed out that, aside from the fact that arboreal mammal work is carried out at night, species identification is less complex than that involved in censusing diurnal birds (7-8 species of arboreal marsupials, 3-4 species of owls, as compared to 150 species of diurnal birds, many of which have morphological differences dependent upon sex, race, and age).

Therefore, the process of gathering information should have two phases, which more or less coincide with the two parts of an Environmental Impact Statement. The first part would be a general survey of the entire EIS area, using vehicular spotlighting (arboreal marsupials) and tape recorded calls broadcast with a directional speaker (nocturnal birds and arboreal marsupials). The second part would be a modeling exercise similar to that used for diurnal birds. In this part of the sampling procedure, the population density of arboreal marsupials and nocturnal birds would be estimated in different broad vegetation types in both the logged and unlogged state. "Broad vegetation type" is used here in the same context as it was in the procedure for birds. That is, vegetation types that correspond to features of the environment at the landscape scale or which have different prescriptions for harvest. The two factors often coincide. For example, rainforest, coastal heath and mixed moist hardwood forest

often occur in the same general area, but are separated by differences in ecosystem requirements for establishment and maintainence, and both have different scales of harvest (in that rainforest is seldom logged at all, and heath is mainly affected by fire). Within these broad vegetation types there may occur many different plant communities or associations. These are of interest in botanical terms, but it is not necessary or particularly useful to sample fauna on this scale for the purposes of environmental impact statements. However, to allow for critical decisions about the value of vegetation types for the conservation of fauna, differences in soil productivity, ground moisture, topography, and the resultant floristic differences in forests, should be taken into account in determining these broad vegetation categories. Where these are widely different, another vegetation category should be defined.

3.2 Study Sites

For the general survey, the entire area which is to be covered in the Environmental Impact Statement should be considered as the study site. As far as possible, all roads within the study area should be spotlighted from a vehicle.

The experimental phase of the study should be carried out on the same sites used for diurnal bird survey, tree trapping and pitfall trapping (see following Sections). These are randomly located sites within the broad vegetation categories described above, with four replicates per vegetation type.

3.3 Methods

The general survey is not an experimental procedure, but rather one of documentation. This can be carried out by local Forestry Commission staff under the direction of an experienced wildlife researcher.

As far as possible, all roads within the study area should be spotlighted from a vehicle travelling 5 kilometres per hour, using two observers and 100 W spotlights. One of the observers should have expertise in the identification of all species of arboreal marsupials and owls.

Surveys should begin when it is completely dark and end before sunrise. At two kilometre intervals, taped calls from the Masked, Sooty and Powerful Owls should be played for 3 minutes each (total of 10 minutes from a standard tape). A five minute waiting period for responses should follow the taped calls. Additionally, whenever a a heavily forested stream catchment is crossed or audibly accessible (e.g., a ridge overlooking the stream), the owl calls should be played. (If possible, the regular stops

and catchment stops should be coordinated). In this manner, 25 kilometres of road could be surveyed by one team in an eight hour night, or 125 kilometres per week.

Information recorded for each species observed should include an accurate road location, distance from the road, tree species in which the animals was observed, height of the tree and height of the animal. Notes on foraging, reproductive condition, sex and age are helpful and should be recorded where possible. The major thrust of this part of the exercise should be kept in mind: to establish distribution patterns quickly and accurately. In many areas, Greater Gliders and Ring-tailed Possums are quite common. Exact details of foraging behaviour in these cases are of little interest; the numbers will tell the story. Powerful, Masked and Sooty Owls are not widespread and numbers will never be extremely high. Notes on sex, age and foraging could be quite useful in providing information about the distribution and status of these animals.

The second phase of the process is an experiment to determine the impact of the proposed activity. This will constitute a spotlight survey of the replicated treatments, primarily for arboreal marsupials, and an auditory census of responses solicited by tape recorded calls, for the three large species of owls. This should be carried out under the supervision of an experienced researcher (5 years or more experience, academic qualifications for processing data scientifically).

The following procedure is proposed. An initial 10 minute listening period to detect any owls or mammals which are calling or moving about on the site will be conducted at the beginning of the transect. Calls of the three owls will be played from a standardized tape through a 10W speaker for 15 minutes, followed by another 10 minutes of waiting for responses. The transect will then be surveyed for a minimum of 45 minutes with two observers using 100W spotlights. In other words, 9 minutes will be spent covering each 100 metres of the transect, if there are no animals seen. All animals seen within a 20 metre band either side of the transect will be counted for the purpose of analysis. All animals seen will be recorded for additional explanatory data.

Data for each species recorded will be tree species, height of tree, and an approximation of the distance from the transect line to the animal (perpendicular, to the nearest 5 metres). Data forms will be made available by the Forest Ecology section at W.T.F.R.D. (see enclosed example).

3.4 Equipment

Special equipment will be required for the spotlight surveys as well as the owl calling phase of the environmental process.

A minimum of two 100W spotlights are required for each team of field workers in both the general survey and the experimental survey. These are powered by 12 volt motor cycle batteries, housed in custom built carrying cases at present. (Plans for building the cases available through the Forestry Commission workshop in Sydney). Alternatively, assembled spot light/battery arrangements are available from sports goods suppliers (the latter assemblage is used by CSIRO). A battery charger is needed to maintain current.

For the owl calling procedure, tape recorders and hand held amplifiers are required. Standard equipment and Sydney suppliers are listed in Appendix 4.

3.5 Results

Results from the general survey should be turned into the appropriate District or Regional office as soon as the individual surveys are completed.

The results should then be compiled by the Region or District into a two way table of animal species by vegetation type. Graphical representation by bar graphs could also be used.

Results of the experimental portion of the survey are amenable to testing using analysis of variance procedures (either parametric or non-parametric). Tests should be conducted for difference between forest types (one-way analysis) and forest types and treatments (two-way analysis).

3.6 Administration

The general survey and the experimental portion of the impact study should be administered through the appropriate Regional office, and supervised by the appropriate District. The majority of the work should be carried out under contract. Forest ecology staff from W.T.F.R.D. would then act in an advisory capacity for the field work, particularly during the initial stage of the operation. A final report would then be written by the Forest Ecology staff or the consultant, including the appropriate analyses and discussion. This should be in a form that is adequate for reference in the process of creating the final environmental impact statement.

4.0 SMALL ARBOREAL MAMMAL SURVEY

4.1 Introduction

A number of small arboreal mammals are not adequately surveyed by spotlighting alone. These include primarily arboreal (tree-dwelling) species:

Brush-tailed Phascogale	*Phascogale tapoatafa*
Eastern Pygmy-possum	*Certartetus nanus*
Feathertail Glider	*Acrobatus pygmaeus*
Sugar Glider	*Petaurus breviceps*

and ground-dwelling species which commonly live in, or forage in shrubs and trees:

Fawn-footed Melomys	*Melomys cervinipes*
Brown Antechinus	*Antechinus stuartii*

The Commission is interested in the nature of tree usage by these species, and is compiling data to enable a comparison of survey techniques to be made. These animals can be **quantitatively** surveyed by the use of tree-mounted traps.

4.2 Methodology

A/ Installation

1. Twenty-five (1 box) 33x10x9cm aluminium ("Elliot") box traps are used per plot.
2. At each "point" along the transect (see Section 1.0), 5 traps are attached to brackets mounted at least 2m above ground on trees representative of that forest type (one per tree). To reduce access to the trap by ants, leave approximately a 1cm gap between the timber support and the tree. Brackets can be obtained from Forest Ecology W.T.F.R.D.
3. Brackets are to be angled approximately 10° above the horizontal to facilitate drainage of the trap during rain. Brackets are to be attached to the south-west facing side of the tree to minimise exposure to early-morning sun.
4. Each trap is placed inside a small plastic bag (freezer bag) to exclude moisture. In cold/wet weather nesting material (leaves/grass or cotton/dacron wadding) should be placed inside the trap to reduce overnight loss of body heat.

5. Each trap is baited with candied honey, best placed on a small piece of paper (eg. 5cm diameter filter papers) to simplify trap cleaning.
6. The tree trunk adjacent to (above) the trap is sprayed with a honey/water mixture as an attractant.
7. Traps are to be checked daily, and re-baited as required. Trees will need to be sprayed with honey daily.

B/ Operation

8. Traps are to be operated for 4 successive nights during reasonably fine weather. Trapping should **not** be conducted from June to October.
9. Animals captured are to be identified to species, weighed, sexed and reproductive status assessed (juvenile, sub-adult, adult, breeding). If identity uncertain, animals should be **accurately** measured (head-body, tail, hind foot, ear length), and body characteristics recorded for later confirmation. Specimens should only be taken in special circumstances (N.P.W.S. permit required).
10. Every **new** animal should be given a temporary marking before release. Clipping the fur on the flank with a pair of scissors is sufficient for short-term studies.
11. Trapping details are to be recorded on a form available from Forest Ecology W.T.F.R.D. (see example).

4.3 Results

Results from the *plot-based* survey should be turned into the appropriate District or Regional office as soon as the individual surveys are completed.

Results are amenable to testing using analysis of variance procedures (either parametric or non-parametric). Tests should be conducted for difference between forest types (one-way analysis) and forest types and treatments (two-way analysis).

5.0 LARGE TERRESTRIAL MAMMAL SURVEY

In these guide-lines, "large terrestrial mammals" is a broad term which basically covers most of the groups not otherwise discussed. Primarily it deals with the Monotremes, large Dasyurids (Quolls), bandicoots, wombats, Macropodids and larger "introduced" mammals. Particular fauna may be considered "of special interest" in certain studies (eg. Parma Wallaby) and *specialized* surveys conducted. For most species however data will consist primarily of presence/absence records compiled during *general survey* procedures.

The presence in the study area of large terrestrial mammals is primarily detected firstly through incidental observations made whilst surveying other groups, secondly by systematic searches at each study plot for evidence such as tracks, diggings, burrows and scats, and thirdly by the use of cage traps.

5.1 General Survey

Throughout the duration of the fauna survey, records should be kept of all animals observed, and an indication of location and activity. Field observers involved in all aspects of the *plot-based* survey should record species identified by scats and other signs.

5.2 Plot-based Survey

In addition to general observations, 30 minutes (minimum) should be spent in the vicinity of each of the 5 points on each plot systematically searching for evidence of animal presence and activity. This search time may coincide with searches for reptiles or other groups.

In order to increase detection of certain groups, cage traps are utilised on the marked plots in the following fashion:

1. Two 60x30x30cm wire cage traps are placed along animal runways at each of the 5 "points" in each study plot (as defined in previous sections).
2. One trap of each pair is baited alternately with fish and chicken (to detect carnivorous marsupials) and the other with a peanut-butter/rolled oats mixture (to detect possums, bandicoots and small macropods).
3. Traps are to be checked daily, and re-baited as required.

(cont..)

4. Animals captured are to be identified, weighed, sexed and measured, given a temporary marking to distinguish them if subsequently recaptured, and then released.

5. Traps are to be operated for 4 successive nights during fine weather.

5.3 Results

Results from both *general* and *plot-based* surveys should be turned into the appropriate District or Regional office as soon as the individual surveys are completed.

It is likely that the number of data records will be low and therefore results are not amenable to statistical testing. General trends with regard to animal distribution and abundance should however be apparent.

6.0 SMALL TERRESTRIAL MAMMAL SURVEY

Routine survey of small terrestrial mammals (*Antechinus* spp. & *Rattus* spp.) is no longer recommended. In keeping with the specific goals of EIS survey, survey of small terrestrial mammals is directed specifically towards species "of special interest" (eg. the Hastings River Mouse *Pseudomys oralis*).

Appropriate *specialised* methodology for trapping species in this category should be discussed with personnel in Forest Ecology at W.T.F.R.D.

7.0 REPTILE AND AMPHIBIAN SURVEY

7.1 Introduction

Many people see the conservation of reptiles and amphibians as a less significant environmental issue than conservation of mammals or birds. There is a growing interest however in these groups, particularly as there is *some* evidence to suggest that frog populations world-wide may be in decline. It may be *some* time before the conservation of snakes becomes an issue of public concern. It is Forestry Commission policy however to maintain the diversity of *all* wildlife.

The general design of the survey guide-lines is to enable wildlife to be assessed at two levels: firstly as part of a general fauna survey, and secondly, concentrating on those fauna of special interest. As with many other groups, reptile & amphibian survey is a skill which requires considerable experience and practice. The approach discussed below is concerned primarily with "general fauna survey". It is recommended that specialist consultants be utilised when a survey for specific "fauna of special interest" is required.

7.2 Survey Techniques

A/ Background Information

All faunal groups exhibit seasonal and diurnal patterns of abundance and activity which influence their "detection" in surveys. This is particularly evident with reptiles and amphibians because they are *ectotherms* and as such rely primarily on external (environmental) sources for body heat. Most practice *brumation* (winter dormancy) which is analogous to hibernation in mammals. This usually extends from May to September in moist temperate regions, but may be extended to include periods of drought or extended cold weather. Frogs may practice *aestivation* which is a dormancy during summer or dry periods. The optimum period for sampling most groups is therefore late spring to early summer, although weather patterns during this period may both enhance or reduce "detectability" in the short-term.

B/ Surveying Amphibians

Frogs have developed certain behaviour patterns (see below) which are primarily designed to protect them from desiccation and predation, but also succeed in making them very difficult to survey and collect. It is necessary therefore to be aware of these behaviours when conducting surveys. A second consequence of these strategies is that *quantitative*

survey of amphibians is largely impossible, although associations between species and habitats can be broadly determined.

i) Because all frogs are dependent upon areas of fresh water for breeding purposes, they are most commonly found near permanent streams. Nearly all species are nocturnal and spend daylight hours well hidden under stones and vegetation, so when collecting during the day, the most successful method is to walk down a shallow creek bed and turn over stones or logs (replace after). Most frogs rely on their camouflage and will not move to escape until the last moment. Move quickly and pick up the frog firmly.

ii) Some species are adapted for foraging on vegetation. "Tree frogs" may be found on reeds and other aquatic plants, or low shrubs or grass which may be adjacent to water, particularly after rain and in the early evening.

iii) A number of species utilize drier areas of forest, however they generally synchronise their activity patterns with periods of extended wet weather. Surveying these species is therefore difficult in areas with limited wet weather access. The most cost-effective method of surveying these species is pitfall trapping (see E below).

iv) Because frog activity increases in wet weather, a useful survey technique involves driving at night along a quiet road during or just after rain. Roads that cross swamps or creeks are the most rewarding, particularly if they pass through a range of different habitats (eg. rainforest, open forest, cleared country). While driving slowly (0-15km/hr.) frogs will be easily seen sitting on the road.

v) During breeding periods, male frogs engage in vocal activity which is geared primarily toward establishing territories and attracting mates. This makes them easier to capture although many frogs are good ventriloquists, making detection by sound alone quite impossible. If it is difficult to determine the position of a calling frog, a procedure called triangulation may be used (at night). This requires two people standing several metres apart, listening to the call (in darkness). Each then shines his or her torch on the spot where they think the call originates. The approximate position of the frog is indicated where the beams cross. This method is particularly useful for small terrestrial frogs which hide in clumps of grass or leaf litter.

vi) To restrict drying out, many frogs will move into small, moist crevices which are inaccessible to the collector. The most appropriate method therefore is to use a small cassette deck to

record calls and then compare them to commercially available reference material.

It is essential to keep accurate and detailed field notes recording the exact locality where a frog was collected, and also the time, date, weather conditions, temperature, and other relevant information. For night survey, collectors require a rugged waterproof torch, gumboots and containers for putting captives in. Head torches are the most useful as they leave the hands free, and plastic bags the most suitable containers. After placing the frog in the bag, blow air into the bag and seal the neck with a rubber band. If kept in a cool, damp place, frogs can be kept in this way for some time (in order to confirm identifications).

B/ Surveying Reptiles

Reptiles display daily and seasonal behaviour patterns as a consequence of particular breeding strategies and to facilitate thermoregulation. A wide variety of collecting/sampling techniques can be used to capture reptiles, but only experience in their use will allow the individual collector to assess those most applicable in a particular situation. The majority of smaller reptiles are literally pounced on.

Reptile survey generally consists of accumulating records from local collectors, quantitative hand-survey, and opportunistic collection from specific microhabitats. The location of study sites for reptile and amphibian surveys should be based on randomly allocated vegetation plots within each forest type and treatment.

C/ Hand Collecting

On a daily basis, some species of reptile emerge at specific times independent from ambient temperature, while others are temperature dependent. For *diurnal* reptiles the following generalisations are relevant and strongly influence survey strategy.

i) In the early morning, skinks, dragons, goannas and snakes emerge from burrows and bask in direct sunlight until operational temperature is reached. Some (especially semi-arboreal dragons) may perch in low vegetation to avoid heat loss to the ground. Survey technique at these times usually involves observation and recording for a fixed time period along a transect.

ii) Animals then begin foraging on the ground, in the litter or in low vegetation. If the temperature increases, they seek shelter under

rocks, logs and litter. This alternate basking and shade-seeking is called "shuttling" and is widely practised by lizards and snakes during the day until they return to their burrows at night. Survey technique at these times is more quantitative, involving observation and recording for a fixed time period. Collectors move through each site turning logs, litter and rocks and examining under loose bark, as well as watching for active species. Collectors may also target specific areas such as creeklines for certain semi-aquatic skinks and dragons, and under exfoliating rock slabs for geckos and legless lizards (Pygopodidae). Loose bark at the base of standing trees provides shelter for geckos and skinks. Large monitors may be observed leaving tree hollows to forage on the ground, and tree-snakes observed in low branches. Snakes should not be approached or handled except by experienced collectors.

As with frogs, it is essential to keep accurate and detailed field notes recording the exact locality where a reptile was collected, and also the time, date, weather conditions, temperature, and other relevant information. If animals need to be removed for positive identification, bags and sacks of unbleached calico (with drawstrings) are the most appropriate.

iii) While not often detected in surveys, the Long-necked Tortoise may be observed in swamps and slow moving rivers, and is occasionally seen moving across land in adjacent areas.

D/ Night Surveys

Certain species of reptile are active at night, particularly after rain. The burrowing snakes (Typhlopidae) may be seen at night on the forest floor in warm weather. The pythons (Boidae) are mostly nocturnal but may be seen basking during the day. Geckos may be terrestrial or arboreal, with arboreal geckos active on tree trunks in wetter forests. Night surveys are generally not quantitative in nature, with casual observation and recording the most common approach.

E/ Pitfall Trapping

Traps can be used to collect reptiles and frogs in the case of long-term field studies in particular areas. Pitfall traps are most commonly used, consisting of jars, tins or drums which are buried in the ground with their lips flush to the ground surface. These are often used in conjunction with covers and drift fences. Drift fences are variable lengths of sheet metal, plastic, wire mesh or bitumenised paper, with one edge buried in the ground and supported by stakes. Reptiles or frogs moving through the area come up

against the fence, and finding their way barred, move along the fence. If pit traps are placed at each end then the animals fall into them.

If *dry* pitfall traps are used they must be inspected at least once a day. *Wet* traps (containing a killing and preserving agent) may be left unattended for several weeks, however special permission (NPWS) is required.

Pitfall traps and drift fences cannot be installed in rocky habitats. Some difficulty is also experienced in steep heavily forested habitats where vegetation and fallen logs and slope prohibit easy installation and accessibility. Hand collecting is a more appropriate technique in these circumstances.

7.3 Methodology

A/ Frogs

- Fixed time survey along creeks where appropriate (30 minutes per plot),
- road survey after rain (where appropriate),
- hand collecting at night (1 hour) where feasible (incorporating recording of calls),
- pitfall trapping (see below).

B/ Reptiles

- Observation in morning (30 minutes) while checking pitfall/Elliot traps,
- fixed-time survey during day using most appropriate technique depending on temperature/weather etc (30 minutes at each point on each plot),
- casual observations at night while surveying arboreal mammals/birds,
- 2 *wet* pitfall traps per point (no covers) left open for 2 weeks (ie. 10 per site). Material collected and analysed by consultants, with specimens then being lodged with the Australian Museum. Note: appropriate permits from NPWS MUST be obtained.

7.4 Results

Results from both *general* and *plot-based* surveys should be turned into the appropriate District or Regional office as soon as the individual surveys are completed.

It is likely that the number of data records will be low and therefore results are not amenable to statistical testing. General trends with regard to animal distribution and abundance should however be apparent.

8.0 BAT SURVEY

8.1 Introduction

While some species of bats are numerous and widespread, there are many with restricted ranges and small populations. Public perception of bats is hindered by a reputation of bats as symbols of darkness and evil, as pests (eg. fruit bats) and disease carriers, and the fact that they are often inconspicuous.

Although bats are often seen as a homogeneous grouping, their life histories and feeding strategies are diverse. Some bats are migratory, while others sedentary. Bats using forest areas may roost in dead and live trees, under bark, in sheds and buildings, abandoned mines and railway tunnels, caves and rocky overhangs, under bridges and in vegetation. Bats may seasonally change their roost sites in response to food shortage and abundance, and a number of species can travel considerable distances to specialized feeding sites. Others feed opportunistically in response to short-term insect abundance (eg. termite nuptial flights) or mass local flowering of feed trees. Some have localised maternity caves which are essential to the long-term survival of local populations.

Research is generally not sufficiently advanced to allow the development of management/conservation guide-lines for bats at present. No Australian bat species appears to have become extinct since the arrival of Europeans (Hall 1990), although loss of habitat has caused localised population declines. Insecticide usage and disturbance of cave (roost) environments are also considered serious threats. Richards and Tidemann (1988) identified the major negative effects on the Australian bat fauna to be: clearing and harvesting of temperate forests, selective logging in the wet tropics, and mining and agricultural practices.

8.2 Field Survey

Bat surveys at this stage can provide **qualitative** data. ie. does habitat A have more bat species than habitat B? Techniques are currently not available to census bat faunas. There are good reasons to believe that captures from traps (see below) cannot provide a reliable index of bat activity or abundance at one site or a comparison of relative activity levels or abundance among several sites (Thomas and West 1989). Field survey is however required to identify habitat, roosting and feeding sites, and feeding behaviour.

Bat surveys should ideally use a variety of capturing and recording techniques. Monitoring of bat colonies can be achieved at known roosting sites (eg caves and mines). Microchiropteran bats can be surveyed by the

use of sonar detectors & tape recorders, harp traps (see Tidemann and Woodside 1978), mist nets, and day-time searches of caves, overhangs, old buildings, mines, under loose bark and in hollow trees.

Probably the most promising technique being developed is the use of detectors to monitor bat sonar activity. However, surveying bat activity in habitats by ultrasonic detectors requires moderately sophisticated and expensive equipment and a knowledge of basic bioacoustics. It represents a specialized technique that relatively few people have expertise with, and cannot provide species identification for all species in all communities.

It should be stressed that an integrated approach is essential and that considerable expertise is required. Bat surveys should therefore be conducted by a consultant with considerable survey experience.

References cited:

Hall,L.S. (1990) Bat conservation in Australia. *Australian Zoologist* 26:1-4.

Thomas,D.W. and West,S.D. (1989) *Sampling Methods for Bats.* USDA Forest Service. General Technical Report PNW-GTR-243.

Tidemann,C.R. and Woodside,D.P. (1978) A collapsible bat trap and a comparison of results obtained with the trap and with mistnets. *Aust. Wildl. Res.* 5:355-62.

9.0 FISH SURVEY

At present, fish populations in the streams and rivers within areas managed by the Forestry Commission are not routinely monitored. Hydrological and water quality studies are conducted as a component of environmental procedures and it is considered that these studies will provide indicators as to the condition of fish habitats.

Where required, consultant expertise should be utilised to survey "fauna of special interest".

10.0 INVERTEBRATE SURVEY

Until quite recently environmental impact studies and similar reports in Australia have largely overlooked the importance of terrestrial and aquatic invertebrates in ecosystems. Recognition of the beneficial role that many terrestrial insects, for example, play in pollination and the natural regulation of "pest" species has led to a growing interest in the use of many groups as indicators of the "health" and condition of the habitat (see New 1984, Majer 1987).

In complex and diverse forest ecosystems invertebrates are the most numerous and diverse group of organisms. While the many "roles" played by the multitude of species are not as yet clear, current information clearly implies that disturbance to the invertebrate fauna may severely disrupt the natural functioning of these systems.

Assessment of invertebrate communities is not currently a routine component of fauna survey, however for "species of special concern" consultant expertise should be employed.

References cited:

New,T.R. (1984) *Insect Conservation. An Australian Perspective.* Dr W. Junk Publishers.

Majer,J.D. (ed) (1987) *The Role of Invertebrates in Conservation and Biological Survey.* Procedings of a workshop held during the 18th Scientific Conference of the Australian Entomological Society, Perth Western Australia. Department of Conservation and Land Management.

APPENDIX 1. SUMMARY OF FLORA SURVEY GUIDELINES

Sampling Strategy

1. Use a plot-based strategy unless very good reasons exist for broad area inventory.

2. Stratify by mapped Forest Type (if available) or major habitat factors, or preferably both.

3. Random location of plots is preferable for flexibility of possible future analyses. Plots should initially be randomly located in strata on maps and plot positions then transferred to the field. Subjectivity should generally be restricted to ensuring within plot homogeneity. Other strategies may be appropriate in particular circumstances, due to practical or other considerations e.g. opportunistic sampling of unusual vegetation types not recorded on maps, accessibility constraints on remote plots in strata which are well represented in more accessible areas.

4. Plots should normally be approximately 0.1 ha, with dimensions 50m x 20m. Size and shape may be varied to ensure sample homogeneity e.g. 100m x 10m plots for riparian vegetation, smaller plots for vegetation of limited extent.

Data Collection

Data should be recorded on standard field recording sheets. Samples of such forms are attached and details are given below.

FLORA SURVEY - FLORISTIC DATA

(fdsflor2 7.90)

DATE (1–8)	PLOT IDENTIFIER (9–16)

RECORDERS		COMPUTER FILE		Sheet of

Cover codes : 1=sparse, < 5% ; 2=any number, < 5% ; 3=5-25 %; 4=25-50% ; 5=50-75 % ; 6=>75%

SPECIES CODE (17–24)	I (25)	C (26)	STRATUM 1 2 3 4 5 (27–31)	SUB.ST A B C D E (32–36)	COMMENTS (eg spec. no, full name)

SPECIES CODE (17–24)	I (25)	C (26)	STRATUM 1 2 3 4 5 (27–31)	SUB.ST A B C D E (32–36)	COMMENTS (eg spec. no, full name)

Floristic Data

FIELD NAME	FIELD WIDTH, TYPE	DATA COLUMNS	FIELD DESCRIPTION	REMARKS
sdate	8,N	1-8	Date	as yyyymmdd
plno	8,A/N	9-16	Plot identifier	survey code identifier or management area code plus plot number, to correspond to code used on site data sheet
spcode	8,A/N	17-24	Species code	8-letter species code, normally consisting of the first 4 letters of the generic name plus first four of the specific name; infraspecific taxa may be identified by the first 2 letters of the specific and first two of the infra-specific names
ident	1,A	25	Identification Reliability	record H if a specimen has been collected and retained in a herbarium, S if a specimen has been collected and examined but discarded, U for an uncertain or tentative identification, otherwise leave blank
totcov	1,N	26	Overall species cover code	overall cover code for each species: 1=few individuals, <5% cover; 2=any number of individuals, <5%; 3=6-25%; 4=26-50% ; 5=51-75%; 6=>75%
scov	5,N	27-31	Stratum cover code	cover codes for each species by stratum; code as for totcov; enter code in columns corresponding to each relevant stratum (height classes 1-5 as described elsewhere) in which a species occurs; otherwise leave blank
subcov	5,N	32-36	Subdivided stratum cover code	cover codes in up to five columns as necessary for strata which have been subdivided

FLORA SURVEY PLOT SITE DATA

(fdsflor1 7.90)

Locality ..... Recorded by .....

Plot Size (if NOT 50 x 20m) ..... Map name/scale (if NOT 1:25000) ..... Site photos roll no./frame no. .....

Air photos name/run/print ..... Computer file name .....

	Plot identifier (4-9)	Date (10-17)	AMG Reference: Zone (18-19)	Map Code (20-23)	Easting (24-29)	Northing (30-36)	Latitude D D M M S S (37-42)	Longitude D D D M M S S (43-49)	Geographic Unit Name (50-68)
1		Y Y Y Y M M D D							

Geog. Unit Name (50-68): Name of SF, FR, NP, NR etc. Enter name only eg Mount Boss S.F. as MOUNT BOSS, truncate if necessary.

NSP (69)	Distrid Code (70-71)	Land Tenure (72-73)	Alt. (m) (74-77)	Asp. (deg) (78-80)	Slope (deg) (81-82)	Topo. Position (83-84)	Soil (85-86)	Geology Code (87-90)	Drain (91)	ER (92)	SRE (93)	SRS (94)	Elevation in degrees at bearings: N (95-97)	NE	E	SE	S	SW	W	NW (110-112)	Map FT (113-115)	Field FT (116-118)	Fire History (119-124)	Logging History (125-130)

NSP (69): Enter 1 if plot is NOT 50x20, otherwise blank. Land Tenure (72-73): SF=State Forest, FR=Flora Reserve, NP=NPWS Lands, VC=Vacant Crown Land, CL=Leasehold, PP=Private Property
Topographic Position (83-84): 1=summit, 2=crest, 3=saddle, 4=upper slope, 5=mid slope, 6=lower slope, 7=simple slope, 8=flat, 9=alluvial, 10=minor gully, 11=creek, 12=swamp or closed depression.
Soil (85-86): 1st digit: 1=deep, 2=shallow, 3=skeletal; 2nd digit: 1=clay 2=loam, 3=sand, 4=organic (eg peat) Geology (87-90): use map code if available.

Description of geology: ..... Sample (Y/N)

Drainage (91): 1=v. poor 2=poor 3=moderate 4=well 5=rapidly Exposed rock (92): 0=nil, 1=<10%, 2=10-50%, 3=>50%,
Surface Rock cover (not continuous with bedrock) (93): cover as for exposed rock.
Surface Rock size (94): 1=20-60mm, 2=61-200mm, 3=201-500mm, 4=501-1m, 5=>1m

Forest Type Description: .....

Fire History (125-130): (125) Intensity of most recent event: 0=no evidence, 1=light, 2=moderate, 3=severe; (126-129)=Time ± accuracy, in yrs eg 2505 = 25 ± 5 yrs, 9900 = >99 yrs; (130): 1=estimate, 2=historical records; Logging History: as for fire.

Description of logging or fire history .....

	Strat (10-11)	Cover Code (12)	S (13)	C (14)	Species 1 (15-22)	Species 2 (23-30)	Species 3 (31-38)	Crown Cover % (39-41)	Crown density % (42-44)	Foliage or Canopy Cover (45-47)	Min. Ht (m) (48-49)	Max. Ht (m) (50-51)
2												
2												
2												
2												
2												

Stratum (10-11): 2 ch code ;1st ch=height code no. 1=>35m, 2=20.1-35, 3=6.1-20m, 4=1.1-6m, 5=0-1m; 2nd ch=letter corresponding to column on floristic data sheet.
Cover Code (12): 1=<5%; 2=5-25; 3=26-50; 4=51-75; 5=>75 Stratification (13): 1 if continuous, otherwise blank.
Floristic Composition (14): 1 if mixed species composition with no clear dominants, otherwise blank.

Description of vegetation: .....

DBHOB of largest individuals of selected species: .....

Comments: .....
(e.g. other disturbance such as grazing or feral animals;age structure of stand as overmature, mixed age or several-aged; homogeneity or patchiness of understorey)

Site Data

FIELD NAME	FIELD WIDTH, TYPE	DATA COLUMNS	FIELD DESCRIPTION	REMARKS
plno	8,A/N	2-9	Plot identifier	survey or management area prefix, followed by plot number (repeated in columns 2-9 for all data lines)
sdate	8,N	10-17	Date	as yyyymmdd
amgz	2,N	18-19	AMG grid zone	2 digit code as specified on 1:25 000 topographic map
amgm	4,N	20-23	AMG map code	as specified on 1:25 000 topographic map
amge	6,N	24-29	AMG easting	6 digit, to 1m, padded with trailing zeroes, as necessary
amgn	7,N	30-36	AMG northing	7 digit, to 1m, padded with trailing zeroes, as required
lat	6,N	37-42	Latitude	6 digit, degrees + minutes + seconds
longit	7,N	43-49	Longitude	7 digit, degrees + minutes + seconds
sgu		50-68	Special geographic Unit	name of SF, FR, NP, NR, etc, recorded as name only, truncated if necessary; e.g. Mount Boss SF as MOUNT BOSS
nsp	1,N	69	Non-standard plot	record 1 if plot size is **not** 0.1 ha, otherwise leave blank
dc	2,A	70-71	District code	2 letter code as used for costing
lt	2,A	72-73	Land tenure	SF=State Forest, not in reserve, FR=Flora Reserve or Forest Preserve; NP=Lands controlled by NPWS; VC=Vacant Crown Land; CL=leasehold; PP=Private Property.

alt	4,N	74-77	Altitude	in metres
asp	3,N	78-80	Aspect	in degrees, use 360 for north; 0 will be assumed not recorded
slope	2,N	81-82	Slope	in degrees
topo	2,N	83-84	Topographic Position	coded as 1=summit; 2=crest; 3=saddle; 4=upper slope; 5=mid slope; 6=lower slope; 7=simple slope; 8=flat; 9=alluvial flat; 10=minor gully; 11=creek; 12=swamp or closed depression.
soil	2,N	85-86	Soil description	col 21 - depth: 1=deep, 2=shallow, 3=skeletal col 22 - type: 1=clay, 2=loam, 3=sand; 4=organic
geol	4,A	87-90	Geology	use map code if available
drn	1,N	91	Drainage	one digit, coded as: 1=severely impeded; 2=moderately impeded; 3=moderately drained; 4=well drained; 5=rapidly drained; note that creeks should be assessed independently of surface water and may be coded in any of the 5 categories
erock	1,N	92	Exposed bedrock	code percentage of area occupied as: 0=nil; 1-<10%; 2=10-50%; 3=>50%.
src	1,N	93	Surface rock cover	code as for exposed bedrock
srps	1,N	94	Surface rock particle size	approx. size range of most numerous particles, codes as 1=<6cm; 2=20-50cm; 3=50-100cm; 4=>100cm
rad1-rad8	8x3,N	95-118	Elevation at bearings	elevation in degrees, including + or -, at each of 8 bearings, padded with zeroes as required
mft	3,N	119-121	Mapped forest type	Forest Type code (R.N. 17) as mapped, if available
fft	3,N	122-124	Field forest type	Forest Type code as determined in the field

firehist	6,N	125-130	Fire history	col 125 - Fire intensity: intensity of most recent fire, coded as 0=no evidence; 1=light (only ground fuel burnt); 2=moderate (shrub layer burnt); 3=severe (tree overstorey burnt), 9=indeterminate. cols 126-129 - time since last fire, ±accuracy (in years); e.g. 2505=25±5 yrs. Use 9900 for unknown or indeterminate; col 130 - 0=estimate, 1=historical record
loghist	6,N	131-136	Logging history	col 131 - Logging intensity: intensity of most significant logging event, coded as 0=no evidence, 1=light (<30% canopy removed) 2=moderate (30-70% canopy removed), 3=severe (>70% canopy rem.) cols 132-135 - time since logging, coded as for fire history. col 136 - code as for fire history

Vegetation structure

strat	2,A/N	10-11	Stratum class	col 10 - height class code: 1=>35m; 2=20.1-35m; 3=6.1-20m; 4=1.1-6m; 5=0-1m col 11 - subdivision code letter corresponding to letter on floristic data sheet.
cov	1,N	12	Cover code	overall cover code for the stratum, as 1=<5%, 2=5-25%, 3=26-50% 4=51-75%, 5=>75%
vs	1,N	13	Stratification	record 1 if vertical layering is obscure or not evident, otherwise leave blank
comp	1,N	14	Composition of stratum	record 1 if of mixed species composition with no clear dominants, otherwise leave blank
sp1	8,A	15-22	Species code	8 letter code for dominant species
sp2	8,A	23-30	Species code	8 letter code for second most dominant species
sp3	8,A	31-38	Species code	8 letter code for third most dominant species
ccov	3,N	39-41	Crown cover	percentage projected crown cover (tree dominated strata only)
cden	3,N	42-44	Crown density	percentage crown density (tree dominated strata only, refer to sample sheet)
folcov	3,N	45-47	Foliage cover	percentage projected foliage cover
htrange	6,N	48-51	Height range	height range to nearest metre; cols 48-49 minimum, cols 50-51 maximum, minimum is optional.

APPENDIX 2. COLLECTION OF HERBARIUM SPECIMENS

1. What to Collect

Collection and maintenance of herbarium material requires considerable investment of resources. The following are regarded as priorities:

- representative samples, including common species; preferably, the majority of species recorded on a Regional basis should be represented by specimens,
- specimens representing unusual distribution or habitat records,
- particularly good or complete flowering or fruiting material,
- unusual morphological forms.

2. Data to be Recorded

As a minimum, every specimen should have the following information recorded and included on the herbarium label:

* Collector,
* Date,
* Locality - as precise as possible, preferably using a brief general description plus grid co-ordinates (latitude and longitude and/or AMG reference). It should be possible to relocate the population on the basis of the information provided,
* Habit - growth type, size,
* Habitat - at least a broad description of vegetation type, preferably also physical habitat such as topography, aspect, altitude, geology.

Any additional information should be included, e.g. frequency or abundance at the collection site, associated species, morphological details not apparent in a dried specimen (fruit, flower colour).

(cont...)

If the specimen is collected from a flora inventory plot, most of the information should already be on the site sheet and may be simply transferred from there to the herbarium label. The plot number should also be recorded on the label.

3. Distribution of Specimens

Regional Research Centres with established herbaria (Coffs Harbour, Wauchope, Eden, Tumut) will be the main repositories of specimens originating in the Regions for which they are responsible. These centres should forward mounted duplicates of all specimens of particular interest to the Herbarium at W.T.F.R.D.

The W.T.F.R.D. Herbarium will be the main repository for specimens from Dubbo Region, and will hold a representative collection of specimens from other regions.

4. Role of Research Permittees and Consultants

Research Permittees and Consultants undertaking any activity which involves collection of plant specimens should be obliged to contribute duplicates of at least a representative sample.

APPENDIX 3. GUIDE-LINES FOR REPORTING FLORA INVENTORY DATA

These guide-lines refer only to descriptive reports which aim to simply present survey data with no attempt at detailed analysis or interpretation.

1. Taxonomic Arrangement and Nomenclature

Taxonomy and nomenclature of plant species are notoriously variable, depending on current interpretations and opinions, and opinions may vary even among specialist taxonomists. As a standard, the Commission will follow the National Herbarium of N.S.W. Forest Ecology section is currently preparing a statewide computerised reference list of vascular species likely to occur on State Forest. This is basically an updated, computerised version of "Plants of New South Wales" by Jacobs and Pickard. It will include taxonomic data, common names and basic attributes such as growth habit. It will be updated regularly and made available as required, for use throughout the Commission.

Floristic lists may be arranged in a number of ways. Preferably, species should be listed alphabetically by Family, Genus and Species, and grouped either in Classes (according to Flora of NSW, Vol. 1) or as Pteridophytes, Cycads, Conifers, Monocotyledons, Dicotyledons. A reasonable alternative would be to simply list alphabetically by genus and species.

2. Distribution and Habitat Information

Should generally be presented concisely, but in as much detail as possible. Species occurrences are best reported as a composite list for the survey area, showing occurrences (by abundance or cover) at individual survey sites. Alternatively or additionally, occurrences (as frequency or mean cover-abundance) may be shown for groups of sites representing similar vegetation, such as Forest Types. Any species recorded during the survey, but not at survey plots, should also be listed. General vegetation descriptions for individual plots or groups of plots, including dominant species, height and cover for at least the canopy stratum, should be included. A list of plot locations (grid references) and habitat details (e.g. altitude, aspect, topographic position, geology), plus maps with locations marked, is also desirable.

3. Herbarium Specimens

An indication should be given of which species records are supported by specimens held in herbaria. As a minimum, a simple annotation, such as "H" preceding the species name, to indicate the existence of a specimen held in

a particular herbarium, would suffice. A reference could also be made to specimen number (collector's number or herbarium accession number).

4. Features of Interest

It is important that any botanical features of interest, such as nationally or regionally rare species, unusual or significant distribution records, or unusual community composition, be emphasized. With the exception of national conservation significance, for which Briggs and Leigh ("Rare or Threatened Australian Plants", ANPWS Spec. Publ. No. 14, 1988) provides a well accepted standard, these features may be difficult to judge because of the frequent lack of accessible, relevant information. Local knowledge of field staff and unpublished data are useful supplements to the meagre published information.

APPENDIX 4. EQUIPMENT FOR ARBOREAL MAMMAL SURVEY

(An example from the Mt.Royal EIS Fauna Survey)

Equipment : TOTAL

Spotlights: 2 items: $22.45 x 2 .....$44.90
Hella Spotlight. 12V 100w Part No. 1089

Battery Charger: 1 item approx. $40.00 .....40.00
Supplier:
Repco Auto Parts
85 Victoria Road Parramatta
Phone 683 4444

Batteries: 6 items: $29.00 x 6 .....234.00
Yuasa Wet Cell Batteries
12 V 12 AH. 12N-12A-4A-1

Supplier: Yuasa Batteries
25 Smith St. (rear entry)
Chatswood Phone 407 0222 Fax 417 8523 Contact: Mark
Pick up by WIFRD required to get activated batteries

Amplifier: 2 items: $331.22 total cost 331.22
TOA Model No. ER-66
Supplier: AWA Distributors
112-118 Talavera Road
North Ryde. Phone: 888 9000

Tape Recorders: 2 items: $525.00 x 2 .....1050.00
Sony WM-D6C Walkman Professional Tape Recorders

Tapes: 10 tapes: 1 box: $33.00 .....33.00
Sony Type I HF120 blank cassettes.
Supplier:
Sony Retail Centre
505 Victoria Road
Chatswood, NSW Phone 411 2090

Batteries: 6: $21.69 x 6 .....130.14
GS Portalac.
Supplier:
Okura and Co. Aust. Pty Ltd.
5th Floor 275 George ST., Sydney
Phone 290 2111 Contact: Mr. Al Keshang

APPENDIX 5. FAUNA DATA SHEETS

The following are examples of data sheets used during the Mt.Royal EIS Fauna Survey. All data recording must conform to this layout. Copies of these sheets are available from:

Forest Ecology & Silviculture Section
Wood Technology & Forest Research Division
Forestry Commission of NSW
P.O. Box 100
Beecroft NSW 2119

BIRDS – SPOT POINT DATA SHEET

Observer..... Location.....

Identifier	Observer	Location	Date D M Y	Time	Census	Point	Temp Co	Wind	Rain	Total Species <30m	Total Species <50m	Total Individuals <30m	Total Individuals 50m	Cicada
1 3	6	9	14 16 18	20	24	25	27	29	30	31	34	37	40	43
Ø 1														

	Species Code	0 to 5	5 to 10	10 to 20	20 to 30	30 to 50	Total 0 to 30	Total 0 to 50	Habitat
1 3	6	10	12	14	16	18	20	22	24
Ø 2									
Ø 3									
Ø 4									
Ø 5									
Ø 6									
Ø 7									
Ø 8									
Ø 9									
1 Ø									
1 1									
1 2									
1 3									
1 4									
1 5									
1 6									
1 7									
1 8									
1 9									
2 0									
2 1									
2 2									
2 3									
2 4									
2 5									

DUPLICATE

Silv27 – 1984

PRINTED IN AUSTRALIA

ARBOREAL MARSUPIAL DATA SHEET

DATE	PLOT	SPP.	DIST	TREE	DBH	HT(AN)	HT(TR)	RDK	NOTES

SMALL ARBOREAL MAMMAL SURVEY DATA SHEET

PROJECT : _____ SITE : _____

Date	Day	Line	Spp.	Sex	Weight	H-B	Tail	HF	Status

COMMENTS : _____

SUMMARY : _____

Lyn,

Herewith, as discussed

(a) District break-up (NB recommendation only)

(b) Regional boundary map

Further enquiries should be directed to the Northern Region - General Manager.

M. Plover
For B. J. SALTER
REGIONAL FORESTER
PORT MACQUARIE

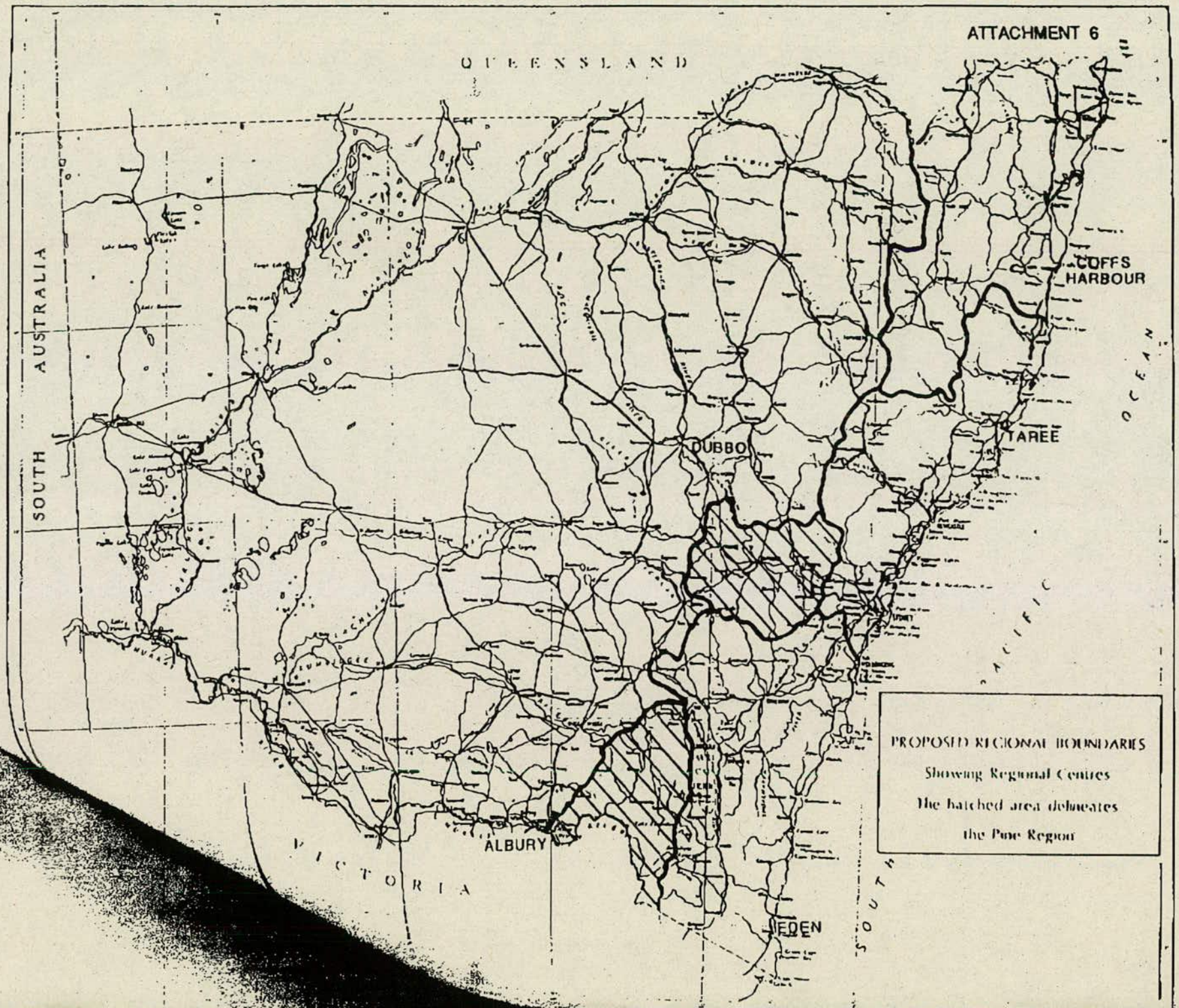
REGION	NEW DISTRICT	EXISTING DISTRICT
WESTERN (DUBBO) (9½ Districts reorganised to 6)	INVERELL	INVERELL TAMWORTH (NORTH)
	BARADINE	TAMWORTH (WEST) BARADINE WARUNG M.A. (MANAGEMENT AREA)
	GRIFFITH	NARRANDERA GRIFFITH
	DENILIQUIN	DENILIQUIN MILDURA
	DUBBO	GILGANDRA MUDGEE COBAR M.A.
	FORBES	FORBES
NORTHERN (COFFS HARBOUR) (11½-7)	GLEN INNES	TENTERFIELD GLEN INNES
	WALCHA	ARMIDALE WALCHA TAMWORTH (EAST)

	CASINO	CASINO MURWILLUMBAH
	URBENVILLE	URBENVILLE
	GRAFTON	GRAFTON COFFS HARBOUR (NORTH)
	DORRIGO	DORRIGO & PART GRAFTON, PART COFFS HARBOUR (WEST)
	URUNGA	URUNGA COFFS HARBOUR (SOUTH)
CENTRAL (TAREE) (11-6)	TORONTO	CESSNOCK (SOUTH OF HUNTER) WYONG SYDNEY
	GLOUCESTER	CESSNOCK (NORTH HUNTER) MT. ROYAL M.A. CHICHESTER M.A. GLOUCESTER M.A. (MINUS CRAVEN S.F.)
	BULAHDELAH	BULAHDELAH WALLAROO M.A. CRAVEN S.F.
	WAUCHOPE	WAUCHOPE KENDALL MINUS COOPERNOOK AND MARSH
	KEMPSEY	KEMPSEY
	TAREE	TAREE PLUS COOPERNOOK
SOUTH EAST (EDEN) (8-5)	EDEN	EDEN, PART BOMBALA BEGA (SOUTH)
	BOMBALA	BOMBALA ADAMINABY M.A.

	NAROOMA	NAROOMA BEGA (NORTH)
	BATEMANS BAY	NOWRA BATEMANS BAY
	QUEANBEYAN	QUEANBEYAN PLUS BADJA MOSS VALE
PINE REGION (ALBURY) (6-4)	OBERON	OBERON, PART LITHGOW
	BATHURST	ORANGE, PART LITHGOW
	TUMUT	TUMUT
	TUMBARUMBA	BATLOW TUMBARUMBA

REGIONS 9-5
DISTRICTS 40-24

ATTACHMENT 6



CODE OF LOGGING PRACTICES

Crown Timbered Lands

PORT MACQUARIE REGION

INDEX

1. SUMMARY

This code will apply to all harvesting operations controlled by the Port Macquarie Forestry Region.

Set out hereunder are codes of logging practice to ensure:-

- good standards of workmanship;
- safe working practices;
- protection of the forest and its environment;
- adequate accountability for products obtained.

All contractors and/or operators in State Forests and other Crown-timber lands are required to comply with the provisions of this code.

2. LEGAL

2.1 Operations on State Forests and other Crown Lands are governed by various Acts. The Acts and their principal provisions are described briefly herein.

2.2 FORESTRY ACT 1916 AND REGULATIONS UNDER THE ACT (administered by the Forestry Commission of N.S.W.)

2.2.1 The Commission is empowered to control the removal of timber and products, the use of fire and many other matters relevant to the proper management of areas under its control.

2.2.2 Arising from 2.2.1, the Commission in conjunction with the Catchment Areas Protection Board has prescribed Standard Erosion Mitigation Conditions for Logging and Clearing in New South Wales and all operations shall conform to these conditions. Nothing expressed in this Code shall affect these Standard Conditions, the latest edition of which is dated June, 1984.

2.2.3 All commercial harvesting operations involving a royalty value above an amount specified by the Commission will be authorised by Timber Licences.

2.2.4 Contractors who engage operators must hold current Contractors Licences.

2.2.5 Operators engaged by holders of Timber Licences or Contractors Licences must hold current Operators Licences.

2.2.6 Timber, Contractor and Operator Licences contain conditions binding on the holders. Nothing expressed in this Code shall affect the conditions attached to any of these licences.

2.2.7 The non observance of an instruction issued by an authorised officer or a breach of licence condition, which embraces inter alia a breach of this Code may lead to the imposition of sanctions. These could include a warning letter, a penalty notice, a suspension of licence, prosecution, cancellation of licence or non renewal of licence.

2.2.8 (i) An operator or contractor suspended from operating by verbal direction from an authorised officer or employee is to cease work immediately. The operator or contractor has a right to make representations to the Regional Forester Port Macquarie within 24 hours.

(ii) If the Regional Forester is of the view that the suspension should stand after consideration of the District Forester's report and any representations made, suspension advice will be served on the operator or contractor as soon as is practical.

2.3 WORKERS COMPENSATION ACT 1987
(Administered by the Workers Compensation Commission)
All employees engaged in harvesting must be insured under the provision of the Workers Compensation Act.

2.4 OCCUPATIONAL HEALTH AND SAFETY ACT
(Administered by the Department of Industrial Relations)
All persons engaged in the Timber Industry are required to comply with the provisions of this Act. The Forestry Commission as "owner" of State Forests has a special responsibility under Sections 16(1) and 17(1) of the Act to ensure that no one is exposed to risks to their health or safety whilst in the forest environs.

2.5 FACTORIES SHOPS AND INDUSTRIES ACT, 1962 and TIMBER INDUSTRY (HEALTH AND SAFETY) REGULATIONS 1983
(Administered by the Department of Industrial Relations)
All persons involved in the Timber Industry are required to comply with these regulations. Included in the provisions are requirements covering the proficiency of workers, first aid, machinery, felling and logging and hand tools.

2.6 MOTOR TRAFFIC ACT 1909 AND STATES ROAD ACT 1919
(Administered by the Department of Motor Transport)

2.6.1 All motorised vehicles engaged in the haulage of timber on roads open to the public in State Forests and Crown timber lands are required to be registered in accordance with provisions of the Motor Traffic Act and to comply with the provisions of the Regulations made under the States Roads Act.

2.6.2 Logging plant other than vehicles described in 2.6.1 above shall be covered by an Unregistered Vehicles permit for the Operation of Logging Vehicles issued by the Department of Motor Transport.

2.6.3 All drivers of vehicles operating in State Forests and Crown Timber lands are required to be licensed in accordance with the Act.

2.7 LOCAL GOVERNMENT ACT 1919

2.7.1 Littering. It is an offence to deposit litter in State Forests. Forestry officers are authorised to take action under this Act.

2.7.2 Load Limits. All vehicles using forest roads shall comply with the Ordinances under the Local Government Act. In regard to load limits these are Ordinances 30C and 30D.

2.8 NATIONAL PARKS AND WILDLIFE ACT 1974
(Administered by the National Parks and Wildlife Service)

2.8.1 Aboriginal Relics. Any relic discovered is to be left undisturbed and reported to the District Forester.

2.8.2 Fauna. Almost all native mammals, birds and reptiles are protected fauna and may not be taken or killed.

2.8.3 Protected Native Plants. Protected native plants may not be picked or removed unless authorised by a licence issued by the Commission.

2.9 SURVEYORS ACT 1929 and SURVEY CO-ORDINATION ACT 1949
No unauthorised person may deface or interfere with any survey mark.

- identification of subunits within the logging area where logging is precluded or modified
- any special features required for the logging area
- assessed erosion hazard as defined in the Standard Erosion Mitigation Conditions.

4.5 Harvesting plans for new logging areas will be issued to the appropriate holders of Timber Licence(s), Contract Licence(s) and Operators Licence(s) prior to commencement of operations in that area.

4.6 The Timber Licensee shall endorse the harvesting plan as a practical plan or shall consult with the supervising Forester to seek amendments judged necessary. No changes to harvesting plans may be made without the prior approval of the supervising Forester.

5. TREE MARKING

5.1 Forestry Commission supervisory staff are the only personnel authorised to mark trees for removal or retention.

5.2 The identification of trees to be retained will be described in the harvesting plan applicable to the area. All unmarked trees judged to meet minimum log standards are to be felled unless it is considered unsafe to do so.

5.3 The identification of trees to be removed, whether as a follow up marking to 5.2 or as an initial marking will be described in the harvesting plan. All trees so marked are to be felled unless it is considered unsafe to do so.

5.4 No person other than the supervising Forestry Officer shall deface or cancel any mark on a tree. The supervising Officer shall inform contractors or operators the identification of a cancelled mark.

6. FELLING

6.1 No person shall operate a chain saw unless holding an accreditation certificate acceptable to the Forestry Commission appropriate to the class of timber in which he is working, unless the operator holds a licence endorsed to the effect that chain saw operation is permitted under adequate supervision from a fully accredited person.

6.2 The holder of the contractors licence or the timber licence shall be responsible for erecting signs in conformity with AS1319-1979 indicating "Tree Felling in Progress" so that they are clearly visible to oncoming traffic from either direction when felling is in progress.

6.3 Stump heights shall be kept to the minimum, consistent with safe working practices and with maximum recovery of utilisable timber. Subject to these considerations, stump height should normally not exceed 50% of stump diameter.

6.4 Directional felling, including the use of wedges shall be used to both minimise damage to retained stems and to comply with safe and efficient felling practice.

6.5 All trees over 20 cm D.B.H.O.B. shall be felled using a scarf and back cut.

6.6 A minimum distance of twice the height of the last tree being felled shall be maintained between persons or groups working.

6.7 Trees lodged or partially cut shall be completely felled or otherwise made safe as soon as practicable.

Any marked tree felled in error is to be reported as soon as is practicable to the Commission's supervisor.

6.9 All trees felled shall be processed to achieve maximum utilisation. Minimum log specifications for all products will be ascertained. Minimum quota sawlog specifications for Port Macquarie Region are given in Appendix 1 of this Code.

6.10 Filter strips as defined in the Standard Erosion Mitigation Conditions shall be identified in harvesting plans together with any additional constraints or conditions, (often associated with felling), deemed necessary.

No tree shall be deliberately or negligently felled into a stream within a filter strip. Accidental cases of heads lodging into such a stream shall be reported to the Commission to determine whether their removal is justified. Any removal of the head should minimise disturbance to the bed and the bank of the stream.

3. SAFETY

3.1 All work performed in the Forest shall be in accordance with the Timber Industry (Health and Safety) Regulation, 1982 and the Occupational Health and Safety Act, 1983 and nothing in this Code shall affect the provisions of this legislation.

3.2 An employee shall comply with all reasonable directions given by the employer pertaining to safety and report to the employer without delay any work situation or vehicle or tool condition which has become or is likely to become a source of danger.

3.3 Industry supervisors shall give effect to Section 5a of the Regulation by ensuring that an employer does not permit an employee to undertake any work unless that employee has been adequately trained and instructed as to

. any dangers associated with that work and

. in any safety precautions which ought to be taken.

3.4 Industry supervisors shall give effect to Section 5b of the Regulation by ensuring that an employer does not permit an employee to operate without competent supervision any power-driven tool, machine or equipment unless the employee has been adequately trained and instructed in its operation and is capable of safely operating it without supervision.

3.5 Employers shall provide their employees with, and contractors shall provide themselves with:

a) an approved safety helmet;

b) suitable heavy-duty footwear, having firm ankle support and non-slip soles.

Such equipment shall be worn whilst on the Forest and shall be maintained in a serviceable condition.

3.6 Employers, contractors and employees shall comply with the hearing conservation provisions of Section 7 of the Regulation.

3.7 Employers shall provide first-aid chests

a) at each logging site within reasonable distance of every employee;

b) on every vehicle used by or on behalf of the employer to transport any person to or from the site of logging work.

These first-aid chests shall be equipped, marked and maintained as in the Regulation.

3.8 Operators in the timber industry shall not, as far as is reasonably practical, work beyond calling distance of another person and in any event, the well being of an operator shall be ascertained at least once during the period of work as well as at the completion of the work period.

3.9 Other specific safe working conditions and practices are provided elsewhere in this code.

3.10 All work injuries are to be reported as soon as practicable to the injured person's supervisor.

4. PLANNING OF HARVESTING OPERATIONS

4.1 Where provided for in Wood Supply Agreements, the Forestry Commission shall provide an Order of Working for each calendar year for the supply of timber to that Industry no later than 30th October of the preceding year.

4.2 It is the responsibility of industry to ensure that it holds sufficient levels of log stocks to allow its mill to continue operation during periods of wet weather logging constraints. Such log stocks should be in the order of 6 - 8 weeks reserve.

4.3 Areas of suitable wet weather logging country are very limited and the operational application of planned Orders of Working will be directed towards minimising the use of such areas.

4.4 Harvesting plans will be prepared in advance for all logging areas. Such plans will include all essential features required to enable logging to proceed, such features to include

- the definition of boundaries of the logging area
- description of product(s)
- tree marking prescription, if applicable
- identification of logging tracks and dump sites
- identification of filter strips as defined in the Standard Erosion Mitigation Conditions

6.12 Trees shall not be felled across roads, tracks, (including road batters, table drains and inverts of drainage structures), or other improvements or structures unless authorised by the Commission. Where such trees are felled under authority, the trees together with associated slash and debris shall be removed as soon as practicable and repairs effected immediately.

7. SNIGGING AND DUMPING

7.1 All operations shall be carried out in such a manner as to minimise soil disturbance, water pollution and environmental damage generally. Disturbance to drainage lines not designated as filter strips should be afforded special protection, and on completion of operations crossings of dry streams by minor roads or snig tracks shall have the sites of the crossing restored to its original condition as closely as possible.

7.2 Snig track construction is not permitted on slopes over 35°, (30° for High Erosion Hazard) unless specifically authorised.

7.3 Grades on snig tracks shall not exceed 25° unless specifically authorised.

7.4 Mechanical logging equipment shall not enter filter strips except to provide access for approved crossing points of drainage lines.

7.5 Where possible, surface vegetation shall not be removed from snig tracks, and as far as is possible snigging shall be uphill.

7.6 "Blading Off" on minor roads and snig tracks is prohibited unless specifically authorised.

7.7 Construction of snig tracks will aim at minimising damage to retained stems, including regeneration.

7.8 Snigging across or along roads or trails will not be permitted except as authorised by the Commission.

7.9 Harvesting plan areas shall be worked in a systematic manner, as directed by a Forest Officer, to ensure that a minimum number of snig tracks and dumps are worked at any one time.

7.10 Drainage of snig tracks and minor roads, other than permanent fire trails, shall be carried out in conformity with the Standard Erosion Mitigation Conditions. The required frequency of cross drainage banks will be prescribed in the harvesting plan. Drainage shall be carried out progressively on each track upon completion of, or temporary cessation of, operations.

7.11 Drainage of fire trails or non piped other roads shall be by crossfall (outfall) drainage or, where run off cannot be controlled, by open cross drains. Works shall be undertaken in conformity with the "Guidelines of Plan Construction and Maintenance of Trails (1983)", issued jointly by the Commission and the Soil Conservation Service.

7.12 Log dumps shall be located as specified in the harvesting plan and shall not be located closer than 10 metres from a filter strip or drainage line. The location of additional or alternative dumps require specific approval.

7.13 Dump size will be minimised subject to efficient operations.

7.14 On completion of operations dumps are to be drained, ripped if directed and unless otherwise authorised shall be levelled and have stockpiled topsoil replaced.

7.15 Unless otherwise authorised by the Commission, bark accumulated at roadside or dump shall be either returned to the forest floor and dispersed or buried in a manner as to not create a fire hazard for retained trees.

7.16 Logs requiring inspections at dump shall be left in a safe position.

7.17 In integrated operations, product segregation will be as directed by the Commission's supervisor.

7.18 Log stacks will be constructed so that they are stable and pose no risk to those working in the dump area.

8. LOG MEASUREMENT, MARKING AND RECORDING

8.1 Unless otherwise authorised by the Commission each item of timber shall be

a) marked to identify the area on which it was cut, and

b) measured, with such measurements marked on the item before it is removed from the area.

8.2 No timber shall be removed from the area unless the timber has been branded with a Commission brand or its removal has been otherwise authorised by the Commission.

8.3 Unless logs have been tallied by the Commission, delivery dockets in a format approved by the Commission shall be completed in relation to each load before it is removed from that area.

8.4 Markings on logs as in 8.1, shall not be altered, defaced or removed unless otherwise authorised by the Commission.

9. ROAD HAULAGE AND USE OF ROADS

9.1 Road haulage vehicles shall conform with Regulations prescribed under the Motor Traffic Act, comply with load limits imposed under the Ordinances of the Local Government Act and safety aspects prescribed under Timber Industry Regulations.

9.2 Roads may be closed to haulage vehicles when in the opinion of the supervising Forestry Officer damage to the road formation or its structure are expected to occur.

9.3 The Commission will carry out normal maintenance to forest roads following completion of operations. However the relevant licensee will be responsible for repair of excessive damage caused by irresponsible actions.

9.4 No vehicle shall be loaded whilst standing on or within 10 metres of a permanent road without the prior approval of the supervising Forester.

9.5 All loads are to be securely bound by a minimum of two binding chains, wire ropes or other devices prior to leaving the log dump.

9.6 No haulage tracks other than those allowed for in the harvesting plan will be constructed without the permission of the supervising Forest Officer.

10. WET WEATHER LOGGING OPERATIONS

10.1 Application

Wet weather constraints on log extraction and haulage will apply to all operations. Automatic closures will apply under certain defined circumstances. Closure other than automatic closures will be applied when in the opinion of the supervising Forester, either roads and tracks are likely to be damaged by operations, or the quality of water entering drainage lines is adversely affected.

10.2 Automatic Closures

Automatic closures will apply to vehicles engaged in log haulage whenever/whilever water commences/continues to flow on road surfaces, other than bitumen or gravelled, including natural gravel. Such closures shall continue until active run off is confined to table drains. No notification to industry will be necessary.

10.3 Notified Closures

10.3.1 Where in the opinion of the supervising Forester closures in addition to automatic closures are required, timber licensees will be advised orally of declarations, terminations and specific constraints relating to notified closures. Timber licensees shall advise contractors and operators of such closures, except in the case of integrated operations where notice shall be given by the Commission.

10.3.2 The Forestry Commission reserves the right to notify operators in the forest direct where it is not possible to immediately advise the Timber Licencee of declarations of notified closures. In such cases the Timber Licencee will be advised as soon as possible.

Notes on Conference 1/c FCNSW @ Pennant Hills 17/6/91

Tony Hare: Chief MPD.
Peter Smith Head EAU.
~~Noel~~ Management Officer MPD.
David Hamilton

collect + and research
WTFR Div

Taking on pre-formal public participation meetings as per other NSW gov't agencies. Public meetings not most productive process.

Wingham MA - Treeyard - Noel Corkery
1/c Epps and Associates. } just let Wingham MA EIS contract

$125 K = a consultancy ⊕ $100 K for F+F. advert then 3 or 4 focus meetings
$100K on Wingham MA flora + fauna!

Mount King Eco. → Dorrigo MA. work.
G.I.S. → need for standardised methodology. "Yes" for nat. env.
methodology → F&F protocols developed by WRT → sent to other agencies
available?
"designed to agree ~~to~~ with NFI" → Jim Shields

emphasising R + End. Sp. → need to have other experts advise about methodologies - presence/absence or habitat requirements

Mistake S.F.: release in next month
Duck Ck / Dome Mtn: in draft form
Ben Halls Gap : " " "
Mount Royal : Kinhills 3/4 finished.

Bob Nimmo (NFI)
C.L.A Div.

Glen Innes MA - expressions of interest called for by end of July = Greg Watts

RESEARCH AND REVIEW REQUIRED FOR THE WINGHAM MANAGEMENT AREA ENVIRONMENTAL IMPACT STATEMENT

WINGHAM FOREST ACTION AND NORTH EAST FOREST ALLIANCE

AUGUST 1991

SOILS

1.There needs to be a thorough assessment of the impacts of burning, grazing, roads, snig tracks and log dumps correlated with soil types. In particular the following aspects need to be detailed and evaluated:

a. nature and depth of compaction resultant from the various machines intended to be utilised , considering frequency of passage and soil types.

b. the effect of compaction on regrowth, productivity, soil density, hydraulic conductivity, aeration, nutrient availability and soil organisms.

c. the role of soil moisture in increasing compaction and the variations with soil types.

d. the extent and nature of compaction and other soil disturbances in logging areas.

e. the natural process of soil reconstruction and time scale involved.

f. the tilling and puddling effects of machines.

g. the impacts of road compaction,wheel ruts and other soil disturbances on soil moisture, hydrological regimes, runoff and erosion.

h. the effectiveness of filtration slopes and filter strips in reducing soil erosion and siltation.

i. the vulnerability of various soil types to disturbance and the impacts of proposed operations upon them.

j. identification and mapping of areas of unstable and easily erodable soil types.

k. measures to be taken to reduce compaction, and their effectiveness.

l. measures to be taken to restore soil structure, and their effectiveness.

2. There needs to be a thorough evaluation of the effectiveness of the Standard Erosion Mitigation Conditions (SEMC) in the management area, with an evaluation of their past implementation and long term effectiveness. Consideration needs to be given to:

a. improving SEMC to take into account local climatic conditions by decreasing spacing of cross drains.

b. increasing extent and protection of filter strips.

c. restricting logging to slopes less than 20 degrees.

d. redifining of watercourses and drainage areas.

e. improving rehabilitation.

NUTRIENTS

1. It is important to identify the reserves of nutrients in soils and biomass available for plant growth for representative samples of major forest and soil types.

2. Correlation between nutrients, vegetation including weeds, and fauna should be identified.

3. Detailed assessment must be made of losses of individual nutrients due to logging operations, run off, erosion, leaching and burning at various intensities.

4. Natural attrition of nutrients (in the absence of fire or human induced disturbances) due to leaching and runoff along with natural inputs (from parent rock and atmosphere) need to be quantified and a nutrient budget prepared.

5. Specific nutrient losses for the various forest types and proposed operations, should then be assessed and mitigation measures and their effectiveness detailed, particularly with regard to repeated short cycle regrowth thinning programs.

VEGETATION

1. Quantative assessment of the impacts of various disturbances (roading, logging, burning, grazing) and their frequency on species composition and structure of vegetation, seed store, regeneration and weed invasion need to be made to enable prediction of vegetation changes over the life span of the longest lived components.

2. Rare, endangered, restricted and sensitive (to disturbance) plants must be identified and their habitat requiremnets ascertained to enable predictive modelling of their future occurance under different management options.

3. Assessment of present and predicted (over the lifespan of the longest lived individual) age class distribution of stands of all forest types throughout the total area of their occurrence,needs to be undertaken and the results detailed.

4. The impacts of roading, logging, burning and grazing on rainforest should be determined and the impacts of various management strategies and mitigation measures identified.

5. The ecology and dynamics of stands of transitional rainforests (" moist hardwoods") need to be assessed, with particular emphasis on :

a. The definition of rainforest, with consideration of the Ecological Society of Australia's definition.

b. The status and longevity of Brush Box, with due consideration to it's classification as a rainforest specie.

c. The role of fire, and it's frequency, in determining species distribution.

d. The accuracy of forest type maps in delineating rainforest, Brush Box and eucalypt forests, given that 20 % canopy cover by eucalypts was sufficient to segregate such forests from rainforest during typing and that typing is biased towards economic values.

e. The impacts on rain forests resultant from disturbance (roading, logging, burning and grazing) to ecotones with particular reference to exposure, physical damage and fire. Long term increases in vulnerability to fires, weeds and successional regression must be considered.

f. Various management stratagies, and their effectiveness, for rainforest conservation must be detailed.

6. The impact of logging on vascular epiphytes, bryophytes, mistletoes and other sensitive plant groups need to be determined and their occurrence through the life span of the longest lived component and under different management options predicted.

7. There should be consideration of the effects that changes in fauna populations, resulting from disturbances, will have on plants and fungi, emphasising herbivory, pollination success and degree of outcrossing, dispersal and germination of mycorrhizal fungus spores and seeds, nutrient cycling and disruption of other essential services provided by sensitive fauna.

FAUNA

1. Clearly forest surveys are a fundamental component of any viable strategy for wildlife management. Extensive faunal surveys (with detailed assessments of population densities, disturbance history and site characteristics) need to be undertaken throughout the Management Area in a systematic manner to enable the results to be used in a Geographic Information System (G.I.S.) to identify critical habitat attributes for various species and predict the distribution and abundance of species. Prediction needs to be able to be generated on a compartment, district and regional basis. It is important that all land tenures and habitat be systematically sampled over the whole region.

2. Surveys and research should concentrate on rare, endangered, threatened, restricted, sensitive (to disturbances) and indicator species. For these species optimal habitat (including the amounts, arrangements and interactions of resources comprising it) social interactions, home ranges, dispersal ability, longevity and reproduction need to be identified in a quantifiable manner.

3. To undertake a valid assessment of impacts, it is necessary to predict the occurrence of species, population densities, habitable areas and the likelihood of them being inhabited through a complex dynamic mosaic of vegetation for the life span of the longest lived component of that habitat. Predictability is the key to developing long term strategies and prescriptions. To be able to predict changes under alternative management strategies, valid mathematical models of the habitat requirements of species must be developed. A suggested procedure for evaluating the impact of logging on fauna is:

a. Map forest types.

b. Map available compartment histories (including dates and nature of past logging, silvicultural treatments, fire history etc.)

c. Map forest structural and age classes, distinguishing old growth, mixed age and even age class forests.

d. Digitise above maps and topography, geology, soils and forest cover and store in a G.I.S.

e. Stratify forests on basis of habitat type and disturbance history for fauna surveys using G.I.S.

f. Conduct rapid, low cost, standardised field surveys at sample sites in each stratum.

g. Measure micro-habitat variables (vegetation structure, floristics, ground cover

etc.) at all fauna survey sites.

h. Analyse all available data to:
- -predict and map species habitat requirements and distribution in space and time.
- -predict each species response to post logging succession,
- -predict each species response to alternative logging treatments
- -predict and map species distribution and habitat at different times in the future (e.g. 20,50,100,200,500,1000 years), under different logging regimes.
- -model the cumulative effects of logging intensity on species and populations.

I. Plan logging regimes on the basis of the above predictions and all other available information so as to ensure the long term maintenance of regional diversity. Incorporate a mixture of silvicultural methods and ensure retention and promotion of adequate areas of tall old growth and mixed age class stands.

j. Establish long term fauna monitoring programs to test impact predictions.

k. Periodically review and modify silvicultural methods as required.

4. Natural processes (drought, wind and wildfire) and human induced disturbances (logging, roading, burning and grazing) need to be considered within a wildlife planning framework and incorporated into modelling. It is essential to consider long term impacts, most importantly the consequences of global warming and ozone depletion.

5. Many animal species are wholly or partially dependent upon structural, floristic or other attributes of the various forest types. For forest dependent fauna there is a necessity to variously determine :

a The minimum size and attributes of areas of suitable habitat required to conserve viable populations.

b. Barriers to dispersal (streams, roads, clearings, logged forest, unsuitable habit).

c. The plant species utilised, and where appropriate, the period of use and factors affecting use (eg phenological, flowering, and fruiting changes).

d. The effect of slope and spatial distribution of retained habitat components on populations.

e. The total population size of each species in isolates within or adjacent to the management area.

f. The future population size of each species under current management practices, their effect on each species, and the extent and nature of modifications to current

logging practices necessary to permit conservation of each species.

g. The effect of alteration to forest structure on environmental attributes upon which specific species may rely (e.g. microclimate, moisture regime, periodicity of solar radiation).

6. Numerous species are dependent upon hollows in trees for denning, nesting, hibernation, roosting and other requirements. For hollow-dependent fauna there is a necessity to determine :

a. The characteristics of hollows required by various species of hollow dependent fauna.

b. The time required for the formation of suitable hollows in various tree species.

c. The density and spatial distribution of hollows required to preserve adequate populations of all dependent species.

d. The mortality rate of retained hollow bearing trees .

e. The numbers of vigorously growing trees, in a full compliment of age classes, required to provide adequate recruits to ensure there is no loss of suitable hollows over time.

7. Many species have requirements for the microclimate, protection (from fire and predators), food sources (particularly fruits) and other necessities provided by rainforest plants. For rainforest dependent species it is necessary to determine :

a. Species dependent upon rainforest plants and the attributes (e.g. fruits and their seasonality, microclimates) they depend on.

b. The transitional stage at which developing rainforest becomes suitable habitat for various species, and any seasonal requirements they may have for resources provided primarily by early successional plants.

c. The impact that alteration and destruction of rainforest under eucalypt dominants is having, and means of mitigating such impacts.

d. The necessity of treating rainforest and adjoining transitional rainforest ("moist hardwood") as single units for management purposes.

8. Species dependent on fallen timber for hibernation, egg laying, denning, food sources or other attributes need to be identified and assessments made of :

a The specific attributes (stage of decay, size, species) of logs required by species

of vertebrates and invertebrates.

b. The effect of disturbance (fire, removal for timber) on availability of suitable logs for two lifespans of the longest lived component and predictions of their availibility under different management regimes.

c. The density and distribution of various log forms .
d. The effect of charred material on the suitability of logs as habitat.

9. There must be an assessment of minimum populations required to maintain genetic fitness and the consequences of logging, roading, burning and grazing on habitat suitability and fragmentation effects.

10. An assessment of the role of roads and habitat simplification (by logging, grazing and burning) in facilitating the ingress and hunting efficiency of predators and invasions by exotic and non forest species must be made. The consequences for vulnerable species must be detailed. The necessity of reserving adequate areas free from these disturbances has to be determined.

11. Species dependent upon specific moisture regimes likely to be altered by proposed operations need to be identified and mitigation measures determined.

AQUATIC SYSTEMS

1. Assessment of the effects of roading, logging and burning on streamflows resulting from increased runoff in wet periods (due to alterations in soil structure, loss of canopy and soil cover, road channeling etc) and long term decreases in dry periods (due to increased transpiration etc.) must be made.

2. Measurements should be made of changes in sediment and nutrient loads, sedimentation, streamflows, ionic concentrations, water temperature and oxygen levels resultant from current operations and the persistence of impacts.

3. Species of invertebrates, vertebrates and plants sensitive to filling of interstital spaces, increased turbidity, altered streamflows, nutrification and other changes in water quality along with altered stream flows should be identified, effects determined and mitigation detailed.

4. The effect that altered stream flows, increased erosion sedimentation and degraded water quality resultant from proposed operations will have on water

users downstream need to be assessed.

FIRE

1. The natural (pre-european) fire frequency for major forest types should be ascertained through charcoal analysis.

2. The frequency of proposed fire regimes (broad area, hazard reduction and top disposal) and actual (including accidental and illegal) frequencies should be ascertained from available records.

3. An assessment is required of the effect of fire and its frequency, intensity and seasonality on:

a. The composition of plant communities (overstorey and understorey), how they influence seed stores, regeneration success and sensitive species.

b. Structural components (large trees and logs and understorey complexity).

c. Invasion and proliferation of exotic and problem plants.

d. The flammability of the vegetation by its promotion of fire tolerant species.

4. The effect of fire and its frequency, intensity and seasonality, on faunal populations and the habitat components upon which they rely must be assessed. Assessments of recovery times for necessary habitat components (eg hollow bearing trees, large logs, leaf litter, vegetation structure) and species' populations are required.

5. Fire sensitive species and plant associations need to be identified along with the effects of various fire frequencies (eg 0-2, 2-5, 5-10 and 10-20 etc. years). Fire mitigation measures and their effectiveness must be detailed.

6. Particular attention has to be given to the role of fire and its frequency in maintaining the dynamic transitional zone from open forest through to mature rainforest and the rainforest successional phases involved. The role of these zones in protecting mature rainforest from fire incursions, and the effects upon them from logging need to be detailed along with proposed mitigation measures.

GRAZING

1. There must be a thorough evaluation of the impact that grazing and its frequency, intensity and seasonality, is having on:

a. Species composition (eg. reductions and elimination of more palatable and sensitive plants), weed invasion, regeneration.

b. Soil degradation(soil compaction and trampling around water points).

c. Animals disadvantaged by loss of shelter, specialised food plants, habitat degradation and / or competition.

2. There is a need to consult all available information and generate the additional information required for a complete and adequate assessment. Monitoring sites should be established to assess long term changes. It will be necessary to reserve representative areas of open forest free from grazing impact.

3. Means of mitigating impacts (exclusion from sensitive areas, removal of artificial watering points, reducing intensity ,varying seasonality) and their effectiveness, need to be assessed.

4. Fires initiated by graziers are a major problem .The frequency and seasonality of fire regimes they prefer are having major impacts.There need to be effective regulations in place to control such burning,and the power to cancel the grazing leases of any person abusing such regulations.

5. The combined impacts of grazing and burning also require assessment .

BEEKEEPING

1. There must be a thorough evaluation of the effects that introduced bees are having on pollen and nectar availability and fertilization success.The role of bees in excluding and competing with native pollinators (various invertebrates, birds and mammals), and the impact these are having on their populations, and the other species which they benefit, need to be detailed. Native species disadvantaged should be identified.

2. Means of mitigating such impacts must be identified (permanent or seasonal

exclusion, minimisation of hive numbers, limitation of sites etc.) and action to be taken delineated.

3. Such assessments should consider the effects of logging in reducing pollen and nectar availability due to the removal of mature trees and understorey simplification, and the consequences of this on intensifying competition for scarcer resources.

ECONOMICS

I. The full costs of proposed operations (roading, logging, marketing) including all applicable costs (management, planning, supervision, construction etc), must be detailed along with the anticipated revenues. Former and existing proposals to log sensitive areas elsewhere in the country have required a police presence in order to "keep the peace". The possible costs of these measures should also be considered.

2. Royalties for all species and classes of timber to be taken need to be detailed, along with all forms of rebates and any other subsidies obtained directly or indirectly from the government.

3. Royalty systems must be evaluated and detailed and a determination made of necessary rises required to cover the full costs associated with timber extraction, including production of an adequate environmental assessment, adequate public compensation, and environmental restoration.

4. Proposed uses (woodchips, cross arms, building, pallets, veneer, etc.) and quantities of timber proposed to be taken must be detailed along with assessments of higher value adding options to enable the maximisation of royalties and/ or employment opportunities. High value adding opportunities should be explored and actively encouraged .

5. Estimations must be made of the true costs per cubic metre and per tree that would be incurred if the major commercial species were grown to various size classes(40-60, 60-80, 80-100, 100-120, 120-140, 140+ cms dbhob) in plantations on purchased land.

6. Soil degradation and soil nutrient losses due to logging operations must be assessed and the full monetary costs of nutrient and soil replacement and site rehabilitation, determined.

7. The impact of laden trucks on roads and road safety should be determined and proportional costs of repairing the damage caused determined, with provisions to compensate Councils and the R.T.A.

8. The compilation of an energy and materials budget for the forest if left unlogged and comparison and contrasting of this to where the materials removed from the site in wood, smoke, solutes or other particles are redistributed should be undertaken.This should focus on nutrient elements and carbon , and should include time estimates for the carbon compounds to be oxidised to carbon dioxide.The energy budget should include the energy content of the timber harvested , the energy consumed during harvesting, transporting and milling logs, that consumed in distribution of the products and a proportion of the lifespan of the machinery times the energy used in its construction and maintenance.

9. The future prospects and direction of the hardwood timber industry, given that competition from pines and overseas eucalypt plantations will supplant many current uses of hardwoods, need to be discussed and strategies for maintaining a viable timber industry delineated.

SOCIAL IMPACTS

1. The visual impact of operations (logging, roading, clearing, waste and burning) need to be examined if not quantified.

2. The long term plans for educational use of the area need to be established.

3. The possible impcts on growing local, national and international tourism opportunities must be examined.

4. Social strains resulting from high feelings engendered by the woodchip and logging debate must be assessed, particularly in relation to the smaller rural communities. A series of informal meetings with these communities would give some indication as to the depth of their feelings on these issues.

SUSTAINED YIELD

1. Maps illustrating the post european deforestation of the region as a whole at

various dates (eg 1770, 1800, 1850, 1900, 1950, 1970 and 1990) should be prepared. Such maps should clearly indicate the previous loss of old growth forest, its current extent and its prospects for the future (eg 2000, 2020, 2040 etc).

2. A firm commitment should be given to the establishment of hardwood plantations on non forested land with a view to a cessation of logging in old growth forest in the immediate future and a swing towards plantation dependence, as opposed to native forest dependence, in the longer term.

3. An acceptable level of sustained yield has to be established. Such sustained yield should be product specific (eg. large sawlog, small sawlog, pulpwood etc) rather than a total general yield.

ABORIGINAL AND HISTORIC VALUES

1. A comprehensive study of aboriginal sites, places of significance and any other aboriginal values must be thoroughly assessed and documented.

2. A similar survey of post european settlement and areas of historic significance must be assessed and documented.

WILDERNESS VALUES

1. It must be established whether or not any of the management area is eligible for listing under the Wilderness Act, The Heritage Act, as National Estate, or any other form of legal recognition or protection.

SUGGESTED BACKGROUND READING

1. Forest and Timber enquiry Draft Report, Volumes 1 and 2
Resource Assessment Commission, July 1991 (Aust.Govt.Pub.Svcs.)

2. Report on the Forestry Commission (p.61)
Public Accounts Committee Report, No. 52. Dec 1990. (N.S.W.Parl.)

3. E.I.S. for a North Coast Woodchip Export Project by Sawmillers Exports.
W.D.Scott & Co.Pty Ltd., Oct 1977.

4. Woodchips and the Environment. Report from the Senate Standing Committee on Science and the Environment. Canberra 1977. (Aust Govt. Pub.Svcs)