BIOREGIONAL LANDSCAPE CONSERVATION FRAMEWORK: BIODIVERSITY COMPONENT

Brigalow Belt South

Stage 2

NSW WESTERN REGIONAL ASSESSMENTS

FINAL REPORT 24 MAY 2004

Resource and Conservation Assessment Council

BIOREGIONAL LANDSCAPE CONSERVATION FRAMEWORK: BIODIVERSITY COMPONENT

NSW WESTERN REGIONAL ASSESSMENTS

BRIGALOW BELT SOUTH BIOREGION (STAGE 2)

NSW National Parks and Wildlife Service (NPWS)
(The NPWS is part of the Department of Environment and Conservation)

A project undertaken for the
Resource and Conservation Assessment Council
NSW Western Regional Assessments
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PROJECT SUMMARY

This report describes a project undertaken for the Resource and Conservation Assessment Council as part of the regional assessments of western New South Wales. The Resource and Conservation Assessment Council advises the State Government on broad-based land use planning and allocation issues. An essential process for the western regional assessments is to identify gaps in data information and the best ways in which to proceed with data gathering and evaluation.

Project objective/s

The main objective of the Bioregional Landscape Conservation Framework project was to develop a means by which conservation decisions on public land in the Brigalow Belt South Bioregion (BBS) could be placed within a bioregional context, by evaluating the broad-scaled distribution of conservation values and priorities across all tenures.

The project was originally designed to consider a range of environmental values, relating to both conservation of biodiversity and provision of ecosystem functions and services. NPWS has been responsible only for the biodiversity component of the project, and this report therefore focuses on this component.

Methods

To assess biodiversity conservation values and priorities within the BBS this project adapted and refined a set of computer-based tools that NPWS had been developing over the past few years for “whole of landscape” assessment and planning. These tools were then applied to “best available” region-wide datasets for the BBS, describing the distribution of vegetation communities, land-use, vegetation condition, and future threats to biodiversity.

Key results and products

The tools developed by this project provide a broad framework for: 1) evaluating the overall effectiveness of any given land use scenario for the BBS, in terms of how much of the region’s biodiversity is predicted to persist into the future under the scenario; 2) estimating and mapping relative levels of conservation priority across the region; and 3) developing alternative land use scenarios for the region.

While application of the tools in the WRA process is being limited to the evaluation of alternative scenarios for public land, the tools have considerable potential to contribute to other natural resource planning processes in the future.

1. INTRODUCTION

1.1 BACKGROUND

The NSW Government initiated the Western Regional Assessment (WRA) process within the Brigalow Belt South Bioregion (BBS) in 1999, to guide future planning and encourage partnerships to protect the environment. The Resource and Conservation Assessment Council (RACAC) is coordinating the assessment which also involves the National Parks and Wildlife Service (NPWS), State Forests of NSW (SF), the Department of Land and Water Conservation (DLWC), Department of Mineral Resources (DMR) and NSW Agriculture as well as local and regional stakeholders. The WRA is a broad-based process applying to areas not already covered by NSW forest agreements. The WRA considers environmental, social and economic values of forest and non-forest land systems focusing on conservation, land management and regional planning (RACAC web site, 2001).

The BBS assessment process is being implemented in two stages. Stage 1 was concluded in February 2000 and was concerned with the assessment of State Forest, National Park and Vacant and Reserved Crown Land south of Narribri within the BBS (Stage 1 project reports may be viewed and downloaded at the RACAC web site http://www.racac.nsw.gov.au). Stage 2 of the assessment is focussed mainly on forest and woodland ecosystems across all land tenure within the entire BBS. Stage 2 assessments include fauna, flora, vegetation, cultural heritage, socio-economic and environmental factors.

1.2 THE BIOREGIONAL LANDSCAPE CONSERVATION FRAMEWORK PROJECT

1.2.1 General background

The Bioregional Landscape Conservation Framework (herewith abbreviated to "Bioregional Framework") Project was a joint initiative of DLWC, NPWS, SF and the Resource and Conservation Division (RACD) of PlanningNSW. The project has been managed by the WRA Integration Technical Working Group (ITWG) chaired by RACD.

The project was originally planned to start in February 2002 and run for seven months through until the end of August 2002 (when the results of the work were required to inform the public land negotiation process). Unfortunately funding was not approved until April 2002, and work on the project was therefore compressed down to five months. The biodiversity component of the project was nevertheless successfully completed by the end of August 2002.

1.2.2 Basic project objectives

The main objective of the project was to develop a means by which conservation decisions on public land in the BBS Bioregion could be placed within a bioregional context, by evaluating the broad-scaled distribution of conservation values and priorities across all tenures. The data-sets and evaluation approaches developed by this project were also intended to contribute to other natural resource planning activities within the bioregion, such as regional vegetation planning and catchment planning.

The project was viewed by the participating agencies as an initial trial of a “whole of landscape” approach to planning that, depending on its success, may be adopted and applied more rigorously in subsequent WRA assessments in other regions.

1.2.3 Values considered by the project

The project was originally designed to consider a range of environmental values, relating to both conservation of biodiversity and provision of ecosystem functions and services. It was also intended that some consideration be given to economic and social factors. NPWS has been responsible only for the biodiversity component of the project. (In this report, “biodiversity” refers specifically to native biodiversity.)

1.2.4 Caveats on the use of results from the project

As indicated above, this project was instigated to trial a new “whole of landscape” approach to planning. Many of the spatial data-sets employed in this trial are relatively coarse-scaled and likely to contain inaccuracies. Furthermore, most of the parameters employed in the modelling are based on expert opinion, rather than on any direct data analysis or literature review. Propogation of multiple uncertainties associated with both spatial data-sets and model parameters is likely to result in a relatively high level of uncertainty being associated with the biodiversity indices generated by the modelling described in this report. Unfortunately, due to budget and time constraints, no sensitivity analysis or error estimation was conducted in the current project. These activities should be regarded as a mandatory component of any future application of the approach in subsequent WRAs. In the interim, extreme caution should be exercised when interpreting any results derived from the application of the approach in the BBS Bioregion.

1.3 ABOUT THIS REPORT

This report describes the analytical techniques and datasets employed in developing the biodiversity component of the Bioregional Framework Project. The report also outlines how the outputs of this work will contribute to WRA negotiations over public land, and how they may also potentially contribute to future planning processes across other tenures.

2. METHODS

2.1 BIODIVERSITY ASSESSMENT TOOLS

To assess biodiversity conservation values and priorities within the BBS this project has adapted and refined a set of computer-based tools that NPWS has been developing over the past few years for “whole of landscape” assessment and planning. Earlier versions of these tools have been previously applied to assessments in various parts of the state, e.g. the Key Habitats and Corridors Project in north-east NSW and the Conservation Options for Regional Environments (CORE) Project in Moree Plains Vegetation Region.

The tools are implemented as a set of scripts within ArcView (ESRI), with calls to Dynamic Link Libraries (DLLs) written in C++ (for intensive mathematical calculations) and Microsoft Excel macros (for charting) where necessary. At this stage the tools can be operated only by staff from the NPWS GIS Research and Development Unit, but there is considerable potential to further adapt and document the software for wider use if required by later planning processes.

The capabilities of the assessment tools developed for BBS are summarised in Figure 1. In this diagram the components shown in black are those that have now been implemented as part of the WRA process. Components shown in grey indicate capabilities of the tools that have not yet been applied within BBS but could potentially be implemented as part of any subsequent planning process. The tools are designed to do three main things:

- Evaluate the overall effectiveness of any given land use (or management) scenario for the region, in terms of how much of the region’s biodiversity is predicted to persist into the future under this scenario.
- Estimate and map relative levels of conservation priority across the region.
- Develop alternative land use (or management) scenarios for the region by interactively editing or adding boundaries within a mapped land use layer superimposed over the conservation priority layer.

2.1.1 Evaluating the effectiveness of land use scenarios

A “land use scenario” is simply a spatially defined configuration of land use classes (or management zones). The set of possible land use or management classes is quite flexible, but in the current implementation for BBS five classes have been defined across a conservation-production spectrum (see Section 2.2 for details). In addition to evaluating the existing configuration of land use within the region (i.e. the status quo), the tools can evaluate the effectiveness of any proposed scenario of changed land use. Such scenarios may be developed independently of the tools, as is the case for the public land options being negotiated during the WRA (e.g. using the C-Plan decision support system). Alternatively, scenarios can be developed interactively within the tools themselves using a capability described in Section 2.1.3 below. Regardless of how a scenario is developed the tools can produce a tabular / graphical report on the predicted implications of the scenario for biodiversity. This report includes a summary index of effectiveness, which allows alternative scenarios to be compared and ranked in terms of their effectiveness in achieving conservation of the region's biodiversity (the approach used to estimate conservation effectiveness is described in Section 2.2, and examples of the reporting are presented in Section 3.1).

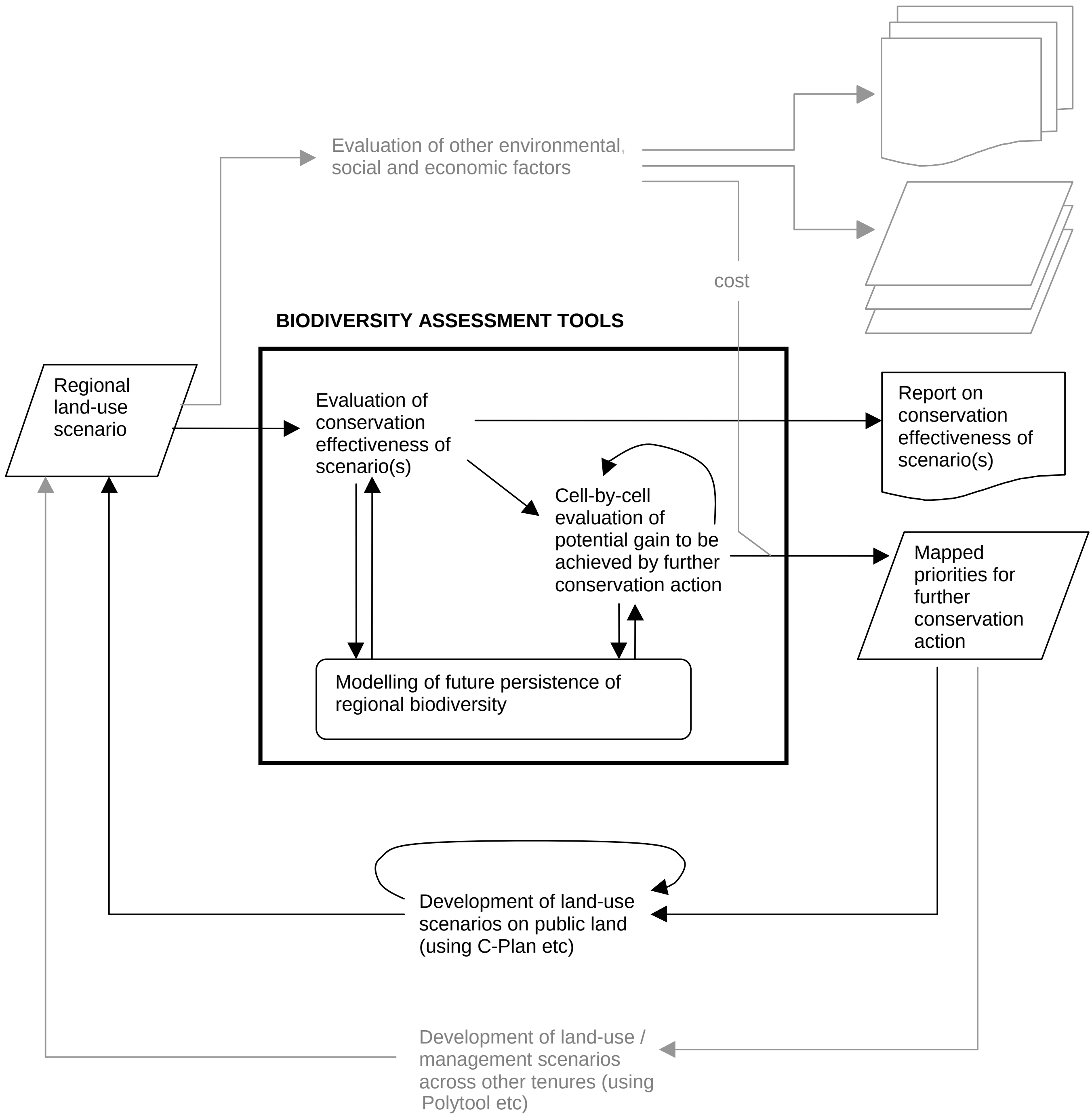
2.1.2 Estimating and mapping relative levels of conservation priority

Conservation priority can be estimated for each and every 1 hectare grid-cell in the region by calculating the marginal gain in overall conservation effectiveness that would be achieved if the current land use scenario (from previous section) were extended to protect (or restore) vegetation within the cell of interest. The calculated priorities across all of the grid-cells can then be depicted as a map with different colours indicating varying levels of conservation priority. As currently implemented within BBS the estimation and mapping of conservation priorities does not factor in the likely cost of implementing different types of conservation action in different parts of the region. If such information becomes available in the future then priorities can be scaled in terms of cost-effectiveness, providing a more useful indication of the potential gain in conservation effectiveness per unit cost.

2.1.3 Developing alternative land use scenarios

One of the tools previously developed by NPWS – "Polytool" – facilitates development and exploration of land use scenarios through interactive editing or addition of boundaries within a mapped land use layer superimposed over the conservation priority layer (from previous section). While this capability is not being used in the WRA negotiation process it offers considerable potential as a rapid means of developing and exploring options in other planning processes within the region (discussed further in Section 3.2).

Figure 1: Capabilities of the biodiversity assessment tools developed for the Bioregional Framework Project



2.2 MODELLING PERSISTENCE OF BIODIVERSITY

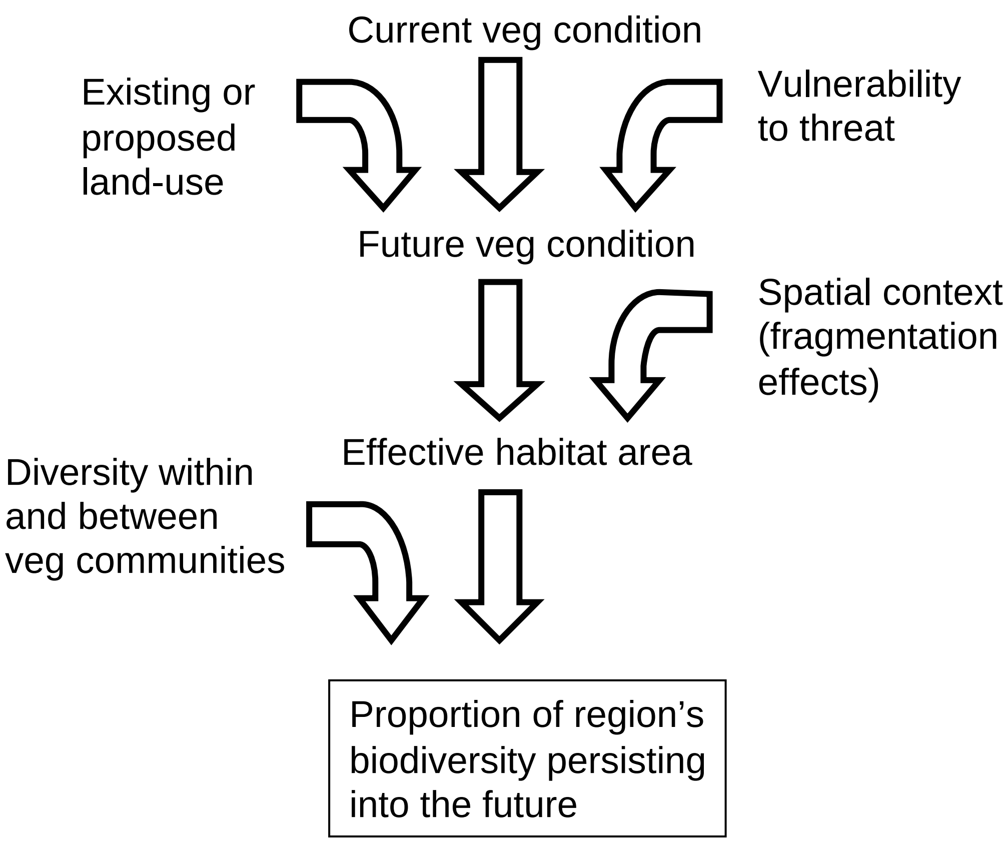
2.2.1 General approach

The tools described in Section 2.1 and depicted in Figure 1 are all underpinned by a new modelling approach for predicting how much of a region's biodiversity is likely to persist into the future, given a particular land use scenario. This provides the basis for measuring the conservation effectiveness of different scenarios, which in turn allows the conservation priority of individual grid-cells to be estimated and mapped (as the potential gain in overall conservation effectiveness if each cell were to be protected or restored).

Modelling persistence of biodiversity is a daunting challenge. It requires consideration both of patterns in the spatial distribution of elements of biodiversity across the region (e.g. distributions of species and communities), and of processes that are likely to affect these elements over time (e.g. the effects of different land uses on habitat condition, and the effects of habitat fragmentation and isolation on population viability). Clearly our knowledge of these patterns and processes is grossly incomplete. The resolution and accuracy of the information currently used in the modelling is therefore often far from ideal, but the work at least provides an initial assessment framework based on "best available" information that can then be progressively refined in the future.

A diagrammatic overview of the approach used to model persistence of biodiversity in this project is presented in Figure 2.

Figure 2: General approach to modelling persistence of biodiversity in the BBS



In general terms, the modelling employs vegetation communities as a broad surrogate for the spatial distribution of biodiversity across the BBS. The future condition of vegetation in each and every 1 ha grid-cell in the region is predicted as a function of current condition, existing or proposed land use, and likelihood of exposure to threatening processes. The effects of habitat fragmentation (patch size, condition and connectedness) on species diversity are factored in by converting the area of vegetation predicted to remain in each community to an “effective habitat area” in which the contribution of small isolated remnants is downgraded relative to large well-connected blocks of vegetation. An approximate estimate of the proportion of the region’s original biodiversity (i.e. all species of plants and animals) predicted to persist into the future is then derived by combining the information on effective habitat area with information on levels of biological similarity between communities and biological variation within communities.

The following sub-sections provide more detail on the datasets and analytical techniques employed in this modelling (see also Figure 3).

2.2.2 Mapping / modelling vegetation communities

Distributions of native vegetation communities (both woody and non-woody) within the BBS were mapped and modelled by the WRA Joint Vegetation Mapping Project (JVMP). The JVMP produced a “constrained probability surface” for each of 115 communities (defined by a numerical classification of floristic plot data). Each of the probability surfaces predicts the probability of a given community occurring in each 1 ha grid-cell in the BBS, prior to clearing. These probabilities were derived by modelling floristic plot data in relation to mapped climate, terrain and soil variables. The predictions were then constrained using all available vegetation mapping derived from air photo interpretation. More detailed information on the derivation and mapping of vegetation communities in the BBS is provided in the WRA report on the JVMP.

2.2.3 Mapping / modelling current land use and vegetation condition

The land use classes adopted in this project were those already defined by the WRA project “Development of Conservation Criteria for the BBS”, and referred to as “management priority classes” in the report for that project. Five classes were defined, the first two focussed primarily on conservation, the third focussed jointly on conservation and production, and the last two focussed primarily on production:

- *Conservation A (CA)*. Areas in which no removal of ecological resources is permitted.
- *Conservation B (CB)*. Areas in which limited removal of ecological resources is permitted only where this is consistent with explicit conservation objectives.
- *Integrated (I)*. Areas supporting sustainable use of ecological resources.
- *Production A (PA)*. Areas in which use relies on, or generates, simplified native ecosystems (e.g. rangelands).
- *Production B (PB)*. Areas in which use relies on, or generates, artificial or created systems (e.g. cropping, irrigation, highly improved pasture).

The current distribution of these classes across the BBS was mapped by applying a set of rules developed in the Conservation Criteria Project to three core WRA data layers: land tenure, land capability and land cover (mapped by DLWC from satellite imagery). The rules are described in the WRA report on the Conservation Criteria Project.

Due to limitations in the quality and resolution of spatial data on vegetation condition within the BBS, the Integration Technical Working Group (ITWG) decided to treat the condition of each land use class as being internally homogeneous, and to assume that all vegetation within a class has already reached an “equilibrium condition level” appropriate to that class. For the purposes of this project “condition” was defined loosely as the expected proportion of species of plants and animals occurring at a "pristine" site within the community of interest, that are likely to occur at a site subjected to a given type of land use. The ITWG assigned equilibrium condition levels to the land use classes, based on the expert opinion of the working group, as follows:

- *CA*: 0.8
- *CB*: 0.7
- *I*: 0.6
- *PA*: 0.4
- *PB*: 0.2

2.2.4 Mapping / modelling potential threat

The ITWG originally intended that a number of threatening processes would be incorporated into the modelling of biodiversity persistence, including salinisation. However, pending the availability of suitable spatial data on other threats, the modelling currently considers only the threat of clearing. A spatial layer depicting likelihood of future clearing across the region was derived by analysing DLWC statistics on past clearing trends, and recent clearing applications, in relation to land capability mapping. Vegetated grid-cells within each land capability class were assigned a constant annual probability of being cleared. This probability was estimated by dividing the average annual area of clearing applications (1995 to 2000) within each land capability class by the total remaining area of vegetation within the class. The ITWG decided that each of these probabilities should then be multiplied by 0.66 to compensate for the fact that not all of the area covered by clearing applications may actually be cleared. It was also assumed that the probability of future clearing within existing National Park and State Forest, and any areas specifically identified for future conservation action (protection or restoration) in a given land use scenario, is zero.

2.2.5 Modelling future condition

The biodiversity assessment tools model future condition of vegetation in the BBS as a function of current condition, likelihood of clearing, and existing or proposed land use. For each grid-cell future condition is calculated as:

$$(1-V)^Y\left(C_i+\left(\frac{Y(C_j-C_i)}{T_{ij}}\right)\right) \qquad \text{if } Y \text{ is less than } T_{ij}$$

or

$$(1-V)^Y C_j \qquad \text{if } Y \text{ is greater than or equal to } T_{ij}$$

where Y is the user-defined number of years into the future for which the prediction is being made (specified as 50 years for most of the simulations run in the WRA), V is the annual probability of this grid-cell being cleared (from Section 2.2.4), C_i is the equilibrium condition for the existing land use i in the grid-cell (from Section 2.2.3), C_j is the equilibrium condition for the land use j proposed by the scenario under evaluation, and T_{ij} is the expected time (in years) for C_i to shift to C_j after converting from land use i to land use j (assuming a linear transition between these two condition levels over time).

Transition times (i.e. T_{ij} values in years) between equilibrium condition levels for the five land uses were set by the ITWG based on expert opinion, as follows (rows of the table represent existing land uses, while columns represent proposed land uses):

	CA	CB	I	PA	PB
CA	0	0	0	0	0
CB	20	0	0	0	0
I	50	30	0	0	0
PA	100	80	50	0	0
PB	180	160	130	80	0

It should be noted that there is considerable uncertainty associated with these parameters. Current knowledge of change in vegetation condition following change in land use is poor. Different experts, or groups of experts, are therefore likely to assign different values to the parameters. Future effort needs to be directed to evaluating the sensitivity of the biodiversity assessment tools (and derived outputs) to variation in the transition-time parameters, and to better incorporating uncertainty in parameter estimation into planning and decision-making.

2.2.6 Modelling effective habitat area

Once the future condition of vegetation across the region has been predicted this is used to estimate “Effective Habitat Areas” (EHAs), initially for individual grid-cells and then for whole vegetation communities (by summing the EHAs for all grid-cells within each community, as described in Section 2.2.7 below). The EHA concept has been applied widely in North America (e.g. Sisk et al. 1997; Sisk et al. 2002) as a simple means of incorporating the effects of habitat fragmentation into estimates of total remaining habitat for a species or community. Earlier approaches to estimating EHAs have tended to focus on edge effects. However the approach employed in this project extends the technique to consider other aspects of habitat configuration, including patch size and connectedness. This is achieved using new tools developed by the NPWS GIS Research and Development Unit during the past few years.

The new approach is based on the concept of “habitat neighbourhood” sometimes employed in metapopulation ecology (e.g. Hanski 1999a; Hanski 1999b; Hanski and Ovaskainen 2000), in which the amount of habitat “available” to an individual animal or plant at a given locality is calculated as a function of the size of the habitat patches in the surrounding neighbourhood and the isolation (or, inversely, connectedness) of these patches relative to the locality of interest. The NPWS GIS Research and Development Unit has extended the habitat neighbourhood approach to work with grid-cell data, rather than polygonal data, and with continuous measures of habitat suitability or condition, rather than a simple suitable/unsuitable habitat classification. A detailed description of the approach is beyond the scope of this report (for more detail see Drielsma and Ferrier in prep, Ferrier et al. 1999; Ferrier et al. 2002b).

Estimates of habitat value and impedence for each grid-cell in the region (required to estimate habitat neighbourhoods and thereby EHAs) are derived by simple linear transformations of predicted future condition (from Section 2.2.5). The parameters defining these transformations were fitted by an initial statistical analysis of the WRA fauna survey data in relation to the current condition layer (from Section 2.2.3). This involved iterative application of Poisson regression (Pearce and Ferrier 2001) with vertebrate species diversity as the response and habitat neighbourhood (derived using varying parameters in each iteration) as a single predictor.

The EHA for each grid-cell under a given scenario is calculated by expressing the habitat neighbourhood value for the cell as a proportion of the maximum habitat neighbourhood value that could be achieved if all of the region’s vegetation still remained in pristine condition, and then multiplying this proportion by the area of a grid-cell (in this case 1 ha).

2.2.7 Modelling level of persistence within each community

The total effective area of habitat predicted to remain for each vegetation community is calculated by summing the EHA values across all grid-cells within the BBS, weighting each value by the probability of the community of interest occurring within a given cell (from Section 2.2.2). An approximate estimate of the proportion of species originally occurring in this community that are predicted to persist into the long-term future (within the remaining area of the community) is then derived through application of the species-area relationship. While the applicability of the species-area relationship to this type of prediction has been hotly debated over the past decade (e.g. Simberloff 1992) the technique continues to be applied widely around the world as a rough means of predicting biodiversity loss, apparently with reasonable success (e.g. Pimm and Askins 1995; Andren 1999; Rosenzweig 1999; Pimm and Raven 2000; Brooks et al. 2002; McAlpine et al. 2002). Based on the species-area relationship the proportion of species expected to persist after habitat reduction is:

$$\left(\frac{A_r}{A_o}\right)^z$$

where A_o is the original area of habitat, A_r is the remaining area of habitat, and z is a parameter reflecting the level of beta diversity, or spatial turnover in species composition, within the region of interest. In the current project EHA is used as a refined estimate of A_r, that incorporates the effects of habitat configuration. We assigned a constant value of 0.27 to z for all vegetation communities in the BBS (i.e. all communities were assumed to be equally variable, an approach that could, and should, be refined by future work). The value of 0.27 was based on a statistical analysis of compositional turnover in the WRA floristic survey data, using generalised dissimilarity modelling (Ferrier 2002; Ferrier et al. 2002a) in conjunction with a technique for estimating species-area relationships from turnover data, described by Harte et al. (1999). This value also matches closely values for z used in similar studies around the world.

2.2.8 Modelling level of persistence across entire region

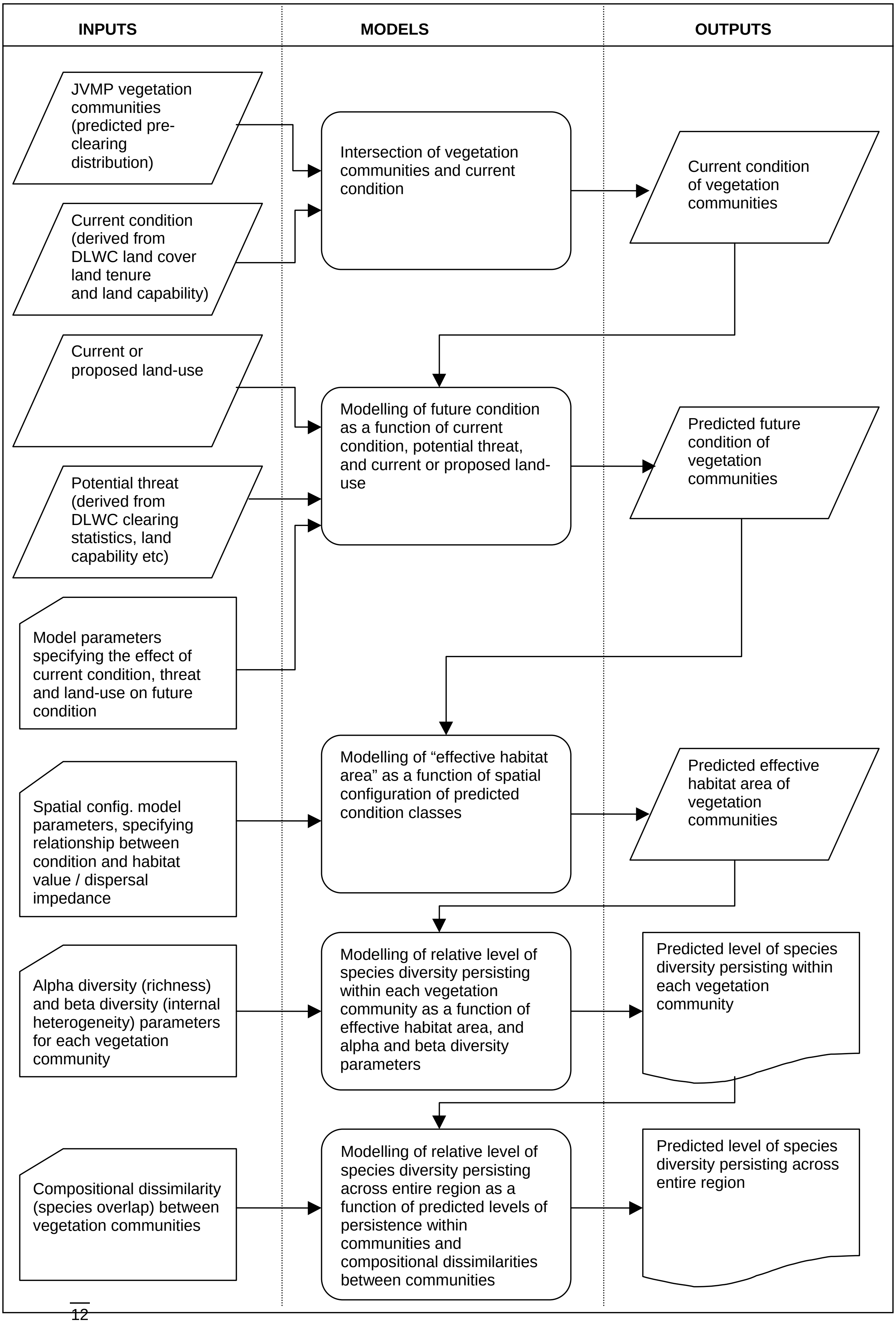
For a given land use scenario, the analysis described in the previous section produces a measure of conservation effectiveness for each vegetation community in the BBS, i.e. the proportion of species originally occurring within that community that are expected to persist into the future. In the final stage of the modelling process these individual measures are aggregated into a single overall measure of conservation effectiveness. This is achieved by calculating the quadratic diversity index Q (Izsák and Papp 2000) as follows:

$$Q = \sum_{i=1}^{n}\sum_{j=1}^{n} d_{ij}\, p_i\, p_j$$

where n is the number of communities (115 in the BBS analysis), p_i is the proportion of species predicted to persist in community i (from Section 2.2.7), and d_{ij} is the dissimilarity in species composition between communities i and j (estimated as Bray-Curtis dissimilarities between communities derived in the JVMP numerical classification of floristic survey data). As applied here, the calculations assume that all communities originally supported the same number of species (an assumption that could, again, be improved upon by future work involving more detailed analysis of the available data).

By expressing the Q value calculated for a given land use scenario as a proportion (or percentage) of the maximum possible Q value for the region (i.e. $p = 1$ for all communities or, in other words, no habitat loss) we obtain an overall measure of conservation effectiveness (or "biodiversity outcome") for the scenario. This can be interpreted, albeit loosely, as the proportion of the region's original biodiversity predicted to persist into the future under the scenario of interest.

Figure 3: Components involved in modelling persistence of biodiversity in the BBS

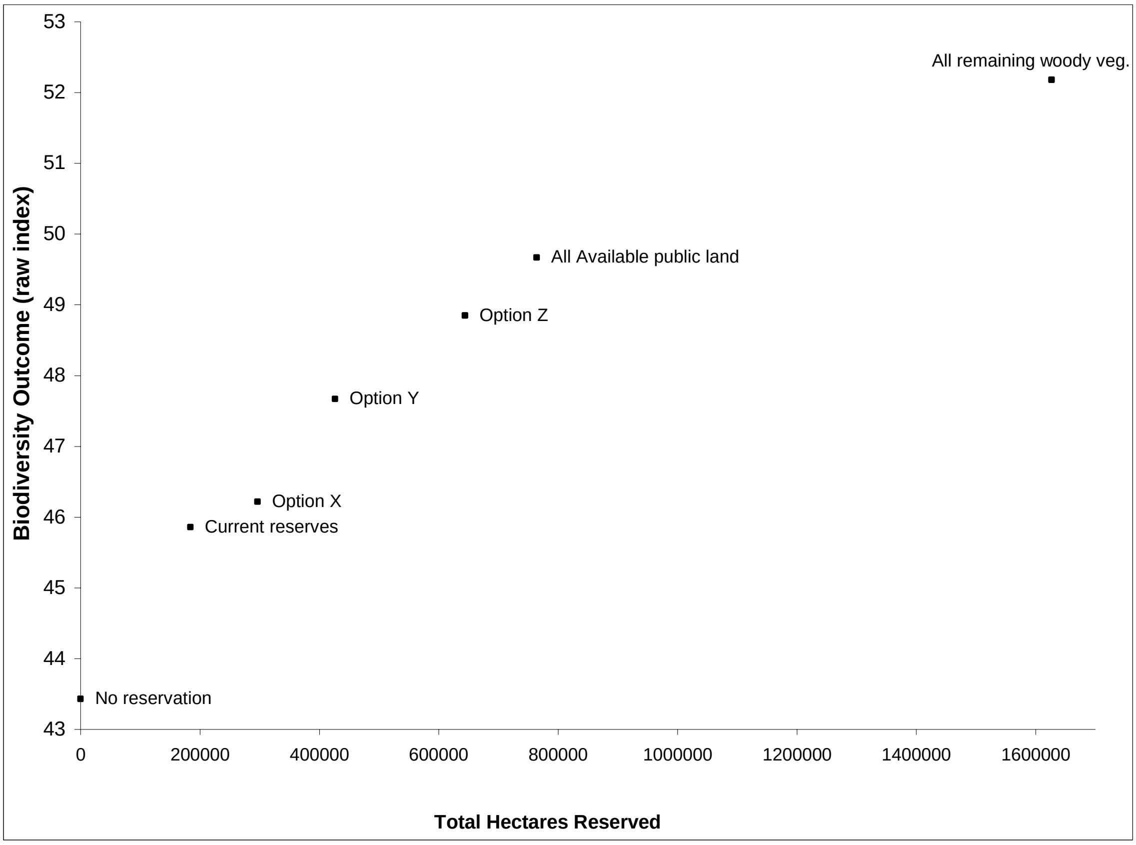


3. APPLICATIONS

3.1 ROLE IN PUBLIC LAND NEGOTIATIONS

The biodiversity assessment tools are being used in the WRA process to evaluate land use scenarios (options) for public land, such as those being generated by agency and stakeholder negotiations. This is allowing different options to be compared and ranked in terms of how much they contribute to improving the outcome for biodiversity across the bioregion as a whole. The summary index of the conservation effectiveness of each option can be readily plotted against other measures such as the total area reserved or the percentage reduction in wood resource associated with the options. A hypothetical example of such a plot is presented in Figure 4. The conservation effectiveness (or “biodiversity outcome”) versus total reserved area for three hypothetical reservation scenarios (Options X, Y and Z) is plotted in relation to the

Figure 4: The conservation effectiveness of three hypothetical reservation scenarios plotted against total reserve area. The “Biodiversity Outcome” index can be loosely interpreted as providing an indication of the percentage of the bioregion’s original diversity predicted to persist under different land use scenarios (see text for detail). The total possible range for this index is 0 to 100.



effectiveness of four benchmark scenarios: “No reservation” which is simulated by converting all existing reserves back to the integrated land use class; “Current reserves” in which only existing reserves are considered; “All available public land” in which all public land is treated as reserved; and “All remaining woody vegetation” in which the previous scenario is extended to include all timbered vegetation (as per the DLWC land cover mapping) on private land within the bioregion (excluding the 15km buffer). This scenario represents approximately 31% of the total area of the bioregion.

The “Biodiversity Outcome” index can be loosely interpreted as providing an indication of the percentage of the bioregion’s original diversity (i.e. all species of plants and animals occurring in the BBS prior to European settlement) predicted to persist under different land use scenarios. However, there is considerable uncertainty associated with this prediction. As noted earlier in the report, much of the spatial information employed is of reasonably poor resolution and accuracy. In addition, many of the parameters used in the modelling have been assigned values based on expert opinion alone. Further work is needed to better understand the sensitivity of the modelling to variation or uncertainty in these parameters.

Considerable caution needs to be exercised when intepreting results such as those depicted in Figure 4. For example, this chart indicates that for the current configuration of land use in the BBS (i.e. no additional reservation), the Biodiversity Outcome index has a value of about 46% (i.e. less than half of the region’s original diversity is predicted to persist), and that reservation of all available public land in the region would increase this value by only about 4%. At first glance this may appear to be a very modest improvement in conservation outcome. However, to appreciate the real implications of such a change, decision-makers would need to give due consideration to a range of factors, including the following:

- Biodiversity in the BBS is currently in a critical state. The 46% index value (from above) suggests that more than half of the region’s original complement of species may be either already regionally extinct, or likely to become extinct in the near future. Any improvement in this outcome, no matter how modest, should be viewed as a step in the right direction.
- Given that the total number of species (including invertebrates and lower plants) occurring in the BBS is likely to be in the tens of thousands (a conservative estimate), then an improvement of 4% in the Biodiversity Outcome index may be interpreted as preventing the regional extinction of at least several hundreds of species.
- Reservation of public land should be viewed as forming one component of a multi-faceted strategy to conserve and restore biodiversity within the BBS, including protection of remnant vegetation on private land, and strategic revegetation of currently cleared areas. It could be argued that any single component of this strategy, if viewed in isolation, provides only marginal improvement in conservation of the region’s biodiversity. Significant gains will be achieved only by applying these components in combination.

The biodiversity assessment tools can also be used to generate more detailed charts for any given land use scenario, in which effectiveness is reported at the level of individual vegetation communities. Examples of such charts are presented in Figures 5 and 6. Figure 5 depicts the Effective Habitat Area (EHA) of each vegetation community, expressed as a percentage of the original (pre-clearing) area of that community, as estimated by the WRA Joint Vegetation Mapping Project (JVMP). Each bar of the histogram shows three different EHA values: 1) the EHA for the current configuration of land use within the BBS (across all public and private tenures; 2) the improvement in EHA that would be achieved by the additional reservation proposed in the land use scenario under consideration; and 3) the further improvement in EHA that could be achieved by reserving all available public land. In Figure 5 the vegetation communities are ordered according to similarities in floristic composition, as reflected in the dendrogram on the left side of the figure (derived from a numerical classification of floristic survey sites). Figure 6 presents the same EHA information as Figure 5 but the communities are now sorted according to current EHA. Communities with the highest current EHA (expressed as a percentage of original area), indicating a relatively sound conservation status, are at the top of the figure, while communities with the lowest EHA indicating poor conservation status are at the bottom.

Figure 5: Example of more detailed reporting of a hypothetical reservation scenario: Effective Habitat Area of vegetation communities as a percentage of original area estimated by the Joint Vegetation Mapping Project (communities ordered according to floristic similarity)

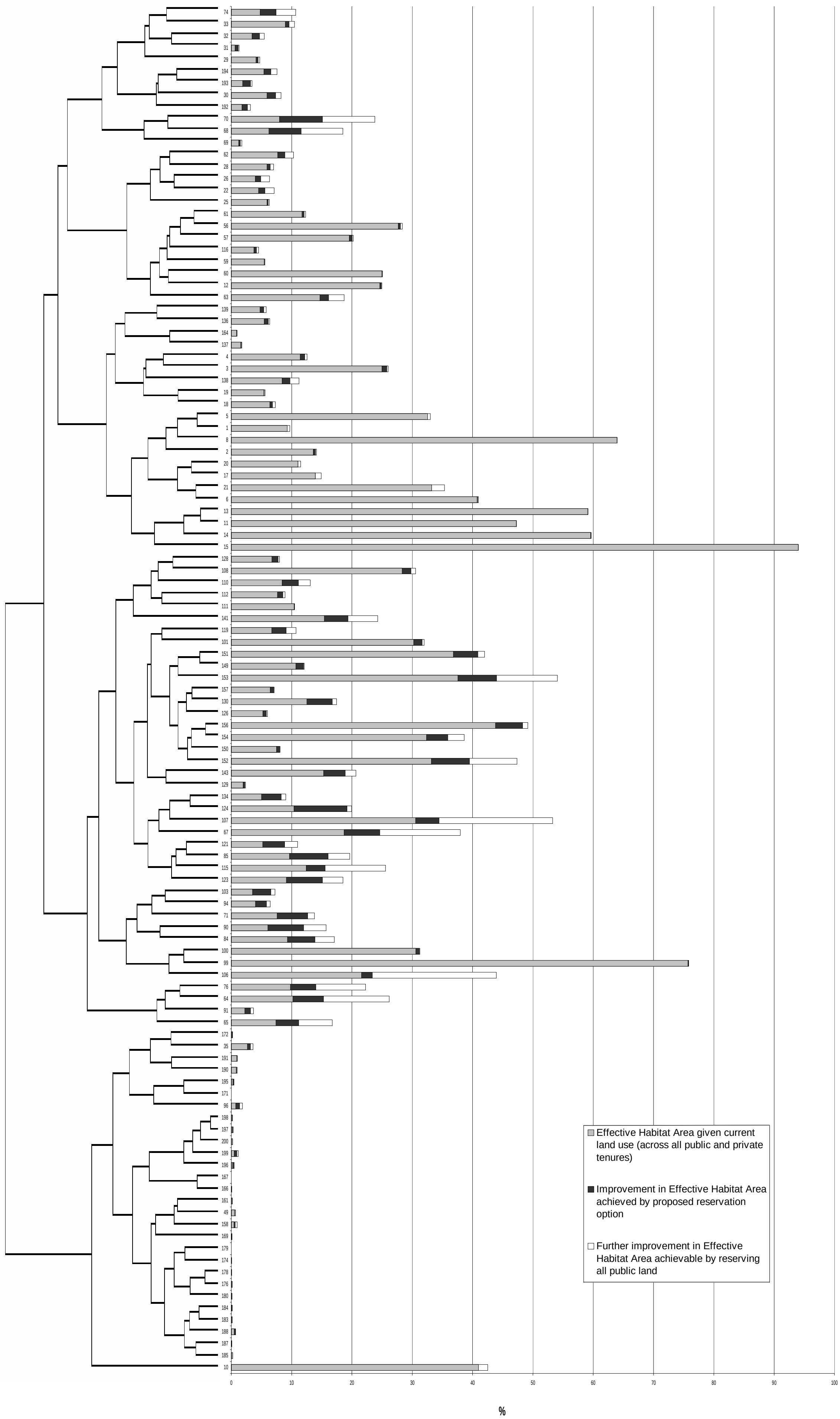
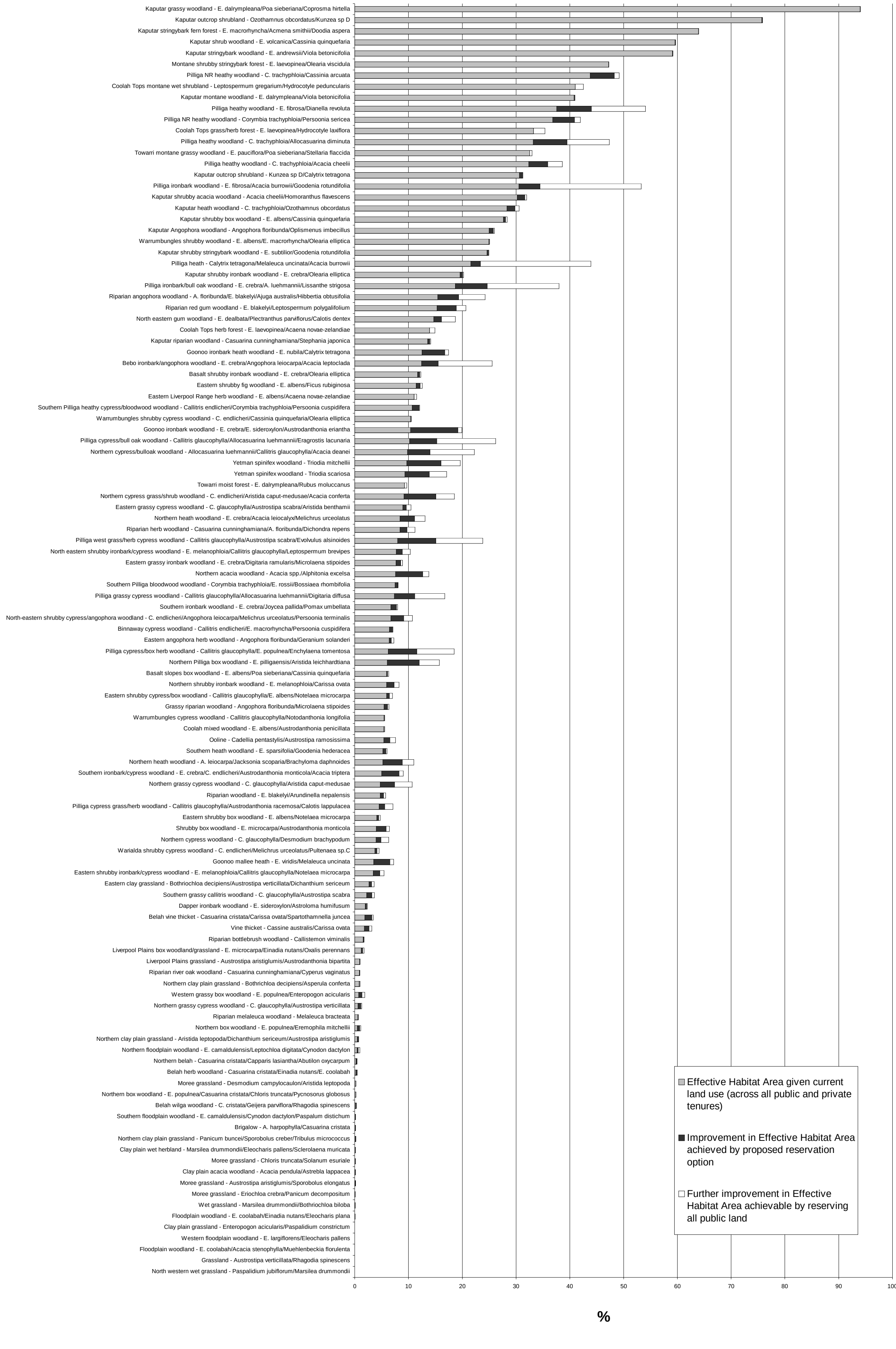


Figure 6: Example of more detailed reporting of a hypothetical reservation scenario: Effective Habitat Area of vegetation communities as a percentage of original area estimated by the Joint Vegetation Mapping Project (communities ordered according to current EHA)



3.2 POTENTIAL ROLE IN OTHER PLANNING PROCESSES

The assessment tools developed by this project have considerable potential to contribute to other natural resource planning processes, including regional vegetation planning and catchment planning. The tools enable conservation priorities to be mapped across all tenures, indicating both priorities for protecting remaining vegetation remnants and priorities for revegetating areas of cleared land (including the identification of optimum corridor routes). The tools can also facilitate development and evaluation of land use or management scenarios across all tenures, through application of the interactive editing capability described in Section 2.1.

The following caveats should, however, be noted when considering any potential application of the tools to other planning processes within the region:

- The main product of this project was never intended to be a static map of conservation priorities, but rather a dynamic mechanism for conservation prioritisation and evaluation that can best be applied through interactive collaboration with other planning processes.
- The assessment tools can provide guidance as to “where” best to direct conservation effort within the region, but do nothing to solve the problem of “how” to fund and facilitate such action. For the assessment tools to contribute to any real conservation outcomes outside of public land they will need to be linked to processes that address the “how” issue, e.g. incentive schemes.
- Although they have the potential to do so, the assessment tools do not currently consider any environmental values other than biodiversity (e.g. other ecosystem functions and services), nor do they address social or economic values. Further effort needs to be directed towards incorporating these other values into the prioritisation of conservation action (i.e. the “where” issue from the previous point). Of particular importance is the need to factor implementation costs into the estimation and mapping of biodiversity conservation priorities – i.e. enabling priorities to be expressed in terms of the predicted gain in conservation effectiveness achieved per unit cost.
- As noted earlier, many of the data-sets employed in the assessment of biodiversity are relatively coarse-scaled and likely to contain inaccuracies. Further effort needs to be directed towards refining these data layers, particularly those relating to condition and threat. Effort also needs to be directed to refining the analytical techniques used to model persistence of biodiversity.
- While the assessment tools described here can help to provide a “big picture” context for local planning decisions, the identification of priority areas from remotely mapped information should, wherever possible, be validated and augmented by direct field observation.
- The use of vegetation communities as a general surrogate for biodiversity should ideally be supplemented by consideration of the needs of individual species of particular conservation concern (e.g. threatened species).

References

Andren H (1999) Habitat fragmentation, the random sample hypothesis and critical thresholds. Oikos 84: 306-308

Brooks TM, Mittermeier RA, Mittermeier CG, da Fonseca GAB, Rylands AB, Konstant WR, Flick P, Pilgrim J, Oldfield S, Magin G and Hilton-Taylor C (2002) Habitat loss and extinction in the hotspots of biodiversity. Conservation Biology 16: 909-923

Ferrier S (2002) Mapping spatial pattern in biodiversity for regional conservation planning: where to from here? Systematic Biology 51: 331-363

Ferrier S, Drielsma M, Manion G and Watson G (2002a) Extended statistical approaches to modelling spatial pattern in biodiversity in north-east New South Wales: II. Community-level modelling. Biodiversity and Conservation 11: 2309-2338

Ferrier S, Pearce J, Drielsma M, Watson G, Manion G, Whish G and Raaphorst S (1999) Evaluation and Refinement of Techniques for Modelling Distributions of Species, Communities and Assemblages. Unpublished report prepared for Environment Australia. New South Wales National Parks and Wildlife Service, Sydney

Ferrier S, Watson G, Pearce J and Drielsma M (2002b) Extended statistical approaches to modelling spatial pattern in biodiversity in north-east New South Wales: I. Species-level modelling. Biodiversity and Conservation 11: 2275-2307

Hanski I (1999a) Habitat connectivity, habitat continuity, and metapopulations in dynamic landscapes. Oikos 87: 209-219

Hanski I (1999b) Metapopulation Ecology. Oxford University Press, New York

Hanski I and Ovaskainen O (2000) The metapopulation capacity of a fragmented landscape. Nature 404: 755-758

Harte J, McCarthy S, Taylor K, Kinzig A and Fischer ML (1999) Estimating species-area relationships from plot to landscape scale using spatial-turnover data. Oikos 86: 45-54

Izsák J and Papp L (2000) A link between ecological diversity indices and measures of biodiversity. Ecological Modelling 130: 151-156

McAlpine CA, Fensham RJ and Temple-Smith DE (2002) Biodiversity conservation and vegetation clearing in Queensland: principles and thresholds. Rangeland Journal 24: 36-55

Pearce J and Ferrier S (2001) The practical value of modelling relative abundance of species for regional conservation planning. Biological Conservation 98: 33-43

Pimm SL and Askins RA (1995) Forest losses predict bird extinctions in eastern North America. Proceedings of the National Academy of Science 92: 9343-9347

Pimm SL and Raven P (2000) Extinction by numbers. Nature 403: 843-845

Rosenzweig (1999) Heeding the warning in biodiversity's basic law. Science 284: 276-277

Simberloff D (1992) Do species-area curves predict extinction in fragmented forest? In: Whitmore TC and Sayer JA (eds) Tropical Deforestation and Species Extinction, pp 75-89. Chapman and Hall, London

Sisk TD, Haddad NM and Ehrlich PR (1997) Bird assemblages in patchy woodlands: modelling the effects of edge and matrix habitats. Ecological Applications 7: 1170-1180

Sisk TD, Noon B and Hampton HM (2002) Estimating the effective area of habitat patches in heterogeneous landscapes. In: Scott JM, Hegland PJ, Morrison ML, Haufler JB, Raphael MG, Wall WA and Samson FB (eds) Predicting Species Occurrences: Issues of Accuracy and Scale, pp 713-726. Island Press, Washington DC