Experiences of national, regional and on-site visitor inventories

Comparing Indicator Effectiveness for Monitoring Visitor Impact at Intervales State Park, Brazil: Park Ranger-Measured Versus Specialist-Measured Experience

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Abstract: This study was conducted to aid administrators in overcoming some barriers to implementation and maintenance of programs for monitoring visitor impact to Brazilian protected areas. One of the problems refers to continuity in collecting field data due in part to lack of institutional commitment. In order to verify the effectiveness of surveys carried out by park employees, the difference between data collected by park rangers and those collected by specialists was studied so that simple and dependable indicators could be selected. 26 indicators of physical attributes were analyzed for four intensive-use trails at Intervales State Park through systematic sampling of points. Results indicate that the group of rangers produced more homogeneous data than the group of specialists did. Significant differences were more frequent among quantitative indicators. Indicators chosen according to their dependability criterion were: bird sighting and hearing, vandalism to park facilities, rock graffiti, number of damaged or carved trees, number of perceptions of vehicle noise, number of exposed rocks, visible erosion, trail depth, traces of fauna and trash litter.

Introduction

Not until recently have studies on impacts of visitors and on monitoring methodologies been conducted in Brazilian protected areas. Even more recent is the use of planning systems such as Limits of Acceptable Change – LAC (Stankey et al. 1985) and Visitor Impact Management – VIM (Graefe et al. 1990), Kuss et al. 1990) in recreation management plans and technical work. Those plans, however, end up not being implemented or lack continuity in the management actions that they recommend.

Scarcity of resources, insufficient personnel, high personnel turnover, inadequate training in park management and lack of consistent and continued policies all hinder adequate implementation of management strategies in Brazilian parks.

In a study on protected area management in Brazil, Brito (2000) verified that many of the management actions are actually responses to critical situations requiring prompt action. According to the author, employees' action is usually based on their experience, with successes and failures, with consequences to biodiversity and to the public.

Despite park administrators' engagement in the planning process, specific plans for structuring recreational activities are devised by hired technical consultants. Thus, to enable continuity of implementation of management strategies as part of the administrative routine it is necessary to assure employees' involvement and commitment.

Having in mind the relevance of the impact of recreation on the environment and on visitor experience in protected areas, it is essential that management decisions be based on objective and dependable information. When gathered periodically as part of a monitoring program, that information may help identify changes before the impact becomes too severe or irreversible (Leung & Marion 1999). Obvious though it may seem, that does not represent reality in Brazilian parks.

Criteria for the selection of indicators and characteristics of good standards are suggested by some authors (Graefe et al. 1990, Whittaker & Shelby 1992, Manning & Lime 2000, Krumpe 2002). According to Cole and McCool (1998) an indicator's most relevant characteristic is its ability to measure and to quantify. For Belnap (1998) little attention has been given to studies that focus on the process of selecting indicators.

In some specific cases, programs for monitoring impacts of recreational use are not implemented due to the lack of credibility of data collected by field personnel. Feasibility and dependability are two essential qualities in choosing good indicators and they are related to that matter. Indicators that can be measured and quantified must have a direct relation with those two criteria.

A discussion of the characteristics of a series of indicators observed and measured by employees in a park as compared to those done by a group of specialists may help implement more dependable monitoring programs.

This study focused on assessing which indicators may be accurately measured by different observers. Two groups were studied, one comprising park rangers and the other made up of environmental specialists.

Research question and hypotheses

After recognition of the need to select dependable recreational impact indicators to implement a monitoring program at Intervales State Park the following question was proposed: do park rangers observe and measure indicators the same way as specialists do? That question led to the following hypotheses:

Hypothesis 1 (null): impact indicators are observed and measured the same way when collected by different individuals and groups.

Alternative Hypotheses:

Hypothesis 1a: analysis of impact indicators results in non-significance (p-value >0.05) between data collected by park rangers and those collected by specialists.

Hypothesis 1b: analysis of indicators results in non-significance (p-value >0.05) among data collected by distinct individuals within the group of park rangers.

Hypothesis 1c: analysis of impact indicators results in non-significance (p-value >0.05) among data collected by individuals within the group of specialists.

Methods

Study Area

Intervales State Park is located 270km south of the city of São Paulo, in southeastern Brazil. The 41,705-hectare park is connected to four other protected areas and is part of the Atlantic Forest Biological Reserve, a World Heritage Site as designated by UNESCO in 1999.

Most visitors to Intervales are involved in one-day hiking activities and the park's main attractions are caves and waterfalls. Over fifty caves have been recorded and surveyed to date. The park used to be an old farm and therefore is served by a large network of roads and trails. After more than twenty years without use, many of those paths are now being added to the system of recreational trails for visitors. They are short trails, ranging from 100 meters to 2,000 meters in length.

Heavy pedestrian traffic in recent years has led to impacts which are unacceptable to both the park's administration and to visitors. That problem was first discussed in the Visitor Impact Management Plan carried out in 1999 (Passold 2002), when serious problems of erosion and drainage were reported. A monitoring plan was then presented using a series of indicators. Part of the actions was implemented, but to this date the monitoring plan has not been put to use.

Sampling

Four intensive-use trails with a total of 1,824 meters in length were assessed by means of systematic sampling of points. Due to its simplicity of implementation, that sampling approach is mentioned by Leung and Marion (1999) as being probably the most usual in impact trail assessment and monitoring studies.

Data collection was carried out by nine persons selected to take part in this study. One group comprised four park rangers and the other was formed by five specialists. In a comparative analysis of both groups all sampling points of the four trails, totaling 33 points, were considered in bulk, as one set of data. Observations and measures of qualitative and quantitative indicators were taken at fixed intervals of 25m, 50m and 100m along routes and according to trail length. A list of all 26 indicators recorded during the assessment is presented in Table 1.

Table 1. Ecological and Social Impact Indicators.

Quantitative Indicators	Qualitative Indicators
1-Number of exposed roots	12 - Presence of exotic species
2- Number of trees with bromeliads and orchids	13 - Composition of vegetation
3- Number of trees or bushes with broken branches	14 - Density of vegetation
4- Extent of diseased vegetation	15 - Amount of litter
5- Number of social trails	16 - Apparent cause of social trails
6 - Number of exposed rocks	17 - Visible erosion
7 - Trail width	18 - Drainage problems
8 - Trail depth	19 - Hazards
9 - Number of carved/damaged trees	20 - Type of hazards
10 - Number of perceptions of vehicle noise	21 - Bird sighting or hearing
11 – Number of noise or quarry explosion	22 - Presence of Wildlife Sightings
	23 - Vandalism against park facilities
	24 - Rock graffiti
	25 - Presence of trash litter
	26 - Sanitation problems

Shapiro-Wilk's non-parametric test to assess normality of quantitative data was used in this study. For comparison between the two groups, data were analyzed by means of Friedman's test for quantitative variables (Zar 1984) and Likelihood Ratio Chi-square (χ^2) to assess independence or homogeneity of qualitative variables (Mann 1995).

Results

Parametric statistics could not be utilized for comparison between groups because of asymmetrical distribution of the data presented by the quantitative variables. In the comparison test between groups and among individuals within the same group the quantitative variables did not present normality either for t-Student parametric or for Shapiro-Wilk non-parametric tests.

Friedman's non-parametric test was thus used for quantitative variables while the Likelihood Ratio Chi-square test was used for qualitative variables.

Results of the comparison between the two groups (park ranger and specialist) and among individuals within the same group are shown in Table 2.

Hypothesis 1a: analysis of impact indicators shows non-significance (p-value >0.05) between data collected by the group of park rangers and those collected by the group of specialists.

Table 2. Comparison between the two groups and among individuals within the same group

Indicators	Between Groups	Park rangers	Specialists
Number of exposed roots	0.083(F)	**0.021*(F)**	0.891(F)
Number of trees with bromeliads/orchids	0.234(F)	**<.0001**(F)**	**<.0001**(F)**
Presence of exotic species	0.335 (G)	0.658(G)	**<.0001**(G)**
Number of trees or bushes with broken branches	0.215(F)	**0.030*(F)**	**0.036*(F)**
Extent of diseaded vegetation	**0.024*(F)**	**<.0001**(F)**	0.975(F)
Composition of vegetation	**0.004**(G)**	NR [a]	0.852(G)
Density of vegetation	**0.004**(G)**	NR [a]	0.323(G)
Amount of litter	**0.012*(G)**	NR [a]	0.603(G)
Number of social trails	**0.000**(F)**	NR [a]	0.994(F)
Apparent cause of social trails	**<.0001**(G)**	NR [a]	0.915(G)
Number of exposed rocks	**0.000**(F)**	0.467(F)	0.133(F)
Visible Erosion	**<.0001**(G)**	0.217(G)	0.079(G)
Drainage problems	**0.047*(G)**	0.774(G)	**<.0001**(G)**
Trail width	**0.000**(F)**	**0.002**(F)**	0.353(F)
Trail depth	**0.000**(F)**	0.891(F)	0.097(F)
Hazards	**0.002**(G)**	0.904(G)	**<.0001**(G)**
Type of hazards	**0.003**(G)**	0.428(G)	**<.0001**(G)**
Bird sighting or hearing	0.078(G)	0.845(G)	0.412(G)
Presence of wildlife sightings	**<.0001**(G)**	0.476(G)	0.314(G)
Vandalism against park facilities	0.788(G)	0.205(G)	0.537(G)
Rock graffiti	0.417(G)	0.764(G)	1.000(G)
Number of carved/damaged trees	0.843(F)	0.876(F)	0.933(F)
Presence of trash litter	**0.015*(G)**	0.424(G)	0.585(G)
Sanitation problems	0.123(G)	NR [a]	0.156(G)
Number of perceptions of vehicle noise	0.836(F)	0.149(F)	0.231(F)
Number of noise or quarry explosion	**0.007**(F)**	0.380(F)	**<.0001**(F)**

(G) Likelihood Ratio Chi-Square for qualitative indicators
(F) Friedman test for quantitative indicators
* Differences statistically significant at p= 0.01-0.05. (Indicated with bold letters)
** Differences statistically significant at 0.01 level, valor-p<0.01. (Indicated with bold letters)
[a]NR= (non registred indicator by wardens group)

Results showed that, from Friedman's non-parametric test (p>0,05) and the probability test in the assessment made by both groups, 16 indicators presented significant values and 10 presented non-significant values, as shown in Table 3.

Hypothesis 1 b: analysis of indicators shows non-significance (p-value >0.05) in the data collected by individuals within the ranger group.

Results of the test among individuals within the group of rangers indicated that there was a significant difference for five indicators: number of exposed roots, number of trees with bromeliads/orchids, number of trees or busches with broken branches, extent of diseaded vegetation and trail width. A total of 21 non-significant and 5 significant indicators were observed.

Hypothesis 1c: analysis of impact indicators shows non-significance (p-value >0.05) in data collected by individuals within the group of specialists.

Within the group of specialists 19 indicators were non significant, from a total of 26 indicators. The seven indicators which showed significant differences were: number of trees with broken branches, number of trees with orchids and bromeliads, presence of exotic species, drainage problems, hazards, type of hazards, mining explosion noise.

Those results suggest that in comparing both groups, the ranger group's evaluation was more homogeneous.

Nevertheless, five indicators, which were not recorded in the field by members of the ranger group, may have influenced that conclusion. Apparently rangers failed to record them because they are difficult to measure and are not directly observable. Those indicators include: composition of vegetation, density of vegetation, litter deposition in the area of degraded vegetation, number of social trails and apparent cause of social trails.

Trail surface and vegetation off official paths were significantly different for the two groups.

Number of exposed rocks, erosion and trail depth indicators were significantly different between the groups but not among individuals (Figure 1).

Statistically significant differences were more frequent among quantitative indicators, showing that they are less dependable and feasible. Van Bueren and Blom (1997) state that quantitative indicators are more preferable than qualitative ones as the latter are often ambiguous. Unfortunately, for many important criteria there are no quantitative indicators available and it is difficult if not impossible to develop them.

Table 3. Indicators that presented significant and non-significant values in the analysis of comparison between ranger and specialist groups.

Statistically significant	No statistically significant
1 - Extent of diseaded Vegetation	1 - Number of exposed roots
2 - Composition of vegetation	2 - Number of trees with bromeliads and orchids
3 - Density of vegetation	3 - Presence of exotic species
4 - Amount of litter	4 - Number of trees or bushes with broken branches
5 - Number of social trails	5 - Bird sighting or hearing
6 - Apparent cause of social trails	6 - Vandalism against park facilities
7 - Number of exposed rocks	7 - Rock graffiti
8 - Visible Erosion	8 - Number of carved/ damaged trees
9 - Drainage problems	9 - Sanitation problems
10 - Trail width	10- Number of perceptions of vehicle noise
11 - Trail depth	
12 - Hazards	
13 - Type of hazards	
14 - Presence of wildlife sightings	
15 - Presence of trash litter	
16 – Number of noise or quarry explosion	

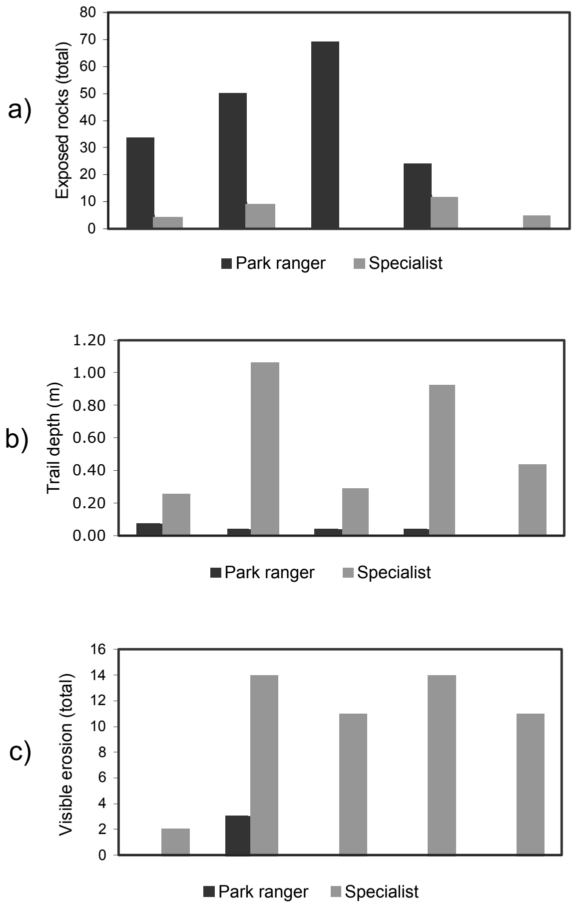

Figure 1. Evaluation of quantitative indicators: (a) number of exposed rocks, and (b) trail depth; and qualitative indicator: (c) visible erosion for different groups (4 park rangers and 5 specialists).

Final selection

In order to select the most representative indicators a comparative matrix was devised which contains 3 classes: 1) non-significant indicators between the two groups (park rangers and technicians); 2) non-significant indicators between the two groups and among individuals in the ranger group and 3) non-significant indicators between the two groups and among individuals in the group of technicians. Coinciding indicators between classes are indicated in the matrix shown in Table 4.

Considering that adequate indicators are those which do not present significant differences in the readings among the three groups which were compared, the following were selected: bird hearing or sighting, vandalism to facilities, rock graffiti, number of damaged or carved trees and number of perceptions of vehicle noise, all highlighted in bold characters in Table 4.

The second level of importance considered the non-significant difference among individuals within the same group (see Table 2): number of exposed rocks, visible erosion, trail depth, animal traces and trash litter.

Besides the selection of dependable indicators which can be evaluated on site by the field personnel themselves, it is important that data be collected as simply as possible. Krumpe (2000) points out that when it is necessary to use sophisticated equipment and complicated analyses the likelihood that field employees will abandon the method is high.

Conclusions

The purpose of this study was to compare the effectiveness of recreational impact indicators and to verify their dependability when data on them is collected by one group of park rangers and one group of specialists.

Table 4. Comparative matrix for selection of the most representative indicators

Indicators	Between Park rangers and Specialist	Between Groups and Park rangers	Between Groups and Specialist
Number of exposed roots			X
Number of trees with bromeliads/orchids			
Presence of exotic species		X	
Number of trees or bushes with broken branches			
Extent of diseased vegetation			
Composition of vegetation	X		
Density of vegetation	X		
Amount of litter	X		
Number of social trails	X		
Apparent cause of social trails	X		
Number of exposed rocks	X		
Visible Erosion	X		
Drainage problems			
Trail width			
Trail depth	X		
Hazards			
Type of hazards			
Bird sighting or hearing	X	X	X
Presence of wildlife sightings	X		
Vandalism against park facilities	X	X	X
Rock graffiti	X	X	X
Number of carved/damaged trees	X	X	X
Presence of trash litter	X		
Sanitation problems	X		X
Number of perceptions of vehicle noise	X	X	X
Number of noise or quarry explosion			

Results suggest that there is considerable subjective bias in assessing a great part of the indicators, thus confirming the importance of including this type of comparative test towards selection of indicators. Only 10 out of the 26 indicators recorded in the field proved dependable for application in the monitoring program at Intervales State Park.

Considering the first level for the selection of indicators which are dependable and feasible and comparing the results between the groups of evaluators, the following should be used: number of exposed roots, number of trees with bromeliads and orchids, presence of exotic species, number of trees or bushes with broken branches, bird sighting or hearing, vandalism against park facilities, rock graffiti, number of carved/damaged trees, sanitation problems, number of perceptions of vehicle noise.

In a more restrictive selection, considering the differences between and within both groups of evaluators, the most adequate indicators are: bird sighting or hearing, vandalism against facilities, rock graffiti, number of damaged or carved trees, number of perceptions of vehicle noise, number of exposed rocks, visible erosion, trail depth, animal traces and trash litter.

We believe that the results presented above may be used towards implementation of a monitoring routine and assist in the planning and management of visitor flows in other parks with similar problems.

Acknowledgements

This research was funded by the Boticario Foundation for Protection of Nature (FBPN).

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