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A Method for Assessing Protected Area Allocations Using a Typology of Landscape Values

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ABSTRACT *Traditional park and reserve selection techniques that rely exclusively on expert assessment can marginalize local knowledge and values in the review process. Using survey data from the Otways region of Victoria, Australia, we present a method that differentiates between public and private lands using locally perceived landscape values. The results are used to assess prospective national park expansion areas. Two data models of mapped landscape values—vector and raster—were analysed using discriminant analysis to classify and predict land status. Results indicate survey respondents hold more indirect and less tangible values for national parks and reserves, and more direct use values for private lands. There was moderate agreement between public and expert-derived national park boundaries. The mapping of local landscape values appears useful in planning and reviewing public land classifications, and when combined with biological assessments, can strengthen protected areas planning and management in Australia and elsewhere.*

Introduction

Australia has a diverse protected areas system that is mainly confined to public lands (Fitzsimons & Wescott, 2004). In recent years, there has been a concerted effort to establish a reserve system that samples ecosystems in a comprehensive, adequate, and representative (CAR) manner (Figgis, 1999; Worboys *et al*., 2001). Conservation planning includes the process of identifying these CAR regions, developing mechanisms to achieve the protection of the system and monitoring the system for desired outcomes (Brown *et al*., 2004). It has traditionally been a top down process characterized by studies on species richness and reserve algorithms, and monitoring indicator or endangered species (Prendergast *et al*., 1999).

In recent years, there have been calls for understanding how places are socially constructed and contested. Williams (2000) argues that many of the challenges facing

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conservation planning arise from contested meanings of places and ecosystems that can be attributed to modernity and globalization. He and his colleagues endorse a shift to discursive, participatory approaches that focus on place-based meanings (Williams & Stewart, 1998). There have been a number of examples of these research efforts. Open-ended questions and semi-structured interviews, for example, have been used to collect local knowledge and perspectives about natural changes in water quality in a Brazilian wetland (Calheiros *et al.*, 2000). But the incorporation of local perspectives and values into conservation planning has been criticized by some natural scientists as being 'subjective, biased and value-laden' (Bojorquez-Tapia *et al.*, 2003, p. 367) because it does not follow a rigorous scientific method.

Economists argue that monetary valuation of natural areas contributes to a more rational allocation of a scarce resource. Economic valuation methods such as the travel-cost method or the contingent valuation method (CVM) can assist in the conservation planning process and often indicate people are willing to pay for the conservation of remote and attractive areas (see e.g. Lee & Han, 2002). The contingent valuation method assumes that people are able to translate a wide range of environmental services into a single monetary amount representing the total value of the particular resource (White & Lovett, 1999). However, this approach discounts the ethical and moral values for nature (Stevens *et al.*, 1991, 1993; Foster, 1997; Clark *et al.*, 2000) that are deeply held and privately defended (Satterfield, 2001).

Both ecological and economic criteria are essential in evaluating the designation or allocation of protected areas for conservation purposes. However, in this paper we present an expanded view of human valuation for protected area planning to augment traditional economic and biological diversity criteria for conservation outcomes. Humans perceive protected areas such as national parks as having a variety of non-use or option values (including future, intrinsic and spiritual values) that may not be fully incorporated using traditional economic or biological assessment models. By adding place-specific social perceptions of landscape values to land-suitability assessment, planners can explicitly address the 'wicked' problems in land-use planning characterized by a lack of understanding of the multiple and competing values and goals for land management. For the past six years, Brown (2005) has included spatial measures of perceived landscape values and other place attributes in public surveys with the goal of systematically integrating local values and perceptions with biophysical landscape information. The post-data collection process of applying various decision criteria to the mapped public landscape values to determine their consistency with prospective land uses or allocations has been called Values Suitability Analysis (VSA) and was first applied by Reed & Brown (2003) in the Chugach National Forest (USA) planning process in Alaska. VSA provides a means to systematically review and revise prospective land classifications and management options to be more consistent with publicly held landscape values.

One constraint of suitability analysis, whether based on conventional physical land attributes, or unconventional perceived landscape values, is that suitability decision thresholds must be established using expert judgement. To reduce the potential for bias in judgement, statistical tools can be used to more objectively approach classification decision thresholds.

This study builds on value suitability analysis by using discriminant analysis to find the linear combination of independent variables (i.e. 12 landscape values) that best differentiates or 'discriminates' between known land classifications (dependent variables) consisting of national parks, state forests and private land in the Otways region of Victoria, Australia. Discriminant analysis uses the quantitative relationship between existing land classifications and perceived landscape values to build predictive discriminant functions to classify prospective lands for conservation purposes. Land classes generated using the discriminant model can then be mapped and overlayed with expert-derived land classifications for assessment of land-use consistency.

The question examined in this study is whether landscape values can be used to differentiate between public lands and private lands, and if so, can the results be used to review and revise national park classifications. We used discriminant analysis on vector (shape) and raster (grid) data to mathematically determine which landscape values best differentiate national park lands from other lands. We included both vector and raster data analysis because the two data models make different assumptions about the spatial data. Humans may perceive landscape values as discrete occurrences on the landscape suggesting the use of a vector model (e.g. an aesthetic value location will be found either inside or outside a national park boundary), or humans may perceive landscape values as being on a continuum or gradient across a landscape suggesting the use of a raster model. Following a presentation of the research results, we discuss the implications of using vector and raster value mapping approaches for future protected area allocation in Australia and elsewhere.

Methods

Study Area

The Otways region is located in southwest Victoria, Australia. The primary focus of this study is on forested lands located within the Otway Hinterland and along the Otway Coast. Historically, these forests were broadly classified as state forest (Figure 1a), open to sawlog and pulpwood production; and national park, state park and reserve, designated for the conservation of flora and fauna (VEAC, 2004). Two new public land classifications titled the Great Otway National Park and Otway Forest Park were designated in the *National Parks* (*Otways and Other Amendments*) *Act* (*Vic*) 2005 in response to the Victorian Government's commitment to cease logging in the region by 2008; they are zoned for conservation and recreation, respectively (Figure 1b). For simplicity, former state forest-land classifications will be denoted as 'old state forest', and former national park, state park and reserve classifications will be denoted as 'old national park' (Figure 1a). The Great Otway National Park will be referred to as the 'new national park', the Otway Forest Park as the 'new forest park' and the remaining area of land in the Otways study area as 'private land' (Figure 1b). Finally, the difference (increase) between old and new national park lands will be denoted as 'national park expansion'.

Sampling

We randomly selected Otway residents from the 2003 electoral roll for the division of Corangamite, Victoria (Australian Electoral Commission, 2003). This database

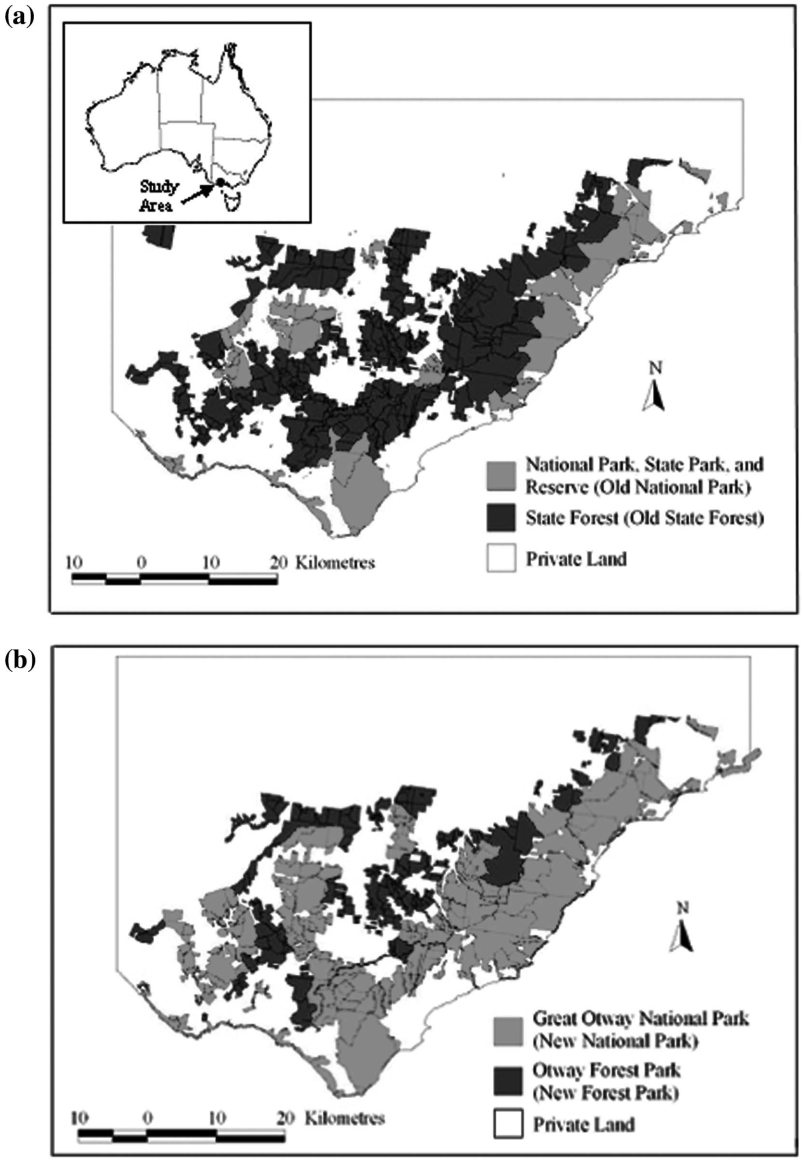

Figure 1. (a) Old and (b) new land classifications in the Otways region.

contained the names and addresses of residents over the age of 18 who had registered to vote in a Commonwealth Government election. We initially selected 1400 individual households to receive a mail questionnaire and then conducted three rounds of mailing in the summer of 2005 using a modified Dillman's (1978) Total Design Method. Survey administration involved three mailings: (1) an introductory letter informing of the purpose of the research; (2) complete survey packet; and (3) a second complete survey packet to non-respondents from the first round.

Survey Responses

Part 6 of the 2005 Otways survey directed participants to a 1:125 000 greyscale map of the Otways region (Spatial Vision, 2001) and accompanying map legend (Table 1). The map legend contained 12 rows of sticker dots for each of 12 landscape values, ranging from aesthetic value to wilderness value. An operational definition for each value appeared adjacent to the respective row of sticker dots. Each landscape value was assigned five dots weighted from 50 to 5, with the larger numbers reflecting more of the landscape attribute, i.e. more scenic or more recreation value. Participants were requested to place their sticker dots on the map locations that held the 12 landscape values. The spatial data set used in the analysis consisted of 14 306 digitized points from 500 Otways region residents representing an overall survey response rate of 40%.

Spatial Data—Comparing the Mix of Values Found in Public and Private Lands

The Otways map showed the boundaries of the old national park, state forest and private land. Survey respondents could place as many or as few landscape value dots in any of these three land classifications. We expected that respondents would associate more direct use values (e.g. economic and recreation) with private land and indirect use values (e.g. biological diversity, intrinsic, spiritual) with national park lands, while state forests would have a mix of direct and indirect use values. We used discriminant analysis to test this assumption.

Discriminant analysis consisted of three phases: data extraction, data analysis and data mapping. The data were extracted using both vector and raster approaches to account for different assumptions about landscape value perception. The raster

Table 1. Landscape value definitions used in the Otways region survey

Aesthetic/scenic value—I value these places for the attractive scenery, sights, smells or sounds.

Economic value—I value these places for the economic benefits such as agriculture, tourism, or commercial activity.

Recreation value—I value these places because they provide outdoor recreation opportunities.

Life Sustaining value—I value these places because they help produce, preserve, and renew air, soil, and water.

Learning value (knowledge)—I value these places because we can use them to learn about the environment.

Biological diversity value—I value these places because they provide for a variety of wildlife, marine life, or other living organisms.

Spiritual value—I value these places because they are spiritually special to me.

Intrinsic value—These places are valuable for their own sake, no matter what I or others think about them or whether they are actually used.

Heritage value—I value these places because they have natural and human history.

Future value—I value these places because they allow future generations to know and experience them as they are now.

Therapeutic value—I have these places because they make people feel better, physically and/or mentally.

Wilderness value—I value these places because they are wild.

model assumes that landscape values can be assigned continuously over space (grid cells), whereas the vector model assumes landscape values have a discrete location on the landscape (e.g. either inside or outside a national park polygon).

The vector analysis involved digitizing eight polygons from each of the different Otways land classifications: old state forest, old national park, new national park and private land. While only eight polygons were selected, there were approximately the same numbers of landscape value point locations ($n = 4000$) in the vector model as the raster model, making both models plausible for discriminant analysis.

The type and frequency of landscape values found in each polygon were extracted from the GIS and the landscape values were classified as either being 'inside the old national park', 'inside the old state forest', 'inside private land', or 'inside new national park'. Values were only selected from mutually exclusive land classifications (e.g. values held for new national parks were not included in the old national park designation) to reduce within group variance. We then calculated the relative frequency of landscape values for each of the selected polygons and imported the data into SPSS® for discriminant analysis.

Raster data extraction involved converting the study area, old national park, old state forest and new national park into grid themes using a 500 m grid cell size. Cell sizes for generating density maps were heuristically derived based on the map scale and assumed respondent error in the placement of a dot (i.e. 500 m). The three public land classifications ($n = 5250$ cells) were assigned a unique identifier for each type (e.g. 1, 2 and 3) and the remaining grids were coded as private lands; however, because private lands were overrepresented in the study area ($n = 16\,000$ cells), a random sample of 1750 private land cells were generated in SPSS®. The 12 landscape values were also converted into grid themes using a consistent cell size of 500 m and 2 km search radius prior to merging with the land classification database.

Data analysis involved exporting the extracted vector and raster data to SPSS for performing the disciminant analysis operation. Discriminant analysis can identify potential differences in the mix of landscape values held for different land classifications in this study—national parks, state forests and private lands. The discriminant procedure generates one or more discriminant functions based on the linear combination of the landscape values that best differentiate between land classifications. The discriminant function is described by the following equation:

$$\text{Land Classification} = \beta_0 + \beta_1\text{Aesthetic} + \beta_2\text{Economic} + \beta_3\text{Recreation} + \cdots + \beta_n\text{LandscapeValue}_n$$

where the β values are linear weights or coefficients that describe the contribution of each of the 12 landscape values to the integer coded land classification variable (national park, state forest or private land). For each discriminant function generated (the number of functions will be one less than the number of classification categories or in this case, two), an eigenvalue is calculated that measures the percentage of variance accounted for by the discriminant variables. The Wilks's Lambda γ statistic is used to determine whether a discriminant function is statistically significant, thus requiring interpretation of the function. Interpretation of the function proceeds by examining the derived standardized β values. These standardized β values are functionally equivalent to the standardized betas in linear regression, and describe the relative contribution of each landscape value to the discriminant function variate.

The derived discriminant function is then used to predict the group membership of the ungrouped private land and new national park cases (i.e. 1 = 'state forest', 2 = 'national park', 3 = 'private land') based on the known group membership of grid cells used to derive the function. The predicted group memberships are displayed in a classification table to show how well the discriminant function predicts the land classification results.

The final step is to map and visually inspect the predicted group membership results. Each predicted group has an x and y Cartesian co-ordinate, representing its spatial location on the landscape. The coordinates of the predicted land classifications were imported into ArcView® software and converted to polygons on a 1:125 000 Otways region map. This overlay was titled 'value-based national park'.

Results

Discriminating between Public and Private Lands Using Landscape Values—Vector and Raster Approaches

Table 2a shows the output from the discriminant analysis of both the vector and raster models. Two discriminant functions were generated from each model. In both the vector and raster models, the first function accounts for >81.2% of the variance compared to the second function which accounts for <18.8% of the variance. Column five shows Wilk's lambda that represents the ratio of error variance to total variance. Large eigenvalues lead to small values of Wilk's lambda and statistical significance (Field, 2000). In the vector model, only the first discriminant function is significant ($p < 0.05$) suggesting one underlying dimension, whereas in the raster model, both functions are significant. Because the second function in the raster model accounts for less than 8% of the total model variance, our interpretation will focus on the first function in each model.

The relative contribution of each variable to the functions appears in Table 2b. For the vector model, aesthetic (1.212) and economic (1.203) values are the largest contributors to the first discriminant function based on standardized discriminant

Table 2a. Canonical discriminant functions

Function	Eigenvalue	Variance (%)	Canonical correlation	Wilks' λ	χ^2	d.f.	p
Vector							
1	3.856	81.2	0.8911	0.109	35.49	22	0.034
2	0.892	18.8	0.6867	0.529	10.20	10	0.423
Raster							
1	0.448	92.1	0.5564	0.665	2132.44	22	0.000
2	0.038	7.9	0.192	0.863	196.33	10	0.000

function coefficients, and for the raster model, biological diversity (0.619) and wilderness (0.443) value are the largest contributors. Future value (−0.014) is a minor contributor in the vector model while heritage (0.004) and recreation (−0.072) values are minor contributors in the raster model.

The correlations between the predictor variables and the discriminant functions appear in Table 2c. The direction of the correlations suggests the functions are discriminating based on direct vs indirect human uses of the landscape. For example, the negative correlations for the vector model represent indirect or less tangible landscape values—wilderness (−0.429), biological diversity (−0.307), life sustaining

Table 2b. Standardised discriminant function coefficients

Variable	Vector Function 1	Raster Function 1
Aesthetic	1.212	−0.372
Economic	1.203	−0.182
Recreation	0.412	−0.072
Life sustaining	0.647	0.247
Learning	0.477	0.258
Biological diversity	0.383	0.619
Spiritual	1.047	0.285
Intrinsic	0.558	−0.116
Heritage	0.763	0.004
Future	−0.014	−0.298
Therapeutic	−0.357	[b]
Wilderness	[a]	0.443

[a]Wilderness value failed the tolerance test in the vector model.
[b]Therapeutic value failed the tolerance test in the raster model.

Table 2c. Structure matrix for pooled within-groups correlations between discriminating variables and standardised canonical discriminant functions ordered by absolute size of correlation within function

Vector		Raster	
Variable	**Function 1**	**Variable**	**Function 1**
Economic	0.681	Wilderness	0.896
Wilderness	−0.429	Biological diversity	0.838
Biological diversity	−0.307	Life sustaining	0.734
Spiritual	0.276	Learning	0.725
Learning	−0.230	Intrinsic	0.669
Aesthetic	0.200	Future	0.643
Life sustaining	−0.379	Spiritual	0.506
Recreation	0.211	Heritage	0.499
Intrinsic	−0.269	Therapeutic	0.499
Heritage	0.250	Aesthetic	0.415
Future	−0.107	Economic	−0.004
Therapeutic	0.017	Recreation	0.099

(−0.379), learning (−0.230), intrinsic (−0.269) and future (−0.107) values while the positive correlations represent more direct human uses of the landscape—economic (0.681) and recreation (0.211) values in particular. The discriminant functions evaluated at group centroids (Table 2d) suggest indirect use values align with national park land, whereas direct use values align with private land. The raster model interpretation in Table 2c is less clear, although economic value (−0.004) appears opposite to the other landscape values.

The classification results (Table 2e) show that the raster model has less discriminating power than the vector model (61.7 vs 87.5%), but when used to predict unclassified group membership, has more cross-validation power (61.5% vs 50.0%). The centroid positions of the public and private lands do not change in the vector and raster models (Table 2d; Figures 2a and b). National park allocations align with more indirect or non-use values of the landscape, private land allocations align with more direct uses and state forests are positioned somewhere in between these extremes. The distinctions between state forests, national parks, and private lands are not as clear in the raster model as shown by the smaller differences between discriminant function centroids. In the raster model, state forest is closer to private land than national park, whereas in the vector model, state forest is closer to national park than private land.

Table 2d. Canonical discriminant functions evaluated at group means (centroids)

Group	Vector Function 1	Raster Function 1
1. Old State Forest	−1.088	−0.345
2. Old National Park	−1.499	0.939
3. Private Land	2.587	−0.588

Table 2e. Classification results

		Vector Predicted group membership				Raster Predicted group membership		
Actual group	***N***	**1**	**2**	**3**	***N***	**1**	**2**	**3**
1. Old State Forest	8	7 (87.5%)	1 (12.5%)	0 (0%)	1747	858 (49.1%)	70 (4.0%)	819 (46.9%)
2. Old National Park	8	1 (12.5%)	7 (87.5%)	0 (0%)	1737	527 (30.3%)	905 (52.1%)	305 (17.6%)
3. Private Land	8	0 (0%)	1 (12.5%)	7 (87.5%)	1750	216 (12.3%)	68 (3.9%)	1466 (83.8%)
4. Ungrouped Cases	8	3 (37.5%)	4 (50.0%)	1 (12.5%)	16 420	2768 (16.9%)	1210 (7.4%)	12 442 (75.8%)

Per cent of cases correctly classified: Vector = 87.5%, Raster = 61.7%.
Per cent of cases correctly cross-validated: Vector = 50.0%, Raster = 61.6%.

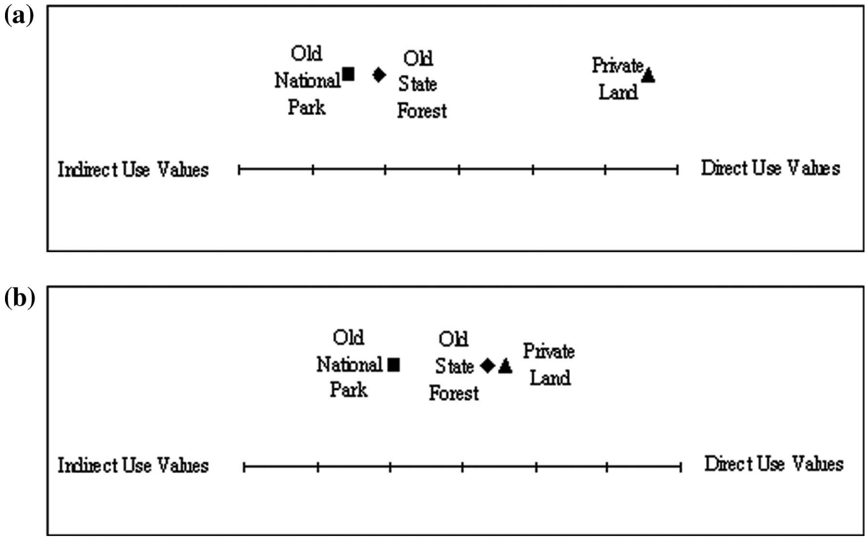

Figure 2. Group centroids plotted for first discriminant function for vector and raster data analyses. *Note*: discriminant functions in both (a) and (b) are significant $p < 0.05$.

The vector model classification results indicate that one polygon of state forest was incorrectly classified as national park, one polygon of national park land was incorrectly classified as state forest and one polygon of private land was incorrectly classified as national park, yielding 87.5% accuracy overall (Table 2e). The vector model also suggests that the eight unclassified polygons are best characterized as state forest (three polygons), national park (four polygons) and private land (one polygon).

In contrast, the raster model incorrectly predicted 70 state forest grid cells (4.0%) as national park, 527 national park grid cells (30.3%) as state forest, and 68 private land grid cells (3.9%) as national park, yielding 61.7% overall model accuracy. Restated in the affirmative, the raster model correctly predicted 49.1% of state forest grid cells, 52.1% of national park cells and 83.8% of private land cells. Further, of the ungrouped grid cells, 2768 (16.9%) would be classified as state forest, 1210 (7.4%) as national park and the remaining 12 442 cells (75.8%) as private land. Thus, private lands were most accurately predicted in both the raster and vector models while state forest and national park predictions were less accurate in the raster model.

Spatial Distribution of Predicted National Parks

The spatial distribution of the value-based national park allocations, as predicted by the discriminant analysis for the raster model, is presented in Figure 3. The value-based national parks appear to closely track the boundaries of existing national park land and also include areas contained within the national park expansion. Although not perfect, the landscape values expressed by Otway region residents appear to confirm the national park status of both the old Angahook-Lorne State Park (2) and

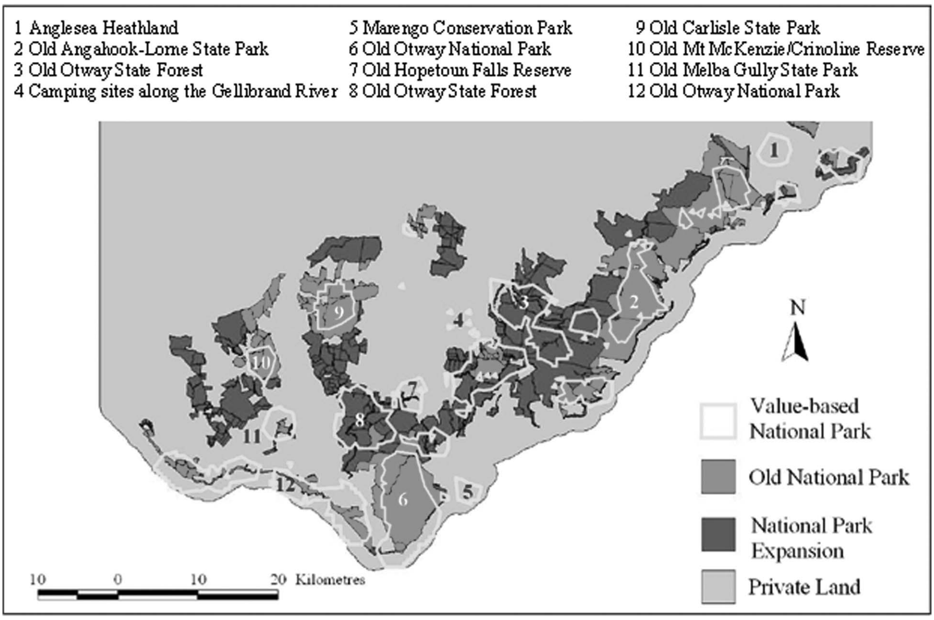

Figure 3. Assessment of new national park allocations based on community-held values for national parks.

the old Otway National Park (6 and 12), as well as support for conversion of a significant proportion of Otway State Forest (3 and 8) into new national park land. Land not located in the expanded national park includes the Anglesea Heathland (1), camping sites along the Gellibrand River (4) and the Marengo Conservation Park (5). These results present an opportunity for government agencies to review the present classification and management of these lands because they hold values consistent with national park status.

The misclassification of national parks into state forests and private lands also warrants explanation. Visual inspection of the maps not included with these results suggest the majority of national park grid cells incorrectly classified as state forest encroach the boundaries of the national parks, with the exception of the Angahook-Lorne State Park where state forests surround a large portion of the land area. The majority of national park grid cells incorrectly classified as private land are located around coastal townships and tourist attractions, in particular Aireys Inlet, Lorne and Cape Otway Lighthouse Station.

Discussion

The objective of this study was to examine whether it was possible to differentiate between public and private land classifications based on the values people hold for landscapes, and use the results to review and identify areas for protected status, especially national parks. In both the vector and raster models, there were few differences in the mix of landscape values held for state forests and national parks, which suggests that people do not perceive a large difference between these public land classifications. Both are public reserves, although the degree of regulatory protection for national parks is arguably stronger.

The vector model displays greater differences between the mix of values held for national parks and private lands compared to the raster model (Figures 2a and b). In the vector model, respondents hold more indirect or non-use values for national park land, including wilderness, biological diversity, life sustaining, learning, intrinsic and future values, but hold more direct use values for private lands, in particular recreation and economic value (Table 2c). In the raster model, the distinction between indirect and direct use values for protected areas is not as clear, which may relate to how people perceive landscapes. The vector model uses discrete land classification boundaries to delineate public and private lands, a process that is closer to the actual decision process faced by survey participants when they place landscape values on a map displaying national park and state forest allocations. It is possible that a vector model is better suited for some landscape values and raster for others. For example, people may perceive landscape values attached to a particular setting (e.g. recreation site) discretely and other more symbolic values (e.g. intrinsic value) with amorphous boundaries.

Wilderness and therapeutic values failed the tolerance test to enter the vector and raster discriminant models, respectively (Table 2b) suggesting the presence of some multicollinearity in the typology of landscape values. The typology was intended to be an exhaustive list of values people hold for the landscape, which may compromise mutual exclusivity. Some values may be ambiguous with inevitable conceptual overlap between different types, as shown in previous sense of place research. For example, Fredrickson & Anderson (1999) found that wilderness areas (wilderness value) were a source of spiritual inspiration (spiritual value). While the level of multicollinearity in this study does not appear high enough to invalidate the basic predictive findings, a high level of multicollinearity can lead to spurious results and must be carefully evaluated. A visual inspection of the predicted land classifications suggests there is moderate overlap between national parks identified through discriminant analysis (value-based national parks) and actual national park classifications (Figure 3). There is not complete agreement because land near national park boundaries was sometimes incorrectly classified as state forest or private land; for example, national park land adjacent to Lorne was incorrectly classified as private land and national park land adjacent to the Otway State Forest was incorrectly classified as state forest. Some classification error may be attributed to error in the digitizing of value locations. Using a 1:125 000 scale map, there is the potential for up to a 2 km error in digitizing. Future studies could investigate the use of scaleable digital maps accessible to survey participants via the Internet to allow more precise placement and recording of landscape value dots.

There is less spatial overlap between value-based national parks and the national park expansion areas. Areas of alignment occur mainly around nature-based attractions, including Lake Elizabeth, the Otway Fly and Triplet Falls located within the old state forest (see areas 3 and 8 in Figure 3). State forests in the eastern and western sections of the Otways region were not identified as value-based national park, highlighting the importance of multiple criteria in the assessment and revision of protected area classifications. These areas appear to have proportionately fewer indirect and non-use values such as wilderness, biological diversity, and intrinsic value and proportionately more direct use values such as economic and recreation value. A logical next step would be to overlay potential ecological reserve selection indicators such as the presence or absence of keystone/rare species, net primary productivity, type of vegetation communities, area of reserve and representativeness of the reserve. This approach would enable the true integration of biological reserve selection procedures with perceived community values for the landscape and may provide a clearer picture of appropriate regions for both conservation and development.

Implications of Using Landscape Values in Conservation Planning

Conservation threats are accelerating throughout the world because policy frameworks give priority to short-term economic values over non-use values for the landscape. Contingent valuation studies attempt to measure the fuller range of human values by creating hypothetical markets for non-use values (White & Lovett, 1999), but there are technical and logical limits to the monetarization of natural assets, especially where resource values are perceived as nonsubstitutable, or contain significant intergenerational or spiritual values. This study indicates that people identify protected areas as containing significant indirect use values, including spiritual, intrinsic and future values that are largely ignored, or at best, neglected in contingent valuation models.

There remains ample scope for improving the way local values are integrated into the conservation decision process. The research reported in this paper indicates that the mapping of landscape values provides a systematic and rationally defensible methodology for including perceived community values in the assessment and revision of protected area classifications, but the limitations of using discriminant analysis for identifying land classification decision thresholds in suitability analysis must be acknowledged. Discriminant analysis is a probabilistic model and as such, it will misclassify areas, leading to potential protected area underclassification or overclassification. Results of the analysis provide a useful starting point for protected area classification, but no statistical method, including the method described herein, will obviate the need for human judgement and adjustment.

The decision criteria in resource management should reflect a wide variety of place-specific values to ensure consistency between top–down reserve selection procedures, such as the CAR model, and local environmental values on the landscape. By soliciting empirical observations about what and where humans value in regional landscapes, policymakers can develop plans that are consistent with human values for the landscape. Policy recommendations resulting from these value-based models are also more likely to be recognized and implemented by local people who have been actively involved in the research process (Calheiros *et al.*, 2000).

By overlaying expert-derived land classifications with classifications derived from general public values, land managers can develop more socially acceptable conservation plans. For example, it is in the Victorian government's political interest to protect the old Otway National Park because there is a strong agreement between expert-derived land allocations and local values for these lands. Further, land managers are better able to target conservation planning strategies to areas of potential conflict where expert selection criteria may not be consistent with public landscape values. The value-based national park classifications presented in this paper indicate that some of the state forest lands in the far east and west of the Otways do not currently contain a mix of landscape values perceived by regional residents to recommend national park classification. However, the absence of landscape values consistent with national park classification in these areas should not deter the pursuit of important or alternative conservation goals if ecological justification is present. The move towards integrated natural resource management (see Paton *et al.*, 2004) requires a means to link community values of places with land use decisions. This study demonstrates that the mapping of landscape values can be used to systematically assess options for the planning and management of conservation areas that are both inclusive and scientifically defensible.

We recognize there are limitations to relying on local values in conservation planning. Human perceptions of landscape values are influenced by past human experiences with nature, which in turn, are influenced by access to national parks. The value-based national park areas closely align with Otway tourist attractions such as Lake Elizabeth and Melba Gully. Conservation planners, using CAR reserve selection criteria, may place higher biological value on sites away from human access because they are home to rare or threatened species. Similarly, contingent valuation studies may place a high monetary value on the variety of ecosystem services provided by lands outside of the value-based national park because they are seen as 'more natural' or 'more wild'.

A values suitability approach to conservation assumes technical or political constraints to land acquisition can be effectively managed. However, in the real world, national park expansion is strongly influenced by the availability of public land and the cost of private land acquisition. Prevailing ownership patterns affect what land gets protected (or not) in the first place. In many instances, non-governmental organizations can facilitate the public acquisition of new conservation areas based on more strict ecological criteria, but the resources required to 'rearrange' ownership patterns are a significant and often limiting factor in conservation.

In Australia, national park expansion is a state-based decision requiring not only solicitation of local values through public consultation, but also the values of individuals and institutions who may reside outside the area under consideration. Key questions emerge: how much weight should be given to local resident values compared to regional, state, or even national values? If local values are biased towards development, how much weight should be assigned to these values vs exogenous desires to preserve biological resources for present and future generations? These weighty questions cannot be answered by one method alone. Any method of analysis, whether it be based on examining local and regional landscape values or cost benefit analysis, should only be viewed as a tool to assist in the analysis of alternatives, not as incontrovertible proof of a case for conservation or development. Given that local interests tend to be more pro-development and less conservation oriented than regional or national interests, the method will likely yield minimum, baseline goals for conservation. Yet, these local conservation values may present an opportunity for a significant increase in protected areas over the status quo, as evidenced in this particular study. The exclusion or discounting of local landscape values, even if they may be said to underestimate a broader public commitment for land protection, does not appear to be a tenable position.

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