







SOCIAL AND ENVIRONMENTAL PARAMETERS FOR PUBLIC USE MANAGEMENT IN MOUNTAIN ECOSYSTEMS

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ABSTRACT – Pico do Marumbi State Park, in the mountains of Paraná, is the cradle of Brazilian mountaineering, sheltering several altitudinal ecosystems and endangered species. The elaboration and discussion of indicators to assist in public use management is urgent due to the vulnerability and pressure that these environments are subject to. It is also important to characterize the visitation profile and the correlation of accidents and incidents to adopt tools to protect visitors and nature. The data analyzed were extracted from official sources, registers, and records of incidents and accidents. Statistical treatment was adopted, in the analysis of variance and mean comparison tests, according to an entirely randomized design. Furthermore, Pearson's correlation coefficient (r) and cluster analysis determined the ideal season for visitation. Statistical differences were verified in different periods, with July with the highest average visitation, 924.6 visitors, and February with the lowest average, with 539.4 visitors. The cluster analysis identified the ideal period for visitation, between June and September. The trails to Abrolhos, Olimpo, and Rochedinho had the highest average, with 965.8, 1,080.4, and 1,088.2 visitors. Of the occurrences attended, 75% were from October to May and 25% from June to September. Olimpo is the trail with the highest number of occurrences, about 45%. For 2018 and 2019, the park received 56% of visitors going on their first time. According to the results, adopting preventive and educational information, consorting with technical and climatic criteria, can better triage and safeguard the environment, users, and rescuers more effectively.

Keywords: Protect Areas; Mountaineering; Serra do Mar.

PARÂMETROS SOCIAIS E AMBIENTAIS PARA O MANEJO DO USO PÚBLICO EM ECOSISTEMAS MONTANHOSOS

RESUMO – O Parque Estadual Pico do Marumbi, na serra do mar paranaense, é o berço do montanhismo brasileiro, abrigando diversos ecossistemas altitudinais e espécies ameaçadas. A elaboração e a discussão de indicadores no auxílio do manejo do uso público, urge pela vulnerabilidade e pressão que estes ambientes estão sujeitos. Como também a caracterização do perfil da visitação e a correlação na ocorrência de acidentes e incidentes, no intuito da adoção de ferramentas para a proteção dos visitantes e da natureza. Os dados analisados foram extraídos de fontes oficiais, cadastros e registros de incidentes e acidentes. Foi adotado tratamento estatístico, nas análises de variância e testes de comparações de médias, segundo um delineamento inteiramente ao acaso. Além disso, o coeficiente de correlação de Pearson (r) e a análise de agrupamentos, determinou para a temporada ideal para visitação. Foram verificadas diferenças estatísticas em diferentes períodos, julho com a maior média de visitação, 924,6 visitantes e fevereiro a menor média, com 539,4 visitantes. A análise de agrupamento identificou o período ideal de visitação, entre junho e setembro. As trilhas para o Abrolhos, Olimpo e Rochedinho apresentaram a maior média com 965,8, 1.080,4 e 1.088,2 visitantes.

Das ocorrências atendidas, 75% foram de outubro a maio e 25% no período de junho a setembro. O Olimpo é a trilha com o maior número de ocorrências, cerca de 45%. Para os anos de 2018 e 2019, o parque recebeu 56% de visitantes indo em sua primeira vez. Segundo os resultados, a adoção de informações preventivas e educacionais, consorciando com critérios técnicos e climáticos, podem permitir melhor triagem e resguardar com maior eficácia o ambiente, usuários e socorristas.

Palavras-Chave: Áreas Protegidas; Montanhismo; Serra do Mar.

1. INTRODUCTION

Humanity faces accelerated degradation of different ecosystems, specimens, and environmental services. Through protected areas, natural sciences seek to ensure the continuity of parts of the biological heritage *in situ* (Borrini-Feyerabend et al., 2017). Thus, the challenge of the correct use of natural resources in different ecological systems experiences the dilemma between preserving and appropriating.

Protected areas were located far from urban centers, tending to be more accessible. As a result of demographic pressure, social stress, and the popularization of technological resources, new groups tend to increase outdoor activities in fragile environments (Borrini-Feyerabend et al. 2017; Spenceley et al., 2019).

In Brazil, the federal environmental body, Chico Mendes Institute for Biodiversity Conservation - ICMBio, presents in its data the continuous growth of visitation. In the last 20 years, between 2018 and 2019, there was a 20.4% increase (ICMBio, 2019a). ICMBio defines visitation management as "public use", an expression used to address the whole, from planning, implementation, and opportunities for natural recreation as well as monitoring (ICMBio, 2019b).

However, variations in public use are complex, involving different social actors, vocations of the natural environment, and different approaches according to the geopolitical particularities of the regions in which they are inserted. Visitation must be studied from a transdisciplinary perspective, due to the influence it exerts on the economic, social, and environmental sectors, as well as being influenced from this perspective (Borrini-Feyerabend et al. 2017; Spenceley et al., 2019).

Public use is more expressive in the "Parks" category, being historically created in natural areas of relevant scenic beauty and having as one of its goals the promotion of educational, leisure, and tourism

practices (Brasil, 2000). This conservation category is distributed all national biomes and in greater quantity in the Atlantic Forest (Canto-Silva e Silva, 2017).

The Atlantic Forest is home to 70% of the Brazilian population. However, it has less than 12% of its original vegetation, thus being classified as the second most threatened hotspot in the world (SOS Mata Atlântica, 2022).

In this biome, the Serra do Mar (*Sea Ridge* – free translation) stands out, a mountainous region stretching from the state of Rio de Janeiro to Santa Catarina. These areas are home to countless springs, expressive diversity of species, as well as being social stages for cultural and sports activities (Savi, 2008).

The Pico do Marumbi State Park, located in the Serra do Mar of the state of Paraná, represents this synthesis of environmental and cultural wealth. Being considered the birthplace of Brazilian mountaineering (Carvalho, 2005), it has historic paths and trails in a scenario of rare ecological integrity. This conservation unit - UC, has management tools for public use that stand out, such as visitor registration and the Mountain Relief Corps - COSMO, a pioneering voluntary group for the prevention of search and rescue in Brazil (COSMO, 2022).

In this context, this work aimed to identify and propose social and environmental parameters that can be used in the management of public use in mountain ecosystems. Through a scientific approach, an attempt is made to understand the specific social and environmental aspects of these areas, aiming to promote conservation and the safety of visitors.

2. MATERIALS AND METHODS

2.1. Characterization of the study area

The Pico do Marumbi State Park is located in the central portion of the state of Paraná da Serra do Mar, in the Atlantic Forest biome. The UC is

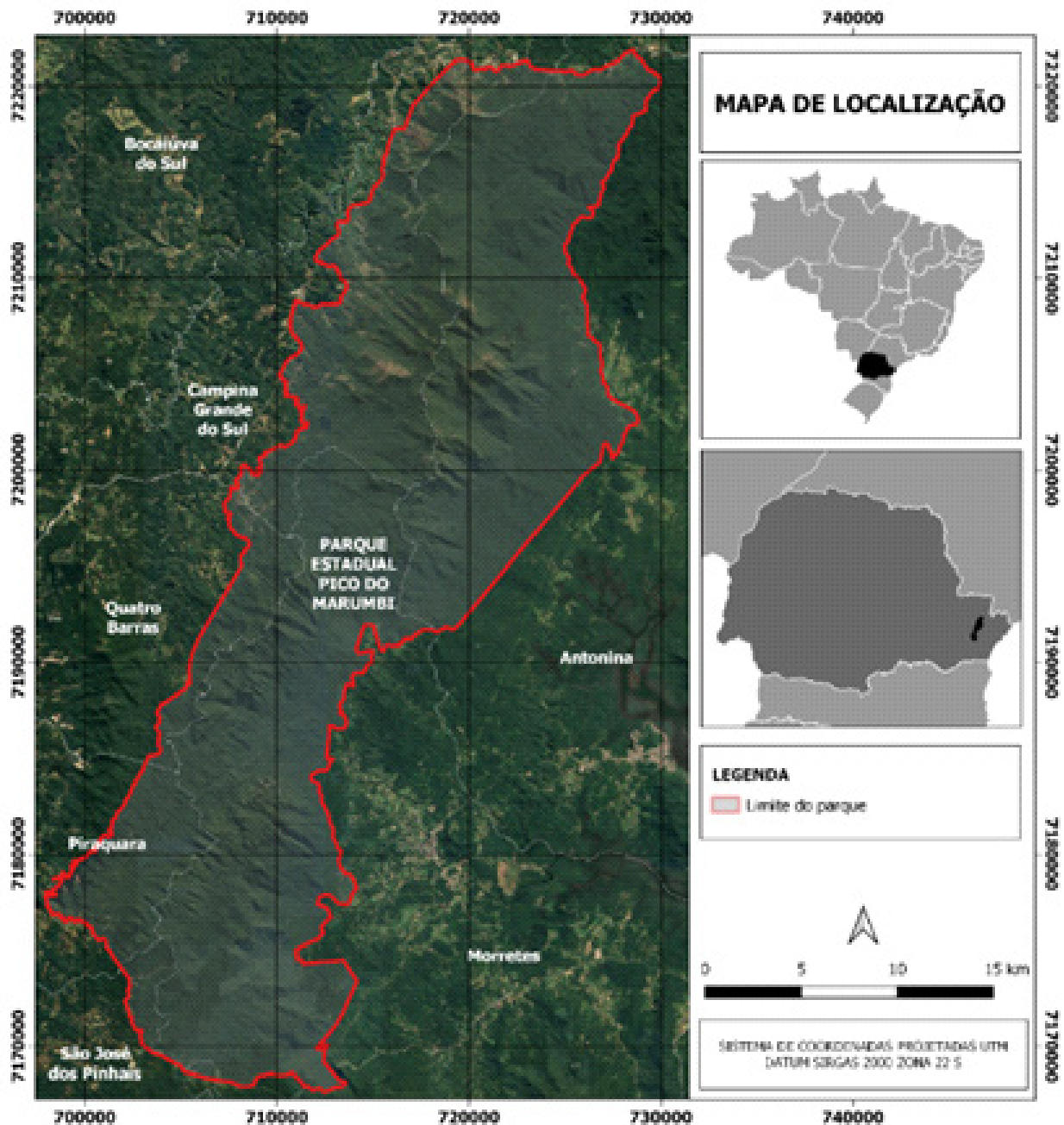


Figure 1 – Location map of the study area, Morretes, Paraná, Brazil.

Figura 1 – Mapa de localização da área de estudo, Morretes, Paraná, Brasil.

located between 25° 05' and 25° 35' S and 48° 43' and 49° 02' W coordinates, 65 km from Curitiba (IAP, 1996) (Figure 1).

There are two climatic types, according to the Koeppen classification: Cfa in the portions

below 700m of altitude and Cfb in the higher parts (Alvares et al., 2013). About the Marumbi, it is covered by Dense Ombrophilous Forest, subdivided into Submontana, Montana, and Altomontana formations (Paraná, 2002).

The park has historical references such as the beginning of Brazilian mountaineering, on August 21, 1879, and 1885 the construction of the Paranaguá-Curitiba railroad (Carvalho, 2005). From the 1920s, with the modernist movement, excursions to Marumbi began, with intellectuals and artists (Struminski, 2001). This mountain culture was so striking that the historian Romário Martins, in 1928, created the neologism “Marumbinism”, synonymous with alpinism or andinism (Savi, 1997).

Consequently, the desire to conserve Marumbi and transform it into a park involved different periods and sectors of society in Paraná, from 1941 to create a National Park until the publication of State Decree No. 7,300 of September 24, 1990 (Paraná, 1990), establishing 2,342,412 hectares under protection. The effective implementation of the UC only occurred in 1995, with the management plan and infrastructure (Savi, 1997).

On October 2, 2007, Decree No. 1,531 expanded the area to 8,745.45 ha (Paraná, 2007), but without updating the management plan. The park has conservation objectives, scientific research, environmental education, and leisure, in addition to mountaineering and technical climbing (IAT, 2022).

In the area of the park, there is a diversity of altitudinal ecosystems and a unique geomorphological set (Savi, 2008). Furthermore, the region was listed by the State in 1986 (Paraná, 1987). In 1991, the United Nations Educational, Scientific and Cultural Organization as a Biosphere Reserve of the Atlantic Forest, and in 1999, included it in the List of Natural Heritage Sites (UNESCO, 2020), recognized it.

The Marumbi set has as main mountains: Abrolhos (1.200m), Esfinge (1.378m), Ponta do Tigre (1.400m), Torre dos Sinos (1.280m), Gigante (1.487m) and Olimpo (1.539m), Boa Vista (1.491m) and Facãozinho (1.100m) (Alves, 2008; Hartmann, 2021). Given the technical and physical difficulty of its trails, several accidents occur. Since 1996, the park has been supported by the Mountain Relief Corps - COSMO, a civil organization that, through legal mechanisms, has a partnership with the State. The objective is the prevention of accidents and collaboration in public use, carrying out maintenance and signaling the trails, as well as assisting the Military Police and Fire Department, in search and rescue (COSMO, 2022).

2.2. Data collection

In this research, references were adopted that guided and complemented the construction of indicators and the monitoring process of public use in mountain ecosystems (ICMBIO, 2011, Borrini-Feyerabend et al. 2017; Spenceley et al., 2019). Based on this foundation, the register of visitors emerges as a fundamental tool for the management of visitation, allowing a more grounded basis for management.

Information for this study was obtained from various sources. Official reports from the Água e Terra Institute were used, such as the visitation register referring to the periods of 1999, 2001, 2002, 2018, and 2019, which present superior quality information. In addition, COSMO's records of incidents and accidents were consulted, as well as scientific articles published on the Marumbi region.

Based on this information, a database was organized to enable the appropriate statistical treatment. To complement the information, meteorological data from the studied periods were also used, such as monthly temperature (°C) and precipitation measurements, obtained by the *Copernicus Climate Change Service* platform (2019).

This methodological approach allowed a robust and grounded analysis of public use in mountain ecosystems, enabling the identification of social and environmental parameters relevant to the management of these areas.

By collecting and analyzing visitor registration data, such as origin, demographic profile, frequency of visits, and previous experience, it is possible to obtain a detailed understanding of the profile of visits to the protected area. This information is essential to guide management actions and decision-making.

In addition, when the data are crossed with information about accidents and incidents that occurred in the mountains, it is possible to establish correlations and identify specific risk factors. This approach broadens the understanding of the challenges and opportunities related to managing visitation in mountain ecosystems, allowing the implementation of preventive and effective measures.

2.3. Data analysis

Statistical treatment was conducted in two stages. In the first stage, the total data were used, considering

information from all the years collected. In the second stage, the 2018-2019 biennium was used, along with data from incidents, to complement the analysis.

For statistical analyses, analyses of variance and average comparison tests were performed. A completely randomized design was adopted to evaluate the annual and monthly distribution of visitors, origin, and used trails.

The determination of the visitation season was based on the monthly averages of visitation and meteorological data. The variables obtained were submitted to a correlation analysis using Pearson's correlation coefficient (r), and a cluster analysis was performed using the complete links method (distant-neighbor). The definition of the high and low season was based on the fusion coefficient of the Euclidean distances of each sample (Izenman, 2013).

Analysis of the variance of annual and monthly visitation averages was performed using *Statgraphics Centurion XVIII* software. The treatments were compared using Fisher's LSD test, following Steel, Torrie, and Dicky (1997) recommendations for the selected periods described in the methodology.

3. RESULTS

Concerning the statistical data used, the Pico do Marumbi State Park received 41,631 visitors in total. 2018 had the highest number of visitors with 9,342 (22.65%) followed by 2019 with 9,080 (21.81%), 1999

with 8,489 (20.39%), 2001 with 7,808 (18.76%) and 2002 with 6,822 (16.39%). The years that statistically differed were 2002 and 2018, periods with the lowest and highest number of visitors, respectively.

The monthly distribution of visitors resulted in statistical differences for specific periods (Table 1).

Statistical differences were found using Fisher's least significant difference (LSD) procedure. The month of July differed from the others and had the highest average number of visitors with 924.6 visitors. February, on the other hand, presented 539.4 visitors, the lowest average number of visitors for the period analyzed.

Comparing the meteorological variables and the monthly distribution of visitation, results were found (Figures 2a and 2b), as well as the analysis of complete linkages (Figure 2c).

The average temperature data and the monthly averages of visitation showed a negative correlation with an r equal to -0.71, as well as the precipitation data with an r of -0.62. Pearson's negative correlation coefficient indicates that as the average temperature rises throughout the year, the number of visitors decreases. The same occurs for precipitation.

The average temperature recorded for the period was 20.81 °C, with July registering the lowest average temperature for the period of analysis with 16.75 °C, while January had the highest average temperature with 24.55 °C. For the total annual precipitation, the average was 2,046.86 mm, with August recording the

Table 1 – Summary of the distribution of annual and monthly visitors in the Pico do Marumbi State Park.

Tabella 1 – Resumo da distribuição de visitantes anual e mensal no Parque Estadual Pico do Marumbi.

Month	1999		2001		2002		2018		2019		Averages
	N	%	N	%	N	%	N	%	N	%	
Jan	474	5.58	708	9.07	590	8.65	763	8.09	694	7.64	645.8 ^{abc}
Feb	449	5.29	726	9.30	583	8.55	878	9.31	61	0.67	539.4 ^a
Mar	434	5.11	511	6.54	815	11.95	801	8.49	387	4.26	589.6 ^{abc}
Apr	628	7.40	1096	14.04	333	4.88	909	9.64	685	7.54	730.2 ^{abc}
May	957	11.27	526	6.74	535	7.84	781	8.28	650	7.16	689.8 ^{abc}
Jun	488	5.75	613	7.85	434	6.36	556	5.89	1409	15.52	700.0 ^{abc}
Jul	1100	12.96	656	8.40	706	10.35	1232	13.06	929	10.23	924.6 ^c
Aug	579	6.82	631	8.08	606	8.88	1029	10.91	1170	12.89	803.0 ^{abc}
Sep	1154	13.59	616	7.89	547	8.02	1270	13.46	811	8.93	879.6 ^{bc}
Oct	707	8.33	523	6.70	537	7.87	430	4.56	528	5.81	545.0 ^{ab}
Nov	723	8.52	712	9.12	613	8.99	0	0.00	959	10.56	601.4 ^{abc}
Dec	796	9.38	490	6.28	523	7.67	783	8.30	797	8.78	677.8 ^{abc}
Total	8.489	100	7.808	100	6.822	100	9.432	100	9.080	100	

Note: N = number of visitors; averages followed by the same letter do not differ statistically from each other by Fisher's LSD test at 95% probability.

Nota: N = número de visitantes; as médias seguidas da mesma letra não diferem estatisticamente entre si pelo teste LSD de Fisher a 95% de probabilidade.

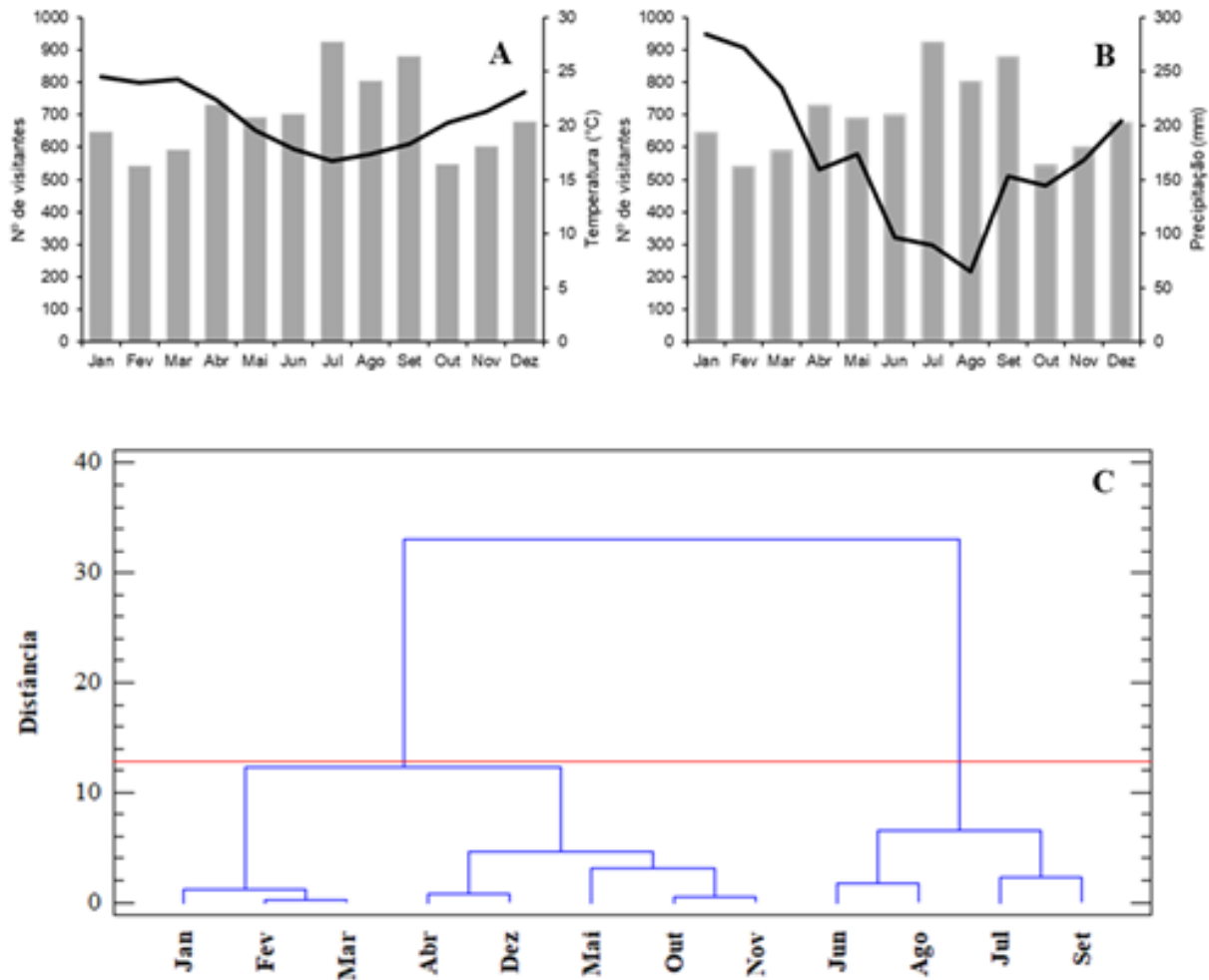


Figure 2 – Average temperature distribution (a); Monthly average rainfall (b) compared to monthly visitation averages; Clustering dendrogram (c).

Figura 2 – Distribuição da temperatura média (a); Da precipitação média mensal (b) em comparação as médias mensais de visitação; Dendrograma de agrupamento (c).

lowest precipitation of 65.4 mm and January having the highest precipitation of 284.93 mm. According to the analysis of distant-neighbor clusters, an ideal period was identified, between June and September.

As for the routes, during the analyzed period, the trail of Rochedinho had a total of 5,441 (22%) visits, Olimpo 5,402 (21%), Abrolhos 4,829 (20%), the Marumbi Set circuit 4,399 (18%), Cachoeira dos Marumbinistas 2,628 (11%), Ponta do Tigre 993 (4%), Parque do Lineu 844 (3%) and the routes not allowed (Gigante, Boa Vista and Facãozinho) had 358 users (1%). The trails to Abrolhos, Olimpo and Rochedinho differed statistically from the others,

showing the highest average number of visits with 965.8, 1,080.4, and 1,088.2 visitors respectively.

Data on search and rescue occurrences totaled 31 events in 2018 and 2019 alone. In meteorological conditions considered adequate, 60% of the search and rescue calls were registered and 40% were in rainy or cloudy periods with no visibility. Of this total, 75% took place from October to May and 25% in the period from June to September. Among the causes, 58% are related to fatigue, delay, dehydration, and physical unpreparedness, 39% had sprains, fractures, injuries, falls and neglected health problems (diabetes, blood pressure, etc.) and 3% had psychological problems.

Olympus is the trail that has the highest number of occurrences, with 45%. The others are distributed among trails that give access to Abrolhos and Ponta do Tigre (16%), the administrative base (10%), Rochedinho (4%), and, finally, records without the exact location signage (25%).

The 2018 – 2019 biennium brought an overview of the profile of the visitor at Pico do Marumbi State Park (Table 2).

For both 2018 and 2019, the highest number of first visitors were registered, corresponding to 56% of the total. Users with more experience represent 33%. Regarding gender, the largest number of male visitors was observed, with 63% of the visitors. As for the female audience, they correspond to 37%.

Concerning the origin, two groups presented statistical differences between the means analyzed according to Fisher's LSD test. The state of Paraná differed statistically from the others, presenting the highest annual average, with 7,659.4 visitors per year, totaling 94.27% of national visits. Then, the second group is composed of Santa Catarina, which represents 2.14%, São Paulo 1.60%, and Rio de Janeiro, with 0.47%.

In international records, the result was an average of 128.2 visitors per year. France and Germany belong to the group with the highest average number of visitors per year, with 22.4 and 18.2 respectively. The US was the third country with the most visitors per year, 17.4 followed by England with 9.6.

Table 2 – visitor profile for the 2018-2019 biennium: experience, gender, and age.

Tabela 2 – Perfil do visitante para o biênio 2018-2019: experiência, gênero e idade.

Experience	2018	2019
First time	4,948	4,417
2-4 times	605	1,398
More than 4 times	2,446	3,254
Gender		
Female	3,151	3,168
Male	6,281	5,911
Age		
0-5 years	0	0
6-11 years	0	0
12-20 years	0	0
21-30 years	2,826	2,481
31-50 years	4,231	4,351
Over 50 years	679	842
Total	6,703	9,081

4. DISCUSSION

The Pico do Marumbi State Park, since its implementation in 1995, has an annual average of over 8,000 visitors. When analyzing this number and its historical continuity, it presents a contradiction in other mountain areas, where there was an increase in expressive demand (Lemos and Gomes, 2021; Massini et al., 2021) and also in other countries, such as Ecuador, the United States and Portugal (Pereira et al. 2020, Valle-Álvarez et al., 2020; Ferguson et al., 2022). However, the analyzed variations about the means of transport and their accesses in the studied area, help in understanding this historical average.

The UC presents different means of arrival: the railway with the passenger train, the *Caminho Colonial do Itupava* trail (Itupava's Colonial Road) with 16 km, the vehicle through the beaches region, limited by the need for traction vehicles and the limited parking space, or the uphill walk along this same path for 5 km.

The passenger train is the main transport, with about 50% of access, the Itupava, in second place, with more than 35%, and the rest by the beach region (Savi, 1997; Vasconcellos, 1998; Takahashi, 1998). The reduction, or even the continuation of the number of visitors, can be explained as a result of privatization of the Federal Railroad Network, which took place in December 1996 (Marques, 1996). After this period, the price of the train ticket, on the Curitiba-Paranaguá section, was changed by “two hundred percent” and, currently, it can be classified as unpopular with the tourists, with values from R\$149.00 (Serra Verde Express, 2022).

The original times of this service were also modified and the departure from Curitiba, which was at 7:30 am with an expected arrival at 9:00 am at Marumbi, was changed to 8:30 am and arrival at 11:00 am. This length of the route does not allow for hiking in the required safety time. For example, the Abrolhos trail, considered as the shortest, lasts at least five hours (Hartmann, 2021). Considering these situations, such as the suspension of access by the Caminho do Itupava from 2000 to 2002 for its restoration, 2011 due to risks to visitors, as well as the limitation for vehicles with 4X4 traction on beaches, it collaborates in the understanding of the historical average of visitation (Kozechen, 2021; Hartmann,

2021). 2018, the one with the highest frequency, coincides with federal data on the growth trend in visitation in National Parks (ICMBio, 2019a).

About the months, the greatest statistically significant differences in the averages were in February, with the lowest frequency, which is associated with the climatic period with intense temperatures and summer rains, in addition to the recreational competition on the beaches (Fundação Grupo Boticário, 2021). The highest visitation peak is in July, when it coincides with school holidays when it has pleasant average temperatures, prolonged droughts, and rainfall below 100 mm.

Thus, it is possible to say that there is a suitable period for mountain activities, which occurs between June and September, and a season not suitable for mountaineering, from October to March. The visitation rates in other mountain Parks with the same vocation in Brazil, such as the Serra dos Órgãos National Park and the Três Picos State Park (RJ) (Pelacani et al., 2013; Lemos e Gomes, 2021) reaffirm the results.

When relating to incidents and accidents, favorable and unfavorable seasons are confirmed, with the expressive majority of accidents between October and May, with 75% of cases. It is noteworthy that this period has the lowest number of visits. However, that season concentrates the highest temperatures and rainfall. In winter, the period of lowest rainfall and highest visitation, only 25% of search and rescue records take place.

Regarding the results of the frequented trails that presented statistical differences, according to the level of difficulty, they are divided as follows: Olimpo is classified as heavy, Abrolhos from intermediate to heavy and Rochedinho is considered light (Hartmann, 2021). In the process of implementing the park, Savi (1997) highlighted in his study that Olympus was the trail with the highest frequency of visitation, from June 1995 to May 1997. However, in this period, there was strategic management action to direct users and disperse the impacts, inducing visitors to the trail of Rochedinho. This practice explains why this attraction has the highest average number of visits.

However, even with the induced targeting of the visitation to Rochedinho, Olimpo has the greatest occurrences of accidents and incidents. This result confirms studies on visitation management (Spenceley et al., 2019), where the impacts are not necessarily

related to the number of users, but to a series of variables, involving expectation, perception, and knowledge, for example. In this sense, Lopez-Richard et al. (2020) that it is not possible to dissociate the environmental effects of visitation from the risk factors.

Furthermore, the results also showed that more than half were visiting the UC for the first time, contributing to the fact that the lack of knowledge and information about the safety conditions, minimum equipment, and characteristics of the area, put users at risk in mountaineering activities. In this perspective, Lopez-Richard et al. (2020) highlight the lack of implementation of management tools that address the environmental impacts of visitation and user safety in adventure activities in conservation units.

About gender in mountain activities, the results are similar to the studies performed by Marski (2009), Melo (2020), and Lemos e Gomes (2022). This demonstrates that the profile of users is still mostly composed of men. Another data that corroborates the research is the age group, with ages between 30 and 45 years old, being the profile of UCs in mountain areas.

The questions of origin and predominance of visitors indicate high regionality. The most expressive Brazilian visitors are from the neighboring states of Santa Catarina, São Paulo and Rio Grande do Sul, as well as Rio de Janeiro, which historically has a strong culture of mountaineering (Lemos e Gomes, 2021).

Most of the foreigners are from countries with a tradition of mountaineering and recreational cultural affinity with National Parks (France, Germany, and the United States). However, the significant absence of visitation from Mercosur countries is noted. This economic bloc could increase better integration with tourism in protected areas (Ministério do Turismo, 2014; Fundação Grupo Boticário, 2021).

The results also highlight the gaps found in the records of the Pico do Marumbi State Park, in terms of quality of information and temporal continuity of data. Considering the Brazilian reality, some problems are shared, reflecting the difficulties encountered in the planning process, resulting from the lack of political priority, financial resources, and lack of technicians. Canto-Silva e Silva (2017) surveyed 196 state parks registered in the National Register of Conservation Units and identified that 63.35% do not have information about visitation activities in the areas.

In this sense, partnerships between managers of public use and institutions can be great allies in the construction of indicators and monitoring of visitation (Vallejo, 2013). In the case of Marumbi, it is performed using COSMO, which, due to the particularities of the UC, the parameters contributed to building basic knowledge about public use, favoring notes on emergency management actions.

To reduce safety-related impacts, establishing social indicators can bring qualitative results. Furthermore, the results confirmed that the climatic phases can be relevant for the optimization of management actions and the prevention of accidents, as well as the adoption of new procedures for these activities based on weather information. If criteria are adopted for social management, regarding experience, physical conditions, techniques, and equipment, as well as adequate guidance, there is a real possibility of greater effectiveness in accident prevention, cost reduction, and a lower risk factor for users, rescuers, and the natural environment itself (Spenceley et al., 2019)

5. CONCLUSION

The Pico do Marumbi State Park presents, through its climatological characteristics and its visitation profile, defined seasons that are favorable and unfavorable for activities in this environment. The quantitative evidence of incidents and accidents reinforces and establishes both periods as distinct. Therefore, the management of the UC, adopting the optimization of preventive and educational information with its means of access, in addition to consortium procedures, with technical and climatic criteria for the screening of the public use of its trails, will better protect users, rescuers, and the ecosystems involved.

AUTHOR CONTRIBUTIONS

Barbara Gabriele de Souza Nogueira: Conceptualization of the idea, literature research, article writing, data collection, methodology development, and discussion. Maurício Savi: Conceptualization of the idea, literature research, article writing, data collection, methodology development, and discussion. João Francisco Labres dos Santos: Data organization, literature research, article writing, statistical analysis, results, and mapping. Alexandre França Tetto: Article writing, literature research, guidance, and revision.

Eduardo Vedor de Paula: Article writing, literature research, guidance, and revision. Pedro José Steiner Neto: Guidance on statistical analysis and revision.

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