Improving Habitat Models and Their Utility in Koala Conservation

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Abstract: *Models of what makes good koala habitat are a key to developing effective conservation policy and practices. Koala habitat models are based on (1) ecological studies of high-density koala populations in limited areas, (2) physiological studies of koala nutrition and characteristics of food plants, and (3) surveys of koala geographic distribution and biophysical features of forests and woodlands. The role of models in koala conservation varies because legislators, decisionmakers, land managers, and citizens have different expectations and uses for models. Although current habitat models address many of these needs, overall they lack sufficient certainty and authority to resolve disputes and develop policy. Unpublished and inadequately peer-reviewed data and models add to misinterpretation and argument. Improvements are needed in the decision-making process to increase the constructive involvement of all interest groups and to focus on the koala conservation problem, thereby reducing use of the popular media and courts of law to achieve objectives.*

Modelos de Mejoramiento del Hábitat y su Utilidad en la Conservación del Koala

Resumen: *Los modelos de lo que constituiría un buen hábitat para koalas son clave para desarrollar políticas y prácticas efectivas de conservación. Los modelos de hábitat del koala se basan en (1) estudios ecológicos de poblaciones de koala con alta densidad en áreas limitadas (2) estudios fisiológicos de la nutrición del koala y características de las plantas usadas como alimento, y (3) reconocimientos de la distribución geográfica del koala y las características biológicas y físicas de los bosques. La función de modelos para la conservación de koalas varía según las expectativas y los usos asignados a estos modelos por los legisladores, las personas responsables de adoptar decisiones, los manejadores de tierras y los ciudadanos. Si bien los modelos de hábitat actuales abordan muchas de estas necesidades, en general carecen de suficiente certeza y autoridad para resolver disputas y desarrollar políticas. Los datos y modelos no publicados e inadecuadamente revisados contribuyen a su interpretación equivocada y argumentación. Se necesita mejorar el proceso de toma de decisiones para incrementar la participación constructiva de todos los grupos de interés y para enfocar en el problema de conservación del koala, y así reducir el uso de medios de comunicación masiva y juzgados para alcanzar los objetivos.*

Introduction

Threats to koalas from habitat loss are well documented (e.g., Hume 1990; Phillips 1990; Reed & Lunney 1990). About 50% of forests and woodlands within the historic range of koalas has been cleared for agriculture and urban development since 1788 (Wells et al. 1984). Most remaining forests have had their structure and tree-species composition altered by logging, grazing, and recreation. Problems of koala conservation and possible solutions are the focus of intense debate among Australian government at all levels, nongovernment organizations, scientists, and community groups (Lunney et al. 1990; Cork et al. 1995; ANZECC [Australian and New Zealand Environment and Conservation Council] 1998). Virtually all actions that can be taken to ensure the viability of the species have at their heart a "model" of koala habitat. These conceptualizations

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range from qualitative or "mental models" based on perceptions (Senge 1992) to quantitative models, including statistical models. The characteristics of models needed differ among users.

Effective conservation depends on the availability and use of appropriate information in a range of circumstances. First we determined who needs models of koala habitat, what types of information are needed in the models, and what standards must be met. Second, we assessed how well current habitat models meet these needs. Third, we considered the role of habitat models in social and political contexts. Science does not exist in isolation and often has less influence on conservation decisions than social and economic factors (Clark et al. 1994; Bennett et al. 1995; Clark 1997); therefore, we offer recommendations in the context of the broader dynamics of the entire decision-making process in society.

Who Needs Habitat Models?

Three broad groups use models of koala habitat: national and international legislators and decisionmakers, conservation professionals and other land managers, and the lay public, including community and other nongovernment conservation groups. These three groups can have different needs for models depending on what actions they wish to take and the scales at which they are to be applied.

Both state and national governments in Australia have a legal responsibility to protect flora and fauna through strategic planning to minimize extinction risk (Lunney & Matthews 1997; ANZECC 1998). Mechanisms for assessing risk must take into account data or expert opinion about trends in populations and habitat and the likely effects of threatening processes (e.g., Lunney et al. 1996). Habitat models are the basis for population estimates at national and state-wide scales because counting individuals is impractical. Because government policymakers act in a social context, they prefer habitat models and estimates of population trends that are broadly accepted by diverse groups. These models must be capable of making quantitative (i.e., mappable) predictions at the range of spatial scales at which policies apply, and they must address the uncertainty of prediction and the likely effects of management (policy) options.

Land managers are responsible for developing and implementing strategic and operational plans at national, state, and local levels (including species recovery plans) in state and local departments of forestry, conservation, and agriculture. Community groups also undertake land management for conservation purposes (e.g., tree planting, fencing, weed or predator control). These diverse groups have a common need for clear characterization of koala habitat and where it occurs so they can develop and implement realistic plans. Some of this information is not easy to map: structural characteristics of canopy and understory, landscape-scale configurations, and predictions about the likely effects of environmental changes and management options.

Most issues requiring decisions pertinent to koala conservation involve assessment and management of risk, including the choice and timing of logging practices, application of fertilizer in or near habitat, use of habitat for grazing sheep or cattle, protection or restoration of habitat, predator and weed control, and fire management. For koala habitat models to be useful for risk assessment, they must incorporate the processes that maintain koala habitat so that the likely effects of land management can be predicted.

Outside their roles as land-management professionals, people can exert a strong influence over conservation decisions and actions by participating in public meetings, communicating with elected representatives, carrying out business, voting in elections at all levels of government, and helping with activities such as planting of trees and surveys of koalas and their habitat. Members of the public want reliable, broadly accepted, and clearly articulated statements about the koala's local, regional, and national distribution and status and the broad actions required to ensure the long-term viability of the species and its habitat. Many disputes between economic and conservation interests over koalas result because of differences in perceptions about what constitutes koala habitat, how much is needed, and what effects development will have.

Appraisal of Existing Habitat Models

We focus on models as scientific constructs, but we acknowledge that people's perceptions, filtered through diverse and complex beliefs and values, can be at least as important in conservation decisions. Scientific studies have determined that climate, soil, forest structure, tree species, the chemical composition of leaves (nutrients and toxins), and exotic and native predators all influence koalas and their habitat. We group models into three types on the basis of the geographic range and scope of processes investigated: (1) intensive studies of individual populations; (2) physiological studies of koala nutrition and of the chemical composition of eucalypt foliage; and (3) broad geographic surveys of koalas in relation to the biophysical characteristics of forests and woodlands.

Intensive Study of Individual Populations

Most koala habitat models are based on reports of the tree species that koalas use for food and shelter (e.g., Bergin 1978; Warneke 1978; Pahl et al. 1990; Phillips 1990). Some of these studies are based on incidental reports or people's memories of koalas in particular tree species (e.g., Phillips 1990; Reed & Lunney 1990; Lunney et al. 1997). Others have surveyed koalas by visual observation in daylight, spotlighting at night, tracking of radiocollared individuals, surveying for fecal pellets, and eliciting responses to taped calls of males (e.g., Hindell 1984; Hindell et al. 1985; Hindell & Lee 1988; Quirk & Smith 1990; Tilley & Uebel 1990; Jurskis et al. 1994; Melzer & Lamb 1996; Callaghan & Phillips 1995; Pahl 1996; Jurskis & Potter 1997). The general conclusion of these studies is that koalas prefer one or a few eucalypt species at any given site but often use other eucalypts and some noneucalypts less intensively. Different species are preferred in different parts of Australia, and the acceptability of leaves and their chemical composition differ among individual trees of a species (Lawler et al. 1998).

Few studies have investigated relationships between koala population processes and habitat characteristics at a landscape scale. At least two studies are under way that relate habitat configuration to dispersal of young koalas (S. Ramsay and S. Cox, personal communication), the results of which will be useful at least locally (Nowendoc and Bathurst, New South Wales). Few data exist on the influence of habitat characteristics on the susceptibility of koalas to predation. Food preferences can differ between sexes and can change seasonally (Melzer 1995). Detailed studies at particular sites in southeastern Australia have identified aspects of forest structure (e.g., presence of large trees, woodland versus closed forest) as important requirements for koalas (Eberhard 1978; Hindell et al. 1985; Hindell & Lee 1988).

Models based on the study of individual populations provide useful recommendations for identifying and restoring koala habitat for the local area where the study was conducted, but they cannot be applied with confidence to other populations that have access to other mixes of tree species or that live under different environmental conditions. Nevertheless, such studies in aggregation can and do form the basis for conservation policy at national and state levels (Martin 1989; Lunney & Matthews 1997). By necessity, these studies have been conducted on populations with a relatively high density of koalas, whereas many of the populations that are the subject of intense debate are low in density.

Unfortunately, the adversarial nature of many interactions between conservation and economic interests often demands greater precision and accuracy of prediction than individual population models are capable of. For example, disputes over individual blocks of forest often require an assessment of how the quality of habitat on that block differs from the quality of other, similar blocks, or of the significance of the block to koalas on a regional or state-wide scale.

Physiological Studies of Koala Nutrition and the Chemical Composition of Eucalypt Foliage

Published ideas on why koalas prefer certain eucalypt species and certain forests have been based largely on the role of foliar nutrients as attractants, the role of chemical toxins as feeding deterrents, and implications of the koala's digestive and metabolic physiology for its habitat requirements. Studies of diet selection by koalas over small geographic ranges in relation to leaf nutrients have revealed few clear trends (Hindell 1984; Lawler & Foley 2000).When it is available, Koalas often prefer new growth to mature foliage (Ullrey et al. 1981), and it is postulated that this is a response to higher concentrations of nutrients, especially nitrogen, in new growth (Degabriele 1983). In dry environments or during drought, water rather than other nutrients is correlated with selection of eucalypt species and communities by koalas (Hindell 1984; Melzer 1995; Melzer & Lamb 1996; Munks et al. 1996). Such findings provide understanding of the foraging habits of koalas but are of limited use for locating and mapping new koala habitat.

Since the 1930s, there has been speculation that terpenoid compounds, including the volatile essential oils that give eucalypts their characteristic odor, influence diet selection (Southwell 1978). Comparisons between eucalypt species preferred by koalas and species that are avoided have revealed inconsistent trends (Southwell 1978; Lawler & Foley 2000). Hume and Esson (1993) suggest that a threshold concentration of essential oils is necessary as a feeding cue for koalas. Currently, knowledge about essential oils is inadequate either for identifying high-quality koala habitat or to predicting its occurrence over small or large geographic areas (Lawler & Foley 2000).

A few researchers have investigated the combined effects of toxins (essential oils and some phenolics), antinutrients (tannins, lignin, and cell-wall carbohydrates), and nutrients (nitrogen, lipids, and available carbohydrates) on diet choice by koalas (Ullrey et al. 1981; Hindell 1984; Cork 1992; Cork & Braithwaite 1996). These studies establish relationships that can be used to distinguish broadly between unacceptable and potentially acceptable food and habitat for koalas and therefore provide a basis for understanding habitat selection. Nevertheless, these models poorly predict the relative quality of forests and their use by koalas locally.

More recently, it has been found that certain highly toxic phenol-terpene hybrids in eucalypts explain a high proportion of the variation in short-term leaf intake by koalas, other folivorous marsupials, and some folivorous insects in captivity (Lawler et al. 1998; Lawler & Foley 2000). With further validation, this approach could be used to identify habitat quality between and within small areas of bushland, and it could be extended to larger areas once methods for rapid screening of the compounds and remote mapping of leaf quality are available (Foley et al. 1998).

Eucalypt foliage contains little available energy. Research suggests that koalas must feed frequently, cannot accumulate excess energy to store as fat, and rely on their low metabolic rate and behavioral mechanisms to conserve energy (Cork & Hume 1983; Cork & Warner 1983; Cork et al. 1983, 1990; Cork & Sanson 1990; Hume 1990; Cork & Foley 1991; Krockenberger 1993). For these reasons, koalas are expected to cope poorly with disturbances that reduce the availability of food or increase foraging effort (Cork et al. 1990; Hume 1990). These hypotheses have provided a theoretical underpinning for habitat management within koala populations, but they have been tested in wild populations only to a limited extent (e.g., Krockenberger 1993).

Broad Geographic Surveys of Koalas in Relation to Biophysical Characteristics of Forests and Woodlands

Broad-scale survey and statistical modeling of koala habitat in relation to environmental variables potentially allows both prediction of koala occurrence or abundance and mapping of the predictions. This approach presents particular problems, however, because koalas are rare in some areas and usually difficult to detect (Nicholls & Cunningham 1995). In practice, this has meant that few surveys have produced reliable estimates of koala abundance. Despite these limitations, several attempts have been made to define koala habitat over broad geographic areas.

In arid and semiarid Queensland, tree species composition, relative density of palatable trees, aspects of woodland structure, and water content of eucalypt foliage are postulated to be prime determinants of habitat quality (Melzer 1995; Munks et al. 1996). These broad predictions appear to meet the immediate needs of policymakers because there is little conflict at present over management of koala habitat in northern Queensland (A. Melzer, personal communication).

In southeastern New South Wales, geographic surveys have shown that arboreal marsupials, including koalas, are most likely to be found and are most abundant in country of flat or undulating topography and in forest types on relatively fertile soil with high concentrations of nutrients in leaves and low concentrations of carbon-based chemical feeding deterrents (Recher et al. 1980; Braithwaite et al. 1983, 1984; Braithwaite 1984, 1996; Lunney 1987; Kavanagh & Lambert 1990; Stockwell et al. 1990; Cork 1992; Cork & Braithwaite 1996; Cork & Catling 1996; Landsberg & Cork 1997). These conclusions are useful to decisionmakers, but the underlying models have various limitations, not all of which are scientific.

Because koalas are rare in the southeastern forests, some of the geographic models are based on inferences from research on other species, with minimal data on koalas (Braithwaite et al. 1983; Cork et al. 1990; Cork 1992). Few of the models consider how predators or changes to forest structure affect habitat quality. This is an important limitation because the models have been needed in debates about the effects of timber harvesting on the species (State Forests of New South Wales 1994; Jurskis et al. 1994; Talbot 1994; Allen 1995, 1998; Braithwaite 1996).

Two state land-management agencies and a coalition of community groups have focused specifically on low-density koala populations in southeastern New South Wales (Reed et al. 1990; Jurskis et al. 1994; Jurskis & Potter 1997; Lunney et al. 1997; Allen 1998). The staff of State Forests of New South Wales (Jurskis et al. 1994) monitored radiocollared koalas to investigate preferences for tree species, forest types, and disturbance levels in timber-production forests. The coalition of community groups surveyed fecal pellets in relation to environmental variables and forest type (Allen 1998). The New South Wales National Parks and Wildlife Service (NPWS) used postal surveys and incidental reports of koalas to investigate where koalas had been seen over various time periods (Reed et al. 1990; Lunney et al. 1997; see also Lunney et al., this issue). All these studies addressed key questions asked by planners and forest managers. Their use in decision-making, however, is limited by a high level of dispute and mistrust among government agencies and community conservation groups, which arose from a long history of disagreement over how forests in the region should be managed (Lunney & Moon 1987). The inherent biases in public surveys and incidental records have allowed contradictory interpretations of these data by different interest groups. Decision making has been further hampered because several of the studies (Jurskis et al. 1994; Jurskis & Potter 1997; Allen 1998) have been publicly debated after limited independent scientific review.

Three recent studies in northeastern New South Wales (Table 1), where koalas are much more abundant and widespread, illustrate the strengths of broad-scale geographic models but also the difficulty of meeting all requirements of decisionmakers. Each of these studies represented far greater time and expense than previous studies, and each substantially increased the fund of knowledge, but each met only some of the requirements of the three groups of users. Although the National Parks and Wildlife Service model produced a map of the potential occurrence of koalas throughout the study area, the use of presence data but not absence data meant that the model could not include measures of statistical confidence. The study took little account of fire history, substrate quality, or forest structure. Kavanagh et al. (1995) investigated three intensities of timber harvesting and found that koalas were most frequently found in logged, wet forests at lower elevations. Nevertheless, the strong correlation between intensively logged sites and low elevations and the relatively broad classification of forests types used by Kavanaugh et al. limited their ability to identify the separate effects of elevation (and hence climate) and logging on koala habitat or possible differences in effect between tree-species associations. Further research on the effects of logging on koala habitat have been reported (R. P. Kavanagh, M. A. Stanton, & T. E. Brassil, personal communication). Cork et al. (1997) accounted for forest structure and environmental variables and made predictions that could be mapped if data on forest floristics and structure were available at suitable scales. But their study suffered from a relatively small number of observations of koalas and has been published only as a report with limited peer review. One strength of this study was a novel analysis of model performance that allows decisionmakers to adjust the reliability of their predictions according to how much certainty about koala occurrence or absence is required. A weakness shared by all three studies was that they were carried out mainly in public forests and took little account of koala populations on freehold land.

Recently, the Australian Koala Foundation (AKF) has refined koala scat surveys to obtain probability-based estimates of tree-species use by koalas (Callaghan & Phillips 1995; Phillips 1996). This information has been combined with vegetation mapping to produce maps of potential koala habitat. The approach attempts to deal with the low detectability of koalas in traditional environmentally stratified surveys, but it does not yet allow prediction of influences on habitat quality other than by variation in tree species. Acceptance of the models has been slow because the assumptions and statistical techniques have not been fully and independently reviewed and because the AKF has taken a confrontational approach in dealing with government and some scientists.

Smith and Andrews (1997) also used scat surveys to answer questions posed by agencies and community representatives about the effects of timber harvesting on koalas and their distribution and abundance in Pine Creek State Forest in northeastern New South Wales. The model predicted koala occurrence well in some areas but poorly in others. Nevertheless, it met the needs of local decisionmakers and managers because it gave clear indications of where koalas are likely to be found and what types of timber harvesting are likely to affect koalas.

Bryan (1995) integrated predictions about the environmental determinants of koala habitat, the tree-species preferences of koalas, and soil characteristics to predict optimal, suboptimal. and unsuitable habitat in the Mt. Lofty Ranges near Adelaide, South Australia. This approach meets many of the requirements of decisionmakers but is limited by the confidence of the predictions made by the original models.

Uses and Limitations of Koala Habitat Models

Models of koala habitat have been used constructively, as illustrated by our four examples. First, the state environmental planning policy no. 44 (SEPP 44) in New South Wales was based on an interpretation of koala habitat requirements and includes a food species list for assessing potential habitat (Lunney & Matthews 1997). Second, the conclusion that koalas prefer forests and woodlands on highly fertile soil has been used to estimate historical and future habitat loss and to guide conservation actions in all states where the species occurs (Lunney & Matthews 1997; ANZECC 1998). Third, perceptions about koala habitat were central to recent submissions to the U.S. Fish and Wildlife Service and both the Australian and New South Wales governments to list

Table 1. Key predictors of koala habitat in models derived from broad-scale, environmentally stratified surveys.*

Study	*Location (approximate area)*	*Details of survey and analysis*: *data*	*Details of survey and analysis*: *analysis*	*Key predictors of koala habitat*
New South Wales National Parks and Wildlife Service (1994)	northeast New South Wales (79,000 km^2)	932 presences	generalized additive modeling	gentle topography, high proportion of adjacent areas cleared, low probability of dry sclerophyll on site, low to moderate moisture index, deep soil, moderate rainfall (1500–2500 mm), moderate disturbance, low ruggedness, south or north latitude within study area
Kavanagh et al. (1995)	northeast New South Wales (15,000 km^2)	40 presences, 251 absences	canonical correspondence analysis	greater probability of occurrence in or at logged than unlogged forests, low elevation, easterly longitude, wet sclerophyll forest with dense understory, few hollow trees
Cork et al. (1997)	northeast New South Wales (26,000 km^2)	31 presences, 515 absences	generalized linear modeling	model 1: low foliar phenolics, increasing probability of occurence with years since fire mode 2: low (less than 1000 mm) or high (more than 1500 mm) rainfall, increasing probability of occurrence with years since fire, intermediate or high ratio of eucalypts to other tree species, increasing probability of occurrence with increasing annual mean daily temperature of 10–18° C.

**In each model the dependent variable was the probability of occurrence of koalas.*

the species or individual populations as vulnerable or endangered. And fourth, at a finer scale, habitat models have been the basis for management plans produced by various agencies and community groups (Martin 1989; Callaghan et al. 1994; Jurskis et al. 1994; Phillips 1994; Allen 1995, 1998; Phillips et al. 1996; Phillips & Callaghan 1997).

A major limitation of many current models is lack of broad acceptance by those carrying on the conservation debate, a consequence of failure to subject all studies, estimates, and expert judgements to rigorous, independent, scientific review. For example, estimates of the national population of koalas range from 100,000 to several million animals (Phillips, this issue), and considerable variation and disagreement exist about regional populations and population trends (Melzer, this issue; Phillips, this issue). Most estimates appear in newspapers with little or no explanation or justification. Similarly, expert judgements about koala status are usually gathered without benefit of critique or guidance according to standardized criteria.

Koala Habitat Models in a Political Context

The potential for conflict over koala habitat is inevitably high. Koalas prefer forests and woodlands that grow on the most fertile soils, which often occur in river valleys and on coastal river mouths. Such land is ideal for farming or timber production, it faces strong pressure for urban development, and is largely in private ownership (Braithwaite et al. 1993; Pressey & Logan 1997). These ingredients lead to a complex mix of participants in the conservation debate, with varied perspectives, beliefs, values, and strategies for achieving desired outcomes.

To make a constructive contribution to this social and scientific debate, habitat models must not only predict the location of koala habitat but also the effects of human activities and environmental processes. Direct effects can be inferred from some of the current models, but the confidence of predictions from all models is low. The effect of timber harvesting, for example, remains a hotly contested issue because data are not available to support confident predictions (Talbot 1994; Cork 1995). Indirect effects, such as those from changed hydrology or widespread use of fertilizers on agricultural land, are either ignored or addressed speculatively. Because most conflict over koala habitat focuses on relatively small areas of forest or woodland, habitat models need to assess the value of these small areas in the context of the local and regional dynamics of koala populations; currently, they do not.

Increasing public concern about koalas has led to increasing demands for information on habitat (Fig. 1). Ideally, information should be used to inform debate about conservation policy, which in turn can lead to scientifically and socially sound management (lower cycle in Fig. 1). An alternative route (upper cycle in Fig. 1) is advocacy in the popular media based on incomplete information (Clark et al., this issue; Stratford et al., this issue). This route has been used increasingly in the koala conservation debate because of the high stakes, financial and otherwise, involved and the strong competition among interest groups for recognition and influence (Harding 1990). A symptom of our current reliance on this cycle is the use of courts of law to resolve scientific questions (Recher 1992; Talbot 1994). A serious side effect is escalation of demands for information because trust and cooperation between opposing participants is low.

In the terms used by Clark et al. (this issue), this is substitution of "promotional activities" for reliable, comprehensive information and an open, fair decision process. In the absence of sufficient information and process, conflict is resolved by power. In a system such as that depicted in Fig. 1, advocacy and conflict can be likened to addictive drugs (Senge 1992). At best, drugs produce short-term relief of symptoms while making the real problem more difficult to solve, thereby creating a dependency on destructive behavior. Just as healing addictive behavior requires de-emphasizing the symptoms to focus on the real causes (Senge 1992), development of successful policy and management for conserving koalas depends on changing the emphasis from the current dy-

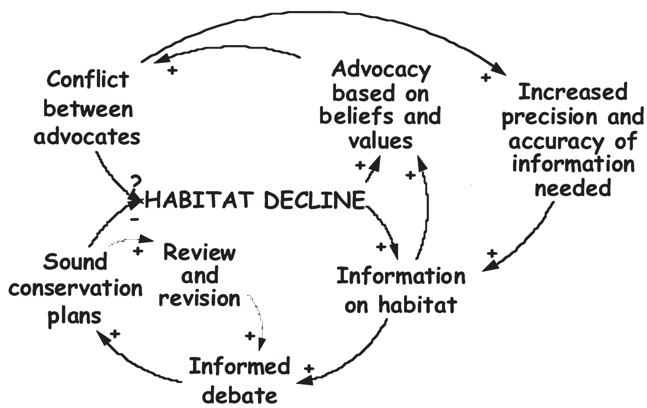

Figure 1. Representation of the koala conservation decision-making process. Plus and minus signs indicate that a variable is increased or decreased, respectively (e.g. "sound conservation plans" reduce "habitat decline"). High stakes for use of koala habitat and inadequate opportunity for involvement in formal decision-making processes force reliance on advocacy to resolve conflict. This increases the need for more detailed information (e.g., from habitat models) to resolve complex conflicts. The formal decision-making route becomes less and less feasible, forcing a dependency on advocacy to resolve conflict.

namic to one that makes better use of existing information, promotes cooperation in obtaining new information, and provides better mechanisms for involving all participants in debates that foster trust and work for the common interest (Clark et al., this issue).

Conclusions and Conservation Recommendations

We have considered habitat models as one component of the set of scientific information needed to inform decisions about koala conservation. It doing so we recognize that a range of other information, especially that on population trends and threatening processes, must be considered. Such information is considered in other papers in this issue.

Current habitat models meet many requirements of participants in koala conservation debates, but they fall short in a few key respects. Two important deficiencies are lack of broad acceptability of model predictions at regional and larger scales and the inability of models to make sufficiently precise predictions to resolve disputes at a local level. This situation can be addressed by both improving the models and dealing better with conflict.

Habitat models could be improved in several ways. The use of radiotracking and survey methods based on koala scat are emerging as ways to provide more detailed and reliable data at local to regional scales, as long as they are rigorously reviewed and, as necessary, modified to gain broad acceptance. Resolution of issues at a national scale by means of broad-scale surveys will be expensive but might be justified if use of such surveys avoids more expensive, protracted disputes. It is unlikely that a nation-wide koala habitat model will be developed, because koalas inhabit widely different vegetation types in different parts of Australia. A manageable number of predictive models is possible, however, with support and cooperation among people with experience and expertise to produce such models. Assessment of leaf nutritional quality across a broad geographic scale is becoming more possible with the development of techniques for estimating chemical composition from near-infrared reflectance (Foley et al. 1998). Above all, the acceptability of habitat models could be increased by publication of a greater proportion of them in peer-reviewed, primary scientific publications.

Dealing better with conflict requires attention to the social context in which the koala conservation debate occurs. Better mechanisms should be put in place for involving all participants in koala conservation debates and encouraging them to contribute constructively to the decision-making processes (Clark et al., this issue). Media reports consistently indicate that the level of distrust of decision-making processes is high in some states, but there are examples of successful efforts to bring participants together, such as in some components of the Deferred Forest Agreement and Comprehensive Regional Assessment processes in New South Wales (Resource and Conservation Assessment Council 1997). The development of the National Koala Conservation Strategy (ANZECC 1998) has met with mixed reaction, but its implementation is an opportunity for national and state governments to develop truly participatory, practical, and effective social and decision processes based on trust and respect. With commitment from authorities, such processes could proceed using current information on koala habitat while key information gaps are filled and working relationships between participants are improved. The alternative is continued confrontational, polarizing advocacy, which is unlikely to allow information or trust to improve to the point needed to resolve disputes and move participants collectively toward koala conservation (Fig. 1).

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