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WILDLIFE RESEARCH AND MANAGEMENT
IN THE FORESTRY COMMISSION OF N.S.W.

A Review

by

J. Shields and R. Kavanagh
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A REVIEW

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Forestry Commission of N.S.W.
Sydney 1985
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I. INTRODUCTION

This review describes the development, current status and progress made in wildlife research and management by the Forestry Commission of New South Wales during the period 1975 to 1984. The role of the Forestry Commission in wildlife research and management and the steps taken to fulfil this role are examined. Forestry Commission projects and their status are reviewed, along with pertinent studies conducted by other institutions and individuals. Implementation of results and interaction with management are discussed.

II. WILDLIFE POLICY, RESEARCH PRIORITY AND MANAGEMENT PRACTICES

To effectively review wildlife work in the Commission and make a rational assessment of its current status, it is necessary to define the legislated obligations and policy decisions upon which this work was based. These are stated in: (1) Forestry Act 1916; (2) Wildlife Policy - Forestry Commission of N.S.W. (1980); and (3) Wildlife Research Policy (1980). The pertinent section of the Forestry Act is presented in section A below.

A. Wildlife Policy - Forestry Commission of N.S.W.

"The section of the Forestry Act 1916 outlining the objectives of the Forestry Commission states inter alia that it shall:

8A (1) (e) " consistent with the use of State forests for the purpose of forestry and of flora reserves for the preservation of the native flora thereon -

(i) to promote and encourage their use as a recreation; and

(ii) to conserve birds and animals thereon"."
(2) "...take all practicable steps that it considers necessary or desirable to ensure the preservation and enhancement of the quality of the environment".

To effectively carry out these objectives, insofar as they apply to wildlife, the Forestry Commission shall ensure that its forests are managed so that the overall diversity of the existing native species of animals is maintained. This shall be done in a manner which is consistent with good forestry practice and with due regard of the potentialities of other forested crown lands.

To accomplish this and recognising the complementary role of the forested lands being managed by the National Parks and Wildlife Service:

(a) Habitats suitable for animal communities will be maintained at an adequate level. Viable populations of all species should be maintained on a regional basis.

(b) Particular attention will be paid to the requirements of forest dependent species such as the arboreal mammals.

(c) Positive steps will be taken to facilitate the survival of any species designated rare or endangered under the National Parks and Wildlife Service Act.

(d) Representative areas of undisturbed forest should be set aside where necessary as reserves for both conservation and research.

The Commission will review its policy and practices in the light of results obtained from continuing research.

Management plans and other directions to staff shall outline the actual steps to be taken to fulfil the above objectives."
Although the Research Policy formulated in 1980 does not necessarily reflect current needs, it is pertinent to the present review in that the principles established were the basis for current work. These principles are:

1. Document the occurrence of animal species within forest types managed by the Commission.

2. Investigate the role of animals in forest ecosystems. How and why are animals dependent on forests?

3. Investigate the effect of existing management procedures on fauna with particular reference to animal species that are dependent on forest.

4. Study and define habitats required for the maintenance or recolonization of animal populations in order to provide reliable guidelines for wildlife management.

5. Assist in detection and conservation of rare and endangered species in pertinent localities as required and stated in the Wildlife Policy.

To fulfil these objectives and requirements, a course of action involving survey, research, and advice to management was undertaken. These activities were determined by staff resources, logistics, funding, existing knowledge, fundamental characteristics of the fauna under investigation, and directives from the Commission.
B. Logistics and Scope

The Commission has the responsibility for management and conservation of wildlife in all State Forests in N.S.W. However, the logistics of manpower, time and geographical distance have forced the Commission's wildlife ecologists to address only wildlife issues of greatest concern. When the Wildlife Section (Wood Technology and Forest Research Division) was created in 1975, the integrated sawlog and pulpwood operation at Eden was the area where need was greatest, and was subsequently subject to the first and most intensive wildlife studies. Due to the scale and intensity of integrated logging operations at Eden, and the lack of information regarding the distribution of wildlife species in the region, it was necessary to undertake the whole spectrum of research recommended in the Research Policy to develop management techniques that would allow the conservation principles of the Wildlife Policy to be fulfilled.

Wildlife work by the Forestry Commission in other areas of the State from 1975 to 1984 followed a "need to" basis or resulted from local initiative. Activities undertaken on a Statewide basis by the Wildlife Section involved direct requests for management advice from Districts, Regions or the Commission, preparation of Environmental Impact Statements in conjunction with the Management Planning Division and organization of research or surveys at the local level. Local wildlife research projects have been carried out in the Tumut, Coffs Harbour, Taree, Wauchope, Kyogle, Narooma and Bathurst Districts (see Research Review in following sections). District and Regional projects have been carried out at a low level of priority on a local basis. These local wildlife projects were usually the result of interest and enthusiasm on the part of officers concerned. Consequently, reliable and valuable results have been obtained with low
cost and input. The role of the Wildlife Section in these projects has been to advise and organize at the outset and provide field and analytical assistance when required and feasible.

C. How to approach the Problem of Applied Wildlife Research

Any type of management or research involving animals requires certain basic information. One first needs to know 1) what they are, 2) where they live and 3) how many of them one is dealing with.

1) What animals to study. A vast array of wildlife inhabits the State Forests of N.S.W., ranging from freshwater plankton to large macropods. At least two approaches to management-oriented research are possible.

Firstly, one can study the lower end of the food web, where energy is taken from primary producers and introduced into the zoological ecosystem, following the assumption that these micro-elements of the food/energy system are indicators of the well-being of the system as a whole. Although this approach has been used to good effect elsewhere in Australia (Kikkawa and Monteith 1980), it was rejected because a) the taxonomy of micro-fauna is generally unknown, b) the ecological relationships of the micro-fauna to other components of forest biology are poorly understood and c) the consequent assumption that the well-being of the system is indicated by the micro-fauna may not be true.

Secondly, one can study and manage for those species that function as the end result of the ecosystem - the macrofauna. These groups of animals - the mammals, birds, reptiles and amphibians - are dependent on the lower echelons of the ecosystem - the invertebrates, the various primary producers and decomposers. The logic to the macro-approach is that if the
upper levels of the ecosystem are well understood and conserved, it implies that the lower levels are apparently functioning at natural levels and in a normal manner. The taxonomy of the macrofauna is relatively well known, and there is at least some background in techniques and fundamental biology. Consequently, wildlife research and management have concentrated on these groups. Nevertheless, attempts have been made recently to examine organisms from the lower end of the food web (i.e. invertebrate fauna) as well as other little studied vertebrate groups (e.g. bats, freshwater fish).

2 Where do these animals occur and how many of them are there?

Given that research and management are concerned with a certain group of animals, the first questions to be addressed must concern distribution and abundance of the species involved. To investigate or conserve animals, it must first be determined whether or not they are present in the areas under consideration. This basic information is not available for many species, although great strides have been made over the past decade. After basic presence/absence information is compiled for an area, it is necessary to determine distribution and abundance of the animals across the range of habitats concerned (in this case, forest types and treatments). If a species is widely distributed in all forest types and treatments and is relatively abundant, it can be assumed that its conservation is assured and research is not urgent. Also, if species are limited to or more abundant in logged forest, unmerchantable stands or non-forested areas (swamps, rocky ground) it indicates that silvicultural and harvesting procedures are unlikely to effect their conservation. Conversely, if a species is low in numbers or restricted to undisturbed mature stands of merchantable timber or both, forest management can and does directly affect the conservation status of the animals concerned.
Preliminary survey work of this nature is not only essential for further research, but provides immediate and practical management information for local use. Most notably, certain groups of animals, such as grazing species, common small mammals, ubiquitous bird species and many widespread and generalist reptiles and amphibians can be removed from initial management consideration as being neither affected nor disadvantaged by timber harvest. Rare and localized populations of animals can be identified and appropriate conservation measures taken in accordance with the Wildlife Policy.

By this process, groups of animals have been identified which require research to establish their relationship with forests and forest management. Generally, these species are dependent on forests for a critical resource at some point in their life cycle. Some groups are dependent on tree hollows for shelter and reproductive sites (arboreal marsupials, forest bats, 20% of terrestrial bird species); others obtain a food resource from the products of the forest; some animals simply require cover and stable microclimates provided by certain forest types, while some species are dependent on forests for all of these factors.

After taking into account logistic limitations and the animal groups which require study and management, work undertaken has been further limited by the nature of the faunal groups under investigation. Studies have been initiated on animal species and groups which, although forest dependent, are common enough to provide results. Animals that are extremely rare or cryptic require intense, concentrated studies to provide any results at all. To maximize information gain, wildlife studies have focused on those animal species which are both forest dependent and yet common enough to provide sufficient data for quantitative analysis. It has
been assumed that results from these studies can be extrapolated to formulate management techniques for less common fauna with similar habitat requirements. It has also been assumed that such studies will have useful applications to species with less precise habitat requirements. This process has led to the adoption of the "indicator species" concept. To date, species chosen as indicator species have been those considered to be among the most sensitive to intensive forest management. Although less than ideal in terms of pure science or data-based management, the indicator species approach has allowed work to proceed on both fronts.

D. Management Practices and Habitat Components

The results of these procedures should lead to recommendations to management that enable the obligations of the Forestry Act and the objectives of the Wildlife Policy to be fulfilled. Two basic approaches to wildlife management can be defined as: (1) Management for selected or featured species; and (2) Management for species diversity.

Management for featured species follows on directly from the indicator species concept. Logically, if a course of management is pursued that seeks to enhance the preferred habitat of the indicator species studied, the conservation status of the species should become more secure. Other species with similar or less precise requirements should be conserved by the same course of action.

Management for species diversity seeks to conserve wildlife by maintaining habitat for a similar range of species in the managed forest subject to forest operations, as occurred in the undisturbed forest. The objectives of this philosophy of management are directly related to basic distribution and abundance information. If the same number of species are
maintained at a stable density through the forest system, conservation of fauna is achieved.

There are advantages and drawbacks to both approaches. The selected species approach is dependent on the correct choice of indicator species, which requires a high level of ecological investigation. However, once the appropriate species have been determined, rapid surveys for populations of these species can usually be made. These data can then be used with some confidence to predict the likely effects of forest operations. Management for species diversity requires in part that animal species and numbers are maintained at natural ratios and adequate levels in patches of undisturbed forest. The use of faunal diversity indices is unreliable because animal species typical of open country often invade forest after logging to replace fauna that has been eliminated. Subsequently, logged areas may have species diversity similar to or higher than unlogged areas, if forest dependent fauna has decreased or been extirpated on these sites.

Management for featured species has been employed to formulate management recommendations generally, although the species diversity concept has been given consideration where appropriate. Management for arboreal mammals has been based primarily on management for selected species concentrating on the larger gliding possums, the Greater Glider (*Petauroides volans*) and the Yellow-bellied Glider (*Petaurus australis*). Management of the avifauna uses featured species concepts extensively (hollow nesting birds, obligate fruit or nectar eaters), although management for species diversity has been useful in some instances. Most reptiles and amphibians are generalists and therefore management has been geared largely towards maintaining species diversity within habitats. Some rare and endangered species have been given special consideration.
Conservation of selected species or maintainance of species diversity can be achieved by reservation of sufficient quantities of preferred habitat or by maintaining important habitat components within areas subjected to forest treatment. In the past, reservation of suitable habitat has been incorporated with existing management prescriptions (stream side protection, slope protection) to maintain an interconnected series of reserves. However, the preferred habitats of many species do not include narrow riparian strips or steep unloggable country. Consequently, it is often necessary to take other measures to reserve suitable areas of preferred habitats to ensure conservation of some species.

Retention of important habitat components normally involves maintaining an adequate number of remnant mature trees, and the structure of the forest in time, if not in space. Effective management of critical habitat components requires detailed investigations of animal ecology to, firstly, identify the important components and secondly, to study the results of their manipulation within different forest types. Both forms of management may involve some constraints on silvicultural treatment and/or intensity of utilization. However, this does not imply total preservation of pristine forest conditions.
III. RESULTS OF CURRENT FORESTRY COMMISSION PROGRAMME

A. Arboreal Marsupials

1. Southern N.S.W.

This group of animals has been the subject of the most intensive research in southern N.S.W. Projects are now complete on many of the preliminary investigations. Studies by CSIRO and the Forestry Commission have shown that the distribution and abundance of arboreal marsupials are related to available nutrients in the forest ecosystem, determined by forest type, soil nutrients, seasonal changes in tree phenology, the complexity of the habitat mosaic, topography and altitude. It is now possible to provide management with the information necessary to map forests with high value as habitat for arboreal marsupials. Conservation can be achieved within these forest types by the establishment of wildlife priority areas where reservation is combined with cutting prescriptions specifically aimed at minimising adverse effects on arboreal mammals. Management has put this information to use in establishing a system of interconnecting reserves of preferred animal habitat in the Eden Region.

Questions that remain to be answered concern the effect of logging on animals within favoured habitat and their rate of recolonization. At present, conservation by reservation of preferred forest types (e.g. managing for habitat) is the safest option because it is not known what level of logging can be undertaken and still retain viable populations of animals, nor is the rate of recolonization known for those areas which are rendered temporarily uninhabitable by logging (e.g. managing for habitat components). A project is currently underway to evaluate the effects of logging on arboreal marsupials near Bombala (R. Kavanagh, WT&FRD).
Radio-tracking of marked animals is employed which is an efficient and necessary means of monitoring animals in studies of this nature. Recolonization studies are tied to the passage of time and are planned to be phased in as part of the research/management of arboreal marsupials as regeneration proceeds.

The initial phase of Forestry Commission studies to evaluate the effectiveness of stream-side reserves in the Bombala pine plantation is complete. It has been established that stream-side forest corridors of a minimum width of 80m containing vigorous stands of native forest will support animals over a minimum period of 10 years. This indicates that reserves of this nature could serve to inter-connect populations of animals between larger forest reserves. Yellow-bellied gliders, however, were not preserved in the forest corridor system (see Shields, 1985).

The 1983 fire in Bombala burnt 17 of the 21 experimental study sites after the initial field work was completed. Monitoring the effect of fire on the reserve system is a programme of continuing research.

Questions yet to be answered concerning the stream-side reserve system are: 1) are movements of animals within the system sufficient to maintain genetic diversity across a net-work of inter-connected reserves? and 2) is the habitat within stream side reserves capable of providing resources necessary to maintain continuous, vigorously reproducing populations of arboreal marsupials? Radio telemetry studies and monitoring of a population of marked individuals are necessary to answer these questions.

The re-introduction of Greater Gliders (*Petauroides volans*) to Cumberland State Forest near Sydney is now ready to proceed; release of animals on a trial basis took place in March 1984. This is the first
experiment of its kind in Australia, and may have widespread implications for forest management in forest areas which do not have populations of Greater Gliders.

Results from the specific studies undertaken by members of the Wildlife Section were presented at the ANZAAS Congress, 1982 and at the Possum and Glider Symposium organised by the Australian Mammal Society at the University of New England, Armidale, in November 1983. Proceedings from the Symposium have recently been published (see Appendix). Results have been published in a popular reading format in *Forest and Timber* Vol. 19 (1): 1983.

2. **Northern N.S.W.**

Research Forester C. Mackowski has completed broad scale surveys of arboreal mammals in the Coffs Harbour Region. Other regions have not been systematically surveyed. Forester Mackowski's research concerning the development of crown structure and hollows in blackbutt (*Eucalyptus pilularis*) forest is nearing completion. Results were reported in November 1983 at the Possum and Glider Symposium, University of New England, Armidale. The results indicate the age at which regenerating blackbutt forests develop hollows suitable for arboreal marsupials. Options for wildlife management can now be defined in the context of silvicultural use of this forest type.

C. **Birds**

1. **Southern N.S.W.**

Because the Forestry Commission was undertaking some of the first detailed research on distribution and abundance of forest birds in Australia, appropriate techniques had to be devised and tested. In itself,
this was a major undertaking, reflected in the publications and presentations made from 1980-1984 (See Research Review and Appendix).

The initial phases of research on avifauna in southern N.S.W. are complete. Distribution and abundance have been described for forest birds across forest types, treatments and in stream-side reserves. Studies of bird foraging have been carried out in unlogged areas. Most forest dependent species are removed by clear felling or the establishment of pine plantations. Stream-side reserves of adequate size and shape function to retain a full complement of forest species, although abundance is decreased generally and long term survival of forest dependent species is therefore questionable. The effect of the Bombala fire on the avifauna of retention strips was drastic - in effect, complete removal of birds. This situation requires continued monitoring.

Further analysis of data collected 1978-1983 will provide background information on the distribution, abundance and foraging patterns of birds. Completion of these analyses is an on-going project.

Studies conducted between 1976 and 1980 in the Eden District were designed specifically to examine the effects of integrated logging for sawlogs and pulpwood on forest birds. The results showed that the immediate effects of logging were a large decrease in the number of birds on the logged plots. However, within five years, about four-fifths of the original avifauna had returned to the logged plots. This high rate of recolonization was probably due to the proximity of unlogged patches of forest nearby. Management of the remaining 20% of the avifauna is dependent on the number of mature trees retained in logged areas, and the provision of unlogged wildlife corridors.
Questions yet to be addressed are: how does logging affect foraging patterns, territory size and reproductive biology of forest dependent species and, how can management most effectively minimize deleterious effects in logged areas? Concise and well set out studies before and after logging can provide answers that can be directly converted to management options. Such a study is now underway in the Bombala District (J. Shields WT&FRD).


2. Northern N.S.W.

The Forestry Commission study of birds in northern New South Wales that began with the Hastings Environmental Impact Study has been carried through to 1982 and is now complete. Birds were found to be relatively evenly distributed across forest types and treatments. Recently logged areas and dry forest types supported more bird species generally, due to the invasion of open country species, than moist unlogged or old logged forests. The effect of logging on foraging resources, reproductive potential and long term survival of forest dependent species remains to be determined. Results were presented at the RAOU Congress, 1982 and will be published in "Birds of Australian Forests and Woodlands", 1985.

Forester D. Binns' study of the effects of rainforest logging at Urbenville could reveal no differences in the avifauna between treatment
and control. The interpretive value of the results was severely limited by the sampling method used (mist-netting and banding) which essentially limited data to birds of the understorey. This information was in itself valuable; the limitations of netting studies are now well known and future work can take this experience into account. Results were reported to the ANZAAS Congress, 1982 and have been presented in popular format in *Forest and Timber* (Shields, 1983).

3. Western N.S.W.

Following inquiries from the Victorian Fisheries and Wildlife Department and the Australian National Parks and Wildlife Service (A.N.P.W.S.), an Interstate Committee was convened to review the conservation status of the Regent Parrot (*Polytelis anthopeplus*) in red gum (*Eucalyptus camaldulensis*) forests near Mildura. The situation requiring review concerned the Regent Parrot's apparent lack of breeding habitat (this species nests in deep hollows in red gums) in Hattah Kulkyne National Park in Victoria, where the birds commonly feed and are a considerable point of interest to park visitors. Breeding habitat appeared to be concentrated in forests on the N.S.W. side of the river, which are controlled by the Forestry Commission, the Western Lands Commission and private landholders. At the first committee meeting, it was determined that a potential conservation problem existed, although logging practices were not removing the over mature red gums containing current nests. There are no National Parks containing large stands of river red gums in N.S.W.

On recommendation from the committee, a study plan was devised jointly by the Commission (J. Shields) and A.N.P.W.S. (J. Foreshaw) to determine nesting habitat parameters and distribution. This study was then funded by
the Commonwealth. The study was administered by the Victorian Fisheries and Wildlife Department and followed a strictly management oriented line of development. The researcher, Mr. C. Beardsell, reported the results of his work on the nesting biology of the Regent Parrot and these were published by the Australian National Parks and Wildlife Service (Beardsell 1985). Further Commonwealth money has been provided to finance studies of the foraging ecology of this species in N.S.W. forests, which are now complete (1985). A study of the similar Superb Parrot (P. swainsonii) is underway (1985/86) in the forests of central N.S.W.

C. Small Mammals

Research on small mammals is now limited to species known to be rare and endangered and to studies of the effects of fire management. It has been demonstrated that small mammals in general are widespread, abundant and rapidly recover from logging effects. Fire regimes, however, have been shown to have a greater effect on small mammal populations than logging, and current policy in some regions prescribes fuel-reduction burning at very short intervals.

The Forestry Commission - Mitchell College of Advanced Education studies of small mammals in a Pinus radiata plantation and a dry sclerophyll forest at Sunny Corner near Bathurst showed that viable populations of the Southern Bush Rat Rattus fuscipes existed in both the pine and the native forest, but that the Brown Marsupial Mouse Antechinus stuartii only existed in the native forest. Exotic rats (R. rattus) and mice (Mus musculus) established small populations in the pine from time to time, but never successfully invaded the native forest. These findings are in agreement with most other studies that have examined the suitability of P. radiata plantations to populations of small mammals. Results of this study were presented at the ANZAAS Congress, 1982.
Research Forester G. King began a study of fire effects on small mammals at Taree in 1978, and initial results are now complete. His work has been extended as part of post-graduate studies and is now investigating the biological mechanisms which control the effects of fire. Fire induced changes in the invertebrate food resources, physical structure and floristic diversity of the forest have been measured and related to populations of small mammals. Upon completion, these studies should provide information that will allow integration of small mammal conservation and fire management.

Mr. King has also investigated the distribution of a small mammal previously thought to be extinct in N.S.W., the Hastings River Mouse (Pseudomys oralis). Rediscovered by the Australian Museum in 1980, the species has since been recorded in five other areas by Forestry Commission workers. Mr. King has described the habitat where the animal was located and formulated conservation strategies in accordance with the Wildlife Policy.

Other Forestry Commission work has documented the distribution and abundance of small mammals in logged and unlogged rainforests and in eucalypt plantations. Forester I. Barnes found that populations of two species commonly occurring in rainforest, the Mosaic-tailed Rat (Melomys cervinipes) and the Southern Bush Rat (Rattus fuscipes) were not disadvantaged by 50% canopy retention logging. Rather, there was evidence to suggest that populations of Melomys may have increased in the logged area.

The effect of establishment of flooded gum (Eucalyptus grandis) plantations on rainforest sites in the Coffs Harbour Region has been studied by Research Forester C. Mackowski. Results showed that when an
area is cleared for plantation establishment, *Melomys* disappears and *Antechinus* and *Rattus fusipes* populations are greatly reduced. *Melomys cervinipes* appears to be the species most affected as its return is associated with the increasing development of a mesic understorey to the plantation.

The implications for management do not appear serious as small mammals generally are very widespread and resilient to disturbance. However, rare species and fire management may require special consideration in some Districts.

D. **Reptiles and Amphibians**

Reptiles and amphibians have been the subject of study in southern N.S.W. since 1978 and in northern N.S.W. from 1980.

Studies on the distribution, habitat relations, diet and seasonality of reproduction of forest dwelling herpetofauna in the Eden region have now been completed. Most reptiles and amphibians are generalist species occurring in a wide range of habitats including man-made habitats such as grassland (pasture) early regrowth forest and pine plantation and are, therefore, unlikely to be seriously affected by forest operations. However, species which are most abundant in moist, mature eucalypt forest are likely to be adversely affected by clearing and conversion practices while these same processes will provide additional habitat for more open habitat dwellers. Current studies in the region (see Appendix AI) aim to further examine this process and to identify means of reducing the impact of these operations on sensitive species.

The herpetofauna of the Hastings River catchment in northern N.S.W. was surveyed between 1980 and 1982. There appeared to be few rainforest
adapted reptiles and amphibians; rather, most were generalists or confined to moist forest (viz. rainforests and various wet and intermediate sclerophyll forests). Species of note in the catchment were the Sphagnum frog \textit{(Philoria sphagnicolus)}, Fletchers frog \textit{(Lechriodus fletcheri)}, \textit{Litoria glandulosa} and the southern angle-head dragon \textit{(Gonocephalus spinipes)} all of which appear on the endangered fauna (Schedule 12) list of the N.S.W. National Parks and Wildlife Service. Concern over the status of the southern angle-headed dragon in the Hastings River catchment and N.S.W. in general, prompted a survey and questionnaire which resulted in a considerable increase in knowledge of its range, habitat preferences and other aspects of its ecology. \textit{G. spinipes} does not appear to be restricted to rainforest and may be found in various wet and intermediate sclerophyll forests as well as in ecotone and moderately disturbed sites. Its conservation in N.S.W. now seems assured. However, at the southern end of the dragon's range (Gosford), its distribution is patchy and reservation of favoured moist gullies is a preferred option for management of this species.

A study of the effects of prescribed burning on the invertebrate litter fauna commenced in 1976 and was extended in 1980 to include ground-dwelling reptiles and amphibians. When completed, this study and the concurrent study on small mammals (G. King) on the same plots will provide much needed data on the effects of prescribed burning on ground dwelling fauna.

\textbf{E. Bats, Invertebrates and Freshwater Fauna}

Although these groups of animals display various degrees of forest dependency, few studies have been initiated. Bats, in particular, have not been included in Forestry Commission studies, mainly because of the problems involved in sampling methodology. Nevertheless, this group
requires considerable attention and efforts are required to gather information on the distribution and basic ecology of forest dwelling species.

The invertebrates inhabiting N.S.W. forests are relatively unknown. Recent studies of the ground dwelling invertebrate fauna of a number of forests including the rainforests of the Hastings River Catchment, the open eucalypt woodland of the Hawkesbury Sandstone formation near Sydney, prescribed burning plots in open eucalypt forest near Taree and tall open and open eucalypt forests and woodlands of the Eden region will provide much needed information on these taxa and the impact of forest operations.

A broadscale survey of selected freshwater fauna in the Batemans Bay Region (Wandella-Dampier) has been conducted by Fisheries Division of Dept. of Agriculture. Freshwater fauna studies are proposed for the South Coast and the Eden region.

IV. IMPLEMENTATION BY MANAGEMENT

In the Eden district, the Commission has acquired the basic information necessary to manage wildlife rationally. Studies have been carried through to the stage that wildlife management priorities and techniques can be clearly defined, and foresters have rapidly and efficiently instituted the recommended procedures, integrating them with silvicultural and economic factors and putting the results into practice in the forest (Dobbyns and Ryan 1983). Consequently wildlife conservation is being achieved to the best of current knowledge at the level required by the Forestry Act and defined in the Wildlife Policy.

Elsewhere in the State, wildlife management has been largely based on extrapolation from the Eden work. In some cases, where conditions are
similar, this is valid and has worked well, for example, the Wandella-Dampier Environmental Impact Statement and Management Plan. In other areas, where forest type, logging practices and animal species bear little relation to those studied at Eden, only basic principles can be extrapolated and forest managers have been unable and justifiably unwilling to implement wildlife management practices which are not based on relevant studies.

In some areas there is a fundamental lack of knowledge concerning the distribution, abundance and ecological requirements of forest fauna. In other areas, particularly in the southeast of the State, sufficient information is available to manage wildlife by reserving known areas of high value for conservation of forest dependent fauna using the Preferred Management Priority Classification. While this is an effective means of ensuring preservation of the species concerned, it is not necessarily the most efficient or appropriate method of managing wildlife, particularly in economic terms. However, it is at present an appropriate means of carrying out the Commission's charter as forest manager.

Where information is lacking, wildlife management will become more effective by undertaking necessary research to determine the natural distribution and abundance of forest and their reaction to disturbance, and consequently adopting appropriate management practices for ensuring its conservation on a regional basis. It is necessary to have more specific information on the effects of logging and other operations eg. burning on the life cycles of forest fauna, to quantify survival rates in intensively managed areas, to determine the effectiveness of reserves and hollow trees retained for wildlife, and to determine the re-colonization rate of species expatriated by logging. Enlightened wildlife management will rely on assessments of the impact of continued operational cycles of forest management on forest fauna.
V. RESEARCH REVIEW: PROJECTS AND STATUS

The following section lists projects on forest wildlife which are of current relevance to the Commission, and gives information on their status and availability as published material. Authors marked * are co-operators from other organizations. For details of individual projects, see summaries in Appendix.

A. Wildlife Section, Wood Technology and Forest Research Division

Completed Projects - Published, presented at Conferences or in press.


*Field work complete; manuscript**


32. **The diet and foraging ecology of the Yellow-bellied Glider in south-eastern New South Wales. R. Kavanagh.


40. Habitat, diet and seasonality of some forest dwelling frogs in south-eastern Australia. G.A. Webb.


42. **Reptiles and amphibians of Bondi State forest (New South Wales) and surrounding areas. G.A. Webb.

44. **The efficiency of some pitfall/drift fence systems for sampling small ground vertebrates in south eastern Australian forests. G.A. Webb.

45. **Food of the Tawny frogmouth, Podargus strigoides in eastern New South Wales. R.H. Eldridge and A.B. Rose*.

Current Projects

46. Effects of logging on a community of arboreal mammals in south-eastern N.S.W. R. Kavanagh.


48. Habitat requirements of arboreal marsupials in south-eastern N.S.W. R. Kavanagh, W. Braithwaite*.


50. The viability of populations of arboreal mammals in native forest corridors in pine plantations at Bombala. J. Shields.


52. The effect of logging on a community of birds in south-eastern N.S.W. J. Shields.

53. Bird communities in forest fragments. J. Shields and R. Webster*.

54. Some aspects of the ecology of an animal community before and after logging in montane tall open eucalypt forest. G.A. Webb.


B. Regional Research Projects - Current or Proposed

Wildlife Research projects in Eden, Albury and Bathurst Regions implemented by WT&FRD staff are discussed in the previous section.

Coffs Harbour Region

57. Habitat preferences of arboreal mammals in the Coffs Harbour Region. C. Mackowski. Analysis in progress.


63. ***Effects of logging and silvicultural treatments on arboreal and scansorial mammals, bats and birds in a range of north coast forest types. R. Kavanagh, J. Shields, C. Mackowski.


Port Macquarie Region


68. Effect of prescribed burning on birds that forage on the ground and in the shrub layer in dry sclerophyll forest - Kiwarrak State Forest. In progress. G.C. King and W.S. Chapman.
Albury Region


C. CSIRO Division of Wildlife and Rangelands Research.

(Authors marked + from Forestry Commission of NSW)


3. Studies on the arboreal marsupial fauna of eucalypt forests being harvested for woodpulp at Eden, N.S.W. III. Relationships between faunal density, eucalypt occurrence and foliage nutrients, and soil


D. National Parks and Wildlife Service


E. Australian Museum, Sydney.

(For cooperative studies see Forest Commission projects, H. F. Recher).


F. Universities and Colleges of Advanced Education

1. The ecology of macropods at Wallaby Creek, Beaury State Forest. P. Jarman, University of New England. Two student projects complete, two current, more planned.


3. Browse selection by the Greater Glider and the phenology and nutrient content of eucalyptus buds and foliage in a montane forest in S.E. N.S.W. Carl Bossard, Canberra CAE. Fieldwork complete; funded by Forest Wildlife Research Advisory Committee.

4. Aspects of the foraging behaviour of the Yellow-bellied Glider at Bombala, N.S.W. Ross Goldingay, University of Wollongong. Project current.


G. Other Studies


VI. REFERENCES

Bibliography of major reviews and references.


APPENDIX

BIBLIOGRAPHY OF SELECTED ABSTRACTS, REPORTS

AND CONFERENCE PROCEEDINGS
The avifauna of the forests of the upper reaches of the Hastings River in north central New South Wales was studied as part of an integrated environmental investigation to determine the impact of logging on these areas. Ornithological studies continued over three years from 1980 to 1982. The purposes of the study were:

1. To determine species composition and relative abundance of birds in the forest types of that region and,

2. To evaluate the immediate and long term effects of logging on the avifauna.

Towards these ends, birds were censused in Cool Temperate Rainforest (Antarctic beech - *Nothofagus moorei*), Warm Temperate/Subtropical Rainforest, Wet Sclerophyll Forest and Dry Sclerophyll Forest. In each forest type, study plots were established in stands that were unlogged, logged recently and logged before 1965.

The bird species composition in unlogged forest was found to vary along a moisture gradient. The moist forest types (Cool Temperate Rainforest, Warm Temperate/Subtropical Rainforest and Wet Sclerophyll) contained a common suite of core species. Of these moist forest types Warm Temperate/Subtropical Rainforest was the least productive in terms of bird species. Wet Sclerophyll Forest had the highest species count of the moist forest group; bird species typical of both eucalypt forest and rainforest were found in this habitat. Dry Sclerophyll Forest harboured a different species association of birds than the moist forest, and had the highest
species count of any forest type. Logging history had little effect on species counts.

Productivity in terms of bird numbers varied little between forest types and logging treatments. Unlogged Warm Temperate/Subtropical Rainforest, recently logged Wet Schlerophyll and Dry Sclerophyll Forest logged before 1970 contained the fewest birds. These forest types were simple in structure and floristic diversity. Unlogged Wet Sclerophyll Forest and recently logged Cool Temperate Rainforest had high counts of individual birds. Recent logging prescriptions in Cool Temperate Rainforest allow the harvesting of only the coachwood (*Ceratopetalum apetalum*) understorey, which leaves a canopy cover of Antarctic beech and allows the development of a lush and varied layer of vegetation from ground level to 4m. In the Hastings region, Wet Sclerophyll Forest consists of a full eucalypt canopy over a rainforest understorey. Thus, both forest types with high bird numbers supply a variety of niches in terms of both floristics and structure.

J. Shields, R. Kavanagh, W. Rohan-Jones

A. Present address National Parks and Wildlife Service.

BIRD POPULATIONS OF A LOGGED AND UNLOGGED FOREST MOSAIC IN THE EDEN WOODCHIP AREA.

Bird counts were made in alternate logged (clearfelled) and unlogged small coupes in the Eden Forestry District. Populations of some bird species were greatly altered as a result of logging and remained so for the duration of the study (1976-1980). The differences in the avifauna were greatest immediately after logging. There were fewer bird species and
individuals in the logged compared to the unlogged coupes. As vegetation on the logged plots regenerated, the number of species and the number of birds increased. Four years after logging 78% of the species present in unlogged forest occurred on the logged plots.

The adverse effects of logging were greatest on birds which require tree hollows for nesting, on species which forage in the forest canopy, and on birds which forage in litter on the ground. In general, non-passerines were affected more seriously than passerines. Species favoured by logging were those normally inhabiting open disturbed situations or requiring dense ground or shrub vegetation. Also the dense eucalypt regeneration provided additional nesting and foraging sites for some honeyeaters.

Coupe size in an alternate coupe logging operation may be an important factor affecting bird populations. The bird density of some species was lower in the small unlogged coupes than in nearby unlogged forest.

A. Australian Museum, Sydney.
B. Present address National Parks and Wildlife Service.

STREAM SIDE RETENTION STRIPS AS WILDLIFE REFUGE IN THE BOMBALA PINE PLANTATION

The intensive forestry operations of the Eden Region generally and in the Bombala District particularly will impose a new regime of ecological parameters on these areas of N.S.W. A significant portion of the new parameters which concern wildlife are determined by the ecological characteristics of the stream side retention strips of native forest left
following logging or clearing for plantations. To determine the effectiveness of these retention strips as refuge for arboreal mammals (a group of animals dependent on native forest) a study of animal populations and floristic diversity was initiated in July, 1981. Twenty-three study sites were selected; 21 on retention strips within the plantation at Bombala and 2 control sites in unlogged native forest at Waratah Creek. These were censused for arboreal mammals by spotlighting during May, August, November (1982) and January, (1983). Data were collected on ground vegetation, shrub vegetation, forest floristics and structure, tree vigour and the geology and topography of the area. Distribution and density of arboreal mammals were related to total area retained, tree vigour and populations of animals present before clearing. Analysis of data collected is taking place to determine the relationships amongst these and other factors.

J. Shields.

BOMBALA BIRD STUDIES

1981 saw the end of the field studies on birds at the Bombala study sites. Emphasis during 1981-82 was placed on analysis and presentation of results. Papers were prepared and presented at the May, 1982 ANZAAS Congress at Macquarie University, Sydney and at the Royal Australasian Ornithologists Union Congress at the University of New England, Armidale, N.S.W. (see listings for titles and other publications).

A. Present address National Parks and Wildlife Service.
B. Australian Museum.
One of the major effects of forestry operations is a reduction in the number of tree hollows that are available for animals to use for reproduction or shelter or both. Many species of arboreal mammals are dependent on tree hollows for daytime shelter, while some 20% of Australian birds use tree hollows as nesting sites.

Experimental work elsewhere has shown that artificial hollows are acceptable to at least some species of wildlife. A project to construct and test artificial hollows was started in October, 1982. Hollows were designed at the Wood Technology & Forest Research Division and constructed at the Putney Workshop. They have been placed in suitable areas of habitat in Cumberland State Forest and their subsequent use by wildlife will be monitored.

J. Shields, R. Kavanagh.

WANDELLA-DAMPIER ENVIRONMENTAL IMPACT STATEMENT

In 1981 the Commission began preparation of a statement concerning the impact of the proposed logging operations in the Wandella and Dampier State Forests near Narooma on the South Coast. A literature search was made for species known to occur in the region and the R.A.O.U. Bird Atlas scheme provided data on bird species distribution by individual 10' grid squares. A brief nocturnal field survey for the most forest dependent species i.e. possums, gliders and owls, was conducted in Dampier State Forest. This work gave good indications of the distribution and relative abundance of one of the most common but sensitive species, the Greater Glider (*Petauroides volans*), throughout the major forest types of the area.
Results were essentially in accordance with more extensive studies in the Eden Forestry Region to the south and allowed a comprehensive system of management prescriptions to be devised for the maintenance of wildlife populations in the area.

W. Rohan-Jones, R. Kavanagh, J. Shields.
A. Present address National Parks and Wildlife Service.

DISTRIBUTION AND ABUNDANCE OF GREATER GLIDERS IN SOUTH-EASTERN N.S.W.

In 1981 and 1982 extensive spotlighting surveys for arboreal mammals were conducted through representative forests of the Eden Region. The results showed clearly that Greater Gliders (Petauroides volans) a good indicator species, were much more abundant in the moist tablelands forests than in the drier, lower altitude coastal forests.

The major differences between the tablelands and coastal districts appear to be altitude (moisture) and forest type. Flat to undulating topography supporting tall moist forests were the richest areas sampled. Forests in which Greater Gliders were most abundant were typically mixed associations consisting of Eucalyptus radiata, E. viminalis, E. fastigata, E. obliqua, E. aypellocarpa, and E. ovata. Forests which were poor in numbers of Greater Gliders were those which had large components of E. sieberi, E. bosistoana, E. globoidea, E. agglomerata, E. consideniana, or E. longifolia. In coastal forests of the South-East, arboreal mammals appear to be generally confined to the moist mixed E. maculata forests and the wide creek flat areas characterized by E. aypellocarpa.

All previous studies of arboreal mammal distribution and abundance have failed to take full account of fluctuations in the food resource. The objective of this study, commenced in July, 1981 is to examine seasonal changes in the distribution of arboreal mammals within a mosaic of forest types and to relate these to changes in animal diet and tree phenology.

Data are being collected on the cyclical patterns of tree flowering and new leaf growth production. At the same time, regular walk spotlighting surveys record changes in the use of different habitat types by the four species of gliders and one possum species in the study area. For most of the year, the folivorous Greater Gliders (*Petauridae volans*) were highly selective of eucalypt tree species and individual trees having the greatest amounts of new leaf growth. Feed tree selection by Greater Gliders also showed a high correlation with the levels of foliage nutrients. Recent analyses of the new leaves of preferred tree species have shown them to contain much higher levels of the nutrients NPK than the new leaves of less preferred tree species. The Yellow-bellied Glider (*Petauris australis*), a nectivorous and partly insectivorous animal appeared to rely on the heavy flowering of one particular tree species in the study area *Eucalyptus ovata*. Two species *E. viminalis* and *E. fastigata* were highly preferred as sap feeding trees at different times of the year. The periods of major bark shed particularly on *E. cypellocarpa, E. ovata* and *E. viminalis* co-incided with many observations of insectivorous feeding activities.

This work is helping to build up the picture of the importance of various components in the forest as habitat for arboreal mammals.

R. Kavanagh
The quality and availability of food is an important determinant of the distribution and abundance of animals in different habitats. Over a three year study, the use of food resources by the Yellow-bellied Glider followed an annual cycle which was related to the pattern of phenological changes in the forest. *Eucalyptus viminalis* and *E. fastigata* were identified as species providing food resources which formed a major contribution to the diet, and *E. ovata* and *E. oypseillocarpa* provided important resources at times when little other food was available. The bark shedding pattern of these eucalypts was staggered to provide a year-round supply of associated food resources which the Gliders clearly responded to (50% of observed foraging manoeuvres) and the winter flowering *E. ovata* provided an important supplementary source of energy and protein. Sap provided by *E. viminalis* and *E. fastigata* was important in the diet when no other exudates were available.

Forest habitats which provide sufficient diversity of the favoured eucalypt species to enable a year-round supply of the dispersed food resources of Yellow-bellied Gliders will have the highest concentrations of these animals. Habitat patchiness may therefore be explained largely in terms of floristic diversity but, more specifically, in terms of the complexity of the habitat mosaic.

R. Kavanagh
Two study plots were established in Sunny Corner State Forest to detail the population dynamics of *Rattus fuscipes* and *Antechinus stuartii* in unlogged eucalypt forest of *Eucalyptus fastigata - E. pauciflora - E. dalyrmpleana* and an adjacent 22 year old pine plantation. Two 10 hectare trapping grids were established with an additional trap line alongside an unused access road separating the two habitats. The grids were trapped for six nights each session throughout 1977 and 1978, for periods varying from four to eight weeks.

The trappable population of *Antechinus stuartii* was much higher in the native eucalypt forest than in the pine. *Rattus fuscipes* density was slightly higher in the eucalypt forest but the seasonal fluctuations in both habitats suggest that this is non-significant. Most captures of *R. fuscipes* in the pine occurred along the creek and in associated vegetation. Elsewhere in the pine the understorey was sparse to absent. *A. stuartii* showed the greatest seasonal fluctuation, both sexes markedly decreasing in density after August with no males present during September to December inclusive. *R. fuscipes* populations reached a peak twice in the year, during autumn and again in spring. During the spring period males formed a greater part of the population than females.

Estimates of home ranges for the two species have been made. These range between 1-3 ha for most individuals of both *R. fuscipes* and *A. stuartii*.

D. Goldney\textsuperscript{A}, R. Kavanagh, W. Rohan-Jones\textsuperscript{B}

\textsuperscript{A} Mitchell College of Advanced Education

\textsuperscript{B} National Parks and Wildlife Service
VARIABLE LOGGING INTENSITY AND ITS IMPACT ON THE MAMMALS, BIRDS, REPTILES, AMPHIBIANS AND INVERTEBRATES OF A TALL TABLELANDS FOREST IN SOUTH-EAST N.S.W.

The aim of this study is to provide management with a series of options concerning the conservation of wildlife in areas identified as being of prime importance to wildlife. The options under consideration are reservation in blocks or as wide creek reserves, 50%, 25% or 10% canopy retention logging. The 10% canopy retention treatment is similar to the normal logging intensity conducted in this forest type and region. Experimental coupes are greater than 60 ha in size. Coupe and experimental design and layout were completed in 1983, and pre-logging assessments of the fauna were conducted during spring and summer 1983/84. The fauna are being studied in terms of their distribution and abundance in the study areas, their habitat preferences and foraging ecology. Logging took place during winter 1984 and post-logging assessments of the fauna are currently being made (1984/85).


GEOGRAPHICAL DISTRIBUTION OF REPTILES AND AMPHIBIANS IN THE EDEN FORESTRY REGION.

The most up-to-date listing of reptiles and amphibians species for south-eastern N.S.W. was compiled from extensive records gathered while working in the region and from other sources. It provides a good base for the analysis of geographical and altitudinal distribution of species and helps to identify species and areas worthy of special consideration.

G. A. Webb
IMPACT OF RAINFOREST LOGGING ON REPTILES AND AMPHIBIANS IN THE HASTINGS CATCHMENT.

A preliminary assessment has been carried out on the impact of logging on reptiles and amphibians in various rainforest types and under different logging regimes. Results indicate an initially severe impact on amphibians with a recovery in numbers with canopy re-establishment. Lizards in general appear to benefit from canopy opening. However, those that benefit most are vagrant, corridor species which invade from more open habitats.

G. A. Webb

ASPECTS OF THE ECOLOGY OF A LIZARD COMMUNITY IN SOUTH-EASTERN AUSTRALIA.

1. HABITAT PREFERENCES.

Lizard species prefer particular habitats, structural components of habitats and ground covers. Thus species are ecologically separated at least in the spatial component of the niche dimension. Heterogenous habitats support a greater number of lizard species and it is suggested that stand improvement techniques such as removal of dead and hollow trees, understorey clearing, log removal and control burning may seriously reduce habitat heterogeneity for lizards.

G. A. Webb, R. Kavanagh, H.F. Recher\textsuperscript{A}, G. Gowing\textsuperscript{A}

A. Australian Museum

ASPECTS OF THE ECOLOGY OF A LIZARD COMMUNITY IN SOUTH EASTERN AUSTRALIA

2. DIET AND ARTHROPOD ABUNDANCE.

Lizard species tend to be generalists in their feeding habitats though the favoured habitat of the lizard is often reflected in their diet. Thus
a lizard that is cryptic or fossorial in nature taking shelter beneath litter and logs during the day more commonly encounters arthropods which occur in these habitats such as amphipods, isopods, gastropods and collembolans. Conversely, an active, diurnal lizard will tend to take arthropods such as flies, wasps, bugs and beetles.

The number of lizard species and individuals occurring in a habitat is apparently related to arthropod abundance. Arthropod diversity and abundance may also be related to habitat heterogeneity. The importance of habitat heterogeneity for lizard species is being investigated.

G.A. Webb, H.F. Recher, G. Gowing

A. Australian Museum

ASPECTS OF THE ECOLOGY OF A LIZARD COMMUNITY IN SOUTH EASTERN AUSTRALIA

3. REPRODUCTION.

Reproductive modes of all species are examined. Most species are viviparous, this strategy being an adaptation to cold climates. Three male sexual cycles occur within the community which differ in mating times and sperm retention in both males and females. Ages and sizes at which species mature are determined.

G. A. Webb

HABITAT USE AND ACTIVITY PATTERNS

IN SOME SOUTH-EASTERN AUSTRALIAN SKINKS

Habitat use and activity patterns were examined in a lizard community in montane tall open forest in south-eastern Australia. The three most common lizard species, (Leiopisma coventryi Rawlinson, Pseudomoia
speneri (Lucas and Frost) and *Sphenomorphus tympanium* (Lonnberg and Andersson) showed differences in their spatial and temporal use of the habitat. *Leiopisma coventryi* was most common in good litter. *Pseudemoia speneri* and *Sphenomorphus tympanum* were most often observed on elevated perches such as logs, though time spent on the ground increased during the middle of the day when they were presumably foraging or avoiding excessive heat. Logs were particularly important for these two species as shelter and basking sites. The broad activity period of all species was 0900-1800 hrs. with peak activity occurring between 1100 and 1700 hrs.

G.A. Webb

**HERPETOFAUNA ALONG AN ALTITUDINAL GRADIENT IN SOUTH EASTERN AUSTRALIA.**

Herpetofaunal distribution is discussed in terms of altitudinal limits and ecological replacement along an altitudinal gradient from Bombala (alt. 900 metres) to Eden (on the coast) N.S.W. The eastern edge of the tablelands provides a steep drop of over 300 metres in which most of the montane lizard species disappear but are generally not replaced. This is related to the dry, unproductive nature of forests from below the escarpment to the coast. Some montane species do persist in cooler, moist refuges towards the coast. It is suggested that these areas may need special consideration.

G. A. Webb, R. Kavanagh, J. Shields

**BLACKBUTT (Eucalyptus pilularie) CROWN MORPHOLOGY**

The aim of this study is to measure crown allometry, branching patterns and hollow patterns (in developing trees) and to relate these to stem diameter and stand structure. This will provide information on the age at which a regrowth forest will contain hollows sufficient for a full
complement of hollow dependent wildlife. The development of hollows in eucalypts is considered in the context of the life history of *Eucalyptus pilularis*. During early and middle growth stages, growth in terms of height and crown are the dominant factors of life history, while at maturity crown biomass is maintenance by branch loss. Hollows are formed through the combined processes of branch breakage, primary excavation by termites, decay assisted by internal drainage within the tree and continuing processes of growth and senescence. The hollow requirements of gliders and possums is then discussed in terms of hollow production in eucalypt forests.

C. Mackowski

**SMALL MAMMALS IN FLOODED GUM PLANTATIONS - COFFS HARBOUR DISTRICT**

Small mammals have been trapped in logged and unlogged rainforest and flooded gum (*E. grandis*) plantations of differing ages on Wild Cattle Creek State Forest.

Results show that when an area is cleared for plantation establishment, *Melomys* disappears and *Antechinus* and *Rattus fuscipes* populations are greatly reduced. *Rattus rattus* and *Mus musculus* increase to a maximum shortly after clearing but then decrease dramatically by about four years. The decrease in the populations of these introduced species coincides with the return of *Rattus fuscipes* and *Antechinus stuartii*. The relatively show return of *Melomys* is associated with the development of a mesic understorey.

C. M. Mackowski, T. Tweedie, G. Gray.
EFFECT OF MAXIMUM UTILISATION LOGGING FOLLOWED BY A HOT REGENERATION BURN ON SMALL MAMMALS

This study was situated in wet sclerophyll forest with an overstorey of tallowwood (*Eucalyptus microsora*), blue gum (*E. saligna*), and brushbox (*Lophostemon confertus*). All sites had a well developed rainforest understorey prior to logging. Three sites were studied one of which was unlogged, one site logged and burnt in 1963/64 and the remaining site logged and burnt in 1978/79. Trapping took place over 5 years for a total of 11,759 trapnights. Trapping was along 500 metre transects with 50 traps per transect with trapping for 4 consecutive nights.

Habitat diversity was scored for each trap-point. Rainfall records were kept throughout the study.

Preliminary examination of results indicate a disturbance effect on small mammals followed by a progressive recovery of animal numbers. There was also an apparent correlation between animal numbers and rainfall.

G.C. King

EFFECT OF PERIODIC FIRE ON SMALL MAMMAL POPULATIONS

This study which commenced in 1980 investigates the effect of periodic fires of varying intensity on mammal populations and the resources that they utilise in wet sclerophyll forest with an overstorey of blackbutt (*Eucalyptus pilularis*) and dry sclerophyll forest with an overstorey of grey gum (*E. propinqua*), ironbark (*E. siderophloia*) and white mahogany (*E. aemenioides*). Three 4.3 ha trapping grids have been established in each forest type. Trapping takes place at least twice annually. Two of the grids remain unburnt, one grid is recovering from an intense wildfire and the remaining three grids have been subject to experimental prescribed fires.
Resources investigated include floristics, vegetative cover, log and stump cover, surface litter, litter fall, hypogeous fungi and rainfall.

G.C. King

PSEUDOMYS ORALIS - DISTRIBUTION AND HABITAT REQUIREMENTS

Following the rediscovery of *Pseudomys oralis* in New South Wales in late 1981 efforts were made to increase knowledge of its natural distribution and describe its known habitat. Trapping was carried out on seven State Forests and one National Park from the Hastings Valley north to the Queensland border. *Pseudomys oralis* was only captured at two sites.

Habitat variables, primarily floristic and structural, were either measured or recorded at two capture sites in New South Wales together with another known site at Emu Creek near Warwick in Queensland. High density of low ground cover and proximity to running water were common to all sites. The limited number of animal captures precluded detailed dietary analysis. Studies are continuing.

G.C. King, C. Mackowski

EFFECT OF PRESCRIBED BURNING ON BIRD POPULATIONS

This study investigates the effect of prescribed burning on birds that forage on the ground and in the shrub layer in dry sclerophyll forest with an overstorey of grey gum (*Eucalyptus propinqua*), ironbark (*E. siderophloia*) and white mahogany (*E. acomenioides*).

Census and foraging data is collected every 2 months from 24 burnt and 24 unburnt quadrats each of which has dimensions of 30m x 30m. Vegetation structure, floristics, surface litter, litterfall and rainfall resource data is collected.

G.C. King, W.S. Chapman
RAINFOREST LOGGING AND SMALL MAMMALS

The immediate and long term effects of selective logging on small mammal populations is being studied in a sub-tropical rainforest in Wiangarie State Forest. Two similar catchments were selected and trapped in March and July 1978 prior to logging one of the catchments in August/September 1978. The routine logging operation retains about 50% of the upper canopy, maintains tree species diversity and removes approximately 25% of the basal area of trees over 20 cm diameter.

Fifty individual trap sites were set up on each area and trapping was carried out concurrently on both areas over five consecutive nights for each trapping session. The traps were checked daily with each animal being weighed, sexed, and numbered by toe clipping prior to release. The first post-logging trapping was carried out in October 1978 and continued twice yearly until August 1983.

The population of one common native rodent, the Southern Bush Rat *Rattus fuscipes*, was found to be very abundant in rainforest. Another more specialized species, the Fawn-footed Melomys *Melomys cervinipes*, was also common in the study area. A third species, a marsupial, the Brown Marsupial Mouse *Antechinus stuartii*, was captured only towards the end of the study and following the logging.

After four and a half years of study there has not been any decline in the populations of small mammals in the logged area relative to the unlogged area. In fact, greater numbers of all species appear to be living in the logged area. The reason for this increase is apparently due to the prolific regeneration of undergrowth following logging, which has increased the food supply and/or provided shelter from predators.

I. Barnes, C. Nicholson
CSIRO PROJECTS

STUDIES ON THE ARBOREAL MARSUPIAL FAUNA OF EUCALYPT FORESTS BEING HARVESTED FOR WOODPULP AT EDEN, N.S.W.

Dr. W. Braithwaite's field studies in the Eden Region finished in late 1981 and three papers published in *Australian Wildlife Research*, one in the 'Possum and Glider' book, and a Technical Report have been produced as a result of this work. The first paper described the species of arboreal mammals encountered and their patterns of distribution and abundance in the forests of the Eden Region. His results are essentially in agreement with those studies conducted by the Forestry Commission-Australian Museum research team. Dr. Braithwaite's major points were that of all arboreal marsupials found, 63% of the number of individuals came from 9% of the forest area and that forests identified as the most important for arboreal mammals were among those cleared for replanting with *Pinus radiata*. The second paper described the most important habitat parameters affecting overall distribution and abundance of arboreal mammals in the Eden Region. The most important habitat variables were: landform profile, time since severe fire, degree of forest maturity, floristic diversity, basal area of peppermints, basal area of gums and the levels of nitrogen and potassium in the foliage of tree species. The third paper established a relationship between fauna density, vegetation and geology. Fauna were found to be concentrated in those vegetation communities most characteristically occurring on Devonian intrusive geologies. The combination of all these findings are summarized and integrated in Dr. Braithwaite's fourth paper which deals with the identification of conservation areas for possums and gliders in the Eden Region. The Technical Report provides results from an earlier study in the Eden District which was principally concerned with
comparing methodologies for surveying the distribution and abundance of fauna.

Dr. Braithwaite still maintains an interest in the forests of the Eden Region, but his current field studies are in the forests of the Bateman's Bay Region. These studies are following a similar line to those conducted in Eden.

W. Braithwaite
CSIRO Division Wildlife Research, Canberra.

III UNIVERSITY PROJECTS

FOREST MACROPODS : BEAURY STATE FOREST

An area at Wallaby Creek is used for educational purposes and as a research site for graduate students. Current studies concentrate on the ecology and behaviour of open country and ecotone species of macropods; most research is actually carried out on agricultural land adjacent to Beaury S.F. Studies on forest wallabies are planned for the near future. Two diet studies of forest wallabies have been completed (species: Swamp Wallaby (Wallabia bicolor), Parma Wallaby (Macropus parma), Red-necked Pademelon (Thylogale thetis) and Red-legged Pademelon (T. stigmaticus)).

P. Jarman
Department of Ecosystem Management, University of New England.

SATIN BOWER BIRD ECOLOGY & ETHOLOGY : BEAURY STATE FOREST

Dr. G. Borgia, is carrying out a detailed study of the reproductive behaviour of Satin Bower-birds (Ptilonorhynchus violaceus). Over 150 movie cameras are used to monitor behaviour at the bowers built as courtship stages by the male birds. Although the thrust of the research is aimed at
explaining the ethology and evolution of the unique reproductive behaviour of Bower-birds, a considerable amount of information on the ecology of this forest species has been acquired as an inherent side effect of the study.

G. Borgia
University of Melbourne and the University of Maryland, U.S.A.

HABITAT CHARACTERISTICS AND OCCURRENCE OF ARBOREAL MARSUPIALS WITHIN A COASTAL FOREST OF SOUTHERN N.S.W.

A PhD study jointly supervised by Dr. W. Braithwaite CSIRO Wildlife Research and Dr. R. Florence ANU Forestry Department. The study is principally concerned with the development of a method for classification of arboreal mammal habitats in the coastal forest types of the Bateman's Bay Region. Other aspects of the study include feeding ecology and movements of arboreal mammals species. Mr. Davey's work supports Dr. Braithwaite's general conclusions about animal forest/nutrient relationships and thus is of interest because of the different range of forest types being studied. However, Mr. Davey's work highlights the importance of forest structure to arboreal marsupials. Results concerning this aspect will be published as a result of the Possum and Glider Symposium held in Armidale in November 1983.

S. Davey
Forestry Department, Australian National University, Canberra.

CONSERVATION OF ARBOREAL MAMMALS AND REPTILES IN MOIST HARDWOOD FORESTS

The overall objective of this research programme is to identify silvicultural methods and management practices that will permit conservation of arboreal mammals and terrestrial reptiles in moist hardwood forests with minimal detriment to sustainable wood production. To meet
such an objective it is necessary to provide answers to the following specific biological research problems:

1. Which species occupy unlogged unloggable reserves (left unlogged for reasons of steepness, difficult access, erosion control, streamside protection), what is the density of animals in such areas and are they sufficiently large and interconnected to provide a conservation network?

2. What is the relationship between cutting intensity (100%, 66%, 33%, 0% canopy retention) and survival of animals during and immediately after logging (particularly with respect to native forest dependent species that are normally eliminated by clearfelling)? To what extent is it possible to selectively log retention systems without jeopardizing animal conservation?

3. Do any moist hardwood animals exhibit marked preferences for particular stages of regenerative secondary succession after logging (or natural) disturbance? If so at what age can recolonization occur and do current compartmental logging mosaics and retention systems provide an adequate arrangement for reinvasion to occur at a suitable time after logging?

4. Which particular habitat attributes most affect species abundances within moist hardwood, and can the impact of logging on these attributes (e.g. particular food trees, den trees) be minimized?

A. Dunning, A. Smith, M. Dillon,
Department of Ecosystem Management, University of New England.
(Project funded by the Forest Wildlife Research Advisory Committee).
BROWSE SELECTION BY THE GREATER GLIDER AND THE PHENOLOGY AND NUTRIENT CONTENT OF EUCALYPT BUDS AND FOLIAGE IN A MONTANE FOREST IN S.E. N.S.W.

An MSc. study jointly supervised by Dr. W. Braithwaite, CSIRO Wildlife Research and Mr. L. Best, Canberra C.A.E., was designed to more closely examine the nature of greater glider (Petauroides volans) food selection from a nutrient point of view. In summary, the study found that greater gliders do indeed strongly select food items from tree species, individual trees and parts of individual trees which have the highest levels of nutrients, particularly nitrogen and potassium. These results support Dr. Braithwaite's conclusions that greater gliders are more abundant in forest types in southern N.S.W. which have high levels of N and K in their foliage.

C. Bossard
Canberra College of Advanced Education.
(Project funded by the Forest Wildlife Research Advisory Committee)

ASPECTS OF THE FORAGING BEHAVIOUR OF THE YELLOW-BELLIED GLIDER (PETAURUS AUSTRALIS) AT BOMBALA, N.S.W.

Previous studies of the Yellow-bellied Glider have shown that the diet consists solely of arthropods and plant exudates. However, these studies have employed faecal analysis or qualitative observations which have not allowed determination of the relative importance of the various dietary items. A diet with such a large component of energy-rich items, which may be limiting in abundance, has an important influence on the allocation of time in various activities. Thus the objective of this study was to obtain quantitative data from active gliders thereby allowing firstly, a greater resolution of this species' dietary requirements and secondly, allowing a time-activity budget to be constructed.
Eucalypt sap, arthropods and honeydew were the main constituents in the diet at Bombala during 1984. These varied seasonally: sap 0-94% of the observed feeding time (O.F.T.), arthropods 4-86% (O.F.T.), honeydew 2-56% (O.F.T.). Manna was harvested only during December (29% O.F.T.) whereas nectar was almost totally ignored throughout the year. Gliders spent more than 70% of their activity time engaged in foraging behaviour in each study period except Aug./Sept. At this time, foraging declined to 57% and behaviour associated with reproduction occupied a significant proportion of the gliders' time.

R. Goldingay,
University of Wollongong.

THE DISTRIBUTION AND STATUS OF *Aepyprymnus* AND *Potorous* IN NORTHERN NEW SOUTH WALES.

The rufous rat-kangaroo (*Aepyprymnus rufescens*) and the long-nosed potoroo (*Potorous tridactylus*) are very uncommon small macropods. The rufous rat-kangaroo has suffered a dramatic decline in distribution and abundance over the past 100 years and it is assumed, because of less information, that this has also been the case for the potoroo. Today the rufous rat-kangaroo is patchily distributed only along a narrow belt on the eastern slopes of the Great Dividing Range from Queensland in the north, south to about Coffs Harbour. An isolated population exists in the Barrington Tops area. The potoroo occupies a similar range but extends further south into Victoria and also occurs in some coastal areas. The decline of the rufous rat-kangaroo is attributed to increasing stock densities particularly sheep in the western parts of its previous range together with competition for food and shelter by rabbits and hares and predation by foxes and dingoes. The potoroo is considered to have been
primarily affected by reduction of its forested habitat through fire and clearing for agricultural purposes but evidence was found to suggest that predation by foxes and dingoes may be significant in some areas.

The rufous rat-kangaroo now occurs in open dry sclerophyll woodland habitat (usually incorporating *Eucalyptus maculata*), preferring those sections where there are patches of tall bladey grass (*Imperata cylindrica*) and *Poa* tussock. Many locations of rufous rat-kangaroo were found in State Forests, often at woodland-pasture interfaces and particularly where low intensity beef cattle grazing has been a prominent land use.

The potoroo is more of a wet sclerophyll forest dwelling species with a strong requirement for a dense shrub and/or grass layer. It frequents dense mesophyll shrub sections found in wet sclerophyll and disturbed rainforest communities. It has also been found in drier sites, where dense areas of bladey grass, *Poa* and *Lomandra* provide suitable cover, and in some tall mature heathland areas near the coast.

The two species rarely occur sympatrically and so present different problems for sympathetic land managers. The most difficult problem in studying these animals was simply determining their presence. Potoroos particularly are difficult to detect but rufous rat-kangaroos can readily be detected by spotlight at night. As with most uncommon species, initial detection is usually by chance (e.g. road killed animals, surveys primarily for other species, etc.).

Little specific data has been gathered on the habitat preferences of potoroos. According to the present level of resolution, the habitat of the potoroo should generally be secure from further gross alteration. Concern has been expressed over the continued use of fire as a forest management
practice where this would reduce understorey density. However, the extent of wet forest on the escarpments of northern N.S.W. would suggest that fire may not be such a major problem considering the potoroo's overall range. It is much more important at this stage to know exactly where the animals are currently found. Accurate locations of potoroos in State Forests are not available but these are being obtained. Controlling the use of fire and reducing the number of foxes (and dingoes) is recommended in areas where the potoroo is known to occur.

Rufous rat-kangaroos have been found in more localities than potoroos and this has enabled a better picture to be formed of the habitat requirements for this species. Ground truth searching (e.g. spotlighting) for rufous rat-kangaroo appears to be feasible once suitable habitats (dry open sclerophyll woodland often characterized by *E. maculata* with an open tussocky understorey on flat to undulating topography) have been delineated. More accurate locality information of rufous rat-kangaroos in State Forests is being acquired. Management to favour rufous rat-kangaroos could best be achieved by controlling competitors (mainly rabbits), predators (foxes and dingoes) and beef cattle stocking rates.

F. Schlager
University of New England.

IV NATIONAL PARKS AND WILDLIFE SERVICE PROJECTS

EFFECT OF INTEGRATED LOGGING ON WILDLIFE IN THE FIVE FORESTS NEAR BEGA

A study of the effects of the woodchip industry on wildlife was initiated in the Five Forests near Bega in 1979. The study examined four treatments: "uncut forest", "recently clearfelled forest", "forest
clearfelled one year previously" and "15 year old regeneration from timber stand improvement (TSI)". Although the "uncut" treatment had not been subject to recent integrated logging operations or past TSI practices it had, nevertheless, been subject to a long history of less intensive timber utilization. The study was complicated by the effects of severe drought and wildfire but efforts were made to incorporate these factors into the experimental design.

All species of vertebrate fauna in the Five Forests were studied. Work on the birds was conducted by Dr. P. Smith who studied the effects of logging, habitat preferences and foraging ecology. Results showed that on ridges 10-15 year old regenerating forest supported a smaller bird community (20% fewer birds) than mature forest. In gullies the bird communities of mature and regenerating forest were similar in size but different in composition. Bird species more abundant in regenerating forest were mostly birds that feed, nest or shelter in or under dense shrub thickets. Bird species less abundant in regenerating forest were mostly birds that feed in mature eucalypts. The retention of remnant trees at the rate of 9 per ha in the regenerating forest provided both food and nest hollows for birds and were used extensively. It was concluded that had no trees been left, then birds would have been less abundant in regenerating forest than they were. Fire had its greatest effect on birds of the shrub layer, which became restricted to unburnt and lightly burnt patches of forest.

Mr. D. Lunney studied populations of arboreal marsupials, small mammals, bats, reptiles and amphibians in the Five Forests. Surveys of possums and gliders showed that their numbers were too low throughout the whole Five Forests area to provide quantitative analysis. The large
species of gliders were restricted to only a few gully areas in the District. Studies of the small mammals, reptiles and amphibians showed an immediate effect of logging by a reduction in the numbers of these animals, but the populations had recovered within one year. Results indicated that fire has a greater effect on small mammals yet only a small effect on reptiles. Both groups are adversely affected by drought. A population of a rare small ground dwelling marsupial carnivore the White-footed Dunnart *Sminthopsis leuopus*, was found in the Five Forests area. Details of the ecology of this species were obtained. Considerable work has been done in Mr. Lunney's studies to test methodologies and to obtain results regarding the distribution of forest bats throughout the District. The effects of logging on bats, however, appeared inconclusive because the mosaic size of the logged and unlogged patches of forest was much smaller than the normal foraging area for a bat. The major finding was that gullies containing relatively mature forest provided important breeding and feeding areas for most species of forest bats.

D. Lunney, P. Smith

**BIRD SURVEYS**

Mr. G. Holmes has conducted bird surveys under contract to the National Parks and Wildlife Service of two areas, Washpool and the upper Hastings River, and two rare bird species, the Eastern Bristlebird (*Dasyornis brachypterus*) and the Rufous Scrub-bird (*Atrichornis rufescens*). The area surveys were associated with the controversy surrounding rainforest logging. Both of these surveys provided bird lists from different forest types. The rare bird surveys were conducted to describe the range of these species in northern N.S.W. These species were largely unknown in terms of their distribution and habitat preferences. (See S. Ferrier, University
EFFECTS OF EUCALYPT PLANTATION ESTABLISHMENT ON NATIVE MAMMALS IN
OLNEY STATE FOREST, WYONG.

Members of the Royal Zoological Society of N.S.W. (Mammal Section), have been monitoring the effects of clearing and subsequent eucalypt plantation establishment in Olney State Forest. Work began in 1976 with pre-logging surveys of native mammals and has continued on a regular basis since plantation establishment in 1977. The major findings are in agreement with the Commission's own studies in the Dorrigo area. That is, that arboreal mammals are eliminated from plantation areas and show no sign of recolonizing young eucalypt forest without an overstorey component of mature trees. However, small mammal populations are steadily increasing towards pre-plantation levels. Populations of one small mammal species, *Melomys cervinipes*, have yet to show substantial signs of recovery.

R. Williams

VERTEBRATE FAUNAL STUDIES IN THE WASHPOOL - GIBRALTAR RANGE REGION.

Between November 1980 and January 1982, a faunal study was carried out in the Washpool forests for the Australian Conservation Foundation (ACF) and the N.S.W. Department of Environment and Planning. A management committee comprised of representatives of conservation societies, National Parks and Wildlife Service and the Forestry Commission was set up to advise on scientific aspects of the study. This project was completed and written up as a report to the above organizations by the end of 1982.
Co-operation and liaison were maintained by officers from the Wood Technology and Forest Research Division during both the planning and write-up stages of the work. The objectives were firstly, to document the distribution and abundance of vertebrate fauna within the major forest types of the Washpool - Gibraltar Range region and secondly, to provide detailed ecological information mainly derived from studies conducted over several seasons on the feeding and nesting habitats of these animals. Most emphasis was placed on studies of birds and mammals.

The major results included an identification of low altitude and high altitude sub-tropical rainforest as being a richer habitat for birds than warm temperate rainforest and viney scrub. New England blackbutt (Eucalyptus andrewsi ssp. campanulata) - Tallowwood (E. microcorys) - Sydney blue gum (E. saligna) forest was identified as one of the richest habitats for birds and mammals, particularly the arboreal mammals. Many birds e.g. Wompoo Pigeon (Ptilinopus magnificus) with 'uncommon to rare' status in N.S.W. were recorded in the Washpool area. Arboreal mammal species, the parma wallaby (Macropus parma) and the tiger cat (Dasyurus maculatus) were found to be relatively abundant in the forests of the Washpool area. The Rufous Scrub-bird (Atrichornis rufescens) was found only in Gibraltar Range National Park.

W. Osborne
VI CONFERENCES RELEVANT TO FOREST WILDLIFE RESEARCH AND MANAGEMENT

A. ROYAL AUSTRALASIAN ORNITHOLOGIST'S UNION CONGRESS

University of New England, Armidale, N.S.W.

26 November - 3 December, 1982.

Theme: Birds of Forests and Woodlands.

Sixteen papers were presented: fifteen of these dealt with topics directly related to forest birds and management. The Proceedings of the Conference, together with invited papers, are published (1985) in book form, edited by Drs. Recher, Keast, Ford and Saunders (Surrey Beatty and Sons, Sydney). This volume, entitled "Birds of Eucalypt Forests and Woodlands" reviews the ecology, conservation and management of forest and woodland birds. Bird communities in various types of forest habitats are discussed, as well as the ecology and adaptations of distinctive forest species. The impact of man on forest is the subject of the final section, which contains information of direct relevance to forest management in New South Wales.

The abstracts following cover those conference reports based on studies conducted on NSW forests and woodlands by Commission staff, co-operators, or by other arrangement.

FORAGING ECOLOGY OF FOREST AND WOODLAND BIRDS IN SOUTH-EASTERN AUSTRALIA

Harry F. Recher

Australian Museum, Sydney

A knowledge of how birds forage is essential for understanding how they use and exploit their environment, for evaluating ecological theory
concerning food selection mechanisms, competitive relations and community structure and for developing sound, scientifically based plans of management. Studies of forest bird communities in south-eastern New South Wales have identified 7-8 guilds of insectivorous and nectarivorous birds. In addition other birds exploit a variety of seeds and fruits or prey on other vertebrates. Insectivorous birds are distinguished by the way in which they forage, the substrates on which they find insects, and foraging height. Nectar feeders exploit carbohydrates other than nectar. This includes honeydew, manna and sap. In addition to the extent to which they use alternative energy sources, nectarivorous birds are separated by foraging behaviour, substrate and height. The pattern of community structure illustrated by the foraging ecology of Australian forest birds is broadly similar to North American forest bird communities. However, Australian avifaunas are generally more diverse, have more foraging specialists, and exploit a greater range of resources.

**AVIFAUNA OF THE HASTINGS RIVER REGION**

Jim Shields, Rod Kavanagh and Wyn Rohan-Jones,
Forestry Commission of N.S.W. West Pennant Hills.
(see Review under Forestry Commission, p. 42)

**INCREASING THE DIVERSITY OF BIRD HABITAT BY FOREST MANAGEMENT PRACTICES**


The aim of managing forests for timber involves the creation of a series of different age and/or size classes. This creates different heights of foliage over set areas of forest each year. This management practice provides different levels of vegetation which is important to maintain a diversity of bird species.
Ninety-six percent of State forests under Forestry Commission management are native forests depending on natural regeneration to recruit further native trees of the same species as the original stands. Native birds that prefer understorey and small shrubs may thrive during the regeneration stage; while other species dependent on high levels of foliage have the opportunity to exploit that niche elsewhere in the forest.

Management objectives for the various management areas have a statutory commitment to supply sawlogs, poles or pulpwood to the community via an industry. The area will be maintained under native forest vegetation to conserve soil resources and water catchment and maintain a diversity of habitat suitable for wildlife indigenous to the area.

Most of the forests of N.S.W. are outside State forest tenure. It is quite likely that no management objectives have been formed for these forests.

Two examples of State forest situations are given:

- birds in managed White Cypress pine forests, surrounded by agriculture, mainly wheat;
- birds in a small forest created in an urban area and surrounded by housing development.

One example of a short-term observation is presented proving that logging does not eliminate the bird population. Another short example corroborates the presence of birds in even-aged stands.

Under concepts of multiple use by the Forestry Commission of N.S.W. the forestry environment is maintained in different stages of growth provided in some areas so that people can enjoy the sights of growing trees,
protected watersheds and the wildlife.

BIRDS AND EUCALYPTUS DIEBACK IN NEW ENGLAND

Hugh A. Ford

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Eucalypts have been dying on the Northern Tablelands of N.S.W. for a long time but defoliation and death of trees reached disastrous proportions over the last decade (see Mackay et al 1984). Insects, specially Christmas beetles, are largely implicated in the condition.

One possible reason why insects have increased is that their natural predators, including birds, have been lost. The density, foraging ecology, diet and energy requirements of birds were measured in 1981 in Eucalypt woodland near Armidale. Densities averaged from 8.3 to 11.1 birds per ha at four sites. From 39 to 64% of these were insectivorous birds, and 25-52% were honeyeaters. The common leaf-gleaners were Fuscous and White-naped Honeyeaters, Striated and Spotted Pardalotes and Golden and Rufous Whistlers; bark foragers included Brown and White-throated Treecreepers and Varied Sittella, and ground-feeders Yellow Robin, Superb Fairy-wren, Speckled Warbler, White-winged Chough and Australian Magpie. Beetles, followed by ants, were the main insects eaten, but larvae, psyllids, other bugs, flies and spiders were eaten often.

The annual demand for energy by birds was estimated at 11.7 - 20.5 x 10^4 Kcals/ha, with some 3.40 - 4.25 x 10^4 Kcals/ha being consumed as insects from foliage. It was assumed that insects consume 10% of the estimated 1.64 x 10^3 kg of leaf material produced per ha per year and convert 10% of what they consume into insect biomass. If so, some 16.4 kg of insects, yielding 9.02 x 10^4 Kcals per year will be produced. Birds, assuming an assimilation rate of 67%, would consume 5.10-6.37 Kcals/ha/yr or 57-71% of these insects.
Although these calculations are crude and do not prove that birds can regulate insect populations they do indicate that birds have considerable potential for influencing insect populations in some years.

Attempts to regenerate eucalypts in New England should encourage insectivorous birds and honeyeaters. Dense shrubs for nesting and alternative foods such as nectar and berries should be provided.

EFFECTS OF LOGGING ON BIRDS IN EUCALYPT FOREST AT BEGA, N.S.W.

Peter Smith
N.S.W. National Parks and Wildlife Service,
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Birds were censused on one hectare plots in eucalypt forest near Bega. Comparisons were made between mature forest and forest regenerating after intensive logging 10-15 years before. On ridges regenerating forest supported a smaller bird community than mature forest: the mean number of bird species recorder per 30 minute census was 20% lower. In gullies the bird communities of mature and regenerating forest were similar in size but different in composition, the number of species more abundant in regenerating forest balancing the number less abundant. Bird species more abundant in regenerating forest were mostly birds that feed, nest or shelter in or under dense shrub thickets. They were most abundant in regenerating gully forest because the shrub layer was most dense there. Bird species less abundant in regenerating forest were mostly birds that feed in mature eucalypts. Remnant trees, of which there were 9 per ha in the regenerating forest, provided both food and nest-hollows for birds and were used intensively. Had no trees been left then birds would have been less abundant in regenerating forest than they were.
A COMPARISON OF FOREST BIRD COMMUNITIES ON THE N.S.W. SOUTH AND MID-NORTH COASTS

David R. Milledge
C/- P.O. Rosebank, Via Lismore, N.S.W.

Birds were counted in eucalypt forests near Eden and Kendall during spring in 1975 and 1978 respectively.

A standardised census method was used at sites selected as representative of mature, relatively undisturbed forest of the coastal plains and ranges of each area.

Sites fell into three broad divisions on the basis of vegetation structure. Plains sites were dominated by dry open forest, ridge slope sites by tall dry open forest and gully sites by tall wet open forest. In the Kendall areas slightly higher annual rainfall, richer soils and a more equitable climate have resulted in generally taller forests with an increase in the mesic component of understorey layers.

Results showed that bird communities at Kendall were richer than those at Eden in terms of species, numbers of individuals and species diversity.

A little under half of the total species were common to both areas with Kendall sites characterised by species with tropical affinities and Eden sites by those of temperate origin.

Some congeneric or closely related and ecologically similar species pairs demonstrated straightforward replacement between the two areas whereas others had both species present at Kendall but only one at Eden. In the latter case this can be seen as largely a response to an increase in foraging niches afforded by the more mesic nature of the forest understorey at Kendall.
A comparison of species richness, numbers of individuals and bird species diversity between site classes in both areas showed that increases in these variables could not be correlated with increases in the structural diversity of vegetation as contemporary community theory would have predicted. Examination of the trophic components of bird communities of the site classes showed that nectarivores were responsible for high values at dry open sites and frugivores at tall wet open sites.

These findings indicate that prediction of community richness based on the structural variation of habitats may not be suitable for Australian eucalypt forests and that floristics must also be taken into account, particularly considering the importance of nectar feeding among vertebrates of these forests.

HABITAT REQUIREMENTS OF THE RUFOUS SCRUB-BIRD

Simon Ferrier

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The habitat of the Rufous Scrub-bird *Atrichornis rufescens* has generally been regarded as both rare and highly specialized. However, little effort has been made to elucidate the critical parameters determining the suitability of such habitat. The species was studied over a three year period at several localities scattered throughout its entire range. A detailed study of habitat was conducted at two of these localities - Wiangarie and Barrington Tops. Multivariate comparisons were made between habitat plots centred on male song territories, and plots located at random. Territories at Wiangarie occur mostly in subtropical rainforest, whereas territories at Barrington Tops occur mostly in tall open forest. Despite these broad forest type differences, the specific habitat requirements of scrub-birds at the two localities are essentially
the same. The major requirements are a dense layer of ground cover at least one metre high, a moist microclimate at ground level, abundant leaf litter, and the presence of rainforest near, but not necessarily within, the territory.

**BIRD POPULATIONS OF AN UNLOGGED-LOGGED FOREST MOSAIC IN THE EDEN WOODCHIP AREA**

R. Kavanagh, J. Shields¹, H. Recher² and W. Rohan-Jones³

¹ Forestry Commission of New South Wales, Forest Research Division, P.O. Box 100, Beecroft.
² Australian Museum, Department of Terrestrial Vertebrate Ecology, Sydney.
³ National Parks & Wildlife Service, N.S.W., Central Region, P.O. Box 22, Parramatta.

Bird counts were made in alternate recently logged (clearfelled) and unlogged small coupes in the Eden Forestry District. Counts were made in November of each year from 1977-1980. The study area was dominated by an *Eucalyptus sieberi* - *E. agglomerata* dry ridge forest association where the average coupe size was 15 ha.

There were fewer bird species and individuals in the logged compared to the unlogged coupes. The differences between coupes in total number of species and total number of individuals recorded appears to be declining by the last year of data collection, approximately 5 years after logging. Populations of some bird species had become greatly altered as a result of logging and remained so for the duration of the study.

The greatest effects of logging fell among the hollow nesters (White-throated Treecreeper, Grey Shrike-thrush), eucalypt canopy feeders
(Spotted Pardalote, Rufous Whistler, White-naped Honeyeater) the moist ground litter feeders (Fan-tailed Cuckoo, Yellow Robin, Scarlet Robin) and the non-passerines in general. Species favoured by logging were those normally inhabiting open disturbed situations (Superb Blue-wren), dense ground/shrub cover (Pilot Bird) and birds advantaged by dense eucalypt regeneration (Yellow-faced Honeyeater, White-eared Honeyeater).

Findings from similar unlogged forest nearby indicate that coupe size in an alternative coupe logging operation might be an important factor affecting bird populations. The bird density of some species was lower in the unlogged coupes compared with surrounding unlogged bulk forest.

B. AUSTRALIAN MAMMAL SOCIETY, ANNUAL MEETING

University of New England, Armidale, N.S.W.

28-30 November, 1983.

Theme: Possums and Gliders

Sixty-five papers plus eighteen posters were presented at this conference on all aspects of the taxonomy, biology, ecology, conservation and management of possums and gliders. More than half of these papers contributed information of relevance to forest management. Proceedings of this conference was published in 1984 as "Possums and Gliders" edited by A.P. Smith and I.D. Hume, Australian Mammal Society, Surrey Beatty and Sons, Sydney. This volume comprises a comprehensive treatment of the physiology, ecology, reproductive biology and behaviour of possums and gliders. The final section is devoted to conservation and management, which has many ties to forest management in New South Wales. "Possums and Gliders" was the first major publication of the Australian Mammal Society, and, as far as possible, contains the most recent and complete information
available on this group of forest animals. A key to identification is included, and the format is designed to appeal to any interested reader. The abstracts following are based on those reports to the meeting which are most relevant to NSW forests and cover papers by Commission staff and/or co-operators working on State Forests.

ON IDENTIFYING IMPORTANT HABITAT CHARACTERISTICS AND PLANNING A CONSERVATION STRATEGY FOR ARBOREAL MARSUPIALS WITHIN THE EDEN WOODPULP CONCESSION DISTRICT

L.W. Braithwaite
CSIRO Division of Wildlife and Rangelands Research, Lyneham, Canberra, A.C.T.

A study of the possums of three families, Phalangeridae, Petauridae and Burramyidae, of the Eden forests addressed two questions. How is this fauna distributed? What are the factors determining the distribution?

Data were collected on animals (eight species) found by felling crews in 5010 ha of forest clear-felled in 337 coupes dispersed in the 405,000 ha concession district. Data were also recorded on the felled areas as habitat. This included information on floristics, geology and analyses of nutrient (N,P,K) content of eucalypt foliage.

All species and most individuals were found to be concentrated in minor portions of the forest (63% of animals in 9% of total area felled).

Eucalypt communities were defined using a UPGMA sorting strategy, and principal components and eigenvector ordination techniques were adopted to analyse relationships between faunal densities and habitat variables.

An index of foliage nutrient concentration of eucalypt communities appeared to be the major determinant of density and species richness of
animals. The richest communities (in terms of nutrients and fauna) were mainly confined to the most fertile soils derived from Devonian intrusive rocks.

The findings emphasise the conflict existing between the habitat requirements of the fauna and human requirements of the same forest lands for either intensive wood production or for farmland.

Resolution of the conflict is seemingly a political problem, dependent in part at least, on the acquisition of knowledge on the distribution, extent and planned land use patterns for remaining eucalypt forests of high nutrient status.

DISTRIBUTION OF POSSUMS AND GLIDERS IN INTENSIVELY LOGGED, BURNT FOREST NEAR BEGA, N.S.W.

D. Lunney


The distribution of seven species of possums and gliders were mapped, based on spotlight searches and analysis of dog and fox scats. The methods gave different patterns of distribution and relative abundance. Both showed that the Greater Glider was rare. Spotlighting indicated that Sugar Gliders were common and Brush-Tailed and Ring-Tailed Possums were rare. Scat analysis indicated the reverse. A census in a compartment of cut and uncut coupes showed that there were less animals, particularly the large gliders, in cut coupes. The census was repeated following a wildfire and the results indicate that fire compounds the problems associated with cutting and that deep moist gullies, not prone to fire, act as refuges. Analysis of tree species preferences shows marked differences between possum and glider species. This suggests that the conservation of all
possum-glider species depends not only on substantial areas of uncut, unburnt forest, but also on retention of tree species diversity.

HABITAT CHARACTERISTICS AND THE OCCURRENCE OF ARBOREAL MARSUPIALS WITHIN A COASTAL FOREST IN SOUTHERN N.S.W. S.M. DAVEY, DEPT. FORESTRY, AUSTRALIAN NATIONAL UNIVERSITY, CANBERRA (SEE ABSTRACT p.61)

FLORISTIC AND PHENOLOGICAL CHARACTERISTICS OF A MONTANE FOREST IN SOUTHERN N.S.W. SUPPORTING A DENSE POPULATION OF ARBOREAL MARSUPIALS. R. KAVANAGH, WT&FRD (SEE ABSTRACT p.48)

THE ONTOGENY OF HOLLOWS IN EUCALYPTS AND ITS RELEVANCE TO THE MANAGEMENT OF FOREST FOR POSSUMS AND GLIDERS. C.M. MACKOWSKI, REGIONAL RESEARCH STATION, COFFS HARBOUR. (SEE ABSTRACT p.54)

STREAMSIDE FOREST CORRIDORS AS REFUGE FOR ARBOREAL MARSUPIALS IN PINE PLANTATIONS AT BOMBALA, N.S.W. J. SHIELDS, WT&FRD (SEE ABSTRACT p.44)

C. AUSTRALASIAN HERPETOLOGICAL CONFERENCE

University of Sydney,
28-31 August, 1984;

and THE ANNUAL GENERAL MEETING OF THE AUSTRALIAN SOCIETY OF HERPETOLOGISTS

Springwood,
1-2 September, 1984.

92 Papers and 5 posters were presented at the Conference on a wide range of aspects of herpetology. Following the convenence, 27 papers were presented to the A.G.M. Australian Society of Herpetologists. Many of these contained information relevant to wildlife management and conservation. The majority have been published in the proceedings of the
The status of rare and endangered reptiles and amphibians is discussed in this volume. Habitat use, the effects of fire in semi-arid habitat and the concept of refugia for conservation of herpetofauna are also considered. Forestry Commission contributions are listed below.

HABITAT USE AND ACTIVITY PATTERNS IN SOME SOUTHEAST AUSTRALIAN SKINKS.  
G. WebB, WT&FRD (SEE ABSTRACT p.53)

THE DISTRIBUTION, ECOLOGY AND STATUS OF THE SOUTHERN ANGLE-HEADED 
GONOCEPHALUS SPINIPES IN NEW SOUTH WALES. G. WebB, WT&FRD (SEE ABSTRACT p.24)