A MULTIVARIATE FRAMEWORK FOR EVALUATING THE MANAGEMENT OF PROTECTED AREAS

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Abstract

As the human population grows, Earth's natural resources are under increasing threat from deforestation, biodiversity loss, pollution, and habitat fragmentation. For many years conservation scientists have set aside protected areas to preserve intact landscapes. Today, the network of protected areas covers over 12% of the world's landmass. However, management of these areas is often constrained by varying financial, physical and scientific resources. Therefore, effective management is key to the success of protected areas in conserving biodiversity. Over the last decade, international NGOs and government agencies have developed tools to monitor management effectiveness (ME).

This project uses multivariate analysis to assess one of these methods. The Management Effectiveness Tracking Tool (METT) was created by the Wildlife Conservation Foundation and the World Bank to monitor the strengths and weaknesses in protected area ME around the world. It contains an Assessment Form with 33 questions that measure ME on a scale of 0-100. In this study, METT responses from 526 parks in 57 countries were analyzed with Principal Components Analysis and Factor Analysis to find common themes. The goal was to understand what determines good management.

The results indicated that the following six factors account for the trends within ME: personnel capacity, tourism, local community involvement, resource inventory, equipment and budget. Results also suggest that the current design of the METT Assessment Form could be improved to effectively measure ME. To address this issue, further research is recommended to develop a structural model to improve the definition of ME.

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1. Introduction

In 1872, Yellowstone National Park in the United States become the world's first official protected area (or "park") (Eagles, McCool and Haynes 2002; Chape et al. 2005). More parks followed, but it wasn't until the end of World War II and the 1948 creation of the World Conservation Union (IUCN), that their numbers began rising. One IUCN commission that was pivotal in this expansion was the World Commission on Protected Areas (WCPA). The WCPA's mission is the "establishment and effective management of a worldwide representative network of terrestrial and marine protected areas…" (WCPA 2008). In the years following, attention on species loss and biodiversity conservation created exponential growth in the worldwide network of parks. In February 1992, the IVth Congress on National Parks and Protected Areas, encouraged the trend by setting a goal to preserve a minimum of 10% of each major biome by 2000. By 2000, over 13,250,000 km^2 of land was protected in 30,000 parks. That is an area roughly the combined size of India and China (IUCN 2008). Four years later, the Convention of Biological Diversity (CBD) made a goal of effectively conserving 10% of each of the world's ecoregions (CBD 2004), as measured by park coverage (CBD 2006) by 2010. Consequently, the number of parks has continued to rise. There are now over 100,000 parks around the world, covering more 12% of Earth's landmass (20 million km^2) (Chape et al. 2005).

A park is officially defined as, "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means" (IUCN 1994; p. 7). They are an essential in-situ conservation strategy in the preservation of biodiversity around the world (CBD 1992). By preserving intact landscapes, parks can protect endangered species, improve water quality, and provide livelihoods and food for local people. Creating an effective network of

parks, some think, may still be the best hope for protecting natural ecosystems and species around the world (Chape et al. 2005). Within park boundaries the threats from land clearing, logging, hunting, fire and grazing of domestic animals is lessened (Bruner, A. G., et al. 2001). Since habitat loss leads to species extinction in biologically diverse ecosystems (Brooks et al. 2002), parks will continue to be important for conservation, and may even serve as a good indicator of conservation efforts (Chape et al. 2005).

However, not all parks are managed for the same conservation objectives, nor are they all free from threats. The IUCN has developed six management categories that define the range of park management objectives, from strict wilderness preservation, to sustainable extraction of natural resources (such as timber). The recent addition of the last two categories indicate a shift in strategy to parks that are more inclusive of human natural resource use. This is worrying to some conservation scientists because humans are the source of many threats to parks (Locke and Dearden 2005). The most pervasive of these threats are: poaching of animals, the removal of non-timber forest products, invasive species, tourism, logging and encroachment (Ervin 2003). More threats come from human-set fires and grazing of domestic animals (Bruner, A. G., et al. 2001). The most effective way to protect forest resources has been found to be regular monitoring and sanctions (Gibson, Williams, and Ostrom 2005). However, park management activities are often constrained by insufficient management of capital, along with institutional and capacity problems (Hockings 2003). Furthermore, limited staff often lack equipment for protection and transportation, training, education, and research capacity to monitor the natural resources they are protecting.

Continued fragmentation of the natural landscape caused by human population growth and unsustainable land-use practices makes effective management of existing parks crucial. In

the last decade, conservation organizations have been developing and applying both site-level and global park monitoring and evaluation programs. In 2004, the CBD's 7th Conference of the Parties (COP-7) declared that "All protected areas to have effective management in existence by 2012" (Decision VII/28, Goal 1.4). In 2006 the COP called for "management … evaluations of at least 30 per cent of each Party's protected areas by 2010 and of national protected area systems and, as appropriate, ecological networks" (COP-8; Goal 4.2.2.) (CBD 2008). ME evaluation is the "assessment of how well parks are being managed – primarily the extent to which management is protecting values and achieving goals and objectives" (CBD 2008). There are many reasons to do ME evaluations, including improving adaptive management systems and project planning, and creating accountability (Hockings, M. et al. 2000). ME assessments "can [also] identify broad trends in management strengths and weaknesses; indicate areas of high biological and social importance; and reveal the scope, severity, prevalence, and distribution of an array of threats and pressures… . [They enable] policy makers to refine their conservation strategies, reallocate budget expenditures, and develop strategic, system-wide responses to the most pervasive threats and management weaknesses" (Ervin 2003; p 833).

In the last ten years, ME evaluations have become a common tool used by conservation organizations. Regional evaluations include the World Wildlife Fund's (WWF) CATIE method for parks in Latin America and The Nature Conservancy's (TNC) PROARCA/CAPAS system used in Central America (CBD 2008). A tool for worldwide assessment is the Rapid Assessment and Prioritization of Protected Area Management (RAPPAM) tool, created by WWF-International. It focuses on country-level management of protected area systems (Ervin 2003). Another tool, used and developed by TNC, is called the Conservation Action Planning (CAP) toolkit. It includes methods for planning, implementing and monitoring conservation projects

(CBD 2008). Finally, the research presented in this paper is provided by the Management Effectiveness Tracking Tool (METT), a site-level assessment developed by WWF and the World Bank.

1.1 The Management Effectiveness Tracking Tool

In April 1998 the World Bank/WWF Alliance for Forest Conservation and Sustainable Use set a goal to secure 50 million hectares of threatened forested parks under effective management by 2005. In cooperation with the IUCN-WCPA the METT was created to measure their progress toward this goal. After five years of revision, the METT became available for widespread use in 2003. It is now a mandatory monitoring tool for biodiversity and park projects within WWF, the World Bank, and the Global Environment Facility (GEF) (Dudley et al. 2007). Additionally, it has been adopted by government agencies in countries such as China and Japan (Leverington 2008). This makes the METT the "largest multi-national repeat survey of [park management] using a single methodology" (Dudley et al. 2007).

The METT is designed to increase the understanding of the strengths and weaknesses of parks and how they are changing over time. It does this through a survey based around the IUCN-WCPA's Framework for Assessing Park Management. Each question measures a characteristic of one of the following elements: context, planning, inputs, process, outputs, and outcomes (Table 1). These six elements represent the necessary stages of an effective management cycle and therefore, an effectively managed park. Questions measuring the design aspects of ME are split into Context; referring to the park's existing conditions and threats, and Planning, concerning the park's in place legal and policy framework, the physical design of the park, and planning process. The appropriateness, or adequacy, of the management system is

measured by questions about Inputs of available and well allocated resources and the appropriateness of the management Process. How well park objectives are met is asked in terms of "outputs" of expected products and services produced by effective parks, and "outcomes" of achieved conservation objectives (UNEP-CBD 2008).

The METT is split into two sections. First, the Data Sheet records background information such as park location, ownership (public v. private), funding, staffing, objectives and threats. Second, the Assessment Form contains a quick, scorecard style survey with 33 questions (including 3 extra points questions). Completing the full Assessment Form gives the park a final ME score from zero to 100 (See Appendix A for a sample METT form). In the standard application of the survey, each question is weighted

Table 1. IUCN-WCPA's Framework for assessing park management.

	Design		**Appropriateness / Adequacy**		**Delivery**	
Element	**Context**	**Planning**	**Inputs**	**Process**	**Outputs**	**Outcomes**
Evaluation focus	Importance, threats and policy/cultural environment	Design and planning	Adequacy of resources needed to manage	How management is conducted	Implementation of management programmes and actions	Extent to which objectives have been achieved
Criteria that are assessed	- Values	- Protected area legislation and policy	- Resources available for management	- Suitability of management processes	- Results of management actions	- Effects of management in relation to objectives
	- Threats	- Protected area or system				

equally, however evaluators are given the option of changing the way each question is weighted to match the individual park's environment. These questions are meant to be completed every two to three years, by a group composed of the project manager, the park manager, and representatives from local stakeholders (Leverington 2008).

Since its inception, the METT has been used in wide-scale surveys in 2003/2004 and 2005/2006. While no research using the METT has reached peer-reviewed publication, some work has been presented in published reports, and a large global study is now underway. A study by WWF-International and UNEP-WCMC of the 2006 data, revealed a number of interesting trends just using the ME score. However, it was noted in that report that the methodology employed by the METT might be more useful for monitoring site-level changes over time versus as a global measure. This could have been a response to the challenge of understanding what the ME score really means. Since the score is created by responses to 33 questions measuring correlated variables, finding system-wide trends can be difficult. While in some ways challenging to interpret, the widespread use of the METT and its standardized format provide a unique opportunity to understand the current status of parks around the world. This paper presents research using multivariate analysis to create a framework for making this possible.

1.2 Objective

The purpose of the research presented here, is to provide a multivariate framework of ME that enables a systematic evaluation of park management. To do this, Principal Components and Factor Analysis was used to simplify the relationships between variables measured in the METT Assessment Form into a few common factors. The factors were then verified qualitatively and

quantitatively against variation in park ME across geographical regions, IUCN categories and primary threat types. Both the factors and the original variables were then incorporated into linear models with ME score to make sure that the variables could predict the factors. Once validated and tested, these factors could be used to select indicator variables for a larger model that could define relationships between ME and factors such as: governance, funding, human population density and infrastructure.

2. Methods

2.1 Data Sources

Data for this study is from WWF-International's July 2007 database of METT evaluations. All parks that completed assessment forms after 2000, with ME scores above zero, were included in this analysis. If the park was surveyed for multiple years, only the most recent data was used. Given that individual managers are allowed to subjectively weight questions to produce the ME score, all scores were recalculated with each variable weighted equally. The remaining dataset included 526 parks from 57 countries. The countries with the highest representation were: India (10), Ethiopia (13), Indonesia (15), Italy (14), Argentina (19), China (35), Brazil (40), Kenya (43), Russian Federation (47), and Tanzania (141).

Each ME question is answered along a categorical four point score from 0 to 3. For this analysis, these answers were treated as continuous variables by assuming that higher scores represented proportional increases in positive response to the question. Next, a simple data matrix was created from *m* assessment questions (variables) measured over *n* parks (samples). Lastly, all statistical tests were performed using R software (R Core Development Team 2001).

For regional comparisons, parks were separated into the following four regions used by WWF: Latin America and the Caribbean, Africa and Madagascar, Asia and the Pacific, and Europe and the Middle East.

To compare between IUCN categories, each park in the METT with was linked with the corresponding park entry in the on-line World Database of Protected Areas (WDPA), run by the UNEP-WCMC. IUCN category assignments were then taken from the WDPA (WDPA 2/15/2008). For simplicity, parks in category Ia, strict nature reserve/wilderness protection area managed mainly for science or wilderness protection, and Ib, protected area managed mainly for wilderness protection, were grouped into category I. The following list includes all six management categories: Strict Nature Reserves or Wilderness Areas (I), managed mainly for science or wilderness protection; National Parks (II), managed for ecosystem protection and recreation; Natural Monuments (III), for conservation of specific natural features; Habitat and Species Management Areas (IV), for conservation through management intervention; Protected Landscapes or Seascapes (V), for landscape/seascape protection and recreation; and Managed Resource Protected Areas (VI), for the sustainable use of natural ecosystems (IUCN 2008).

Threat types use for this project were taken from the reported primary threats in the METT Data Sheet. Each reported threat was grouped into the following 10 broad threat types:

1. Habitat Conversion: housing, industrial development, farms, plantations, ski areas, dams
2. Transportation/energy Infrastructure: utility lines, roads, railroads, wind farms
3. Abiotic Resource Use: mining, oil & gas drilling, geothermal energy, water withdrawal
4. Consumptive Biological Resource Use: hunting, non-timber forest products collection, grazing, logging
5. Non-consumptive Biological Resource Use: ATVs/snowmobiles, hiking/biking, scientific research, military maneuvers
6. Pollution: acid rain, solid waste, toxins, radio active fallout

7. Invasive Species (alien and native): plants, animals, disease & pathogens
8. Modification of natural processes/ ecological drivers/ disturbance regimes: climate change, loss of key predators, grazing patterns, fire regime, fragmentation
9. Other
10. No Reported Threat

2.2 Principal Components Analysis

Principal components analysis (PCA) is a technique frequently used in ecology to summarize or represent the total variance in complex multivariate data by a small number of components. Variance is the least squared error from a linear component. PCA is a statistical technique that creates components that can be used to recreate the entire original dataset. Each component is also produced in such a way that it is independent from all other components. In this way PCA generates independent measures from a number of dependent variables. PCA is considered a viable option with sample sizes larger than 100. Normality is not a large concern with a sufficiently large sample size, as the technique is fairly robust.

Visually, PCA can be understood by picturing a cloud of *n* points in a space of *m* dimensions. For this data, that is 526 points (parks) viewable in 33 dimensions (variables), measured on 33 axes (components). PCA transforms the cloud of points onto a new coordinate system so that the internal variability in the data is captured in the fewest linear components. The principal component is simply the linear coordinate that can be drawn through the greatest number of correlated variables, therefore capturing the greatest amount of variance between points. The second component explains the second greatest amount of variance, independent of the variance captured from the first component. PCA always produces *m* components, but if multiple variables are correlated within the data, then related variables will be captured on the

first few components. If all variables are independent, then each component will represent the variance from just one variable.

2.3 Factor Analysis

Factor analysis (FA) is most frequently used in the social sciences to capture hard to measure values such as intelligence or personality type. It allows underlying common factors (or latent variables) to be drawn from a dataset of measurable proximate variables that are sufficiently correlated to the common factors. The overall purpose of FA is to study relationship patterns within a group of dependent variables, so that the nature of the independent variables that impact them can be discovered, without actually measuring the independent variables themselves (Darlington 2008). It is similar to PCA because it identifies relationships among dependent variables, however, FA captures the covariance instead of the total variance measured by PCA. It assumes that the variance of each variable is made of two parts: the variance shared with other variables (commonality), and variance that is unique to that variable (specificity). So, successful factors capture the greatest commonality between multiple variables.

Mathematically, FA unfolds in two steps. The first step is similar (or the same depending on the software package) to the analysis done in PCA. This step produces principal components, called factors. The second step is rotation of the factors to a simpler structure. There are two common forms of rotation, orthogonal or oblique. Orthogonal rotation maintains independent factors by keeping the axes perpendicular to each other when rotated. Oblique rotation allows the angle to change between axes as they rotate, which often improves the output, but makes representation of the results more difficult. Varimax (orthogonal) rotation was chosen for this research, because it maximizes the variance of loadings within the factors, across variables.

Oblique rotation was also tried for thoroughness. The goal of rotation, to reach a simple structure, produces common factors that, ideally, capture the total covariance of only few variables. With perfect data, each variable would also load onto only one factor.

FA produces a matrix of standardized coefficients called a residual correlation matrix. A standardized coefficient, or factor loading, is the proportion of a variable's total variance that is represented by a factor. Any factor loading larger than +/- 0.40 was considered significant for the purpose of this analysis (Darlington 2008), although possible relationships still exist with factor loadings below that significance level. FA also calculates the proportion of each variable that is explained by all factors, or "common". The remaining proportion that is "specific" to that variable is calculated by subtracting the common proportion from 1. Analyzing both outputs helps the researcher choose the optimum number of factors to use. FA is only successful if the factors make sense and can be logically identified based on the variables with the highest loadings. The number of factors chosen is also a balance between a small number of factors providing the simplest solution, or more factors improving the fit to the data.

2.4 Verifying Factors: Region, IUCN, and Threats

To check the validity of the factors, factor scores were used to explain variation in ME scores between parks in different geographic regions, different IUCN categories, and facing different threats. Factor scores are calculated by multiplying the survey response for each variable (0-3) by the corresponding factor loading on each factor, and then averaged across all parks. The test was done in three steps: (1) parks were divided into their category, (2) factor scores were calculated for each variable on all six factors, and then (3) scores were averaged on each factor. The end product was a factor score for each factor, for each category. A high factor

score indicates that parks scored highly on that variable, while a low score means responses were typically low.

2.5 Linear Regression

The main premise of FA is that latent variables (factors) can be extracted from measurable variables, only if they are proximate variables and sufficiently correlated with the latent variables. To verify the correlation between factors and variables, (1) the six factors chosen need to be able to significantly predict ME score, and (2) the variables themselves need to be significantly able to predict ME score. A standard linear model was used to regress ME on the six factors. Then another standard linear model and one stepwise regression was used for regression of ME on all 33 METT variables. If the variables are not significantly correlated to the factors, then they are not good predictors of the chosen factors.

3. Results

3.1 Finding the Commonalities

PCA returned one principal component that captured 36% of the total variance among all ME variables (Figure 1). The secondary component accounted for only 6% of the variance. The third and fourth component captured only 5% of the variance each. The fifth captured 4%, and the remaining five only explained 3%. This supported the assumption that correlation existed between ME variables. FA was then used to identify which variables were correlated, and to provide information about variables correlated with multiple components.

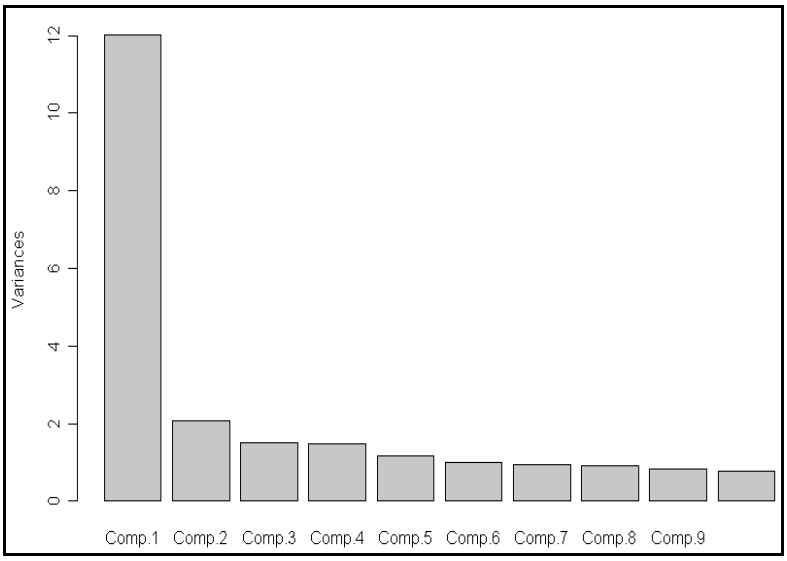

Figure 1: PCA Scree plot results of ME

FA was run with three to seven factors, however, six was the most appropriate number for this analysis. The residual correlation matrix created from the Varimax rotation of six factors is presented in Table 2. Oblique rotation did improve simple structure, but did not change the results enough to make it worth using in this analysis. Table 2 also includes the commonalities and specificities for each variable. Factors were named by using the residual correlation matrix to assign each variable to the factor that explained the largest proportion of that variable's variance (measured as a factor loading). Once each variable with a significant loading was assigned, the factor was named based on best personal judgment.

Ten variables loaded significantly (>0.40) on the first factor, accounting for 13% of the covariance. The first group of significant variables on this factor related to the ability of staff to enforce the boundaries of the park: access assessment, park regulations, law enforcement, and boundary demarcation. The second group of variables represented questions referring to the adequacy of the staff: staff number, management and training. Additional variables related to these two groups, monitoring and evaluation, relations with state and commercial neighbors, and park objectives. With the exception of one of boundary demarcation and state and commercial

neighbors, none of the variables in these groups had high commonality or specificity. This indicates that most of these variables have weak correlations with the other factors. The common theme among these variables gives this factor its name, Personnel Capacity. Some less significant relations to personnel capacity might be condition assessment, education and awareness, resource management, and work plan.

Four variables loaded significantly on the second factor, which represented 10% of the commonality among variables. The theme of this factor was Tourism, because of the following significant variables: visitor facilities, commercial tourism, the availability of fees collected from tourism, along with a weak association with research capacity. A large portion of total variance of both visitor facilities and commercial tourism was common to all factors. Legal status and economic assessments also appear related to the tourism theme, though neither have loadings above 0.40. Weaker relations to tourism might also exist with education and awareness, equipment, budget security, and management planning.

Factor three captures 8% of the covariance with six variables with loadings between 0.43 and 0.57. This factor represents the involvement of local and indigenous communities in park management, and presence of an effective management plan that incorporates those communities. For this reason, this factor is called Local Community. Education and awareness, work plan and resource inventory also related to this factor, though less significantly.

Resource inventory, resource management and work plan loaded significantly on factor four, which captured 7% of the data's covariance. As a result, this factor was termed Resource Inventory. The only other variables that are probably related to Resource Inventory are condition assessment, monitoring and evaluation, research, management plan and park objectives.

Factor five accounts for as much covariance as factor four (7%), but has two variables with very significant loadings. The loadings of equipment maintenance and equipment quantity are over 0.70, with budget management trailing behind with a loading just under 0.5. A high proportion of the variance of Equipment amount and maintenance are captured by the factors. As a result of these large loadings the theme of this factor is Equipment. It is notable here that budget maintenance appears to share more in common with equipment purchases and maintenance than with the final factor, budget amount and security.

The last factor, named Budget, only accounted for 4.0% of the covariance in the data and the two variables that loaded significantly on this factor were budget amount and budget security. Budget amount was very significantly captured by all six factors, which can be attributed to it's almost significant loading on both Tourism and Equipment factors. A significant proportion of budget security is also common to all of the factors.

Table 2. FA residual correlation matrix with commonality/specificity for all METT variables.

Q#	Question	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Common	Specific
1	Legal Status		0.38		0.18			0.19	0.81
2	Park Regulations	0.60*			0.27	0.13		0.45	0.55
3	Law Enforcement	0.52*	0.15	0.21	0.23	0.19		0.44	0.56
4	Park Objectives	0.55*		0.19	0.32			0.46	0.54
5	Park Design	0.19		0.13	0.31	0.12		0.17	0.83
6	Boundary Demarcation	0.45*	0.13		0.26			0.30	0.71
7	Management Plan	0.18	0.30	0.46*	0.31	0.21	0.21	0.52	0.48
7a	Management Plan Extra	0.17	0.36	0.53*	0.11	0.15	0.19	0.51	0.49
8	Work Plan	0.34	0.19	0.33	0.46*	0.31	0.25	0.63	0.38
9	Resource Inventory	0.17	0.30	0.36	0.56*	0.15		0.60	0.40
10	Research	0.17	0.41*	0.28	0.33	0.33	0.10	0.50	0.50
11	Resource Management	0.39	0.26	0.28	0.53*			0.58	0.42
12	Staff Number	0.60*	0.26			0.14	0.24	0.51	0.49
13	Personnel Management	0.65*	0.15	0.18		0.13	0.16	0.52	0.48
14	Staff Training	0.54*	0.17	0.19		0.26		0.43	0.57
15	Budget Amount	0.15	0.33	0.22	0.22	0.31	0.70*	0.81	0.19
16	Budget Security	0.16	0.37	0.15	0.29	0.31	0.55*	0.66	0.34
17	Budget Management	0.29	0.18	0.26	0.14	0.49*	0.27	0.51	0.49
18	Equipment	0.29	0.35	0.15	0.19	0.71*	0.16	0.79	0.21
19	Equipment Maintenance	0.29	0.17	0.25	0.23	0.71*	0.19	0.77	0.23
20	Education & Awareness	0.39	0.35	0.39	0.14	0.28		0.53	0.47
21	State & Commercial Neighbors	0.47*	0.19	0.19	0.24	0.17		0.38	0.62
22	Indigenous People		0.13	0.47*	0.12			0.26	0.74
23	Local Community	0.24		0.57*				0.38	0.62
23a	Local Community Extra	0.22	0.36	0.55*	0.11			0.50	0.50
24	Visitor Facilities	0.21	0.71*	0.18	0.19	0.28	0.17	0.72	0.28
25	Commercial Tourism	0.18	0.69*	0.24	0.17	0.18		0.64	0.36
26	Fees Collected	0.25	0.64*	0.20	0.12	0.16	0.21	0.59	0.41
27	Condition Assessment	0.34		0.16	0.33	0.15		0.28	0.72
27a	Restoration Extra	0.12	0.12	0.43*	0.11	0.18		0.26	0.74
28	Access Assessment	0.65*	0.25		0.24			0.55	0.45
29	Economic Assessment	0.24	0.39	0.18	-0.11			0.25	0.75
30	Monitoring & Evaluation	0.44*	0.22	0.24	0.32	0.22	0.13	0.47	0.53
	Proportion Variance	**0.13**	**0.10**	**0.08**	**0.07**	**0.07**	**0.04**		

Notes: Commonalities are the proportion of total variance of each variable that is captured by all 6 factors, specificities are the proportion of variance not captured by the factors. Factor 1, Personnel Capacity; Factor 2, Tourism; Factor 3, Local Community; Factor 4, Resource Inventory; Factor 5, Equipment; Factor 6, Budget. Proportion variance is total for factor.
* Significant loading > 0.40

3.2 Validating the Factors

3.2.1 Geographical Region

Figure 2 illustrates the distribution of ME scores by the four geographical regions set by WWF. Parks in the Asia-Pacific region and in the Europe & the Middle East region had higher average ME scores than parks in either Africa and Madagascar, or Latin America and the Caribbean. To see if the factors helped explain the reason for this variation, the average factor score was aggregated for parks in each region (Table 3).

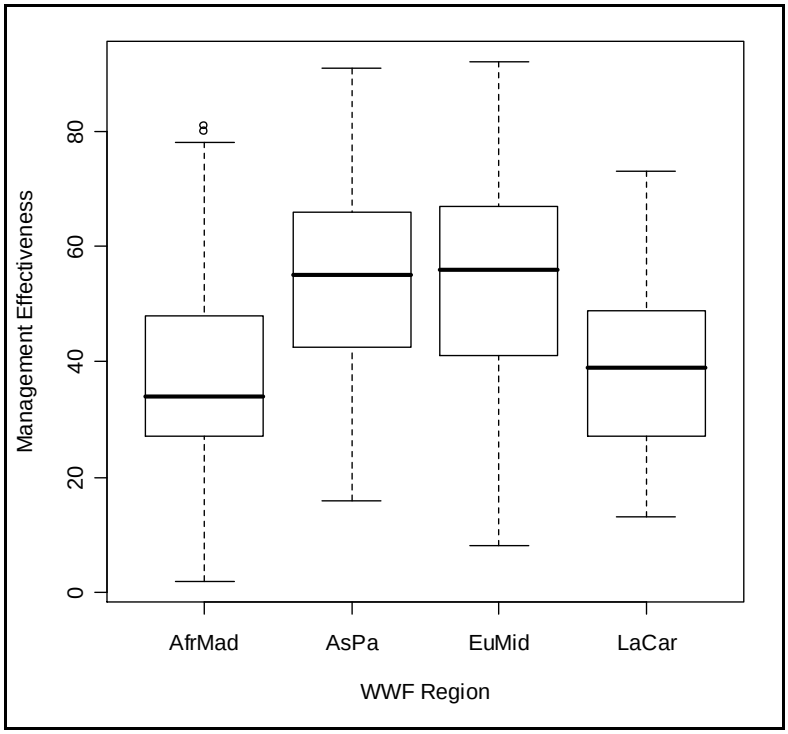

Figure 2. Ajusted ME scores distributed by WWF Region. AfrMad, Africa and Madagascar; AsPa, Asia-Pacific, EuMid, Europe and the Middle East; LaCar, Latin America and the Caribbean.

When the six factors are compared by regions, the relative status of each region in the Figure 2 is repeated in the factor scores (Table 3). Africa/Madagascar and Latin America/Caribbean scores are almost universally lower than the other two categories. High

scores are found for European and Middle Eastern parks in both Resource Inventory and Equipment. Parks in Asia and the Pacific have a high score for Local Community, indicating more community involvement in management systems than in other regions. Latin American and Caribbean parks have a very low score on Personnel Capacity, meaning they might be lacking in staff training or management. Alternatively, African and Malagasy parks did not have strong scores on any of the factors, though they scored lowest on Resource Inventory and Equipment. Figure 3 provides a graphical representation of regional differences in all regions for Personnel Capacity in and Local Community. African/Malagasy and European/Middle Eastern parks score approximately the same for these factors, while Asia-Pacific parks are much higher on Local Community, and Latin American/Caribbean parks are much lower on Personnel Capacity. See Appendix B for additional graphs.

Table 3. Verifying factors across geographic region.

Region	Sample Size	Personnel Capacity	Tourism	Local Community	Resource Inventory	Equipment	Budget
Africa & Madagascar	248	0.14	-0.12	-0.14	-0.38	-0.33	-0.21
Asia-Pacific	108	-0.02	0.24	0.51	0.28	0.12	0.31
Europe & Middle East	97	0.23	0.23	-0.17	0.46	0.49	0.14
Latin America & Caribbean	73	-0.746	-0.26	-0.05	0.28	0.27	0.07

Note: The mean factor scores are presented in this table, aggregated across the four geographical regions identified by WWF.

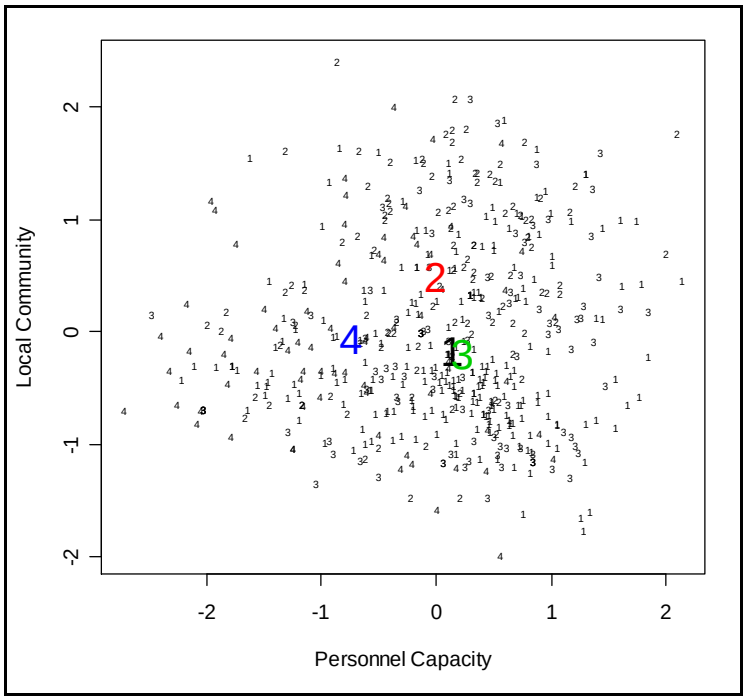

Figure 3: Factor scores averaged by region plotted on Personnel Capacity and Local Community factors. Each point represents the score of an individual park. Average scores by region are represented by large colored numbers. Africa & Madagascar, 1; Asia-Pacific, 2; Europe & Middle East, 3; Latin America & Caribbean, 4.

3.2.2 IUCN Categories

The box plots in Figure 4 illustrates the distribution of ME scores among parks in different IUCN categories. Average ME for parks in categories I, II and IV were significantly higher than in the other three categories. Average ME scores for uncategorized parks were significantly lower than those officially designated by the IUCN. There are not enough Natural Monuments (Category III) in the dataset to make any claims about their ME scores.

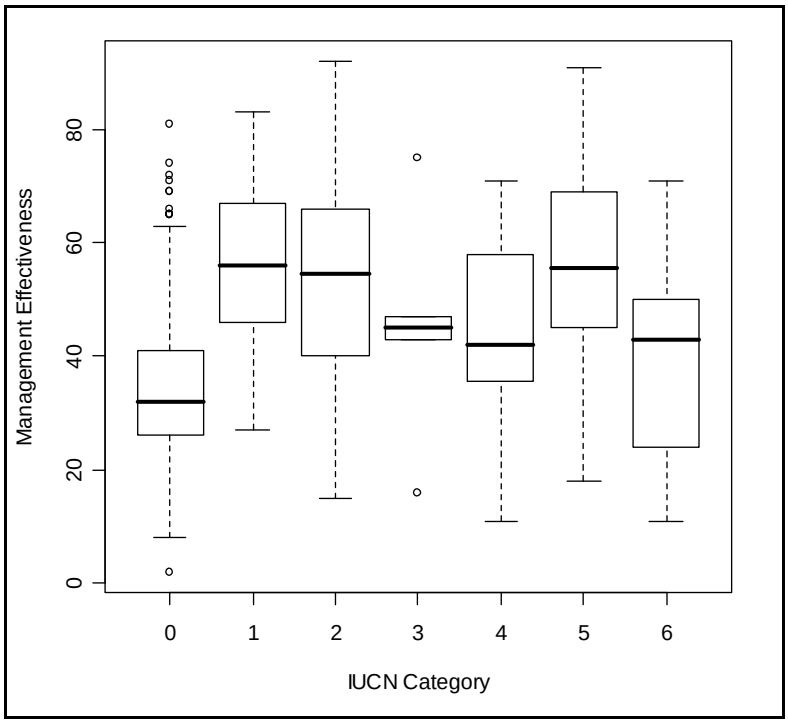

Figure 4: Box plots of adjusted ME scores for parks in different IUCN categories. Undesignated, 0; Nature Reserves, 1; National Park, 2; Natural Monument, 3; Habitat/Species Management Areas, 4; Protected Landscape/Seascapes, 5; Managed Resource Reserves, 6.

Table 4: Verifying Factors across IUCN Categories.

IUCN Category	Park Type	Sample Size	Personnel Capacity	Tourism	Local Community	Resource Inventory	Equipment	Budget
Unset	Undesignated	230	0.04	-0.21	-0.19	-0.41	-0.36	-0.32
I	Nature Reserve	56	0.39	0.02	-0.11	0.57	0.56	0.34
II	National Park	122	-0.15	0.52	0.27	0.13	0.28	0.30
III	Natural Monuments	5**	-0.10	-0.64	0.21	0.38	0.48	0.15
IV	Habitat/Species Management Areas	40	0.05	-0.20	-0.09	0.25	0.03	0.37
V	Protected Landscape/Seascapes	38	0.22	0.00	0.46	0.57	0.32	0.16
VI	Managed Resource Reserves	34	-0.67	-0.13	0.10	0.34	0.04	-0.14

Note: The mean factor scores are presented in this table, aggregated across the six IUCN management categories.
** Note small sample size.

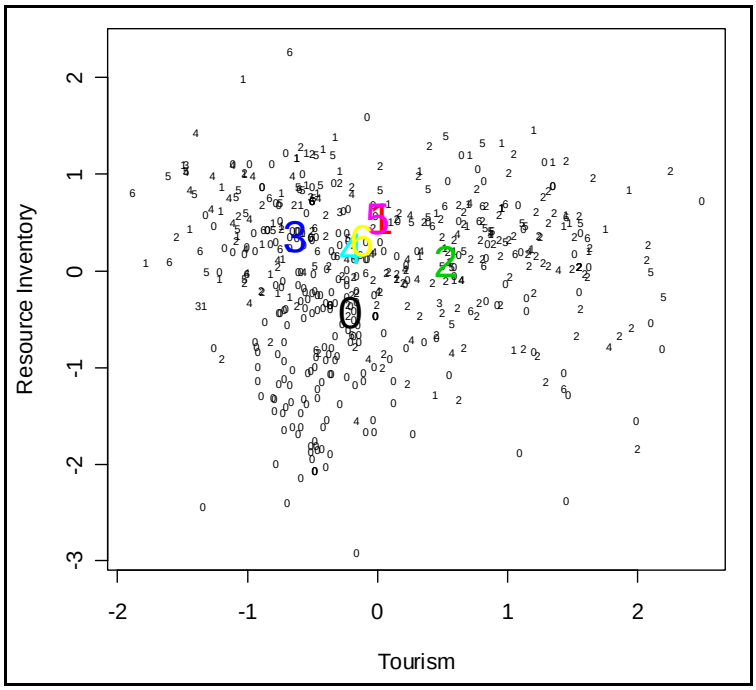

Figure 5. ME factor scores averaged by IUCN category plotted on Tourism and Resource Inventory factors. Each point represents the aggregated score for an individual park. Average scores by IUCN cat. are represented by large colored numbers. Undesignated, 0; Nature Reserves, 1; National Park, 2; Natural Monument, 3; Habitat/Species Management Areas, 4; Protected Landscape/Seascapes, 5; Managed Resource Reserves, 6.

To understand the underlying reasons behind the differences seen in Figure 4, parks in different management categories were compared by mean factor scores on all six factors (Table 3). Undesignated parks had negative scores on all factors except for a very weak positive score on Personnel Capacity, which fits with the low average ME score in Figure 4. In contrast, category I parks had scores above 0.50 for the Resource Inventory and Equipment factors and only one slightly negative score for Local Community. Parks in Categories I, II and V had scores across all factors that were higher than the other categories, the same pattern seen with the box plots. Parks in category II, National Parks, had their highest factor scores in Tourism, and only a weakly negative score for Personnel Capacity. Category IV parks reported highest responses for Budget and Equipment, while Category V scored highly on Resource Inventory and Personnel Capacity. Parks in Category VI scored very badly on Personnel Capacity, and had it's highest score for Equipment. Figure 5 provides an graphical example of these results for all

IUCN categories and their scores on both Tourism and Resource Inventory. In this graphic Category II sticks out on the Tourism factor, and undesignated parks are clearly lacking in Resource Inventory. See Appendix C for additional graphs.

3.2.3 Primary Threat

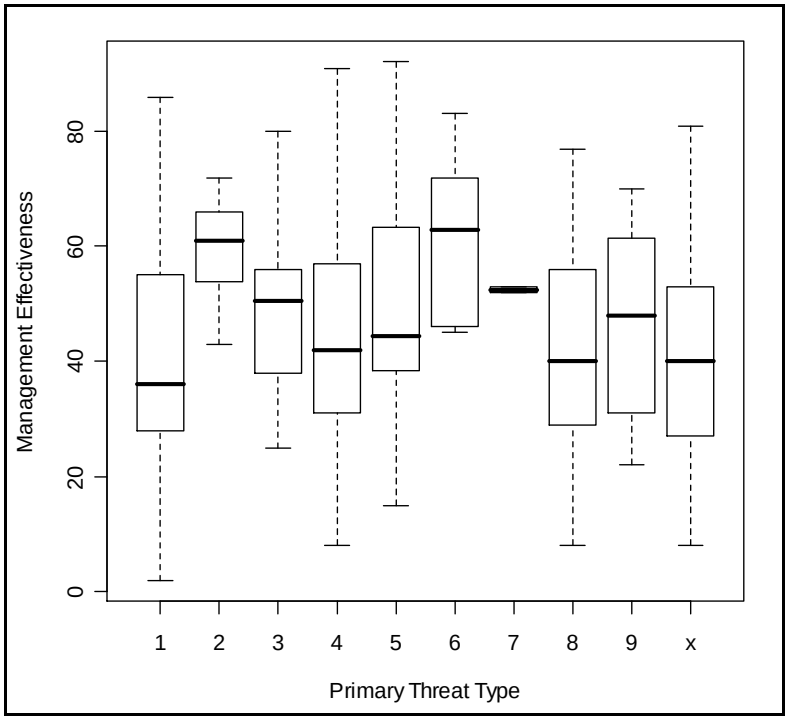

Figure 6. Box plots of adjusted ME scores for parks with different major threat types. Habitat Conversion, 1; Transportation and Energy, 2; Abiotic Resource Use, 3; Consumptive Biological Resource Use, 5; Pollution, 6; Invasive Species, 7; Disturbance, 8; Other, 9; No Threat, X.

ME scores parks under different primary threats is shown in Figure 6. Parks with pollution and transportation/energy problems have higher average ME scores. However, under other threats, differences in average ME scores do not appear as significant.

To further validate the factors, management trends in parks facing different primary threats was broken down by all six factors (Table 6). According to these results, parks with the

strongest personnel capacity, faced the largest problems from transportation and energy infrastructure. Parks with stronger tourism infrastructure were more likely to face threats from pollution, invasive species and transportation and energy infrastructure. They were less likely to face problems from disturbance threats. Parks threatened by transportation and energy infrastructure had higher factor scores for Personnel Capacity and Local Community. The parks with a main threats from abiotic resource use and non-consumptive biological resource use scored highly on the resource inventory factor. Those threatened by pollution scored very highly on the tourism (See Figure 7) and equipment factors. Parks who faced threats other than the possible survey options had significant scores on the budget factor. Once again, Figure 7 gives an example of some of these differences with a scatter plot of averaged factor scores by threat type plotted on tourism and local community axes. See Appendix D for additional graphs.

Table 5. Verifying Factors across primary threat type.

Primary Threat	Sample Size	Personnel Capacity	Tourism	Local Community	Resource Inventory	Equipment	Budget
No Threat	118	-0.14	-0.21	-0.03	0.07	0.03	0.22
Habitat Conversion	93	0.08	-0.03	-0.29	-0.12	-0.02	0.06
Transportation & Energy	7**	0.71	0.45	1.08	0.04	0.16	-0.22
Abiotic Resource Use	20	0.30	0.31	0.45	0.54	-0.10	0.00
Consumptive Biological Use	190	0.21	-0.30	-0.28	0.23	0.19	0.09
Non-consumptive Biological Use	8**	-0.08	0.31	0.06	0.57	-0.05	-0.21
Pollution	6**	0.25	1.50	-0.13	0.16	0.79	-0.34
Invasive Species	2**	0.33	1.38	0.66	-0.22	-0.16	-0.16
Disturbance	62	0.36	-0.41	-0.30	0.00	-0.07	-0.12
Other	20	0.20	-0.26	0.07	0.18	0.27	-0.67

Note: The mean factor scores are presented in this table, aggregated across ten threat types, as reported in the METT Data Sheet of each park.
** Note small sample size.

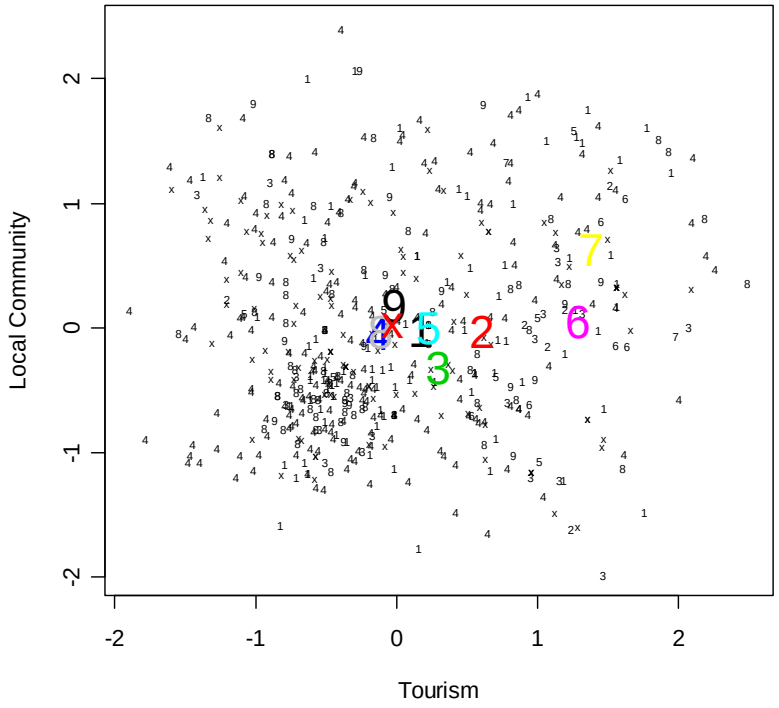

Figure 7. ME factor scores averaged by Threat Type, plotted on Tourism and Local Community factors. Each point represents the aggregate score of an individual park. Average scores by threat type are represented by large colored numbers. Habitat Conversion, 1; Transportation and Energy, 2; Abiotic Resource Use, 3; Consumptive Biological Resource Use, 5; Pollution, 6; Invasive Species, 7; Disturbance, 8; Other, 9; No Threat, X.

3.3 Predicting ME

Linear regression was used to test the ability of the six factors (Table 8) and all 33 METT variables (Table 9) to predict ME score. The first model regressed ME on the factors and invoked only Personnel Capacity (90% CI) and Local Community (95% CI) as significantly correlated to ME. When ME was regressed on all 33 variables, only three variables, Park Regulation and Park Objective and Output Extra, were significant to the 95% CI. Work Plan, Local Community, and Process Extra were also significant, though only to the 90% confidence level. To achieve a better result for the last model, a single stepwise regression was performed on the variables (Table 7). This third model returned a few more variables. Work Plan was completely correlated with ME, while Law Enforcement, Park Objectives, and the extra question

on Restoration were all significant to the 95% CI. Less significant were correlations with Resource Inventory, Local Community and Local Community extra points (for community involvement in the management plan). However, the R^2 for all models was very low, so none of the models could be called successful.

Table 6. Regression of Adjusted ME on the six factors.

Coefficients:	Estimate	Std. Error	t value	Significance
(Intercept)	43.7833	0.7580	57.765	***
Personnel Capacity	1.9183	0.8575	2.237	*
Tourism	-0.3927	0.8867	-0.443	
Local Community	0.1884	0.9378	0.201	
Resource Inventory	-2.9198	0.9468	-3.084	**
Equipment	-1.1910	0.8802	-1.353	
Budget	-0.8291	0.9185	-0.903	
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05				
Residual standard error:		17.38 on 519 degrees of freedom		
Multiple R-Squared: 0.0321		Adjusted R-squared: 0.02091		
F-statistic: 2.869 on 6 and 519 DF		p-value: 0.009295		

Table 7. Single stepwise regression of adjusted ME on all METT variables.

Coefficients:	Estimate	Std. Error	t value	Significance
(Intercept)	39.9353	2.9998	13.312	***
Park Regulations	1.5421	0.9418	1.638	
Law Enforcement	3.7835	1.2061	3.137	**
Park Objectives	-2.9804	1.1495	-2.593	**
Management Plan	1.6111	0.9463	1.703	.
Work Plan	-3.2657	0.9520	-3.430	***
Resource Inventory	-2.3114	1.0531	-2.195	*
Local Community	2.2129	1.0195	2.171	*
Local Community Extra	2.5278	1.2418	2.036	*
Restoration Extra	-5.2367	1.9167	-2.732	**
Access Assesment	2.1015	1.0920	1.924	.
Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05				
Residual standard error:		17.38 on 519 degrees of freedom		
Multiple R-Squared: 0.0321		Adjusted R-squared: 0.02091		
F-statistic: 2.869 on 6 and 519 DF		p-value: 0.009295		

4. Discussion

4.1 Finding the Pattern

The METT Assessment Form is composed of questions designed to measure the characteristics of an effectively managed park. However, using these questions to evaluate ME is complicated by the fact that the questions measure correlated, and potentially dependent, variables. Therefore, the first task of this project was to find the common factors that explain the relationships between the 33 variables with PCA and FA. First, PCA returned one component that explained the total variance of 12 out of 33 variables. This supported the assumption that many of the METT variables were correlated, by indicating that one component connected most of the related variables within the METT. However, PCA couldn't identify the variables in that component or any smaller components. PCA is also limited, because it cannot provide information on the pattern of relationships among all variables. For these reasons, FA was used to pull out factors that explained shared variance between all variables. The selection of appropriate factors was done by analyzing how each variable loaded on the residual correlation matrix and making sure that each factor seemed to make sense.

Conceivably, four to six factors could have been chosen from the METT variables. However, the following six factors seemed the most appropriate: personnel capacity, tourism, local community involvement, resource inventory, equipment and budget. It would make sense if effective management was a combination of personnel/staff capacity, the presence of tourists that pay fees and encourage research, good involvement of the local community in the management and planning processes, the research of what natural resources exist in the park, good equipment and maintenance, and a large and secure budget. These factors, or latent variables, accounted for nearly half of the total variance in the data.

4.2 Verifying the Factors

The six factors need to be verified in two steps before they are used in a model to help evaluate strengths and weaknesses in ME. First, a successful factor should be able to logically explain variation in average ME scores of parks in different categories. In this case, the categories used were geographical region, IUCN category and primary threat type. Many of the trends between parks and factors seen in these comparisons warrant future study, but this is not the focus of the research presented here. The second step verifies the link between the factors, or latent variables, and the 33 METT variables, the proximate variables. The assumption of FA is that the factors represent latent variables measured by the proximate variables that predict them. Therefore, the goal of this step is to use linear regression to make sure the two are significantly correlated.

When looking at parks across the different regions (Table 4), some interesting trends supported the factor's ability to explain ME trends. Parks in Africa and Madagascar, which had the lowest average ME score, had the lowest total factor score for all factors. Overall, African/Malagasy parks had the lowest scores on questions regarding Resource Inventory and Equipment. Asia-Pacific had very high tourism, local community, and scored the highest of all regions on budget. While staff numbers were highest in this Without knowing more about the Asian park system it is difficult to check the validity of these trends. Latin American and the Caribbean parks reported very low scores on the personnel capacity factor. This is supported by the conclusion from the study of the METT 2006 data, where Latin America had the lowest staff number of all regions (Dudley et al., 2007). That study also found that also in Latin America/ Caribbean had the lowest budget per park. The response was low on the Budget factor, but not

negative, indicating that the dynamics surrounding budget might be a little complicated. Parks in Europe and the Middle East had higher factor scores on both Resource Inventory and Equipment factors. Dudley et al. (2007) found that parks in Europe and the Middle East have the highest budget per hectare than in any other region. Knowing this, it's not clear why these parks do not score higher on budget, though this might be a result of different perceptions of an adequate budget by managers in higher-income countries.

Comparing the factors across parks in different IUCN categories (Table 5) also proves to be very interesting. The factor score support that ME scores in National Parks are significantly explained by the presence of tourism. It also makes sense that in Nature Reserves, which are managed mostly for science, good resource inventory and equipment account for a significant proportion of the ME scores. The very low Personnel Capacity score for resource reserves also makes sense, because these are often parks like forest reserves with few staff. Finally, undesignated parks, which have lower average ME scores (Figure 4), do not have high scores on any factor. This supports the conclusion that undesignated parks might not be managed as well as parks with an IUCN designation. While these observations do not prove anything, they add more support the idea that these six factors could be successful at explaining ME.

Further support of the factors comes from comparing the factor scores between parks affected by different threats (Table 6). The most interesting outcomes here come from parks threatened by pollution, transportation and energy, and invasive species, which all have high factor scores on the Tourism factor. Though the sample sizes are not large enough to make any real conclusions, the data supports the hypothesis that parks with more tourism will have greater problems from pollution, invasive species, and transportation and energy development. As with

comparisons with regions and IUCN categories, this justifies the factors that were chosen, and verifies their ability to explain underlying causes of variation in ME score.

The factor's ability to logically explain ME trends is only half the picture. It is also necessary to make sure that the variables can predict the factors. However, in the linear regression model used to regress adjusted ME on all six factors, only personnel capacity and Resource Inventory were significant (Table 8). Only those two factors are able to significantly predict how well parks are managed. The ability of Resource Inventory to predict ME is also supported by regression of the variables themselves, where the variables for Work Plan and Resource Inventory were significant (Table 9). Also significant among the variables were three variables that loaded onto the factor for Personnel Capacity, and three variables that were significant on the Local Community factor. However, the Local Community factor was not significant when regressed by ME score. These results indicate that the variables used in creating the ME score are not sufficient to predict the six common factors.

4.3 Implications

According to the CBD, ME is defined by the following three themes: site and system level park design issues, adequate and appropriate management systems and processes, and the achievement of park objectives (CBD 2008; Hockings, M. et al. 2000). The UNEP-WCMC's Framework for Assessing ME of Protected Areas (the "Framework"), used these three themes to identify six elements, context, planning, inputs, process, outputs and outcomes, necessary for ME. Consequently, the METT's Assessment Form is made of questions designed to measure criteria that represent these elements. However, the six common themes between correlated variables in the METT are: Personnel Capacity, Tourism, Local Community, Resource

Inventory, Equipment, and Budget. The disconnect between the elements and factors could be due to a number of reasons discussed below.

The first potential reason for this difference, is that the elements do not represent latent variables that underlie effective management. Since the elements are designed to capture the management cycle, the difference between the elements and the factors might be that the factors capture common themes that run through all parts of the cycle. So, while the elements are the stages of the cycle, there are different variables that represent factors necessary for each stage of the cycle. This says that, while the elements define necessary components of ME, they might not define common predictable themes that allow that cycle to work. If this is the case, then a specific set of other factors could be agreed upon so that the METT questions can be tailored to measure proximate variables that assess these factors. The factors may or may not be the same as the ones found through the research in this paper.

This leads into the second possibility, that the questions in the METT's Assessment Form are not effectively measuring the elements that define ME in a way that the regression's can capture. If the questions did measure the elements, then the factors determined by FA would be the same as the elements and they would all be associated with the same variables. Table 8 shows that this is not the case. A possible reason for this is that the survey might have either too many or too few questions for FA to return the elements desired. The survey could be effectively measuring ME, but there could be too many ways for a park to get similar ME scores, which means other relationships could be missed by the regressions because of a diffusion of points. Alternatively, the questions might be right, but there might not be enough of them to achieve full measurement of each element or factor. If the number of questions is sufficient, the questions themselves may need to be redesigned so that they accurately measure the agreed upon

factors. Once the definition of ME is confirmed, and appropriate latent variables are chosen, the survey should go through an iterative process of question selection. This would involve piloting potential questions and then performing FA on the answers. Any questions with associated

Table 8: Comparing distribution of variables between WCMC Management Elements and Factors.

#	Question	WCMC Management Element	Factor #
2	Park Regulations	Context	1
3	Law Enforcement		
6	Boundary Demarcation		
1	Legal Status		2
9	Resource Inventory		4
4	Park Objectives	Planning	1
7	Management Plan		3
7a	Management Plan Extra		
5	Park Design		4
8	Work Plan	Planning/ Outputs	
30	Monitoring & Evaluation	Planning/Process	1
12	Staff Number	Inputs	
10	Research		2
15	Budget Amount		6
16	Budget Security		
14	Staff Training	Inputs/Process	1
13	Personnel Management	Process	
21	State & Comm. Neighbors		
20	Education & Awareness		1,3
25	Commercial Tourism		2
22	Indigenous People		3
23	Local Community		
11	Resource Management		4
17	Budget Management		5
18	Equipment		
19	Equipment Maintenance		
24	Visitor Facilities	Outputs	2
26	Fees Collected		
23a	Local Community Extra		3
27a	Restoration Extra		
27	Condition Assessment	Outcomes	1
28	Access Assessment		
29	Economic Assessment		2

Notes: The Factor names are as follows: Personnel Capacity, 1; Tourism, 2; Local Community, 3; Resource Inventory, 4; Equipment, 5; Budget, 6.

variables that did not load well onto one of the chosen factors would be dropped, and then the process would repeat. By going through this process, each question of the final survey would pertain directly to the measurement of one ME factor. This would allow the survey to be used to model trends in ME worldwide and more accurately and systematically identify strengths and weaknesses of park management.

The last reason for the differences between elements and factors could be that predicting ME with a model is not possible. It is conceivable that, even if correctly measured, ME is simply not predictable on a global scale. However, the possibility of modeling ME should not be ruled out until further research is done.

4.4 Next Step

This research suggests that further study will be necessary to explore the pathways that lead to ME before conclusions can be drawn from the information in the METT. The six factors generated from FA could be used to pick independent predictor variables to begin a structural model of ME. Structural Equation Modeling (SEM) is a statistical method used to confirm a structure between latent variables by measuring causation between measurable indicator variables. SEM measures latent variables in terms of a number of indicator variables, found with factor analysis, and then links latent variables using path analysis. The end goal of this technique would be to find a model that represents the process of effective park management. Multiple models can be posed, and SEM can be used to select the most appropriate model for the data (M. Byrne, 2006). With SEM, it would be possible to model the processes that impacted ME and to either confirm or reject the use of the six factors presented here, improving the current understanding and definition of ME.

Creating a SEM has the potential to answer some of the following questions regarding ME of parks worldwide: (1) what are the unobservable/latent variables that predict the covariance in ME? (2) What are the intermediate variables that cause ME to change and how do those variables tie into ME? (3) How does the macro environment affect management and what is the link between measures such as governance, country wealth, population pressure and the ability of a park to attain it's conservation goals? SEM makes tying ME into the micro, intermediate and macro environments more conceivable. Creating such a model will provide greater understanding of ME, so that in the future, conservation strategies can be applied in the most effective way to preserve the Earth's natural resources.

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Appendix A: Sample METT Form

Data Sheet

Name of protected area		
Location of protected area (country and if possible map reference)		
Date of establishment (distinguish between agreed and gazetted*)	Agreed	Gazetted
Ownership details (i.e. owner, tenure rights etc)		
Management Authority		
Size of protected area (ha)		
Number of staff	Permanent	Temporary
Budget		
Designations (IUCN category, World Heritage, Ramsar etc)		
Reasons for designation		
Brief details of World Bank funded project or projects in park		
Brief details of WWF funded project or projects in park		
Brief details of other relevant projects in park		
List the two primary protected area objectives		
Objective 1		
Objective 2		
List the top two most important threats to the park (and indicate reasons why these were chosen)		
Threat 1		
Threat 2		
List top two critical management activities		
Activity 1		
Activity 2		

Date assessment carried out:

_____Name/s of assessor:

Management Assessment Form

Issue	Criteria	Score	Comments	Next steps
1. Legal status Does the protected area have legal status? *Context*	The protected area is not gazetted	0	*Note*: see fourth option for private reserves	
	The government has agreed that the protected area should be gazetted but the process has not yet begun	1		
	The protected area is in the process of being gazetted but the process is still incomplete	2		
	The protected area has been legally gazetted (or in the case of private reserves is owned by a trust or similar)	3		
2. Protected area regulations Are inappropriate land uses and activities (e.g. poaching) controlled? *Context*	There are no mechanisms for controlling inappropriate land use and activities in the protected area	0		
	Mechanisms for controlling inappropriate land use and activities in the protected area exist but there are major problems in implementing them effectively	1		
	Mechanisms for controlling inappropriate land use and activities in the protected area exist but there are some problems in effectively implementing them	2		
	Mechanisms for controlling inappropriate land use and activities in the protected area exist and are being effectively implemented	3		
3. Law enforcement Can staff enforce protected area rules well enough? *Context*	The staff have no effective capacity/resources to enforce protected area legislation and regulations	0	*Possible issue for comment*: What happens if people are arrested?	
	There are major deficiencies in staff capacity/resources to enforce protected area legislation and regulations (e.g. lack of skills, no patrol budget)	1		
	The staff have acceptable capacity/resources to enforce protected area legislation and regulations but some deficiencies remain	2		
	The staff have excellent capacity/resources to enforce protected area legislation and regulations	3		
4. Protected area objectives Have objectives been agreed? *Planning*	No firm objectives have been agreed for the protected area	0		
	The protected area has agreed objectives, but is not managed according to these objectives	1		
	The protected area has agreed objectives, but these are only partially implemented	2		
	The protected area has agreed objectives and is managed to meet these objectives	3		
5. Protected area design Does the protected area need enlarging, corridors etc to meet its objectives? *Planning*	Inadequacies in design mean achieving the protected areas major management objectives of the protected area is impossible	0	*Possible issue for comment*: does the protected area contain different management zones and are they well maintained?	
	Inadequacies in design mean that achievement of major objectives are constrained to some extent	1		
	Design is not significantly constraining achievement of major objectives, but could be improved	2		
	Reserve design features are particularly aiding achievement of major objectives of the protected area	3		
6. Protected area boundary demarcation Is the boundary known and demarcated?	The boundary of the protected area is not known by the management authority or local residents/neighbouring land users	0	*Possible issue for comment*: are there tenure disagreements affecting the	
	The boundary of the protected area is known by the management authority but is not known by local residents/neighbouring land users	1		

Issue	Criteria	Score	Comments	Next steps
Context	The boundary of the protected area is known by both the management authority and local residents but is not appropriately demarcated	2	protected area?	
	The boundary of the protected area is known by the management authority and local residents and is appropriately demarcated	3		
7. Management plan Is there a management plan and is it being implemented? *Planning*	There is no management plan for the protected area	0		
	A management plan is being prepared or has been prepared but is not being implemented	1		
	An approved management plan exists but it is only being partially implemented because of funding constraints or other problems	2		
	An approved management plan exists and is being implemented	3		
Additional points *Planning*	The planning process allows adequate opportunity for key stakeholders to influence the management plan	+1		
	There is an established schedule and process for periodic review and updating of the management plan	+1		
	The results of monitoring, research and evaluation are routinely incorporated into planning	+1		
8. Regular work plan Is there an annual work plan? *Planning/Outputs*	No regular work plan exists	0		
	A regular work plan exists but activities are not monitored against the plan's targets	1		
	A regular work plan exists and actions are monitored against the plan's targets, but many activities are not completed	2		
	A regular work plan exists, actions are monitored against the plan's targets and most or all prescribed activities are completed	3		
9. Resource inventory Do you have enough information to manage the area? *Context*	There is little or no information available on the critical habitats, species and cultural values of the protected area	0		
	Information on the critical habitats, species and cultural values of the protected area is not sufficient to support planning and decision making	1		
	Information on the critical habitats, species and cultural values of the protected area is sufficient for key areas of planning/decision making but the necessary survey work is not being maintained	2		
	Information concerning on the critical habitats, species and cultural values of the protected area is sufficient to support planning and decision making and is being maintained	3		
10. Research Is there a programme of management-orientated survey and research work? *Inputs*	There is no survey or research work taking place in the protected area	0		
	There is some *ad hoc* survey and research work	1		
	There is considerable survey and research work but it is not directed towards the needs of protected area management	2		
	There is a comprehensive, integrated programme of survey and research work, which is relevant to management needs	3		
11. Resource management Is the protected area	Requirements for active management of critical ecosystems, species and cultural values have not been assessed	0		

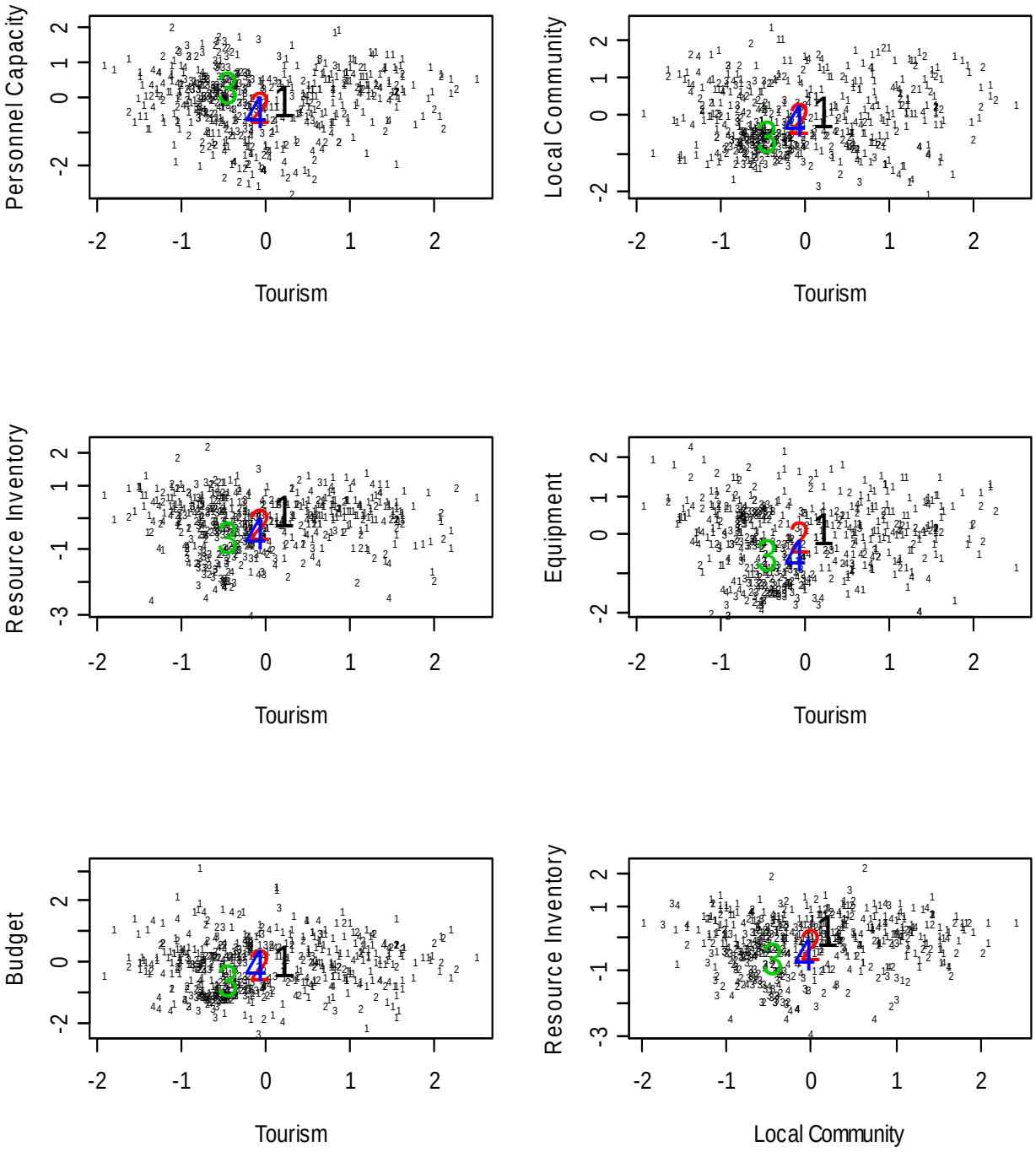
Issue	Criteria	Score	Comments	Next steps
adequately managed (e.g. for fire, invasive species, poaching)? *Process*	Requirements for active management of critical ecosystems, species and cultural values are known but are not being addressed	1		
	Requirements for active management of critical ecosystems, species and cultural values are only being partially addressed	2		
	Requirements for active management of critical ecosystems, species and cultural values are being substantially or fully addressed	3		
12. Staff numbers Are there enough people employed to manage the protected area? *Inputs*	There are no staff	0		
	Staff numbers are inadequate for critical management activities	1		
	Staff numbers are below optimum level for critical management activities	2		
	Staff numbers are adequate for the management needs of the site	3		
13. Personnel management Are the staff managed well enough? *Process*	Problems with personnel management constrain the achievement of major management objectives	0		
	Problems with personnel management partially constrain the achievement of major management objectives	1		
	Personnel management is adequate to the achievement of major management objectives but could be improved	2		
	Personnel management is excellent and aids the achievement major management objectives	3		
14. Staff training Is there enough training for staff? *Inputs/Process*	Staff are untrained	0		
	Staff training and skills are low relative to the needs of the protected area	1		
	Staff training and skills are adequate, but could be further improved to fully achieve the objectives of management	2		
	Staff training and skills are in tune with the management needs of the protected area, and with anticipated future needs	3		
15. Current budget Is the current budget sufficient? *Inputs*	There is no budget for the protected area	0		
	The available budget is inadequate for basic management needs and presents a serious constraint to the capacity to manage	1		
	The available budget is acceptable, but could be further improved to fully achieve effective management	2		
	The available budget is sufficient and meets the full management needs of the protected area	3		
16. Security of budget Is the budget secure? *Inputs*	There is no secure budget for the protected area and management is wholly reliant on outside or year by year funding	0		
	There is very little secure budget and the protected area could not function adequately without outside funding	1		
	There is a reasonably secure core budget for the protected area but many innovations and initiatives are reliant on outside funding	2		
	There is a secure budget for the protected area and its management needs on a multi-year cycle	3		
17. Management of budget: Is the budget managed to meet	Budget management is poor and significantly undermines effectiveness	0		
	Budget management is poor and constrains effectiveness	1		

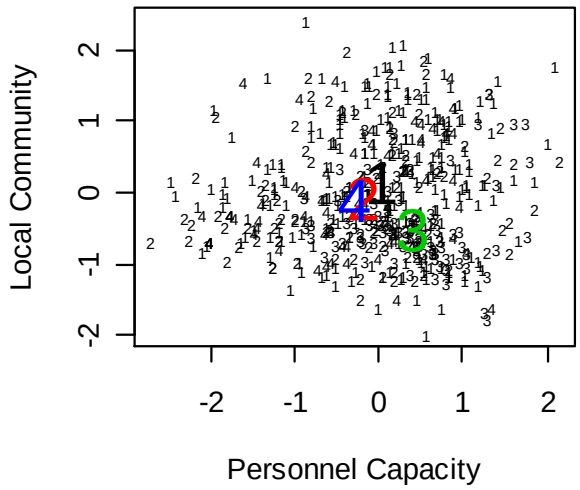
Issue	Criteria	Score	Comments	Next steps
critical management needs? *Process*	Budget management is adequate but could be improved	2		
	Budget management is excellent and aids effectiveness	3		
18. Equipment Is equipment adequately maintained? *Process*	There is little or no equipment and facilities	0		
	There is some equipment and facilities but these are wholly inadequate	1		
	There is equipment and facilities, but still some major gaps that constrain management	2		
	There is adequate equipment and facilities	3		
19. Maintenance of equipment Is equipment adequately maintained? *Process*	There is little or no maintenance of equipment and facilities	0		
	There is some *ad hoc* maintenance of equipment and facilities	1		
	There is maintenance of equipment and facilities, but there are some important gaps in maintenance	2		
	Equipment and facilities are well maintained	3		
20. Education and awareness programme Is there a planned education programme? *Process*	There is no education and awareness programme	0		
	There is a limited and *ad hoc* education and awareness programme, but no overall planning for this	1		
	There is a planned education and awareness programme but there are still serious gaps	2		
	There is a planned and effective education and awareness programme fully linked to the objectives and needs of the protected area	3		
21. State and commercial neighbours Is there co-operation with adjacent land users? *Process*	There is no contact between managers and neighbouring official or corporate land users	0		
	There is limited contact between managers and neighbouring official or corporate land users	1		
	There is regular contact between managers and neighbouring official or corporate land users, but only limited co-operation	2		
	There is regular contact between managers and neighbouring official or corporate land users, and substantial co-operation on management	3		
22. Indigenous people Do indigenous and traditional peoples resident or regularly using the park have input to management decisions? *Process*	Indigenous and traditional peoples have no input into decisions relating to the management of the protected area	0		
	Indigenous and traditional peoples have some input into discussions relating to management but no direct involvement in the resulting decisions	1		
	Indigenous and traditional peoples directly contribute to some decisions relating to management	2		
	Indigenous and traditional peoples directly participate in making decisions relating to management	3		
23. Local communities Do local communities resident or near the protected area have input to management decisions? *Process*	Local communities have no input into decisions relating to the management of the protected area	0		
	Local communities have some input into discussions relating to management but no direct involvement in the resulting decisions	1		
	Local communities directly contribute to some decisions relating to management	2		
	Local communities directly participate in making decisions relating to management	3		
Additional points	There is open communication and trust between local stakeholders and protected area managers	+1		

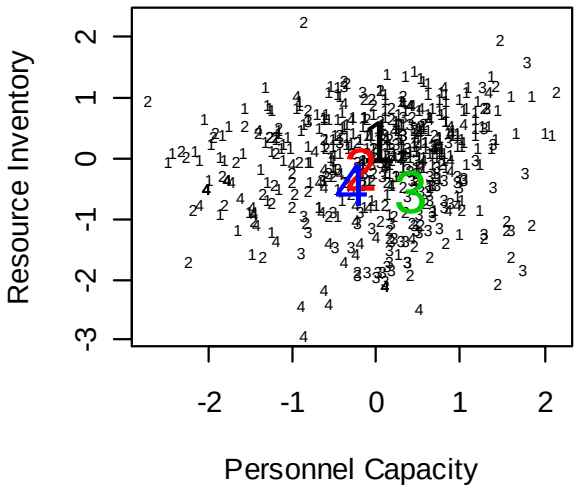
Issue	Criteria	Score	Comments	Next steps
Outputs	Programmes to enhance local community welfare, while conserving park resources, are being implemented	+1		
24. Visitor facilities Are visitor facilities (for tourists, pilgrims etc) good enough? *Outputs*	There are no visitor facilities and services	0	*Possible issue for comment*: Do visitors damage the protected area?	
	Visitor facilities and services are inappropriate for current levels of visitation or are under construction	1		
	Visitor facilities and services are adequate for current levels of visitation but could be improved	2		
	Visitor facilities and services are excellent for current levels of visitation	3		
25. Commercial tourism Do commercial tour operators contribute to protected area management? *Process*	There is little or no contact between managers and tourism operators using the protected area	0	*Possible issue for comment*: examples of contributions	
	There is contact between managers and tourism operators but this is largely confined to administrative or regulatory matters	1		
	There is limited co-operation between managers and tourism operators to enhance visitor experiences and maintain protected area values	2		
	There is excellent co-operation between managers and tourism operators to enhance visitor experiences, protect values and resolve conflicts	3		
26. Fees If fees (tourism, fines) are applied, do they help protected area management? *Outputs*	Although fees are theoretically applied, they are not collected	0		
	The fee is collected, but it goes straight to central government and is not returned to the park or its environs	1		
	The fee is collected, but is disbursed to the local authority rather than the protected area	2		
	There is a fee for visiting the protected area that helps to support this and/or other protected areas	3		
27. Condition assessment Is the protected area being managed consistent to its objectives? *Outcomes*	Important biodiversity, ecological and cultural values are being severely degraded	0	*Possible issue for comment:* It is important to provide details of the biodiversity, ecological or cultural values being affected	
	Some biodiversity, ecological and cultural values are being severely degraded	1		
	Some biodiversity, ecological and cultural values are being partially degraded but the most important values have not been significantly impacted	2		
	Biodiversity, ecological and cultural values are predominantly intact	3		
Additional points *Outputs*	There are active programmes for restoration of degraded areas within the protected area and/or the protected area buffer zone	+1		
28. Access assessment Are the available management mechanisms working to control access or use? *Outcomes*	Protection systems (patrols, permits etc) are ineffective in controlling access or use of the reserve in accordance with designated objectives	0		
	Protection systems are only partially effective in controlling access or use of the reserve in accordance with designated objectives	1		
	Protection systems are moderately effective in controlling access or use of the reserve in accordance with designated objectives	2		
	Protection systems are largely or wholly effective in controlling access or use of the reserve in accordance with designated objectives	3		

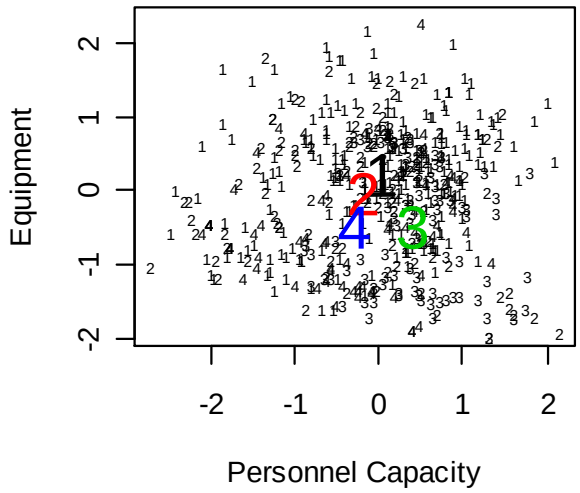
Issue	Criteria	Score	Comments	Next steps
29. Economic benefit assessment Is the protected area providing economic benefits to local communities? *Outcomes*	The existence of the protected area has reduced the options for economic development of the local communities	0	*Possible issue for comment*: how does national or regional development impact on the protected area?	
	The existence of the protected area has neither damaged nor benefited the local economy	1		
	There is some flow of economic benefits to local communities from the existence of the protected area but this is of minor significance to the regional economy	2		
	There is a significant or major flow of economic benefits to local communities from activities in and around the protected area (e.g. employment of locals, locally operated commercial tours etc)	3		
30. Monitoring and evaluation *Planning/Process*	There is no monitoring and evaluation in the protected area	0		
	There is some *ad hoc* monitoring and evaluation, but no overall strategy and/or no regular collection of results	1		
	There is an agreed and implemented monitoring and evaluation system but results are not systematically used for management	2		
	A good monitoring and evaluation system exists, is well implemented and used in adaptive management	3		
TOTAL SCORE		**X**		

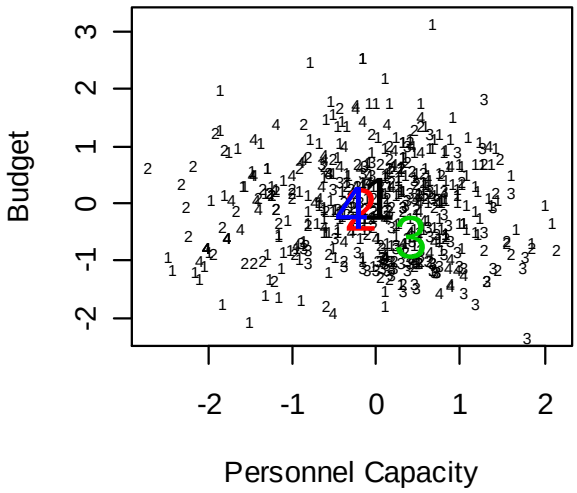
Appendix B: Aggregated Factor Scores by Region

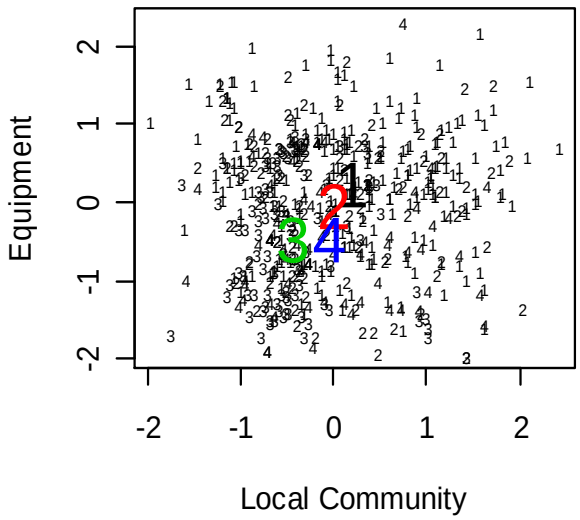


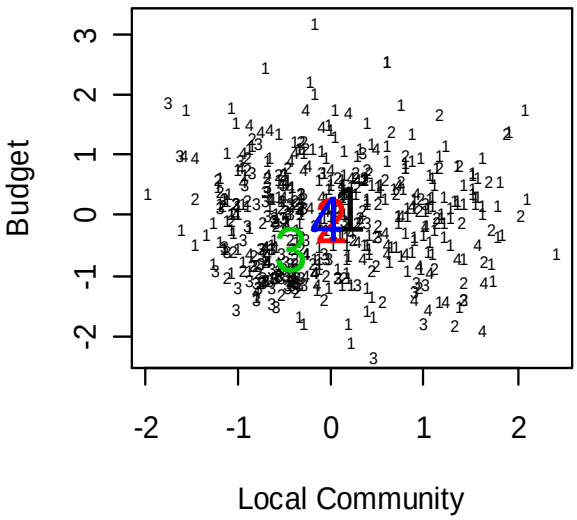

Local Community
Personnel Capacity

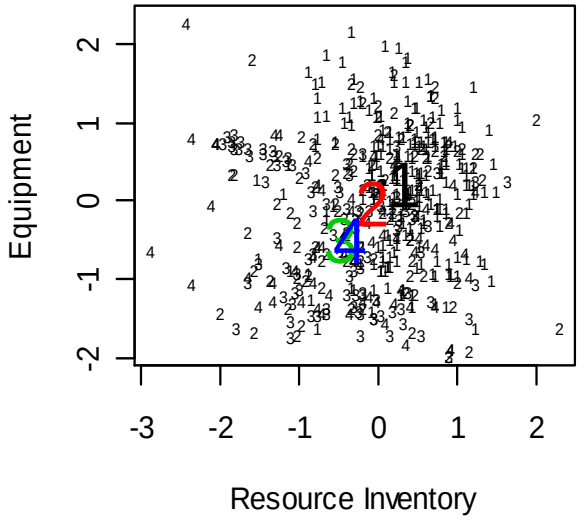

Resource Inventory
Personnel Capacity

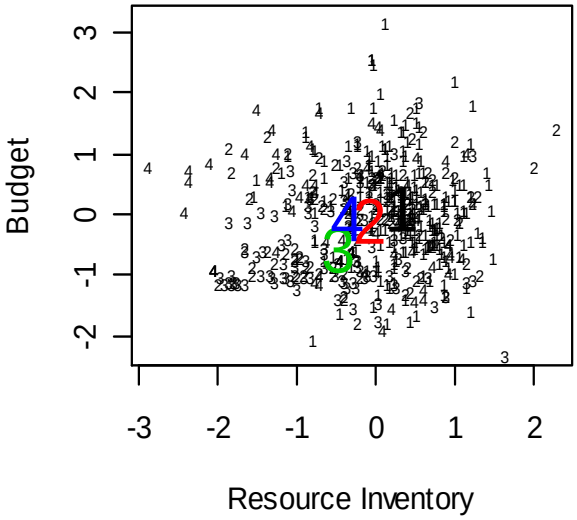

Equipment
Personnel Capacity


Budget
Personnel Capacity

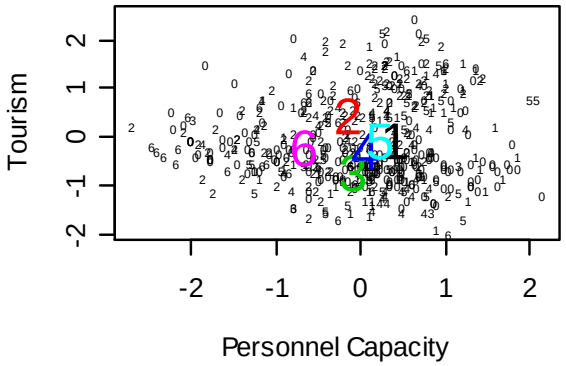

Equipment
Local Community

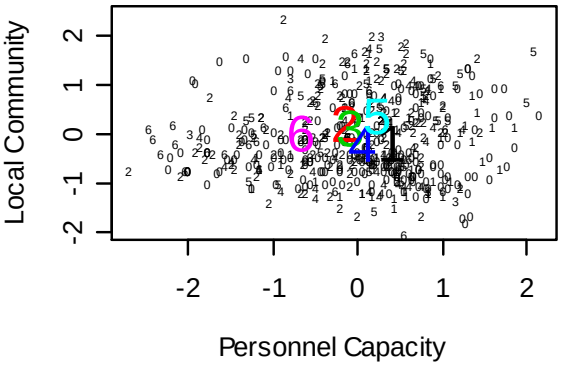

Budget
Local Community

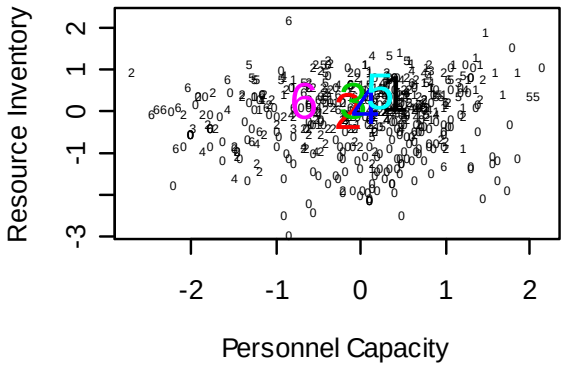

Equipment
Resource Inventory

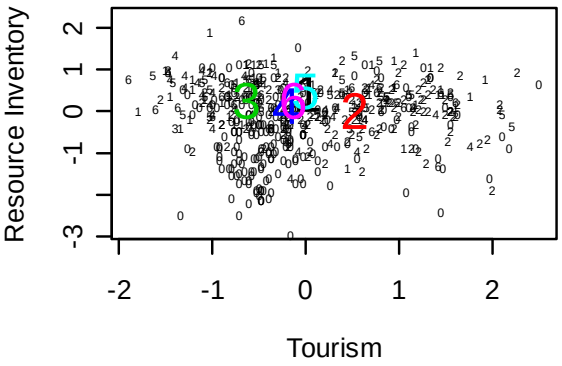

Budget
Resource Inventory

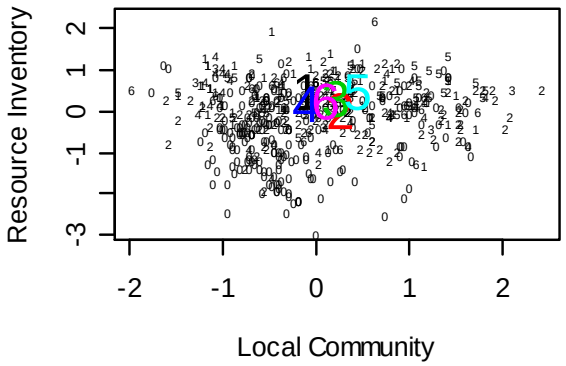
Appendix C: Aggregated Factor Scores by IUCN Category

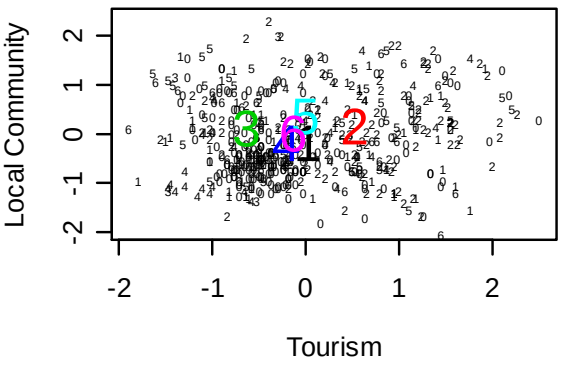


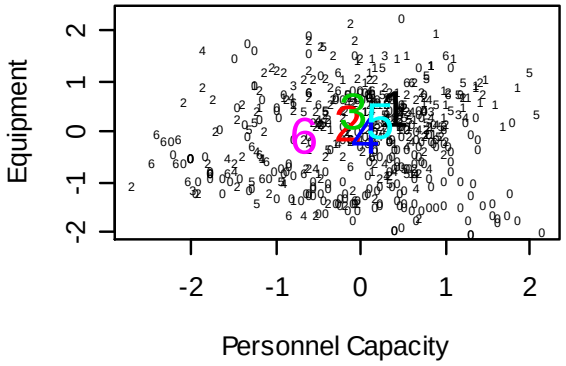


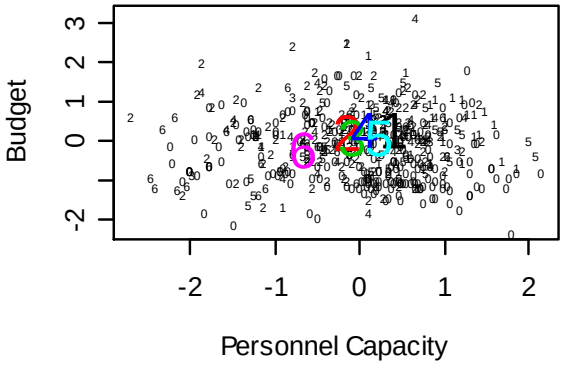


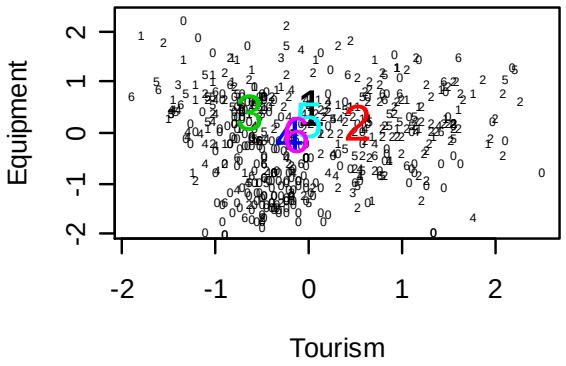


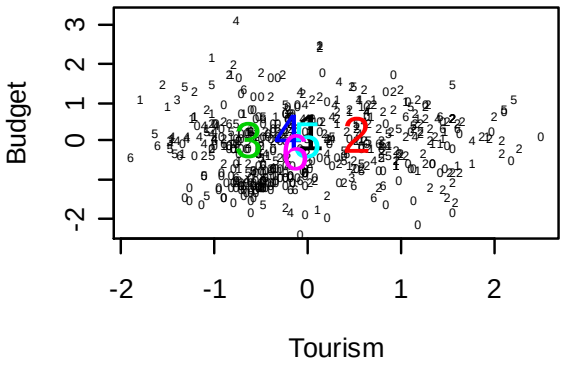


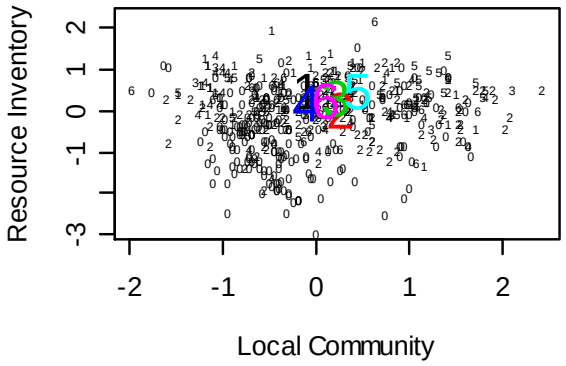


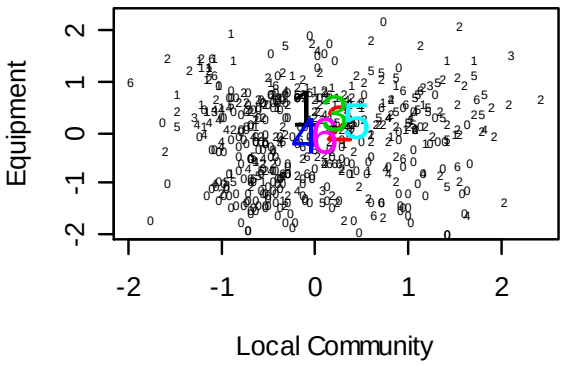

Equipment
Personnel Capacity

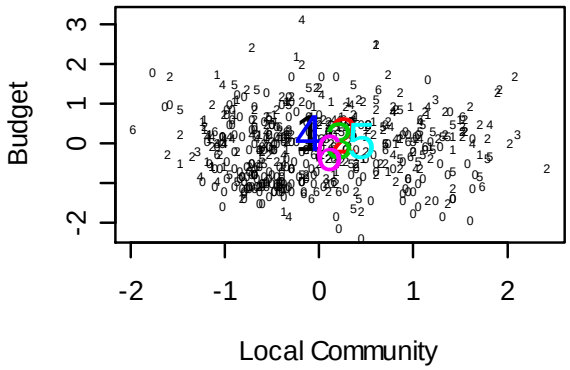

Budget
Personnel Capacity

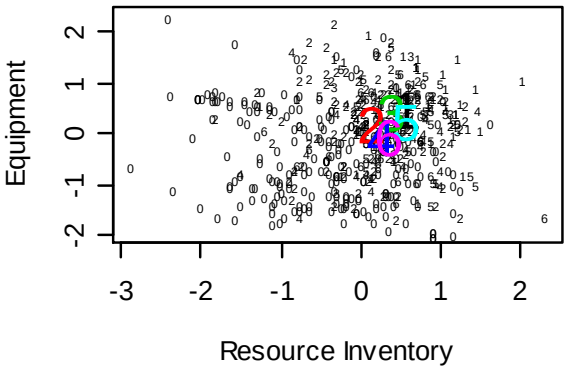

Equipment
Tourism

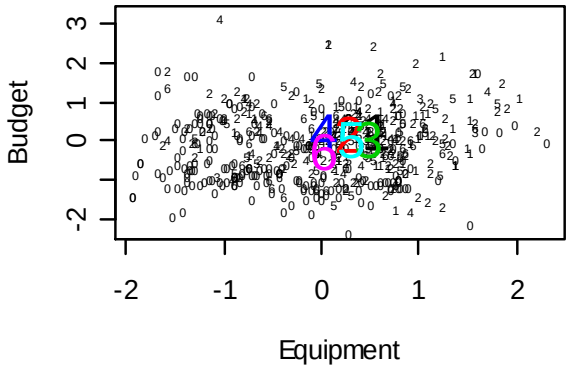

Budget
Tourism


Resource Inventory
Local Community

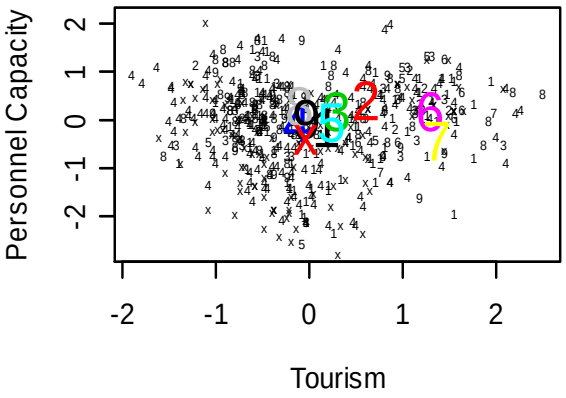

Equipment
Local Community

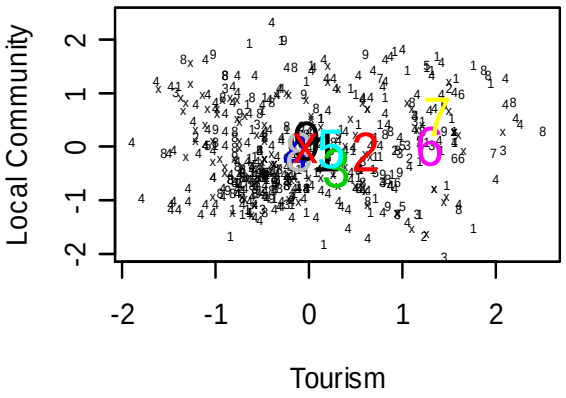

Budget
Local Community

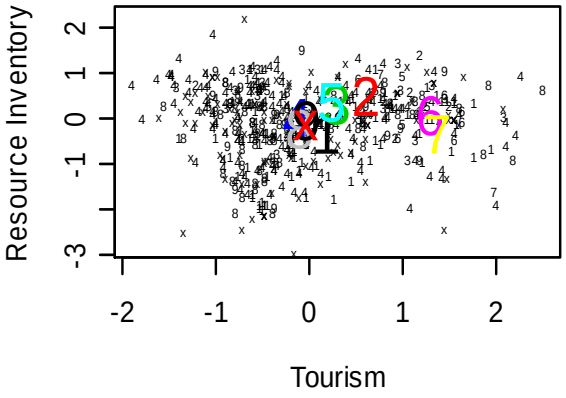

Equipment
Resource Inventory

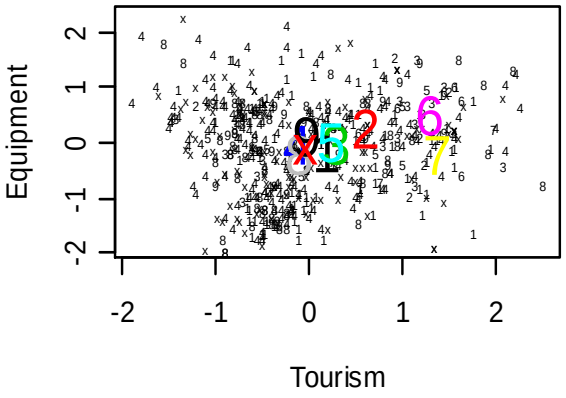

Budget
Equipment

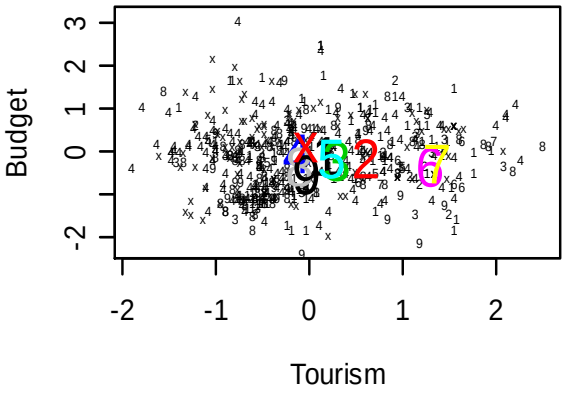
Appendix D: Aggregated Factor Scores by Threat Type

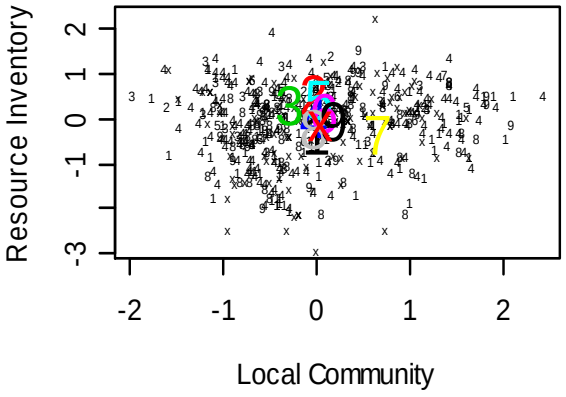


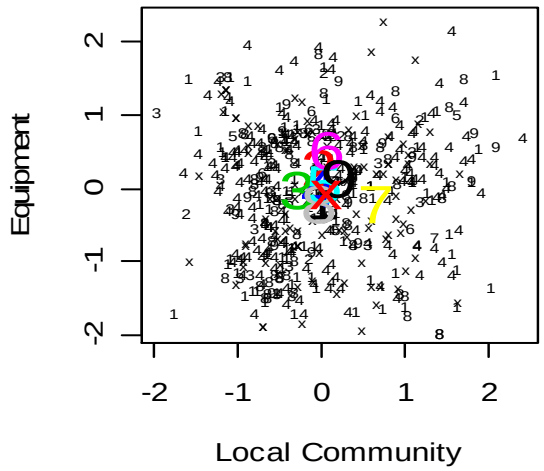


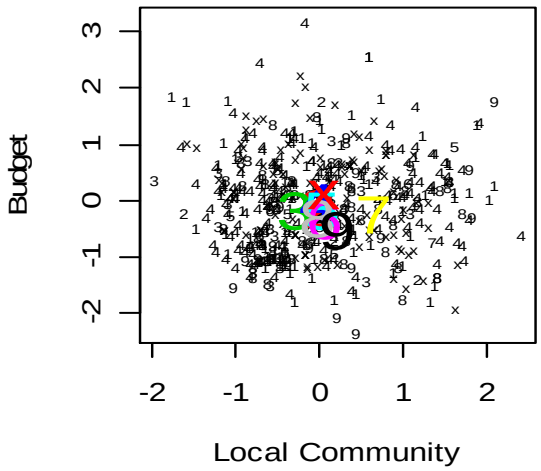


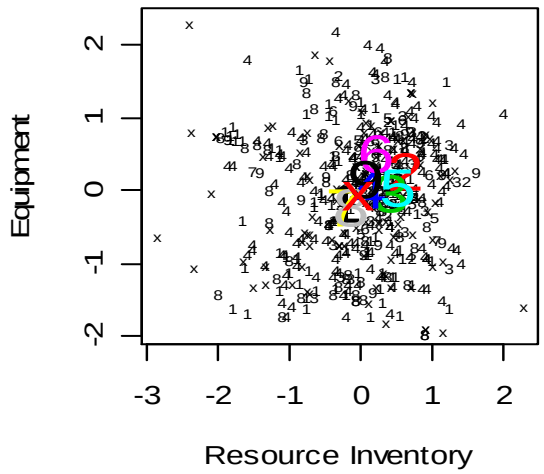


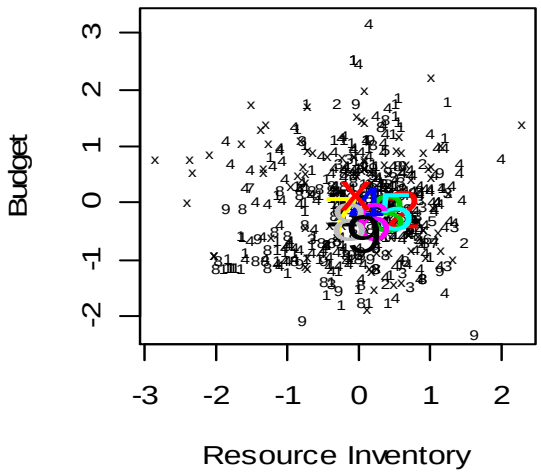


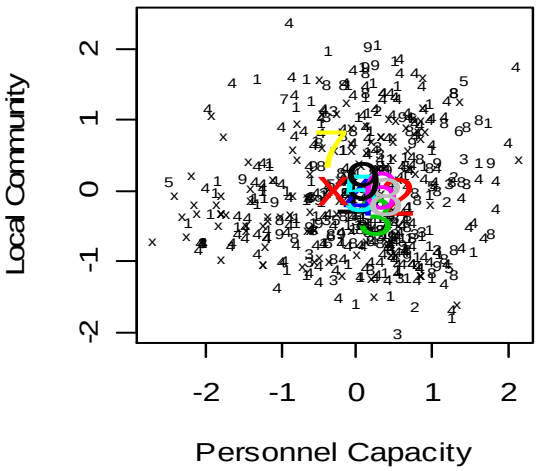


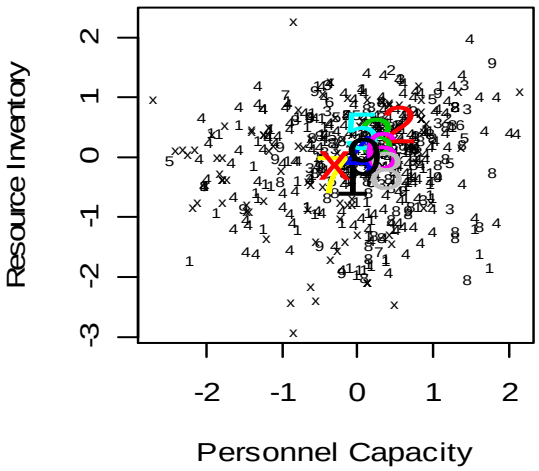

Equipment
Local Community

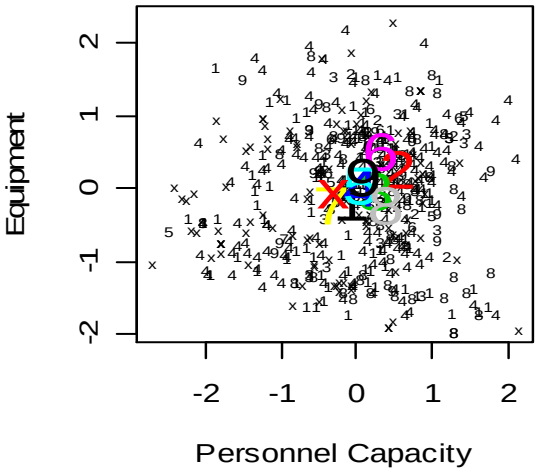

Budget
Local Community

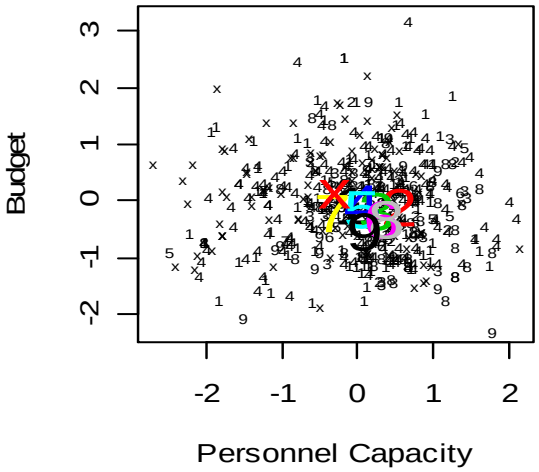

Equipment
Resource Inventory


Budget
Resource Inventory


Local Community
Personnel Capacity


Resource Inventory
Personnel Capacity


Equipment
Personnel Capacity


Budget
Personnel Capacity