

Science, principles and forest management: a response to Abbott and Christensen

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Manuscript received 2 June 1995

As scientists engaged in research and teaching on the biota and ecosystems of Western Australia, we have been stimulated to respond to a recent paper by Abbott and Christensen 'Application of ecological and evolutionary principles to forest management in Western Australia' (Australian Forestry 57 (3), 109-122). In the light of the considerable emotion and rhetoric generated at present in the debate over management of native forests, Abbott and Christensen's paper had the potential to provide a rational basis for this important issue and to set the tone for reasoned and informed debate in all venues. Regrettably, this paper appears to contain fundamental flaws in logic, as well as in its choice and discussion of principles, and fails to live up to the promise of its title. Our concerns about the paper are substantial, making concise rebuttal difficult, and are presented under five broad headings.

1. Building a 'straw man'.

The introduction by Abbott and Christensen caricatures opponents of current forestry management practices in Western Australia as opposing all timber harvesting and prescribed burning on conservation grounds and as demanding full knowledge of all forest species before any of these management practices is carried out. While there are undoubtedly people who fit this portrait, many others raise concerns about forestry management based on economic, political or social criteria (Smith 1991, Sutton 1991, Norton and Mitchell 1994) or ecological grounds (Hobbs and Hopkins 1990, Davey and Norton 1990). Recent commentators such as McKellar (1995), illustrate the complex interweaving of all these issues.

The State Minister for the Environment has laid down conditions for forestry management and timber harvesting which are also used by the Commonwealth minister in evaluating applications for woodchip licences. One such condition is:

'The proponent shall manage karri and karri-marri forest in accordance with the precautionary approach. This approach requires that where there is significant risk that a particular forest management measure could lead to an irreversible consequence, appropriate monitoring and subsequent adjustments to management within an acceptable timeframe should be carried out.' (McGinty 1992)

In relation to jarrah forest there is reference to 'precautionary approach' and 'adaptive and flexible management practices based on research and monitoring of environmental questions' (McGinty 1992). In view of these conditions, the complex of scientific, social and economic factors involved, and the recognition of the South-West Botanical Province (which contains the forests in question) as an area of high endemic

biodiversity of international significance (Mummery and Hardy 1994), it seems proper that the interests of all groups concerned with forest use be heard. By over-simplification Abbott and Christensen create a 'straw man', a dummy with views so extreme that its case is easily demolished. This one-sided argument is then developed throughout the paper.

2. Logical inconsistencies and misrepresentations.

In their introduction the authors criticised the 'empirical, inductivist approach' of conservationists as 'unnecessary and in any case not the principal way that scientific knowledge is advanced' (p. 109). However, their own principles are 'founded on thousands of empirical studies' and involved 'reducing the complex to the simple, and recognizing universal or common patterns which may be embodied in a set of general principles' (p. 110). In short, they used the very inductivist approach they derided earlier. A more powerful method is described by Miller (1994, p. 9):

'In order to discover something true we propose conjectures, which might be true, and incorporate them into science, without regard for whether there is anything that could be called evidence in their favour, without regard for whether there is any reason to think that they are true. We then make the most ruthless and uncompromising efforts to show that these hypotheses are not true, and to reject them from science. It is of the utmost importance that we should not be hampered in our efforts to do this, either by the form of the hypotheses themselves or by the employment of artifices raised in their defence. Not only must our hypotheses be open to falsification by experience, our treatment of them must be determinedly one of eliminating them if in fact they are false.'

Measured against this standard, it is doubtful if Abbott and Christensen's principles could be phrased as useful falsifiable hypotheses. Almost any forestry practice that attempted to return an area to forest after harvest would seem to accord with most of them.

Abbott and Christensen claim '... to leave behind the emotive and unscientific approaches which have crept into the forest debate' (p. 119) yet they use emotive language themselves ('subsequently regenerated with no assistance into magnificent stands', p. 110) while neglecting to mention examples of sites that prove difficult to regenerate (Wardell-Johnson and Christensen 1992) or problems of disease in regrowth karri (Davison and Tay 1994). They also posit, as early as the summary, 'that this forest remains in ecologically good condition' (p. 109) and assemble information selectively throughout the paper to support this assertion. In chastising their opponents for using approaches they em-

ploy themselves and starting out with a conclusion and working towards it, the authors do not inspire confidence that their assessment is unbiased.

In consultations with colleagues we have also located several instances in which Abbott and Christensen use misleading citations and selective or inaccurate reporting of research findings. For example, they claim 'Moreover spring burning rarely results in the forest canopy being burned and mortality of eggs and nestlings is low' (p. 117), citing an earlier study by one of the authors (Christensen *et al.* (1986). Examination of the original paper reveals that no quantitative data relevant to this question were presented. Christensen *et al.* (1986) do observe that 'Many species also nest out of reach of the flames of mild fires. We have recorded nests which have escaped fire and in which broods were subsequently reared. Individuals of species which nest close to the ground are however more severely affected' (p. 298). This is hardly support for the statement that 'mortality of eggs and nestlings is low'.

A second instance is the statement 'There are usually large changes to the soil and litter invertebrate fauna immediately after fire, but over a short period this fauna reverts to its pre-fire state' (p. 110), citing an earlier paper by one of the authors (Majer and Abbott 1989). The earlier paper is far more cautious, noting: 'The impact of prescribed burning on soil and litter invertebrates has been looked at by several workers over the past 30 years, but the conclusions have not always been in agreement with each other' (p. 114). After summarising the results of these studies it reaches the conclusion: 'Although animals have recovered to pre-burn densities by the end of the normal prescribed burn rotation period, the species composition of the community may still be altered' (p. 115). We feel this does not support the assertion that 'over a short period this fauna reverts to its pre-fire state'. Such misleading citations do not engender confidence in Abbott and Christensen's use of the scientific literature to support their arguments.

3. Principles or platitudes?

The major original contribution of the paper is the promulgation of a set of principles, which the authors correctly state would be accepted by most ecologists as applying to forest ecosystems. However, as they admit 'Principles are necessarily simple propositions encompassing irrefragable truths or fundamental patterns discoverable from many studies' (p. 110). Thus, there seems little to be gained by stating them outright, one needs to demonstrate clearly why they are important in the context of the discussion. On this basis, the selection of principles examined in this paper is at best inadequate, and at worst misleading, addressing very few of the concerns or procedures of ecologists or managers that are currently under debate in the scientific community. It is significant that none of the principles is referenced, nor are major ecological theoreticians, such as MacArthur, Simberloff, or Soulé, cited in support of any of them. There is no account of the debate on the applicability of principles of reserve design (Davey and Norton 1990, Hopper and Coates 1990), the critical negative dimensions of edge effects (Janzen 1986), minimum viable population sizes (Soulé 1986, 1993, Gilpin and Soulé 1986), population viability analyses (Possingham 1991), ecologically sustainable development (Dovers and Norton 1994, Maser 1994), the growing array of computer-based systems that can aid in management decisions (Davey and Norton 1990, Bergmann *et al.* 1994), and

the potential power of BACI (Before/After and Control/Impact) studies and the more recent protocols developed from them (Underwood 1991, 1992) to test hypotheses concerning disturbance or impact. There is also no discussion of the use of any of these concepts by forest managers in Australia or overseas.

Many of these very issues form the basis of discussions of ecosystem management in undergraduate texts in biology and environmental science commonly used in Australian universities, including Chiras (1991), Raven and Johnson (1992) and Purves *et al.* (1995). Indeed, the recent major Australian text by Knox *et al.* (1994) further devotes a special boxed highlight section to an assessment of the status of Australian forests. Abbott and Christensen may indeed have been 'taught the basic concepts of ecology and evolution as young university students' (p. 110) but, as the above textbooks show, the application of these concepts to management has advanced considerably since their most recent relevant textbook reference (1973) and overwhelmingly since the 1920s. The texts also address philosophical and ethical reasons for conserving biodiversity. More importantly, many authors have concluded from an examination of these very issues that our knowledge base for making correct management decisions is often inadequate. For example, Possingham (1991, p.37) notes: 'This brings us to a recurrent theme commented on by so many biologists: namely that without adequate surveys on habitat suitability, losses will occur before we have enough data to confidently assess population viability and reform forestry practices accordingly'. This makes it clear how arbitrarily Abbott and Christensen have selected their own principles. Unfortunately, their selection is not representative, and any examination of agreed principal issues highlights a shortfall of data critical for management decisions, so the precautionary principle should be invoked.

4. Alternative interpretations.

One reason we do not find Abbott and Christensen's principles useful in assessing the condition of Western Australian forests is that they are essentially unfalsifiable. Space prevents a consideration of each one but we would like to examine three of these principles to show how they are open to very different interpretations.

(i) Principle 4. 'Insects and fungi are the most speciose groups in natural ecosystems.' This statement is unexceptional, although we would prefer 'invertebrates' to 'insects', given that our knowledge of the total number of invertebrate species is poor. However, the interpretation that: 'The implication of this principle is that the high densities of insects and fungi help stabilize the number of species of higher level organisms which live off them' (p. 112) is unhelpful since it confuses the issue of absolute abundance of organisms (high densities of insects and fungi) with that of species richness (number of species of higher level organisms). Further, it ignores the key point that since invertebrates and fungi are so numerous and diverse they constitute better indicator species for the ecological health of the forest than vertebrates, which are widespread, easily dispersed and comparatively long-lived. Indeed, fungi have been established as effective bio-indicators in northern hemisphere forests where their decline has been noted with grave disquiet (Primack 1993). Similar monitoring programmes might be mounted with profit in Western Australian forests where they would provide a quantitative test of the hypothesis of forest health. With regard to invertebrates, especially arthropods, Kremen *et al.* (1993)

have argued that they make excellent indicator species.

It is clear from this principle that concentration of the research effort related to forestry management in the extreme south-western part of Australia on widespread and/or easily dispersed vertebrate species, has underestimated the biodiversity value of the region. The dominant components of animal biodiversity in the region are invertebrates, many of which cannot move quickly away from disturbance, or to new areas. A significant proportion of species are also geographically restricted in their occurrence and rare by nature (Main and Main 1991, Horwitz 1994), and of considerable value to our society. Generalising for the whole south-west botanical province, Mummery and Hardy (1994, p.36) note: 'The invertebrate fauna has been comparatively little studied but some elements are likely to be as unique as the flora'. Christensen himself appears to agree, Wardell-Johnson and Christensen (1992, p.48) arguing:

'The poor taxonomic base of invertebrate work urges that high priority be given to such work in the Warren Botanical Subdistrict in general and the karri forest in particular. Experimental work to examine the effects of disturbance on invertebrates will establish those vulnerable taxa and sites in need of special consideration in management operations and allow operations to be designed accordingly. ... Further experimental work should be accompanied by considerable taxonomic work. Groups that include relictual taxa of poor colonization ability are in particular need of study. Sites in high rainfall zones in karri-tingle forest may be expected to harbour such species'.

The relictual, endemic species with poor powers of dispersal are particularly prone to disturbances such as logging, road construction and prescription burning. It is surely essential that thorough surveys be undertaken at a scale commensurate with the chance of finding relictual, endemic and vulnerable faunas, prior to clearfall operations, road construction, and further prescription burns. Monitoring is ineffectual without predisturbance information and some form of BACI would be highly appropriate in this context.

(ii) Principle 11. 'Climatic and geological changes result in extinction of many species. Extinction of species over geological time is commonplace, with 99% of all species that have ever existed being extinct.' The authors give no implication arising from this statement, but if they intend that loss of any species from the Western Australian forests could be seen as a natural process, for which we need have no particular concern, this is grossly misleading. The concern of many ecologists is not extinction itself but the fact that it is occurring at a rate paralleling that of the great extinctions of the geological past and that habitat fragmentation has already progressed to the point where, for many of the larger species, there is no longer any opportunity for speciation to occur; new species will not arise to replace those irretrievably lost (Soulé 1986, Chiras 1991). This concern presumably underlies the Ministerial condition for a precautionary approach in the management of the forest in the high rainfall zone of the extreme south west and the requirement of Abbott and Christensen's own department to 'establish whether threatened or specially protected fauna are present before undertaking any activity on CALM land that involves permanent destruction or major modification of habitat of native fauna' (CALM policy statement number 33, section 5.8). It is also important to remember that the scale of climatic and geological change is one of thousands of years, whereas current habitat loss and fragmentation are occurring on a scale of

decades. The principle as stated has no significance or value to management questions except to endorse a precautionary approach.

(iii) Principle 14. 'Species introduced to Australia have profound ecological impacts on elements of the native biota because natural controls present in their place of origin are absent in Australia.' Abbott and Christensen argue from this principle that, compared to the impact of introduced species, 'timber harvesting and prescribed burning in jarrah and karri forest have had minor impact on the native plant and animal species present' (p.115). However, they admit that logging and road movements helped spread the pathogenic fungus *Phytophthora cinnamomi* which now affects more than 200 000 ha of jarrah forest (over 13% of state forest) and that a third of the affected area is termed 'graveyard sites' (p. 115). This is hardly a minor impact. Invoking mammalian introductions as a sole or principal cause of native mammal decline ignores the evidence from studies of mammalian extinctions elsewhere in Australia (eg Recher and Lim 1990, Morton 1990) implicating a range of factors, including habitat destruction, introduced predators and changes in fire regimes in multi-causal models. It appears it is the interaction of factors that is critical in tipping a species into decline or extinction. For instance, habitat destruction can isolate species into pockets where they are more subject to natural disaster and where they can be driven to local extinction by predators. Although the major Australian studies of this topic relate to the arid zone, the principle is applicable elsewhere. Chiras (1991, p. 172) states: 'In fact, multiple causation is the rule in animal and plant extinction'. With specific regard to forests, Possingham (1991, pp 37-38) is equally forthright: 'It is therefore a scientific fact that increasing the area that is logged in any region will increase the probability that forest-dependent flora and fauna will go extinct. ... It is important to accept that forestry does increase the probability of extinction of fauna that depend on mature forest'. Christensen also appears to recognise the likelihood of a link, Wardell-Johnson and Christensen (1992, p.48) recommending: 'The possible influence of disturbance (e.g. roadworks and felling operations) on predation of vulnerable species like the Quokka requires investigation'. Undoubtedly, introduced species have caused much ecological mischief, but their impact has almost certainly been compounded by other forestry practices.

5. Indicators of ecologically good condition of jarrah and karri forest.

Many of the indicators given by Abbott and Christensen in their Table 1 seem susceptible to different interpretation. The non-violation of 'ecological and evolutionary principles' provides little support given that the principles espoused by the authors are, in the main, non-falsifiable. The arguments about survival, contractions in range and the good survival of species at the ends of food chains are misleading in two ways. Firstly, the vertebrates mentioned are poor indicators, since their good dispersal abilities make them the least likely to show negative short-term responses to disturbance. Invertebrates and fungi would be better indicators. Secondly, the critical data from population viability analyses that would conclusively test the hypothesis of 'ecological health' in populations of larger vertebrates are simply unavailable. The authors cite a lack of evidence of population declines and extinctions in the forests as indicating that current management practices are having negligible effects on the biota. However, as admitted by one of them (Wardell-Johnson and

Christensen 1992, p.50) '...data on the distribution of most forest vertebrates are inadequate to define changes in status or be useful for predictive modelling of the effects of disturbance'. Further, Tilman *et al.* (1994) discuss the concept of an 'extinction debt' in which the long time lag between habitat alteration and species loss means that species may be destined for extinction well before they disappear. Where assessments of the long-term prospects of components of the vertebrate biota of the south-west forests have been made, the results are not encouraging (Mawson and Long 1994). It is also important to acknowledge that our inventory of the vertebrate fauna is incomplete and that new species with restricted habitats are still being discovered (Roberts *et al.* 1990). Absence of data should not be seen as *de facto* support for the *status quo*, but rather a compelling argument for urgent appropriate research and a strong precautionary policy in management.

All comments on the 'ecological health' of plant associations need to be balanced against the authors' own admission of the huge scale of the dieback problem in the jarrah forest and the sparse data on whether logging and prescribed burning continue to contribute to the problem. Again, the lack of information on this question is tacitly taken by the authors to mean that current practices are having no effect. Abbott and Christensen also neglect to mention a wide range of other diseases including canker fungi, leaf spot fungi, brown wood of karri and dieback-decline of marri and wandoo, which are acknowledged to form '... a complex of interactions between host, pathogen, environment and human activity' (Shearer 1992, p.99). The fungal disease 'brown wood' is a problem in regenerated karri stands (Davison and Tay 1994), which surely is cause for concern. New vascular plant species are also still being discovered in south-west forests (Hopper and Brown in review), so our inventory of the vascular plant communities is incomplete. These arguments lead us to conclude that in the long term the forests may not even be healthy from the viewpoint of timber production, let alone from the perspective of biodiversity conservation. Current management practices may have little or no impact on the forest biota, but without good evidence based on thorough survey and monitoring and experimental testing of explicit hypotheses relating to management goals it is impossible to reach a valid conclusion on the subject. Indeed, as the arguments above demonstrate, there is strong justification for doubting the 'good ecological condition' of south-western Australian forests, and for implementing both substantive pre-logging surveys and urgent applied research to ensure that the Ministerial guidelines relating to a precautionary approach to timber harvesting are followed.

Conclusion.

Abbott and Christensen's paper has articulated a philosophical position regarding forestry management practices in Western Australia, a position which has existed for many years without being expressed. It seems to us that a major tenet of the philosophy revealed in Abbott and Christensen's paper is to deny the need for much applied research on management issues in forests. While there are many studies of forest organisms, often they are studies of basic science (eg Wooller and Calver 1981) rather than rigorous tests of hypotheses relevant to management, while others may have methodological flaws or limitations which limit their usefulness (see the discussion in Majer and Abbott (1989) concerning the interpretation of past studies of the influence of fire on ground-

dwelling forest invertebrates). The current lack of data from specific, methodologically sound tests on impacts (or absence thereof) of forestry practice on the forest ecosystem and its components precludes rational debate on the subject. This in turn encourages confrontation. Smith (1991, p.301) has referred to '... the narrow perspective of policy formulators, which currently promotes rather than resolves conflict by failing to give adequate attention to non-timber perspectives at all stages of the policy process, from problem definition to coupe planning'. Such an attitude is evident in the introduction to Abbott and Christensen's paper.

We argue that the paucity of good data on management issues prevents any confident assessment of the impact of forestry in Western Australian forests, and we endorse the specific programme of urgent research priorities cited by Wardell-Johnson and Nichols (1991) to rectify the situation. We consider that the elucidation of such a programme for all land with conservation values would be an excellent initial approach to forestry management and in keeping with both CALM's charter and the Ministerial precautionary condition placed on forestry activities in some regions of south-west Western Australia.

Acknowledgments

We thank, without implication, P.I. Atkinson, M. Booth, D. Driscoll, P. Hallen and many other colleagues for discussing with us many of the issues raised.

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