ABSTRACT

Trail settings in national parks are essential management tools for improving both ecological conservation efforts and the quality of visitor experiences. This study proposes a plan for the appropriate maintenance of trails in Chubusangaku National Park, Japan, based on the Recreation Opportunity Spectrum (ROS) approach. First, we distributed 452 questionnaires to determine park visitors' preferences for setting a trail (response rate = 68%). Respondents' preferences were then evaluated according to the following seven parameters: access, remoteness, naturalness, facilities and site management, social encounters, visitor impact, and visitor management. Using nonmetric multidimensional scaling and cluster analysis, the visitors were classified into seven groups. Last, we classified the actual trails according to the visitor questionnaire criteria to examine the discrepancy between visitors' preferences and actual trail settings. The actual trail classification indicated that while most developed trails were located in accessible places, primitive trails were located in remote areas. However, interestingly, two visitor groups seemed to prefer well-conserved natural environment and, simultaneously, easily accessible trails. This finding does not correspond to a premise of the ROS approach, which supposes that primitive trails should be located in remote areas without ready access. Based on this study's results, we propose that creating trails, which afford visitors the opportunity to experience well-conserved natural environment in accessible areas is a useful means to provide visitors with diverse recreation opportunities. The process of data collection and analysis in this study can be one approach to produce ROS maps for providing visitors with recreational opportunities of greater diversity and higher quality.

Keywords: park management, primitiveness, Recreation Opportunity Spectrum (ROS), remoteness, trail settings

1. INTRODUCTION

1.1 Recreational planning in the national parks of Japan

The purpose of Japan's natural parks is to provide visitors with recreation opportunities in natural settings in addition to conserving natural landscapes and biodiversity (Kato 2008). Japan's natural parks are grouped into three types: national parks, quasi-national parks, and prefectural national parks. Among these categories, national parks are generally designated for nationally significant areas of outstanding natural beauty. As of 2012, a total of 30 national parks, 56 quasi-national parks, and 315 prefectural national parks exist in Japan.

Japan’s national parks are managed according to two types of park plan: a regulation plan and a facilitation plan (Kato 2008). Each regulation plan includes measures for the protection of national landscapes (e.g., the zoning of lands, and the regulation of cars and visitors), while a facilitation plan defines the allocation of park facilities (e.g., inn, restaurants, roads, and on the like) and facilities for the conservation of nature (Kato 2008). Although these plans are useful for protecting parks from further development and for appropriately allocating park facilities, they lack comprehensiveness when it comes to the recreational uses of parks; for example, they do not define recreation types to be provided for visitors (Yamaki et al. 2003). Therefore, under this current system, the construction of new buildings can be allowed as long as they are legally authorized, despite the fact that such construction can decrease the quality of recreational use for visitors (Yamaki et al. 2003). To offer visitors high quality recreational experiences, recreational use plans are important.

1.2 The ROS concept

The types and quality of park recreational experiences are defined by the attributes of the available surroundings, both natural and managed (Clark and Stankey 1979; Driver and Brown 1978;

Vogelsong et al. 1997). For example, walking along extensive, undeveloped trails with difficult access and few facilities offers a sense of solitude, challenge, and self-reliance; in contrast, walking in a setting characterized by easy access and highly developed facilities offers more comfort, security, and social opportunities (USDA Forest Service 1990). To support the definition and management of diverse outdoor recreation opportunities in diverse settings, the Recreation Opportunity Spectrum (ROS) was developed by the US Forest Service in the late 1970s (Clark and Stankey 1979; Driver and Brown 1978). The ROS offers a framework for understanding relationships and interactions between visitors and their surroundings by classifying recreation experiences from urban to primitive based on the following criteria: physical setting (e.g., access, remoteness, naturalness, and visitor impact), social setting (e.g., social encounters), and managerial setting (e.g., facilities and site management and visitor management) (Clark and Stankey 1979; Driver and Brown 1978; USDA Forest Service 1990). The combination of these criteria results in six different ROS classes (primitive, semi-primitive non-motorized, semi-primitive motorized, roaded natural, rural, and urban) (USDA Forest Service 1990).

1.3 ROS applications

The ROS concept has been applied not only to U.S. federal lands, but also to assessment projects per the National Environmental Policy Act (NEPA) (Cerveny et al. 2011), non-federal lands（Bulmer et al., 2002), marine protected areas (Gray et al. 2010), New Zealand park planning on a national scale

(Joyce and Sutton, 2009), and national park management in Japan (Yamaki et al. 2003). Cerveny et al. (2011) report that the ROS has been the most frequently used planning tool in NEPA assessment projects. One reason for its widespread use is that the ROS is useful for visualizing decision alternatives and for communicating decisions to the public about how proposed actions could affect recreation use and opportunity (Cerveny et al. 2011). Gray et al. (2010) examined that a ROS-based planning framework can help identify, classify, and preserve a variety of setting types for recreational boating. In New Zealand, it was proposed that ROS maps could be generated automatically using GIS by focusing on the relationships between experience opportunities and spatial data (Joyce and Sutton 2009). In Japan, on the basis of the ROS approach, recreation-suitable trail settings were proposed in Daisetsuzan National Park, a national park located on Japan's northern island, Hokkaido (Yamaki et al. 2003). This study classified park visitors in Daisetuzan National Park into four types according to their preferred trail environments: primitive, semi-primitive, semi-urban, and urban types. Thus, the ROS concept continues to inform management decisions in a wide variety of geographic locations and park types.

In the applied ROS system, some early conceptual articles assume a linear relationship among physical, social, and managerial settings; for example, the concentration of users tends to be low in areas with unmodified natural environments while the concentration is high in areas with urbanized environments (Clark and Stankey 1979; Driver and Brown, 1978). Based on this concept, several studies have recognized ROS classes using linear models such as principal component analysis (see, for example, Yamaki et al., 2003); however, on the other hand, Heywood et al. (1991) pointed out that the relationships among ROS setting components are not linear but multiple linear or non-linear. Therefore, Heywood et al. (1991) suggested the need for more flexible mapping criteria than found in current ROS applications.

1.4 Chubusangaku National Park

Chubusangaku National Park is a mountainous park located in central Japan, at the center of the Hida Mountain Chain known as the "Japanese Alps," the highest mountain range in the country. The southern part of the park is home to the Kamikochi-Hotaka area (Fig. 1). Kamikochi (36°2′N, 137°6′E; ca. 1,500m alt.) is one of the most renowned scenic spots in Japan, and more than 1.5 million tourists visit each year. The Hotaka area, which is located higher in the mountains surrounding Kamikochi, is considered the birthplace of alpinism in Japan and is perennially very popular among climbers. Although progressive park management measures such as the restriction of cars have been introduced in these areas, recreational use plans have not been proposed yet—despite the fact that there have been reports that the overall quality of recreational experiences have diminished with overuse (Shimazu 1999).

In this study, in order to provide visitors with recreational opportunities of greater diversity and higher quality, we propose a plan for the appropriate maintenance of trails based on an ROS approach in the Kamikochi-Hotaka area. Especially, considering the issue about the linearity among ROS components, we used non-linear methods for ROS classification to delve into the matter of suitable trail management. The discussion can meaningfully contribute to the effective management of national parks, particularly from the standpoint of systematic planning for recreational use as well as the verification of the usefulness of non-linear methods for ROS classification.

2. MATERIALS AND METHODS

2.1 Study site

The study site was the Kamikochi-Hotaka area in Chubusangaku National Park, Japan (Fig. 2). The

Kamikochi-Hotaka area is located in the southern part of the Chubusangaku National Park. Kamikochi is a valley plain, which lies along the Azusa River and is surrounded by the tall mountains of the Hotaka area, some of which are more than 3,000 meters high. Among these mountains is Mt. Okuhotaka (3,190m alt.), the third highest mountain in Japan. The climate in Kamikochi is relatively cool with heavy snowfall in winter. At higher elevations, snow lingers as late as summer.

Kamikochi is a major tourist destination, serves as a starting point for hiking and mountain climbing activities in the area, and has a major bus terminal. Since vehicle entry has been restricted in the Kamikochi-Hotaka area, most visitors come to this area by way of vehicles authorized to drive to and from the bus terminal in Kamikochi (e.g., public buses and taxis). After arriving at the bus terminal, visitors travel to other distant recreation sites within the study area by walking; however, a few visitors come to the Kamikochi-Hodaka area without passing the bus terminal by walking mountainous trails only. To propose a general management plan for this park, the preferences of visitors who use the bus terminal were investigated in this study.

2.2 Classification of visitors' preferences

We distributed a questionnaire consisting of thirteen items to park visitors to determine their desired trail attributes (Table 1), as well as their sex, age (out of six classes: Class 1. Younger than 20 years of age; Class 2. 20s; Class 3. 30s; Class 4. 40s, Class 5. 50s; Class 6. Older than 60 years of age), and place of departure (out of twelve districts: 1. Hokkaido, 2. Tohoku, 3. Kanto, 4. Koshinetsu, 5. Hokuriku, 6. Tokai, 7. Kinki, 8. Tyugoku, 9. Shikoku, 10. Kyushu, 11. Okinawa, or 12. Other). This questionnaire was developed by modifying the one Yamaki et al. (2003) used to fit our study site. Considering that the quality of recreational experiences can be significantly decreased in peak season due to heavy congestion, we distributed and collected the questionnaire at the Kamikochi bus terminal using on-site convenience sampling on weekends and/or holidays during the peak tourist season from August to October.

Based on the visitors' responses to the items in the questionnaire, we evaluated their preferred trail types according to the following seven parameters: access, remoteness, naturalness, facilities and site management (facilities), social encounters, visitor impact, and visitor management. These parameters are the underpinnings of an ROS approach. The relationships between the trail types in the questionnaire and the above seven parameters are shown in Table 2.

2.3 Trail settings

The trails in the study site were divided into segments consisting of sections and nodes, depending on the physical, social, and managerial conditions of the surrounding environments (Fig. 2). The sections defined parts of trails with uniform settings, whereas the nodes denoted gaps between the sections. The physical, social, and managerial conditions in each segment were almost homogeneous. From August to October 2011, we recorded or measured the actual trail conditions of each segment based on items in the questionnaire (see Table 1). The scores for each trail setting were also based on Table 1. However, the criteria for some trails settings were modified from the items in the questionnaire to be suitable for evaluation. Such modifications of the criteria are listed in Table 3.

2.4 Analysis

2.4.1 Classification of visitors

The overall process of analysis in this study is shown in Fig. 3. First, on the basis of the ROS parameter scores, we used nonmetric multidimensional scaling (NMS) to reduce the number of variances and to reveal the main gradients of visitors' preferences. NMS is a nonparametric and robust ordination technique that represents a similarity matrix in a multidimensional space and preserves the ordering of relationships among the original items (Fasham 1977; Legendre and Legendre 1998). Unlike other ordination methods, NMS requires that few assumptions be made about the nature of the analyzed data. For example, while principal components analysis assumes linear relationships between variables and reciprocal averaging assumes modal relationships, NMS makes neither of these assumptions; therefore, this method is well suited for a wide variety of data. The NMS results were produced such that visitors with a similar composition of preferred ROS parameters emerged close to one another in ordination space.

NMS was run from a random starting configuration in slow and thorough autopilot mode, with Euclidean selected as the distance measure. In the event that the ROS parameter included more than one trail setting (e.g., facilities and visitor management; see Table 2), these ROS parameter scores were calculated by averaging the scores of related trail settings. Then, the scores obtained were rounded off to assign either three or five classes. The stability criterion was set at 0.00001 and the number of iterations to evaluate stability was set at 15. A Monte Carlo test was carried out with 250 randomized runs.

Next, on the basis of the NMS scores obtained, a cluster analysis using Ward's minimum variance method was performed to classify the visitors according to their trail-setting preferences. The appropriate number of clusters was tested using Beale's pseudo F-statistic ($p < 0.05$) (Beale, 1969). The differences in ROS parameters among the assigned visitor groups were determined by ANOVA with a subsequent Tukey's multiple comparison test. NMS and cluster analysis were performed by

PC-ORD for Windows, version 5.10 (McCune and Mefford 2006). ANOVA and Tukey's multiple comparison were done using R software for Windows 2.11.0 (R Development Core Team 2010).

2.4.2 Important factors for the classification of visitors

After the individual visitors were grouped, random forest analyses (Breiman 2001) were conducted to reveal important factors for the classification. Random forest is a non-linear and nonparametric method for prediction and assessing the relationship among a number of potential predictor variables and a response variable (Breiman 2001). This method combines two recent learning methods, both classification trees and the bagging algorithm, and is known as a robust and accurate approach (Breiman 2001). First, using random forest, a model for the classification of visitor groups based on scores of items in the questionnaire was produced. In this analysis, visitor groups and items in the questionnaire were used as dependent variables and explanatory variables, respectively.

The random forest analysis reveals important trail attributes for the classification of visitor groups based on mean decrease accuracy (MDA) and mean decrease Gini (MDG). MDA quantifies the importance of a variable by measuring the change in prediction accuracy, whereas MDG measures how a variable contributes to the homogeneity of nodes and leaves in random forest (Calle and Urrea 2011). The higher the scores of these indicators are, the more important the variables are as predictors. The rate of correct classification by random forest was calculated by leave-one-out cross-validation. The analysis was carried out with the randomForest package in R software for Windows 2.11.0 (R Development Core Team 2010).

2.4.4 Classification of trails

Using the random forest model constructed above, we also classified each trail node and section based on their scores for trail settings. This process enables us to match between actual trail settings and the preferences of visitor groups regarding trail settings. Based on this matching, we revealed discrepancies between visitor preferences and actual trail settings and could thus propose recommendations for trail managers. This exercise links study respondents' preferences to the criteria of the ROS method.

3. RESULTS

3.1 Questionnaires

We distributed 452 questionnaires, and the response rate was about 68%. Of the 308 respondents, 153 were males (49.7%). The reported ages of the respondents varied (Class 1 = 3.6%, Class 2 = 14.3%, Class 3 = 19.8%, Class 4 = 20.8%, Class 5 = 21.8%, and Class 6 = 19.8%); but the percentage of respondents in their 30s or older (Class 3) was relatively high compared to those in other classes. The majority of respondents came from the Kanto district (48.3%), followed by the Tokai district (21.4%), and the Kinki district (14.9%). These three districts represent some of the most urbanized areas in Japan; they are home to a number of major cities with populations of over one million inhabitants (e.g., Tokyo, Osaka, and Nagoya).

3.2 Classification of visitors

To classify visitors into groups with similar ROS preferences, we used NMS and cluster analysis. The final NMS solution was three-dimensional. The three axes accounted for 75.3% of the variance between the distance in the original n-dimensional space and the distance in the final ordination space. The final ordination required 285 iterations and had a final mean stress of 18.7%, which indicated a fair ordination (McCune and Grace 2002).

Using the resultant scores of NMS for 1–3 axes, cluster analysis was carried out. This analysis grouped the 308 respondents into seven clusters (Groups A-F) based on the Beale's pseudo F statistic at a level that retained 75.4% of the information. The scores of the seven ROS parameters in each group are shown in Table 4. ANOVA and multiple comparisons revealed statistically significant differences between the groups from the standpoint of the ROS parameters; differences in visitor groups' preferences for naturalness, visitor impact, and remoteness were the most prominent. The scores for both visitor impact and naturalness in Groups C, D, and G were much higher than those in Groups B and F. Group C was characterized by the lowest significant score for remoteness, while Groups F and G had higher scores for this parameter. Group A showed a higher score for visitor impact with lower scores for naturalness; on the other hand, Group E exhibited opposite trends to those of Group A. The ANOVA and multiple comparisons also revealed statistically significant differences between other ROS parameters among the visitor groups; however, these differences were relatively small compared to those pertaining to the most important three parameters: naturalness, visitor impact, and remoteness. The average score of seven ROS parameters was the highest in Group G, followed by Group D, and Group C, while the lowest belonged to Group B.

3.3 Important factors for the classification of visitors

The random forest analysis indicated that the seven groups defined by the cluster analysis were predicted mainly with three abovementioned ROS parameters (naturalness, visitor impact, and remoteness), displaying a 3.3% out-of-bag estimate error. As illustrated in Fig. 4, the most important variable was naturalness, based on both mean decrease accuracy (2.9) and mean decrease Gini (67.5), followed by visitor impact (2.9 MDA and 66.4 MDG), and remoteness (2.8 MDA and 47.6 MDG). Using these three trail attributes important for visitor classification (remoteness, naturalness, and visitor impact), the seven visitor groups were mapped (Fig. 5).

3.4 Classification of trails

The trails were divided into 85 segments, consisting of 54 sections and 31 nodes. The actual trail setting was also classified according to how well it matched the random forest model constructed for visitor preferences (Fig. 6). While most of the trails were categorized as matching the ROS preferences of Group G, no trails belonged to those of Groups A and C (Fig. 6). Notably, trails classified as matching Group B's preferences were located mainly in the Kamikochi area; those classified as matching well with Group F's and Group G's were in mountainous areas.

4. DISCUSSION

4.1 Visitor classification

The cluster and random forest analysis showed that visitors were classified into seven groups mainly according to differences in their preferences relating to remoteness, naturalness, and visitor impact. Here, we characterize the visitor groups by using the three important ROS items. Three groups (Groups A, C, and E) showed lower scores for the remoteness (< 2.0; Table 4); especially, multiple comparisons indicated that Group C prefers closer destinations significantly more than the other two groups. Therefore, Groups A and E are characterized as "close" for their preference of distance to the destination while Group C is characterized as "closer." Groups F and G had higher values for the remoteness (> 4.0; Table 4) and are named as "remote" for their preference about distance. Regarding naturalness and visitor impact, considering that both naturalness and visitor impact are deeply related to the degree of conserved natural environments around trails in this study (see Table 3), visitor groups with higher scores for both naturalness and visitor impact (> 4.0; Groups C, D and G) are characterized as "well-conserved" to describe their preference in natural environment. In the case that visitor groups showed higher scores (> 4.0) for either naturalness (Group E) or visitor impact (Group A), their preferences for natural environments are characterized as "less developed" and "less impacted," respectively. These characterizations are shown in Table 5.

4.2 Visitor group and ROS concept

Interestingly, two visitor groups (Groups C and D) preferred accessible areas, though they preferred well-conserved natural environment at the same time. On the other hand, while Group F preferred remote trails, it did not prefer less-developed nor less-impacted natural environment. These findings do not correspond to a premise of the ROS approach, which supposes that trails with unmodified natural conditions should be located in remote areas without ready access (Clark and Stankey 1979; Driver and Brown 1978; USDA Forest Service 1990). As Heywood et al. (1991) previously pointed out; this study also highlights the issue on the assumption about the linearity of the relationships between ROS setting components. Especially, this study showed the aberration between primitiveness of natural environment and remoteness. To reveal the causes for this aberration, we should survey the attitude of visitors for these ROS components in detail. One possible explanation for this aberration may be related to the growing interest in nature recently; many people wish to experience wild environments although they are not immediately familiar with them. According to surveys by the Government of Japan (Ministry of the Environment 2011), the rate of respondents interested in nature increased by more than double from 1981 (16%) to 2009 (35%); however, on the contrary, actual experiences in natural environments decreased. For example, the rate of young people who had never climbed higher mountains without aerial tramways or lifts was 53% in 1998 and 67% in 2009. With regard to camping, the rate of young people who had never camped was 38% in 1998 and 57% in 2009. These results imply that people's interest for nature has been growing recently, yet they have become more alienated from the recreational use of it. This conflicting attitude for nature may affect the preferences of visitors that do not correspond to the existing ROS concept.

Compared with the three ROS parameters mentioned above (naturalness, visitor impact, and remoteness), the differences in social encounter, facilities, and visitor management preferences among the groups were small and the average scores were below 3.0. These results would seem to indicate that all visitor groups accepted moderate interactions between visitors, and preferred trails that were both convenient and moderately managed. Since the study site is one of the major scenic attractions in Japan and is overcrowded in peak season, visitors who prefer silent and unmanaged trails may be predictably few. Additionally, considering that Japanese visitors tend to visit national parks in groups while those in United States tend to visit them more privately (Shinobu 2000), this pattern of group visitation can be related to the results that social encounters proved less problematic for visitors in this study. Shinobu (2000) also pointed out that this trend can be related to Japanese traditional culture to enjoy nature in groups (e.g., cherry-blossom viewing).

4.3 Application of the ROS to trail settings

The ROS maps created by classifying actual trail settings indicate that while most of the trails considered as developed (trails with the lowest ROS scores preferred by Group B) were located in accessible places, most of the primitive trails (trails with the highest ROS scores favored by Group G) were located in remote areas far from the bus terminal and difficult to access.

However, trails with well-conserved natural environment in accessible areas preferred strongly by Groups C and D were scarce on the ROS map (Fig. 6). This might be owing to the fact that accessible areas are prone to be developed as tourist spots. Based on the results obtained, we propose that creating trails which afford visitors experiences of well-conserved natural environment in accessible areas may be a useful means to diversify recreational opportunities for visitors.

This study also indicates that the non-linear relationships among ROS components should be carefully considered before applying the ROS system to park management schemes. As this study shows, by using NMS and random forest based on the questionnaires of visitors and actual trail settings, we evaluated the non-linear relationships among ROS components and propose a ROS map suitable for this study site. The process of data collection and analysis in this study can be one approach for producing ROS maps which provide visitors with recreational opportunities of greater diversity and higher quality.

5. Conclusion

Using the ROS approach, we examined the discrepancy between visitors' preferences and actual trail settings and can propose an appropriate management approach to increase both the quality and diversity of recreation experiences. This study confirmed the issue concerning the assumption about the linearity of the relationships between ROS components and proposed one approach for how to analyze these non-linear relationships to produce ROS maps suitable for study sites. Based on these results, we can suggest a new concept of trail classification, which recognizes that some visitors simultaneously prefer both well-conserved natural environment and accessible trails—even though this situation does not correspond to the assumptions of the ROS concept. In future studies, by integrating physical and biophysical information (e.g., vegetation and species studies and geological surveys, including soil and water analyses) and a consensus building system within the ROS approach, we can hope to propose more effective management plans for trails.

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Figure captions

Fig. 1 Views of the study sites

a) Views from the Kappabashi Bridge; b) Views from Mt. OkuHotaka;

c) Bus terminal at Kamikochi; d) Views of visitor campsites at Karasawa in high seasons;

Fig. 2 Map of the trails surveyed

Fig. 3 Process of analysis in this study

Fig.4 Importance of six ROS parameters to the prediction of visitor groups clustered by random forest analysis

Fig.5 Characterization of visitor groups by three important ROS components

Fig.6 Map of the trails by classification

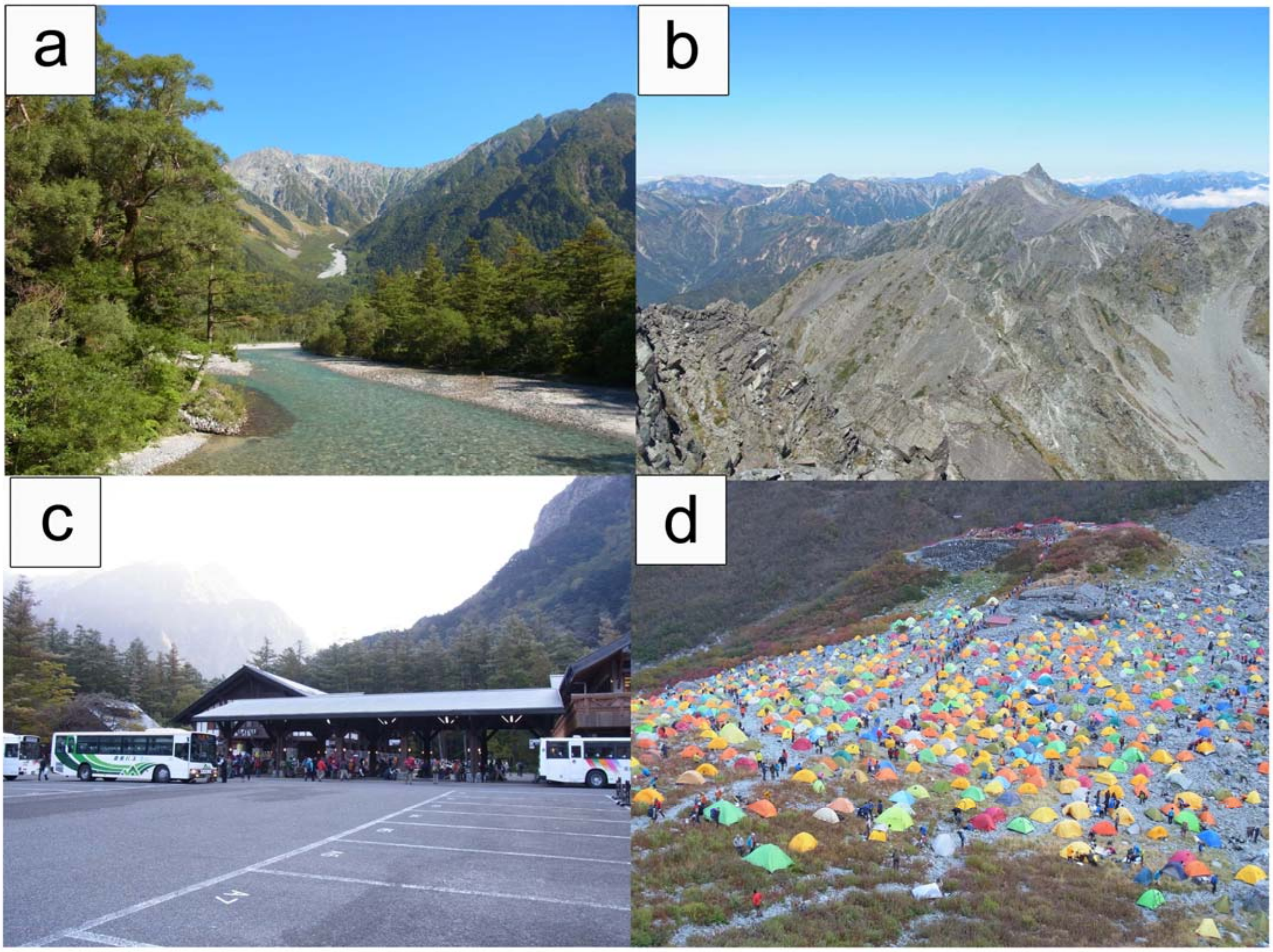


Fig. 1

Kamikochi -Hodaka area
36°2′N, 137°6′E
Mt. Kitahotaka
Mt. Okuhotaka
Karasawa
Yokoo
Mt. Maehotaka
Mt. Nishihotaka
Tokusawa
Kappabashi bridge
Kamikochi Bus terminal
Taishoike pond
Mt. Yakedake
N
0
2km
Bus terminal
Paved road
River/Pond
Trails
Node
Section

Fig. 2

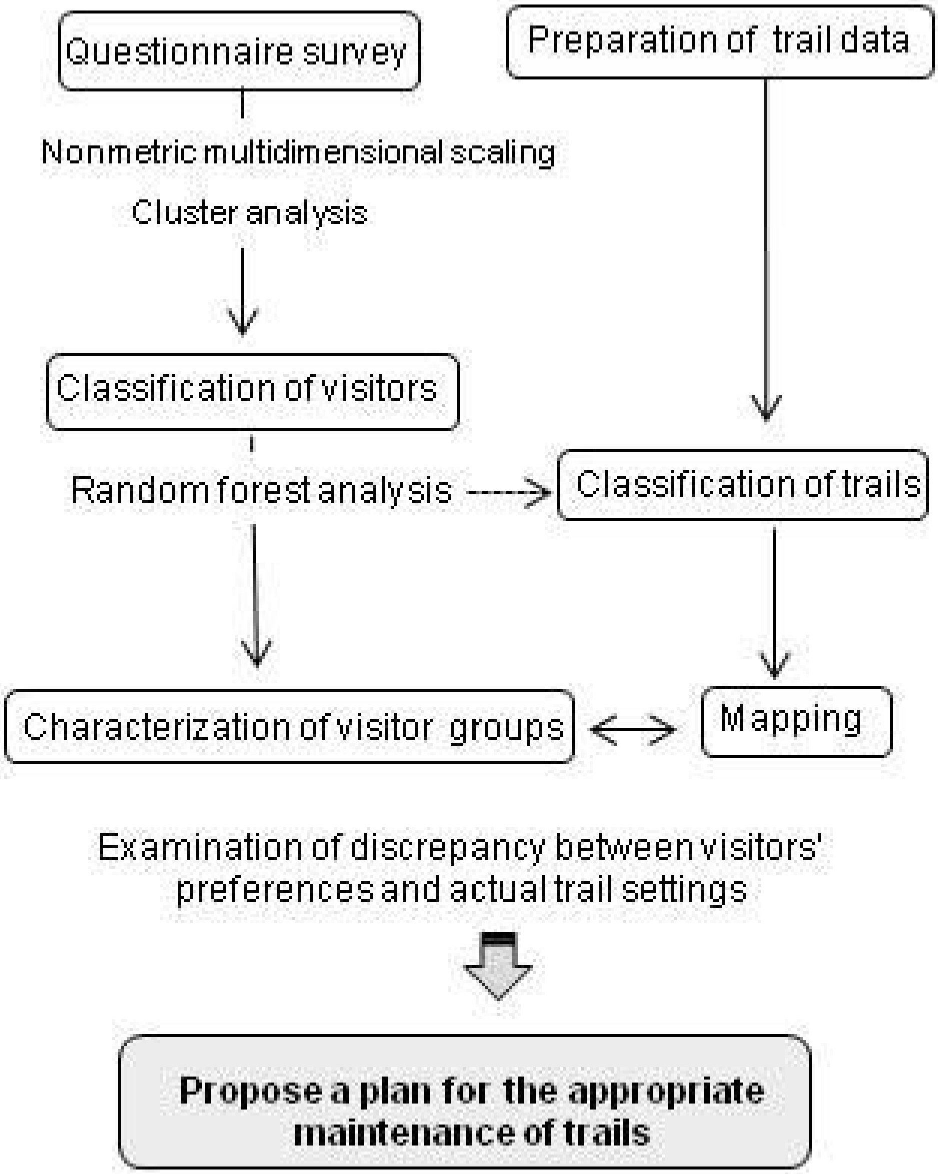
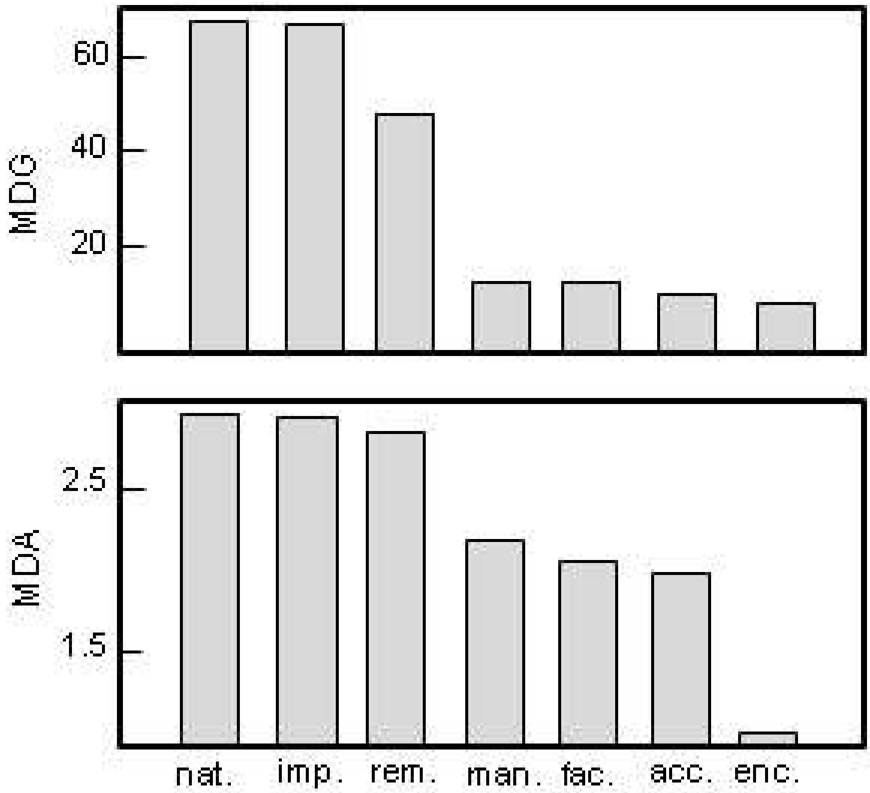
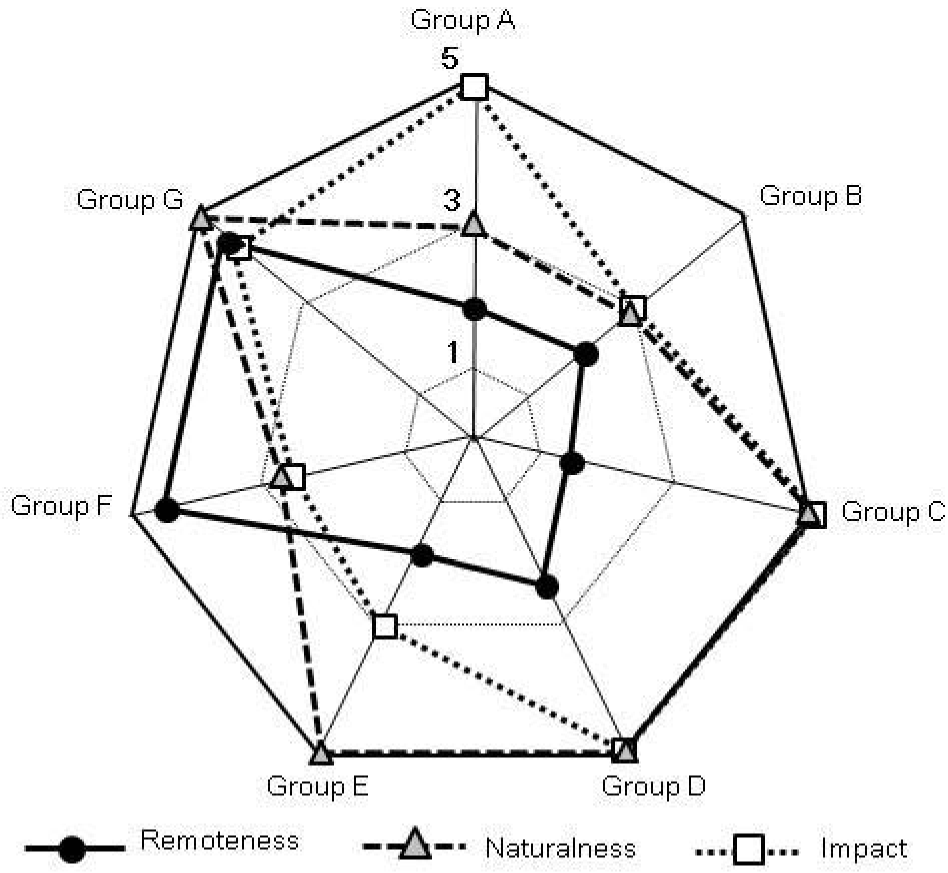

Questionnaire survey
Preparation of trail data
Nonmetric multidimensional scaling
Cluster analysis
Classification of visitors
Random forest analysis
Classification of trails
Characterization of visitor groups
Mapping
Examination of discrepancy between visitors' preferences and actual trail settings
Propose a plan for the appropriate maintenance of trails

Fig. 3



Abbreviations are as follows;
nat. = naturalness, imp. = visitor impact,
rem. = remoteness, man = visitor management,
fac. = facilities, acc. = access,
enc. = social encounter

Fig. 4



Group A
5
3
1
Group B
Group C
Group D
Group E
Group F
Group G
Remoteness
Naturalness
Impact

Fig. 5

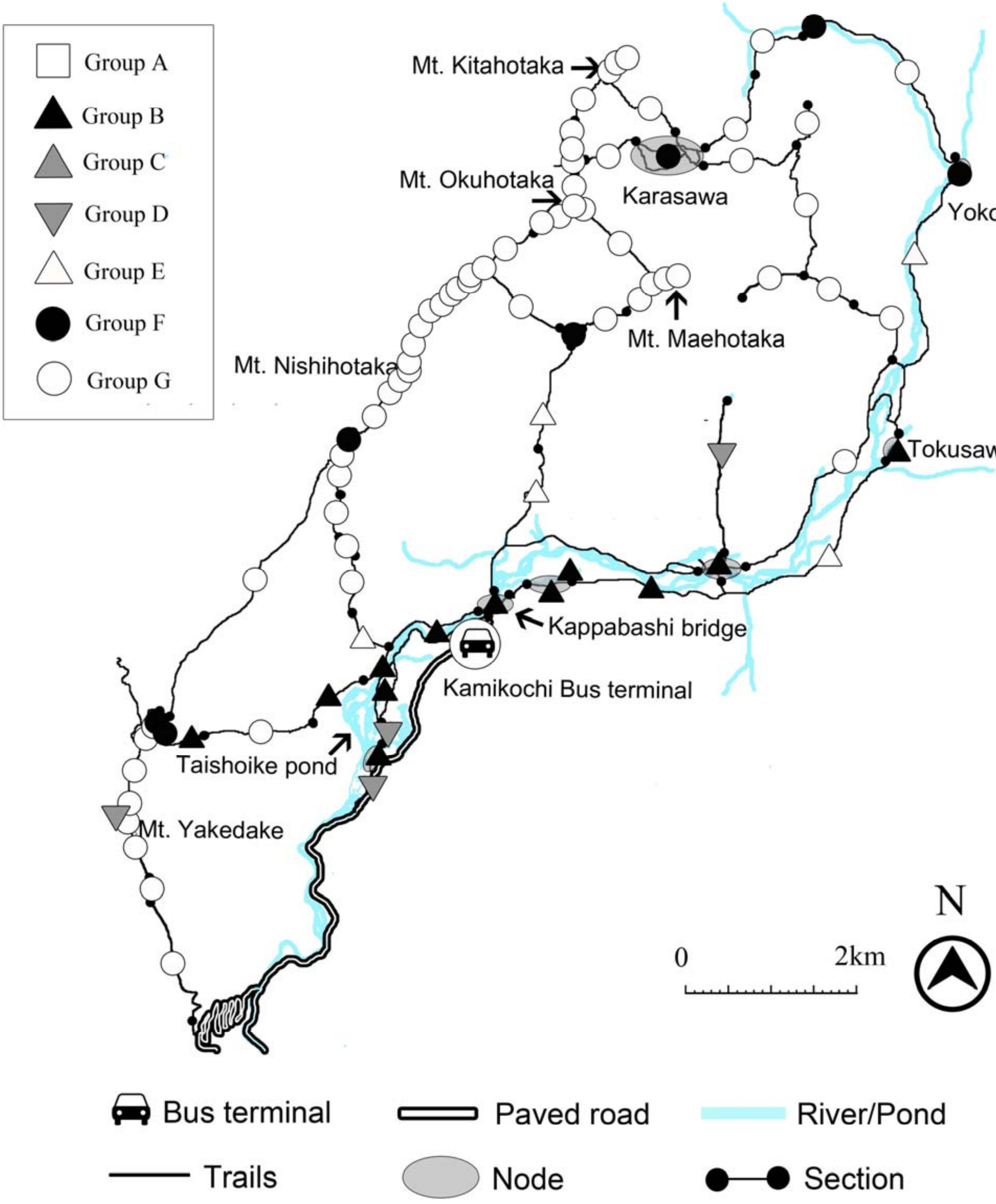

Group A
Group B
Group C
Group D
Group E
Group F
Group G
Mt. Kitahotaka
Mt. Okuhotaka
Karasawa
Yokoo
Mt. Maehotaka
Mt. Nishihotaka
Tokusawa
Kappabashi bridge
Kamikochi Bus terminal
Taishoike pond
Mt. Yakedake
N
0
2km
Bus terminal
Paved road
River/Pond
Trails
Node
Section

Fig. 6

Table 1 Questionnaire used in this study

Items in a questionnaire	Scores: 1 (Developed)	2	3	4	5 (Primitive)
1. Trail condition	Town shoes or heels are usable		Athletic shoes are usable		Tracking boots are necessary
2. Walking time to destination	In 1 hour	In 3 hours	In half a day	In a day	Overnight stay on mountain required
3. Bench and tables	Both bench and table		Only bench		No bench and table
4. Inn	Inn with meals		Inn without meals		No Inn
5. Restaurant	As many as possible		As few as possible		No restaurant
6. Shop	As many as possible		As few as possible		No shop
7. Guide sign	As many as possible		As few as possible		No guide sign
8. Warning sign	As many as possible		As few as possible		No warning sign
9. Rope to prevent trespassing	Everywhere		Only important places		No rope
10. Interpretation boards	As many as possible		As few as possible		No interpretation board
11. Artificial structures	Distinct		A little distinct		Indistinct
12. Frequency of encounters	Continuously met	Several times in 10 minutes	Several times in 1 hour	Several times in a day	Fewer than once a day
13. Loss of vegetation	Distinct		A little distinct		Indistinct

Note: While visitors were asked to choose their favorite trail settings in items 1–10, they were asked to choose acceptable trail settings in items 11–13. The more primitive the trail setting becomes in each case, the higher the score it is allocated.

Table 2 Relationships between ROS parameters and items in questionnaire

ROS parameters	Items in questionnaire
Access	1. Trail condition
Remoteness	2. Walking time to destination
Facilities	3. Bench and tables
	4. Inn
	5. Restaurant
	6. Shop
Visitor management	7. Guide signs
	8. Warning signs
	9. Rope to prevent trespassing
	10. Interpretation board
Naturalness	11. Artificial structures
Social encounters	12. Frequency of encounters
Visitor impact	13. Loss of vegetation

Table 3 The differences in the criteria for the records/measurements of actual trail settings from the items in the questionnaire

	Developed ⟵			⟶	**Primitive**
Items in a questionnaire	Scores				
	1	2	3	4	5
2. Walking time to destination [1]	In 1 hour	In 3 hours	In half a day	In a day	Overnight stay on mountain required
5. Restaurant	More than two		Only one		No restaurant
6. Shop	More than two		Only one		No shop
7. Guide sign	More than two		Only one		No guide sign
8. Warning sign	More than two		Only one		No warning sign
10. Interpretation boards	More than two		Only one		No interpretation board
11. Artificial structures[2]	Distinct		A little distinct		Indistinct
13. Loss of vegetation [3]	Distinct		A little distinct		Indistinct

1) Walking time to destination from the bus-terminal to each trail segment or node.

2) Distinct = artificial structures (cf., buildings) are continuously built along trails; A little distinct = artificial structures are scattered along trails; Indistinct = artificial structured are hardly visible.

3) Distinct = loss of vegetation by trampling is distinct along trails; A little distinct = loss of vegetation is visible along trails; Indistinct = loss of vegetation are hardly visible along trails

Table 4 Comparison of the scores of ROS parameters among the visitor groups

ROS parameters	Group A	Group B	Group C	Group D	Group E	Group F	Group G	*F*-value	*p*
N	40	61	58	58	48	16	27		
Access	2.9 ± 0.4	3.0 ± 0.5	2.8 ± 0.8	3.1 ± 0.4	2.9 ± 0.6	3.4± 0.9	3.5 ± 1.2	4.5	< 0.01
	b	b	b	ab	b	ab	a		
Remotoness	1.9 ± 0.7	2.0 ± 0.7	1.4 ± 0.5	2.3 ± 0.6	1.8 ± 0.7	4.6 ±0.5	4.5 ± 0.6	120.1	< 0.01
	c	bc	d	b	c	a	a		
Facilities	2.1 ± 0.7	2.3 ± 0.7	1.8 ± 0.6	2.5 ± 0.6	1.9 ± 0.7	2.3 ± 0.7	2.2 ± 0.7	6.7	< 0.01
	bc	ab	c	a	bc	abc	abc		
Visitor management	2.2 ± 0.7	2.3 ± 0.7	1.9 ± 0.6	2.6 ± 0.5	2.0 ± 0.7	1.9 ± 0.8	2.3 ± 0.9	5.5	< 0.01
	ab	ab	b	a	b	b	ab		
Naturalness	3.0 ± 0.0	2.8 ± 0.6	5.0 ± 0.0	5.0 ±0.0	5.0 ± 0.0	2.8 ±0.7	4.9 ± 0.4	556.2	< 0.01
	b	b	a	a	a	b	a		
Social encounter	1.8 ± 0.6	1.8 ± 0.7	1.8 ± 0.7	2.1 ±0.6	1.6 ± 0.6	2.0 ± 0.6	2.1 ± 0.9	3.6	< 0.01
	ab	ab	ab	a	b	ab	a		
Visitor impact	5.0 ± 0.0	2.9 ± 0.6	5.0 ± 0.0	5.0 ± 0.0	3.0 ± 0.0	2.6 ±0.8	4.3 ± 1.0	264.9	<0.01
	a	cd	a	a	c	d	b		
Average	2.69	2.44	2.82	3.21	2.6	2.79	3.41		

N = Number of visitors classified in each group

Facilities = Facilities and management

Lowercase letters (a, b, c, and d) indicate significant differences ($p < 0.05$), as determined by Tukey's multiple comparison test.

Table 5 Characterization of visitor groups

Groups	Preference of visitor groups for remoteness and natural environments
Group A	close destination – less-impacted natural environment
Group B	close destination
Group C	closer destination – well-conserved natural environment
Group D	close destination – well-conserved natural environment
Group E	close destination – less-developed natural environment
Group F	remote destination
Group G	remote destination – well-conserved natural environment

Note: The differences among the preference for remoteness were defined based on the scores for remoteness in each Group (Table 4) according to the definition of scores for waiting time to destination (Table 1) as follows: closer; the time to destination is less than 3 hours, close; the time to destination is about 3 hours, remote; the time to destination is more than half a day.