The Precautionary principle and grazing, burning and medium sized mammals in Northern New South Wales

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Abstract

Grazing and burning of forest leases in Northern New South Wales has long been an established practice and are a vital part of the fire protection strategy for these forests. Recent legislative requirements with respect to the conservation of endangered fauna are changing established practices. These changes result from the use of the Precautionary Principle, following concern expressed by conservationists and conservation authorities that burning and grazing is a threat to medium sized mammals or Critical Weight Range (CWR) (see Burbidge and McKenzie 1989), species.

A review of the effects of grazing and burning on CWR species in Northern New South Wales forest areas indicates that some of the species concerned may be adapted to or at least able to cope with a regime of fairly frequent fire. The impact of grazing is less clear but it may not always be deleterious to all of the species concerned. The CWR species have existed in the presence of the current regime of fire and grazing for a very long time and it is not at all clear what would happen if burning and grazing were suddenly to cease.

It is suggested that a blanket change, such as the immediate cessation of all burning and grazing which is being introduced as a result of the new legislation would be unwise. Instead it is recommended that current practices be maintained with some modifications whilst more definitive information is obtained on the effect of burning and grazing on the CWR fauna before major changes are considered.
In other words it is considered that the application of the Precautionary Priciple to invoke immediate and precipitous changes to current practices, is in fact an incorrect interpretation of the Precautionary Principle, which in this case would be more correctly used to caution against any immediate change to the status quo until more information can be collected.

Introduction

Recent Legislative Requirements in New South Wales with respect to the conservation of endangered fauna are precipitating changes to established burning and grazing practices in State Forests. These changes follow concerns expressed by conservationists and conservation Authorities that grazing and burning is a threat to CWR fauna (see Anon 1994a and Anon 1995). The impact of prescribed burning including planned and authorised burning by graziers, on fauna habitat, specifically of CWR species, is being questioned..

Many forest areas in New South Wales have been held under some form of grazing lease since the 1840s, (Williams 1992) Over this time many of these forest leases have been burnt regularly by graziers on a 3 to 5 year cycle to encourage green feed for stock. Typical of fires burning under frequent mild conditions, the burns were usually incomplete and patchy. This practice of grazing and burning dry sclerophyll forest types with a grassy understorey has long been an integral part of the fuel management strategy over large areas of N.S.W. State Forests (Anon 1993 and Anon 1994b).

The deliberate lighting of fires for fuel management purposes may result in the death of individual animals under some circumstances.
The National Parks and Wildlife Act 1974 (Section 120) provides the authority for the issue of a general licence to take or kill or obtain any protected fauna which may include and cover casualties resulting from prescribed burning. The recent Wingham Judgement (Anon 1994a) however, whilst in favour of granting a licence in the same terms as the licence granted by the Director General NPWS, incorporated conditions related to grazing and fire.

The Wingham/NPWS General License court case resulted in the imposition of a series of conditions prohibiting hazard reduction burning and grazing across the Wingham Forest Management Area. In January 1995 NPWS commenced the introduction of these conditions in the Grafton Management Area. In February the conditions were strengthened with the quoting of the Draft Kempsey-Wauchope General License. These conditions focus on the potential habitat for CWR species which covers 80% of the parts of the Grafton Management Area proposed for grazing and hazard reduction.

The CWR species in question are the Rufous Bettong (*Bettongia rufescens*), Long nosed Potoroo (*Potorous tridactylus*), Parma Wallaby (*Macropus parma*), Red-legged Pademelon (*Thylogale stigmatica*), Spotted Tiger Quoll (*Dasyurus maculatus*) and the Brush-tailed Phascogale (*Phascogale tapoatafa*).
The prospect of the cessation of established burning practices resulting from the new conditions which attach to the general licence issued by the Director General NPWS, is causing concern amongst some land managers. It is feared that fire protection in N.S.W. forests and rural areas will be seriously compromised if prescribed burning including grazing and burning of all forest leases should cease. There is also concern that the licence conditions being imposed are inappropriate because some form of fire regime is most likely required to maintain the habitat of some species.

The vital role of fuel reduction burning in wildfire control is well established (see Luke and McArthur 1978. Shea *et al.* 1981 and Pyne 1991). Case studies such as those of Underwood *et al.* (1985) in the south west of Western Australia for example, have documented the value of fuel reduction burning in controlling multiple wildfire situations under extreme conditions in the south west of Western Australia.

The restrictions in range and numbers that has occurred in many CWR species has been ascribed to a variety of causes, including pastoralism and changed fire regimes but. very little definitive evidence was presented in support of the initial decision when the Precautionary Principle was used to impose a cessation of grazing and burning in the Wingham Management Area.

The Precautionary Principle is fast becoming a factor in decisions relating to the management of natural ecosystems. The Precautionary Principle as extracted by Justice Stein (Anon) from the 1992 Inter-Governmental Agreement on the Environment was to the effect that, "in the application of the principle, public and private decisions should be guided by: (i) careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment: and (ii) an assessment of the risk-weighted consequences of various options". (See Anon 1994a). This implies a proper scientific assesment of each situation.

This paper aims to examine the available scientific evidence on the question of burning and grazing on CWR species to asses whether the application of the Precautionary Principle to effect immediate cessation of grazing and burning is justifiable on scientific grounds.

Past and present fire regimes

The general theme that fire is an integral part of the Australian environment and that the flora and fauna evolved with fire is one which has been developed by many writers. The ecological basis for this theme has been reviewed by a number of people, amongst these, Jackson (1968) Mount (1969), Gill (1975, 1981), Recher and Christensen (1981), Christensen *et al.* (1981), Attiwill (1985), Underwood (1985), Attiwill and Leeper (1987) and Christensen and Abbot (1989) (see also Gill *et al.* 1981).

Since the commencement of the breakup of Gondwana in Cretaceous times, and the resultant climatic changes, Australias vegetation has changed from cool-temperate flora to rainforest to one dominated by Eucalyptus and other sclerophyllous genera. Aridity began in Australia in the Eocene, about the time that the continent began to move northwards (Beard 1977). Aridification bought with it an associated increase in fire incidence which was partly responsible for the development of the sclerophyll vegetation of today with its attendant high fire frequency (Jackson 1968 and Mount 1969). More recently, some 30-40,000 years ago, with the arrival of the Aborigine, the frequency of fire increased dramatically (Singh *et al.* 1981, Pyne 1991 and Singh and Geissler 1985).

There is much anecdotal evidence for frequent firing by Aborigines in Australia eg. Hallam (1975), Nicholson (1981) Ryan (1993/94), Cheney (1993) and Pyne (1991). This evidence suggests that a good proportion of dry sclerophyll forests and woodland in Australia, including N.S.W., were open woodland with grassy understorey when the first settlers arrived.

Some of this woodland remains today in the grazing leases, other areas have been cleared and yet others have regenerated in the absence of fire to forest with a scrub understorey.

The use of fire and its importance in many Aboriginal societies throughout the world is well documented (see Aschmann 1977 and Pyne 1982). In some cases fire intervals as frequent as every 2 years have been reliably documented using dendrochronology (Dieterich and Swetnam 1984). Such fire frequencies are consistent with descriptions of open park like forests with a grassy understorey described by early explorers (Dieterich 1980).

The evidence of Australian Aboriginal burning taken together with the broad evidence of frequent burning by aboriginal people across the globe, supports the idea that frequent firing of vegetation where this was possible was common place amongst Aboriginal people.

With respect to early European fire regimes in N.S.W. Cheney (1993) writes, "The major change affected by the Europeans was to reduce the number and frequency of aboriginal ignitions. This changed the fire regime from an annual or biennial burn to a somewhat longer frequency". In the opinion of Cheney, James Cook's description of the area near Botany Bay as an open woodland with grass or very low scrub understorey, fits a vegetation type which is burnt annually. When aboriginal burning ceased near Sydney the grass became "choked with underwood". Howitt (1890) describes a similar situation in Eastern Victoria, hills and valleys "clothed with grass" and scattered trees which became covered with forest after cessation of Aboriginal burning.

Unlike Burrill (1972), Cheney (1993) finds no evidence to suggest that European settlement increased fire frequencies. The annual burning of the Aborigines disappeared rapidly as they were displaced by European settlers. As fire frequency decreased the resultant fuel build up meant that fire intensities increased. There was a period of increased deliberate firing of the forest associated with prospecting from around the 1850's to the 1900's. Prospectors used fire extensively to clear the scrub and litter to expose underlying rocks.

The arrival of Europeans thus heralded a change in the pattern of fire in Australia. Initially the early settlers were largely graziers and burnt the pasture frequently for 'new pick' (the green grass which often sprouts immediately following fire) (Cheney 1993). As agriculture intensified and urbanisation increased clearing burns became more common and fire had to be more controlled in pastoral areas (see Pyne 1991). In the forests, fire exclusion was initially attempted in the early to mid 1900's during the peiord between the 1930s to 1960s. This policy led to fuels building up resulting in horrendous fires which were responsible for to initiation of a policy of controlled or prescribed burning which was introduced to a lesser of greater degree in all states (see Luke and McArthur 1978 and also Gill 1981).

Through all this change the fire regimes in the grazing leases over much of the forested area of N.S.W. remained relatively stable with frequent burning and generally light grazing being the norm.(Williams 1992) This is a situation not unlike that which existed prior to the arrival of Europeans.(see Nicholson 1981)

Grazing

Grazing of regeneration following fire is not something which is associated only with introduced herbivores such as sheep and cattle.Almost all of Australia's terrestrial ecosystems have their native mammalian herbivores and grazing by these can be intense following fire (see Dickinson and Kirkpatrick 1986, Leigh and Holgate 1979). Insect defoliation also may have considerable impact on post-fire succession (Whelan and Main 1979). Leigh and Holgate (1979) demonstrated that grazing following fire may have significant effects on species composition as well as structure of plant communities. They sound a note of caution against making assumptions about successional changes following fire in the absence of an understanding of the interactive effect of grazing. These authors also demonstrate selective grazing by various species. In Western Australia, Tammar Wallabies (*Macropus eugenii*), a CWR species, similarly have been shown to selectively graze native grasses (Christensen 1980).

Grazing by domestic stock may also be highly selective. In semi-arid woodlands, scrublands and grasslands sheep and goats have been shown to markedly influence community structure and composition (Leigh *et al.* 1968, Wilson *et al.* 1969, 1975, and 1976).

In *Eucalyptus pauciflora* woodland communities, grazing by sheep was demonstrated to prevent regeneration of snowgum seedlings (Bryant 1971). Bryant (1969) also demonstrated that on relatively stone free soils protection from grazing and burning did not result in a spectacular increase in shrubs. The proportion of shrubs related to site factors and the degree of competition with herbaceous plants. In the absence of grazing and burning the herb component of snowgrass tussock grassland increased significantly (Bryant 1969).

Grazing by both native and introduced species can affect vegetation composition and structure. Whether this is significant or not in terms of fauna which might be inhabiting the vegetation is likely to depend on grazing intensity and on the species of fauna.

Fire and animals

Survival of fire by mammals and birds is largely a function of fire intensity (see Recher and Christensen 1981, Christensen and Kimber 1975, Christensen *et al.* 1981, Suckling and MacFarlane 1984, Christensen *et al.* 1986 and Christensen and Abbott 1989). Mortality of highly mobile animals such as wallabies and kangaroos and even large birds can be substantial during high intensity wildfires (Hemsley 1967) but it is much reduced for fires of lesser intensity (see Suckling and MacFarlane 1984, Christensen *et al.* 1986, Wooller and Calver 1988, and

Thompson *et al.* 1989). In the weeks following fire a high rate of mortality occurs due to predation and starvation (Newsome *et al.* 1975, Christensen 1980, Newsome and Catling 1983). Recolonisation following fire is rapid for some species but others may require periods of between 20 and 40 years (see Christensen and Kimber 1975, Sawle 1979, Newsome and Catling 1983 and Suckling and MacFarlane 1984).

The return of species following fire may be influenced by a range of factors. With birds for example, seed production has been demonstrated to be important for the ground parrot (*Pezoporus wallicus*) (Meredith *et al.* 1984) and nectar is important for some nectivorous birds returning after fire (Loyn *et al.* 1992). Cover is important for a range of different birds (Christensen *et al.* 1986, Kimber 1974 and Loyn 1992).

Mammals may be affected by cover and food, for example the Rufous hare-wallaby (*Lagorchestes hirsutus*) (Lundie Jenkins 1993), the Tammar wallaby (*Macropus eugenii*) (Christensen 1980 and Christensen and Maisey 1987) or by food availability for example hypogean fungi and the woylie (*Bettongia penicillata)* (Christensen 1980), and the Tasmanian bettong (*Bettongia gaimardi*) (Taylor 1992 and Claridge 1992) and the Long-nosed potoroo (*Potorous tridactylus*) (Claridge *et al.* 1993).

Responses of animals to fire are complex and vary with species as well as fire characteristics.

CWR species, fire and grazing

Information on the fire/grazing impact on species in the CWR group is scarce and the effects as one might expect are highly variable. Where known relationships occur between CWR species and fire on the mainland they are of critical importance to the continued survival of the species because of the relationships between fire,ground-cover and fox and feral cat predation (Christensen 1980, Christensen and Maisey 1987, Lundie-Jenkins 1993, and Christensen and Burrows 1995).

It seems that the primary reason why so many CWR species survive in forests as opposed to say the deserts, the mulga, mallee or many open woodland communities is the prevalence of suitable and sufficient ground cover. Species within the CWR size range are very vulnerable to predation by efficient eutherian predators such as the fox unless they live in areas of reasonable cover where they have a chance of evading detection and of escaping a fox.

The critical importance of cover was effectively demonstrated by Christensen and Burrows (1995) during monitoring of an experimental reintroduction of Golden bandicoots (*Isoodon auratus*) and Burrowing bettongs (*Bettongia lesueur*) in the Gibson Desert.

Burrowing Bettongs are a colonial species which occupy burrow systems similar to rabbits from which they travel up to a kilometre or more to feed in open spinifex and herbland. Forty released bettongs were all predated by cats within 8 weeks. The golden bandicoots which live in somewhat denser spinifex and were able to seek refuge underneath these persisted for 24 weeks in the face of cat predation.

Foxes had been eliminated from the study area as part of the study. Factors like burning and grazing which affect ground cover and may result in increased predation by foxes and cats, can be a critical factor in the continued survival of many CWR species.

Perhaps the best studied example of a CWR species where a relationship has been demonstrated with fire and predation is the Rufous hare-wallaby (*Lagorchestes hirsutus*). Early research by

Bolton and Latz (1978) showed the factors identified as important to the hare-wallaby varied across habitats in relation to time since fire.Further studies on fire-created patch-dynamics were done by Griffin *et al.* (1990). Burbidge and Johnson (1983) suggested that hare-wallabies favoured post fire successional stage areas because of the succulent nutritious nature of the regrowth. As suggested by Lundie Jenkins (1993) this is consistent with results obtained by Holm and Allen (1988) which showed that values for nitrogen, phosphorous and in vitro digestibility were significantly higher in young plants in the first year since fire than in adjacent unburnt stands.

Further work by Lundie-Jenkins (1993) showed that hare-wallabies were dependant upon a specialised form of spinifex habitat. Patchiness, hummock size, food diversity and the degree of floral senescence affected suitability for hare wallabies. In the Tanami Desert suitable combinations of these characters were associated with tight mosaics of different regeneration stages after fire. The dense unburnt patches are important cover for the wallabies protecting them from predation by foxes and cats. These nutritional aspects of burning may likewise be important to certain species in the forests of NSW*.

Another well documented example is the dependence of the tammar wallaby in the open jarrah forests of Western Australia on thickets of *Gastrolobium bilobum* for cover. The *Gastrolobium* plants start to senesce and die at age 25 - 30 years; thereafter thickets break down and the wallabies disappear. *Gastrolobium* thickets are dependant on high intensity fires under dry soil conditions to successfully germinate the seed in quantities sufficient to form new thickets suitable for the tammar. In the absence of fire, thickets for the tammar would decline and the wallabies would be predated by foxes and disappear (Christensen 1980 and Christensen and Maisey 1987).

There is little published data on the fire ecology of CWR species in NSW forests. The work which has been done shows results which are generally concistent with the studies reviewed above. Schlager (1981) suggests that the Rufous bettong (*Bettongia rufescens*) may be either advantaged or disadvantaged by continued frequent burning depending on the degree of grass cover which is already present. Thus t he Rufous bettong is advantaged by the reduction in the scrub component resulting from frequent fires.

Extremely dense patches of blady grass on the other hand limit the availability of food plants and are little used by the species. The encouragement of unpalatable grass species in some areas may provide refuge where this resource is limiting.

The ability of bettongs to quickly recover from the effects of low intensity fire is demonstrated for the Rufous bettong by Schlager (1981) and the Brush-tailed bettong in Western Australia by Christensen (1980). One of the reasons for this ability is the mycophagous habit of bettong, and the relationships between fire and fungi, though the exact nature of this relationship is still being debated (see Taylor 1992 and Claridge 1992).

The Tasmanian bettong (*Bettongia gaimardi)* has been found to increase in numbers in the first two years following fire only to decrease in numbers later, after about 6 years. It is not known whether this is due to the development of thick scrub or to a decline in the abundance of hypogean fungi which are a main part of this species diet (Driessen *et al.* 1991). The other potoroine the Long-nosed potoroo (*Potorous tridactylus*), is disadvantaged by a lack of cover following fire and will not feed in recently burnt areas like *B. rufescens* (Schlager 1981).

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* Pers. comm. Dave Ryan SFNSW

Repopulation of areas regenerating following fire, however, may occur quickly (Dwyer *et al.* 1979).

Studies on the Parma wallaby (*Macropus parma*) by Maynes (1977) and Fox and Read (1989) suggest that the optimum habitat for Parma wallabies is wet sclerophyll forest. Parma wallabies favour disturbed areas and have been recorded from eucalypt plantations.

The abundance of tussock-grass and scarcity or absence of other grasses was shown to be be associated with presence of parmas (Fox and Read 1989). The relative abundance of grasses including tussock grass is a factor which is influenced by fire frequency and season.

The Red-legged Pademelon (*Thylogale stigmatica*) also favours the interface between wet sclerophyll forest and grassy areas in adjacent dry sclerophyll, it also occurs in rain forest in which the parma wallaby is seldom recorded (Maynes 1977 and Johnson 1980). Again fire frequency and season of burning are likely to affect the feeding areas of this species.

The effects of fire on the Spotted quoll (*Dasyurus maculatus*) and the Brush-tailed Phascogale (*Phascogale tapoatafa*) seem to be largely unknown. Studies on a related species *Dasyurus viverrinus* in Tasmania suggest that numbers of this species rapidly increase following fire in tall open forests (Hocking and Guiler 1983 and Dreissen *et al.* 1991). Increases in this species and also of *B. gaimardi* following fire should be seen in the context of the absence of the fox from Tasmania. Numbers of *B. penicillata* in dry sclerophyll forest in Western Australia are affected by fox predation during the first year or two following fire until the understorey provides sufficient cover (Christensen 1980).

There seems to be no published information on the effects of fire on the Brush-tailed Phascogale. In Western Australia it is comparatively common in dry sclerophyll forests which are burnt regularly in spring on a 5-7 year rotation (Christensen *et al.* 1985).

Catling (1991) examined fire regimes and their effect on forest structure and categorised the mammals of south eastern Australian forests as advantaged or disadvantaged by a simplification of forest structure resulting from frequent low-intensity burns. He considers the Spotted-tailed Quoll, the Eastern quoll, Long-nosed Potoroo, Rufous Bettong and the Parma Wallaby to be disadvantaged and the Brush-tailed Phascogale and the Hastings River Mouse to be advantaged.

The results from his model do not always compare with the data from studies listed above, for example the Eastern quoll and the Rufous Bettong are categorised as disadvantaged where the evidence above suggests otherwise. Whether or not the Parma wallaby is disadvantaged as suggested by Catling may depend on whether the fire affects its wet sclerophyll habitat or merely regenerates the adjacent grassy feeding areas. This may be the most important consideration for many species of wallaby, frequent fire can maintain grassy areas adjacent to cover. Fire needs to occur early in the season however so that the cover, usually less flammable vegetation, is not burnt.

Catling's suggestion that the Brush-tailed Phascogale and Hastings river mouse are advantaged by a simplification of forest structure resulting from frequent low intensity burining, is interesting. In the case of the Hastings river mouse other factors such as the extent and location of the burn in relation to the size of the mouse population would obviously be critical because of the few known populations and low numbers of this species.

In summary, although there is a pancity of data, the available evidence suggests that at least some of the CWR Species in Northern NSW may be favoured by a burning regime of some kind.

Discussion

One of the dangers in the current trend of increasing and unprecedented public input into conservation matters of all kinds, in particular the management of natural lands, is the tendency towards a lack of scientific objectivity. The Precautionary Principle mentioned in the introduction, is increasingly being used in decisions with respect to land management issues. The idea of the Precatuionary Principle is that caution should be exercised in all matters of the environment before any deliberate interference for whatever reason, is contemplated. A laudable concept indeed and it's application is obviously meant to be in the best interest of the environment. However the temptations to use it as an excuse to "do nothing until we know everything" is clearly there. If the principle is to prove its worth, its use must clearly be based on scientific objectivity.

It is instructive to look at the judicial pronouncements of which made by the Hon. Justice Talbot in the recent Wingham Fauna Licence Case (Anon 1994a). In this case Justice Talbot clearly establishes the fact that the Precautionary Principle does not necessarily require a complete cessation of activities pending better knowledge. He stated at p. 38 "Furthermore, the statement of the Precautionary Principle, while it may be framed appropriately for the purpose of political aspiration, its implementation as a legal standard could have the potential to create interminable forensic argument. Taken literally in practice it might prove to be unworkable".

Braithwaite, in giving evidence in the above case (Anon 1994a), states that it is important to retain scientific objectivity and not to make decisions driven by "aesthetic and animal welfare values including the fine detail of animal ecology and life history.

"Instead he believes", one should look past this interminable detail and work at the base level of ensuring the conservation of genetic stocks by assessing what is happening to the key environments on which all the various species depend".

Having due regard to the above, we may now ask whether the application of the Precautionary Principle to invoke the proposed changes to grazing and burning regimes in the Wingham Management Area is in the best interests of conservation of CWR species. Specifically, is immediate cessation of current prescribed burning, including burning and grazing practices on forest leases in N.S.W., in the best interests of CWR species?

The evidence which has been presented here leaves no doubt that fire has long been a part of the environment in which the CWR species have lived. The precise burning regime which existed prior to the arrival Europeans will always remain a matter of conjecture. However, the considerable circumstantial evidence, in the form of recorded observations of numerous early explorers and settlers, is compelling and there is a strong case for a regime of frequent fire, annual or biennial, in the grasslands of the forested areas of N.S.W having been the norm in the past.

There are many similar records of the use of fire by Aboriginal people on other continents throughout the world and we should not think that Australia is in any way peculiar or different from other continents in this respect.

It should be noted that Braithwaite*** considers that a grassy understorey in NSW is a predominant characteristic of areas with better soils - a woody understorey more so of areas of poor soils. Such soils, the better ones, are of course now largely cleared for agriculture.

*** Braithwaite CSIRO Canberra pers. comm.

Nevertheless, these areas may well have attracted the aboriginal burning which was observed by early explorers and settlers. Braithwaites observation does therefore not necessarily negate the suggestion made here that fire may be an important factor in the biology of species associated with forests which have a grassy understorey. In many areas a frequent, albeit perhaps not quite as frequent as the original, fire regime has been continued by graziers, and in recent years also by prescribed burning for fuel reduction purposes.

It is clear that fire affects each species differently and that no blanket prescription can suit all species. Although incomplete, there is evidence of beneficial effects from a frequent regime of low intensity fire for at least some of the CWR species. What the optimum regimes may be in terms of season, pattern or mosaic and many other things and this will vary with species, is still unknown. It would be reckless however to ignore the strong probability of a significant positive role of fire in the continued survival of some of the CWR species in Northern NSW forests.

With respect to grazing the picture is less clear. It may be stated that grazing is not new; native herbivores have for a very long time exerted an influence on regeneration patterns following fire, sometimes this influence may be beneficial to themselves or to other species. Cattle grazing is undoubtedly different but even here there are indications, for example with the Rufous bettong, that low levels of grazing could have negligible or perhaps even beneficial effects.

The findings of Lunney and Leary (1988) in a study of historical evidence of effects of land use changes and exotic species on native mammals in the Bega districts of New South Wales implicate changes wrought by Europeans, including fire and grazing, in declines recorded in many native mammal species. However no direct or totally convincing evidence is presented which implicates fire and grazing in the decline of any CWR species.

Catling and Burt (in press), in a recent study of Eucalypt forests in Southeastern New South Wales, examine the effect of habitat variables on distribution and abundance of ground dwelling marsupials. They suggest that grazing and fire have an effect on ground dwelling mammals but again provide only indirect evidence of this and nothing specific on CWR species.

Obviously it is not easy to demonstrate convincingly that CWR species are affected detrimentally or otherwise by either grazing or burning.

Perhaps the most compelling evidence is the indisputable fact of the *continued existence of the CWR species in the forests of Northern N.S.W. under the current burning and grazing regime.* Some CWR species which were formerly more widespread now only exist in forested areas. A major reason for these species disappearance outside the forested areas as well as their decline to low numbers in the forests is very likely predation by the fox and cat.

There is a known interaction between fire and grazing levels and the fox. How important this is for each of the CWR species is not known, though there is some evidence to suggest that in the absence of the fox frequent fire may not be a problem.

It is accepted that those who are pressing vigorously for the immediate cessation of forest burning and grazing may pursue their interpretation of the Precautionary Principle with good intentions, believing that burning and grazing, because they are carried out by graziers,are unnatural and therefore harmful. Although on the face of it this seems a reasonable supposition and one which might in the absence of any proof to the contrary appear to be legitimate and sufficient grounds for immediate cessation of burning and grazing under the Precautionary Principle, it is not supported by the existing evidence.

Firstly there is no such thing as a "natural" fire any longer. The patchwork of cleared farmland, forests and plantations inevitably means that even fires which start from natural causes (lightning) do not behave "naturally". Fires which occur today must therefore inevitably be different from "natural" pre-european or even pre-human fires.

An immediate blanket assation of the current burning regime will therefore not result in a fire regime which is any more 'natural' than the one which is currently being practised. The question then simply becomes one of whether or not the proposed new regime of no deliberate lighting of fires is any better than the current regime of fairly frequent fires.

The situation is no less clear for grazing and whilst it may appear obvious to some that grazing should be detrimental, it has by no means been proven that the low level of grazing which is currently being practiced is detrimental to all of the CWR species in question.

Available scientific evidence suggests that further research on the topic is likely to show that burning, quite possibly fairly frequent burning even, may have a vital role in the continued existence of many CWR species. With respect to grazing, the effect on CWR species is likely to depend on the frequency and intensity of grazing and it may not necessarily always be deleterious. The evidence therefore dictates that the Precautionary Principle should be used in exactly the opposite way to what is currently being proposed ie. rather than stopping burning and grazing immediately it is suggested that no sweeping blanket changes should be made to the current practices of burning and grazing before further information has been obtained on the effect of fire and grazing on the CWR species. CWR species have survived for a very long time under regimes of frequent burning and a further period of 10 years or so of the current regime whilst proper experimental evidence is obtained is likely to pose less danger to the continued survival of these species than will immediate cessation of all burning and grazing, the effect of which is currently unknown.

The other relevant issue which has not received much attention in this paper, because the main thrust of the paper is concerned with biological issues, is protection. The fire protection value of the present system is considerable, not only for human values but also for conservation. It is possible that isolated and restricted populations of certain rare species could be lost in addition to the loss of human values as a result of wildfires if protective burning were to cease ltogether. The protection aspect of the present system is therefore a legitimate value which should also be taken into account when interpreting the Precautionary Principle.

In summary it is suggested that it would be foolhardy to immediately cease the current burning and grazing practices in the belief that this action will necessarily benefit CWR species in the northern forests of N.S.W. If the Precautionary Principle is interpreted in the way outlined by Justice Stein and Justice Talbot then the most appropriate course of action is to continue current practices, until conclusive evidence can be obtained on the benefits or otherwise of these practices rather than cease them altogether immediately.

It is emphasised that this is not a recommendation for the indefinite maintenance of the status quo. What is being proposed should be recognised as a precautionary approach, being the most appropriate decision resulting from an "assessment of the risk-weighted consequences of various actions" to "avoid serious and irreversible damage to the environment".What is being proposed is that the status quo should continue only for a limited period, perhaps 10 years. As necessary data on the most suitable management options, taking into account the welfare of the CWR species as well as protection requirements, become available the current system should be reviewed.

The process of review may start almost immediately by considering what is already known of the ecology and distribution of each species. Location of populations of each species as well as potential areas of habitat will allow immediate management decisions to be made on the best available evidence . This may involve local changes to the current burning and grazing regimes.

At the same time further studies designed to fill the knowledge gaps should be set in progress. These studies are seen primarily as being at two levels of detail:

a. Further field survey work designed to identify populations of each CWR species as well as areas of suitable habitat,

b. Experimental-based studies on the effect of burning and grazing on selected CWR species.

In the current absence of adequate information on fire and grazing effects, fox and cat eradication on burnt areas should be considered as soon as is practical. 1080 baiting using dry meat baits in limited areas at the time of burning could be considered in some locations. Techniques enabling this to be done in the presence of the native carnivore *Dasyurus geoffroii fortis* have been developed in Western Australia. The period immediately after burning, when cover is absent or minimal, is known to be a critical time and fox baiting could be a useful precaution in certain instances.

In conclusion managers should not shy away from managing natural ecosystems by the expedient of ceasing activities altogether. The need to interfere in the environment when there are good and sufficient reasons, as well as the responsibilities that go with it, are well recognised by land managers and the conservation movement alike.

I quote from the five basic principles of fire management accepted in the National Parks Association of N.S.W.'s Policy on Fire Management (Catford 1992). The National Parks Association first formulated its fire policy in 1972, it was revised in 1980 and a further review took place at the request of the Nature Conservation Council of N.S.W. in 1992 (Douglas 1993).

Principle 2 in part states: ".....However, it is considered also that humankind may feel free to manage the remainder of the natural environment within an essentially natural framework, with management strategies based on scientific knowledge and general public consensus".

Principle 5: "The management of both natural and adjoining developed areas must take into account the problems arising from the common need for protection from unplanned fire".

These are excellent principles which may be used to form the basis of land management decisions to do with fire for areas of natural lands now and into the future. In this there is understantedly a role for the so called Precautionary Principle if it is interpreted in the spirit in which it was intended.

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