Appendix III. Biodiversity Research and Development

Five issues impinge on the outcome from the expected conservation evaluation component of this Project. Some are integrated into the Project, for example the relationship between setting targets against which the conservation evaluation is performed and the manner in which priorities are assigned for a each parcel of land. Other issues are fundamental research questions that the Project provides an opportunity to explore.

The five issues are:

1. Definition of the stopping rule (or target) for assigning priorities (ie. "allocate a minimum of 10% of the aerial extent of each attribute to conservation reserves").
2. The relationship between the setting targets and establishing priorities recognising that trade-offs between conservation and production goals may be necessary.
3. The algorithm used to select areas with high conservation priority.
4. The number of attributes used for the conservation evaluation.
5. The size of the areas used in the conservation evaluation.

The first two issues are intertwined and may need to be considered together. These two are in my view an integral part of the conservation evaluation's contribution to the Project. The other three are technical in nature and have been the subject of some research that highlighted their potential impact on the composition of the selected set. They also influence the efficiency of the priority setting process. Efficiency is defined as "the proportion of the study region's area assigned to conservation needed to achieve the agreed target or targets".

The algorithm:

Four basic approaches to developing an algorithm for conservation evaluation can be recognised. The early and (despite evidence of their inefficiency) some current methods were based on ranking the sites in terms of single attributes (ie. species richness) or complex indices derived from many single attributes. The Australian contribution (and subsequent overseas' contributions) to conservation evaluation have demonstrated the limitations of such approaches. Of the target driven techniques (which arise from acceptance of the idea behind complementarity, ie. representing all attributes within the conservation priority network) there are three different approaches. The first was based on a heuristic set of rules (Margules, Nicholls and Pressey 1988) that tend to be driven by one attribute at a time. The second is based on formal mathematical linear programming solution (Cocks & Baird 1989; Underhill 1994) and the third based on a multi-attribute solution (Faith and Walker 1996). The advantages of the first are that it is simple, easy to understand (ie. explain to a land manager), has clear stopping rules, is flexible and easily modified. The advantages of the linear programming solution are that it leads to optimal solutions (ie the solution would represent the most efficient solution) and would be repeatable. The advantages of the Faith and Walker's (1996) approach, using a multi-attribute based method to priority setting, is the ease with which the conservation value of each site can be measured. In addition, it (ie. the multi-attribute approach) has provided a method for measuring the potential relative value of the competing land uses and thus provides a mechanism for finding solutions that allow trade offs between competing land uses.

The disadvantages of the three approaches are simple. Linear programming solutions are complex, require substantial computing facilities and have yet to be demonstrated capable of yielding solutions with more than simple examples (Possingham and Pressey *pers comm*).

The single-attribute and multi-attribute approaches may not yield truly optimal solutions (that is, the defined targets may be achievable with less efficiency than these algorithms produce).

As land use planning is a complex process often with many social and political inputs to the final solution, the loss of a truly optimal solution is of little consequence in the overall picture. The differences between the single-attribute and, multi-attribute driven algorithms have yet to be explored. The preliminary work reported in the Milestones Report represents the first attempt to compare the two algorithms. Comparative work on a range of closely related algorithms and approaches can be found in the work of Pressey and colleagues (Csuti *et al.* 1997; Williams *et al.* 1996).

Number of attributes:
In an ideal world conservation evaluation would be undertaken with complete knowledge of the distribution of all species and their dynamics. The reality is of course very different. This means that surrogates must be used in place of complete knowledge. The detail at which such surrogates are mapped or otherwise attached to the selection units has been shown to have an impact on the selection process (Pressey & Logan 1994, 1995). This is a complex issue, with number of attributes, the nature of the attributes, the manner in which the attributes have been mapped or other wise assigned to the selection units all impacting on the outcome. The Pressey and Logan studies were based in the Western Division of New South Wales and utilize the land system database that will provide one significant component of the current study. In broad terms the level or true representation declines as the resolution of the attribute base declines. As the resolution of thematic mapping declines (ie the mapped polygon increase in size and the number of distinct classes mapped declines) relative to the size of the selection units the efficiency of the solution can be expected to decline.

Size of Selection Units:
Pressey and Nicholls (1989, but see Pressey and Logan (1998) for a review and detailed example) demonstrated that as the size of the selection units increased the efficiency of the single-attribute algorithm decreased. The reason is that as the target for each attribute is approached it becomes difficult to find a selection unit that will achieve that target exactly and not over represent the attribute. When this feature of the algorithm is applied to all attributes there is a strong tendency for the final solution to represent a proportion of the region that is above the target set. While the solution is this would be to decrease the size of the selection units, two other considerations impinge on the problem. The first is that small selection units may not represent viable areas from a conservation point of view both in terms of land management and of biological population viability. The second issue is that the single-attribute algorithm tends to break down as the number of attributes per selection units goes to one. Unless the scale or resolution of attribute mapping is made finer and finer as the size of the selection units decrease the average number of attribute per selection appraoches one. The latter point may not be important (or as important) with the multi-attribute algorithm. To my knowledge this aspect of the problem has not been explored within the framework of the multi-attribute algorithm.

The work to date (within this Project) has explored the implication of different selection unit sizes as generated by different grid resolution. The use of the thiessen polygons is an attempt to achieve two objectives, to allow the inherent nature of the landscape to influence the selection unit size and to provide an objective method for setting the selection unit size. The importance of the selection size has been recognised by Pressey and Logan (1995) in their work on the effect of the resolution of the attribute mapping and very recently in a study explicitly on the influence of size of selection unit (Pressey and Logan 1998).

One aspect of the selection unit size problem as it influences efficiency that has not been explored is the relationship between selection unit size in relation to the size of the region under study. It may be that the relative size of the selection units with respect to the size of the region is more important than the absolute size.

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