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Change Patterns between 1993 and 2023 and Effects of COVID-19 on Tourist Traffic in Tatra National Park (Poland)

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Abstract: Tatra National Park (TNP) is one of the most popular national parks in Poland. The purpose of this study was to examine changes in the number of tourists visiting the Park each year from 1993 with a special focus on the COVID-19 period. The main part of this study focused on tourist traffic data for the period from 1993 to 2023. Daily, monthly, and annual data were examined. The source of most of the data is park entry ticket sales. The largest number of tourists entering TNP in the period of 1993–2022 was recorded in 2021 at 4,788,788. Tourist traffic in TNP is concentrated on so-called long weekends in May and June. An examination of data from 2010, 2015, and 2021 shows that tourist volumes on the long weekend of 1–3 May be up to 40 times larger than those on other weekends in May. On the other hand, long weekends in June can attract eight times more tourists relative to the average other weekends in June. The number of tourists engaging in hiking, climbing, spelunking, and ski touring declined during the COVID-19 pandemic in 2020. However, the number of ski tourers in TNP in 2021 was about four times larger than the total between 2015–2022. Data on traffic patterns are key in designing, implementing, and measuring the efficiency of solutions for sustainable management for both the peak usage periods and future patterns in tourism.

Keywords: changes in tourist traffic; national park; mountain area; mass tourism

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1. Introduction

The development of the tourist industry in mountain areas represents one of the greatest challenges in the management of environmentally protected areas [1,2]. Mountain areas are significantly impacted by the emergence of tourist infrastructure and tourist traffic itself, leading to irreversible changes in the natural environment [3–7]. This is why it is extremely important to determine ways in which tourist traffic can be managed so that its spatial distribution and temporal pattern lead to a balance between tourist flow and the functioning of the natural environment [8–10]. Hiking tourism is one of the most basic forms of human impact on the natural environment in mountain areas. Tourist traffic can trigger certain environmental processes that may lead to the emergence of large degradation zones across slopes [11–14].

Authorities managing environmentally protected areas are increasingly taking action to help protect mountain areas from human impact [15,16]. Tourists often litter along trails [17,18], generate excessive noise [19], and find themselves in emergency situations requiring intervention on the part of mountain rescue units (Tatra Volunteer Emergency Service). Transportation issues are also a growing problem in many mountain areas [20]. The growth of tourist traffic in mountain areas is a challenge that local authorities have to face, and it leads to a search for the boundary between mass tourism and sustainable tourism [21,22]. The basic question is the following: When should local authorities and other entities intervene in the management of local tourist traffic in order to yield or maintain sustainable tourist growth in the context of environmental, economic, and sociocultural priorities in a given protected area? Tourist traffic in environmentally protected mountain

areas varies over time and in a spatial sense due to differences in the attractiveness of particular geographic areas and the ability of tourists to physically reach particular locations. According to the European Tourism Indicator System, the TOOLKIT for Sustainable Destinations' separated core and optional indicators enables the determination of both destination management and economic value as well as social, cultural, and environmental impact. On this basis, we can coherently and uniformly compare differently functioning areas attractive to tourists. These indicators may be helpful for local stakeholders to improve their destination's sustainable progress. Additionally, according to one of the EUROPARC Federation, strategy-research indicating management methods and development directions in protected areas, both on a regional and local scale, is also extremely valuable. Mountain areas are particularly vulnerable to the effects of climate change. For example, an increase in temperature may contribute to a reduction in biodiversity, while extreme rainfall may result in irreversible transformations of ecosystems. This is indicated by, among others, data, for example from the Volcans d'Auvergne Regional Nature Park or the Sixt Fer-à-Cheval-Passy National Nature Reserve (https://www.europarc.org/climate-change-adaptation-articles/, accessed on 4 April 2024).

The study described herein was conducted in Tatra National Park (TNP) in Poland, which is one of the smaller mountainous national parks in Europe, yet one where the tourist traffic is very high [23]. Tourist density in other popular national parks in the United States is rather low compared with TNP (National Park Service, https://irma.nps.gov/, accessed on 4 April 2024). This includes Grand Canyon National Park, Yosemite National Park, and Rocky Mountain National Park. It is important to note that given the much larger size of American national parks the level of tourist infrastructure in the said parks varies substantially from the Tatra National Park. For example, the most popular national park in the USA, Great Smoky Mountains National Park, is 10 times larger than TNP, and tourists traverse the Park by car or free bus. Tourist traffic is concentrated around selected attractions where tourist infrastructure is adapted to the volume of tourists hiking in the area of a given location featuring some type of tourist attraction.

Disproportion in tourist traffic also exists between the Polish and Slovak parts of Tatra National Park. This disproportion was noted based on data from automated counters [24–26]. The Slovak part of Tatra National Park has been counting tourists since 1972, although these data cover just one summer day per year, as the Park does not charge entry fees [27]. In 1993, the sell entry tickets began in the Polish part of the Tatra National Park, and since then the information on tourist traffic has been collected based on ticket sales. The Park's database features 30 years of data, which is very helpful in order to manage the tourist traffic. What is even more, those data could be helpful in strategic decisions in periods of higher tourist traffic—such as when the crocus comes into bloom [20]. TNP also possesses tourist traffic data for selected sections of trails found at higher elevations based on pyroelectric sensors installed along trails [24–26]. Hiking is the most popular form of tourism in the Park, although it is not the only one. Ski touring is becoming more and more popular in the winter season. Data on the number of ski tourers come from direct counts carried out by sellers of entry ticket points. In TNP, in specially dedicated areas people can also climb or visit selected caves. Data from these activities are collected by means of dedicated systems that register and at the same time legalize these activities (source TNP).

The COVID-19 pandemic caused a severe challenge to the normal functioning of the Park. Many parts of the Park faced excessive tourist traffic and fairly difficult behavior on the part of some tourists flocking there due to government restrictions regarding maintaining a distance of 2 m from each other and a ban on using tourist infrastructure. In response, the Park was forced to periodically close all tourist trails, at the beginning this was only for tourists from outside Tatra County but later it was for all tourists, and it was also forced to introduce educational programs designed to make tourists aware of sustainable practices and the need to share the temporarily unavailable beauty of the park [28,29].

The purpose of the present study was to examine changes in the number of tourists visiting the Park per year, and to compare the temporal and spatial distribution of tourists

in the Park in the years 1993–2023, with a special focus on the COVID-19 pandemic period, which began in early 2020. Most of TNP is covered with a dense network of tourist footpaths. In fact, 96% of the surface of TNP is located closer than one kilometer to tourist trails [20]. Compared to other high-mountain areas, TNP experiences enormous anthropogenic pressure, which constitutes a great challenge for managers. In this research, the most important goal is to indicate changes in the volume of tourist traffic as well as activities undertaken in connection with mass tourism.

2. Study Area

Tatra National Park is one of the most popular national parks in Poland. It is the fifth largest national park in Poland, with an area of 211.6 km^2 (Figure 1a). Tourists are limited to the 275 km of trails provided by the Park, which include areas specially designated for hiking, caving, skiing, and climbing. Mount Rysy is the highest peak in the Polish part of the Tatra Range at 2499 m a.s.l. The upper tree line is found between 1500 and 1550 m a.s.l. The Tatra Mountains are a border mountain range divided into Polish and Slovak parts. The Polish part consist of a section of the Low Tatras, Western Tatras, and High Tatras.

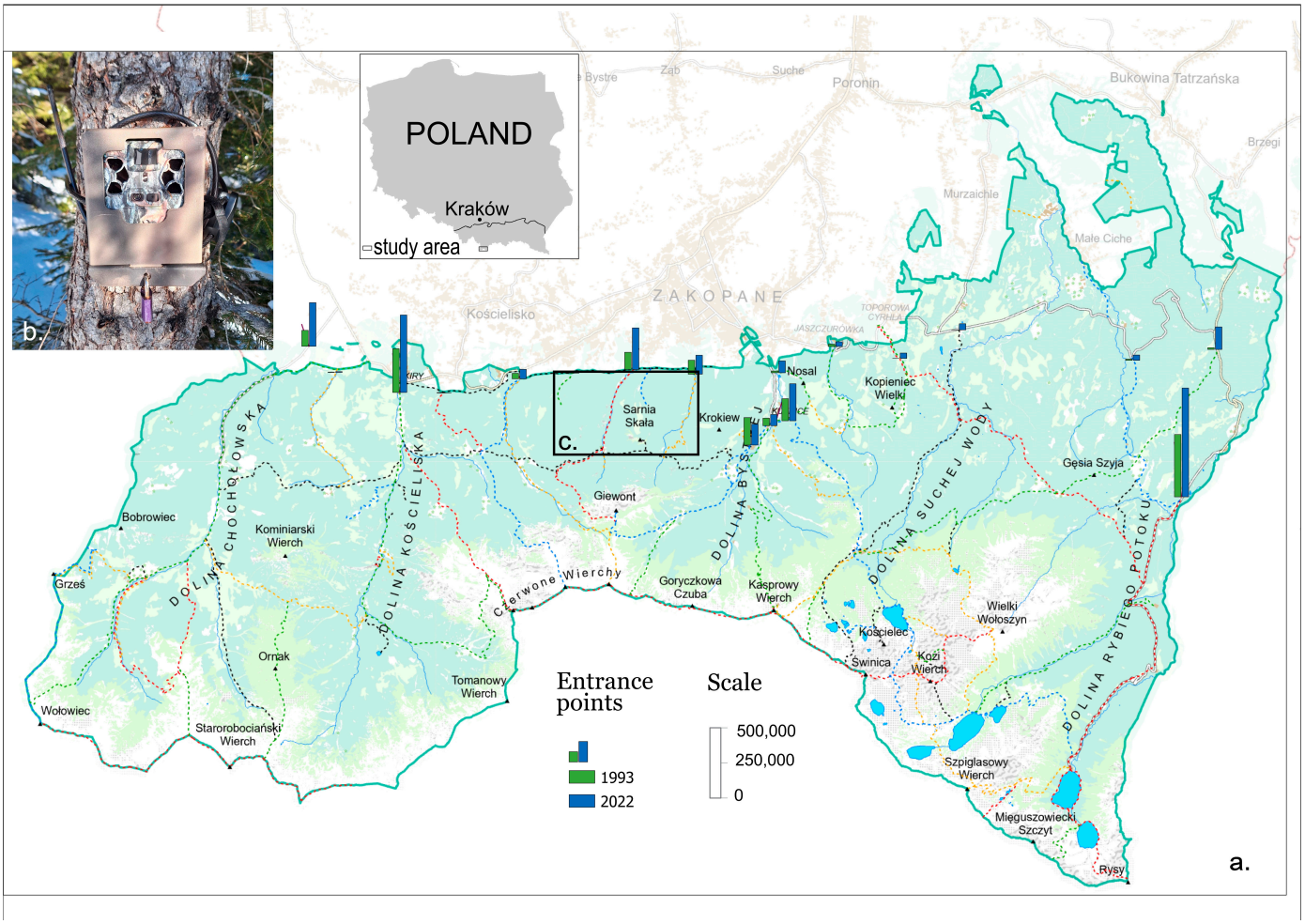

Figure 1. Distribution of tourist traffic in 1993 and 2022 in individual valleys (**a**). The camera trap installed next to the footpath (photo by: Antoni Zięba) (**b**). Valleys open to tourists during the period of increased restrictions related to COVID-19 (**c**). Source: Compiled by authors.

The Low Tatras section, also known as the Tatry Reglowe, is a belt of lower mountains mostly covered by forest, in some cases rocky, mostly below 1500 m a.s.l. This section of the Tatras is formed of sedimentary rocks, and at some sites Podhale flysch, and features small valleys that end at lower elevations and do not reach the highest Tatra summits. The

Western Tatras section is a high mountain area featuring distinct climate and vegetation zones. The maximum elevation of this section of the Tatra Range is 2176 m a.s.l. (Staroroba-ciański Summit). This part of the range is formed of metamorphic and sedimentary rocks and features extensive valley systems as well as partly rocky summits that sometimes resemble domes. The High Tatras section is a high mountain area featuring typical alpine relief. This section of the Tatras also features well-defined climate and vegetation zones. The highest summit in this area is Mount Rysy at 2499 m a.s.l.

The highest precipitation totals in the study area are noted from June to September. The highest totals for summer at the Zakopane weather station were noted in 2010 at 897.8 mm, while the lowest were noted in 2015 at 342.3 mm. The above data reflect the 2001–2022 study period and were obtained from the Institute of Meteorology and Water Management, part of the National Research Institute of Poland. Snow cover duration in the study area varies depending on elevation, ranging from 120 mm to 200 mm [30]. Tourist traffic in the area varies depending on climate conditions and precipitation amount as well as snow cover duration and wind speed.

Tourism in Tatra National Park

Tourism in the Tatras has its roots in the 17th century, when the first tourists began to ascend the Tatra summits. The emergence of a more modern version of tourism in the Tatras began in the 19th century with the establishment of the Tatra Society. Since that time, the trails were marked and the shelters for the tourists were built. In 1920 the Tatra Society changed its name to the Polish Tatra Society following the formation of a free Polish state in 1918. The Society attracted members from across the reestablished state of Poland. In 1950 it combined forces with other large Polish tourist associations to form the Polish Tourist and Sightseeing Society, known by the Polish acronym PTTK. The combined society continues to function today, and its primary objective is to promote tourism in Poland and especially in the Tatra Mountains. Today the Tatra Mountains are crisscrossed by a large network of tourist trails operated by Tatra National Park, with a combined length of 275 km. The Park also features eight tourist lodges operated by PTTK and four food service points as well as a cableway that reaches Mount Kasprowy Wierch at an elevation of 1987 m a.s.l. (https://www.tpn.pl, accessed on 4 April 2024).

The first mountain climbers who summited the highest peaks in the Tatras lived in the 19th century. This period was followed by the emergence of more sophisticated mountain climbing efforts in the late 19th and early 20th centuries. While climbing routes have been identified on virtually every accessible rock wall in the Tatras, only a few routes are available now for the climbers. Climbing routes in the High Tatra Range are open in the following valleys: Rybi Potok, Five Polish Ponds, and Hala Gąsienicowa. Only three climbing rocks are open to climbers in the Western Tatras.

The roots of spelunking in the Tatras reach back to the 19th century. Since then, more than 900 caves have been discovered, mostly in the Western Tatras. Of this number, there are 30 caves available to the cavers. Some of these caves have multiple entrances. Most of the said caves are found in the Kościeliska Valley and Mała Łąka Valley. A few are located in the Bystra Valley. The mentioned caves are mostly long caves—longer than a 100 m. Six of these belong to the longest caves in the Polish Tatra Mountains with a length greater than one kilometer (https://www.tpn.pl, accessed on 4 April 2024). The length of caves available to the cavers is almost 58 km, which is close to 50% of the total length of Tatra area caves. Moreover, for tourists there are six available caves: in the Kościeliska Valley and Ku Dziurze Valley.

Skiing in the Tatra Mountains began in the 19th century. Skiing has been gaining popularity in Poland for some time now. A few skiing slopes are available to skiers wishing to pursue this sport in the Tatras: two downhill routes are currently open to skiers in Gąsienicowy Kocioł and Goryczkowy Kocioł. A small ski lift is also available in Suchy Żleb leading to the Kalatówki Glade. Ski touring is permitted almost in all tourist trails open in the winter. In addition, some special trails are added just for ski tourers. A fairly large

network of ski touring trails is found in the following valleys: Goryczkowa, Kondratowa, Gąsienicowa, and Chochołowska. Noticeable on the Tatra trails are also cross-country skiers (https://www.tpn.pl, accessed on 4 April 2024).

3. Materials and Methods

The first part of this study focused on tourist traffic data for the period from 1993 to 2023. Both monthly and annual data were examined. However, the data from 2023 were only partially used because they were not fully processed by the Park, and the data did not account for nonstandard visitors. The source of most of the data is park entry ticket sales. Depending on the year there are between 16 and 18 entry points that are open in TNP. Some tickets are now also sold online. Visitors who do not have to purchase entry tickets, such as local residents from the city of Zakopane and surrounding villages, are still counted as visitors at Park entry points. The next step consisted of an analysis of daily data, mostly for periods with increased tourist traffic in the Park, especially long weekends. Daily data analyses were performed for the years 2010, 2015, and 2021. The year 2010 was selected due to a large decrease in tourist traffic, which may have been due to high precipitation in the summer—the highest on record in the period of 2001–2023. Precipitation data were examined for events exceeding 30 mm in the summer period from June to September for the years 2001–2023. Corresponding daily data were also examined. All the data were obtained from the Zakopane weather station. The authority collecting the data was the Institute of Meteorology and Water Management, which is part of the National Research Institute of Poland. The research showed that 2010 was the wettest year on record in the study period, with the largest share of days featuring precipitation over 30 mm and the largest summer precipitation totals in the study period (Figure 2). The corresponding lowest precipitation total for the summer was noted for 2015. This is why both 2010 and 2015 were selected for the analysis of daily tourist traffic data. The year 2021 was also selected for daily data analysis due to its record-breaking tourist volumes—the highest noted during the study period from 1993 to 2023.

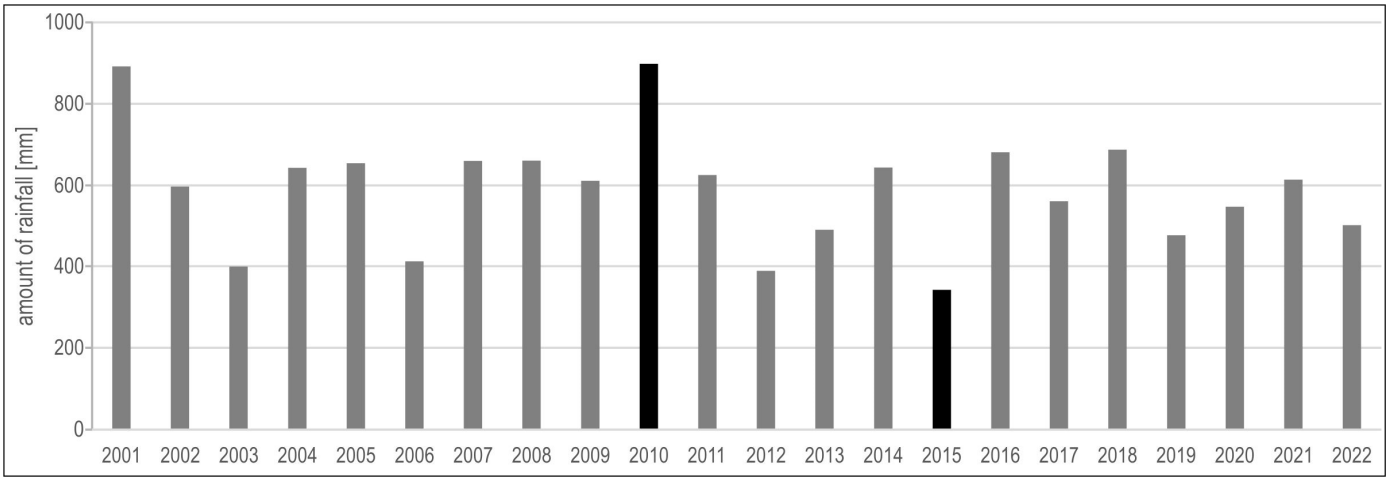

Figure 2. Precipitation totals for the summer period from June to September for the Zakopane weather station obtained from the Institute of Meteorology and Water Management, a part of the National Research Institute of Poland. Source: Compiled by authors.

The second part of this study focused on data collected during the COVID-19 pandemic—focusing on the year 2020, which featured the largest number of health-oriented restrictions. The number of hikers in the Park was also examined along with other forms of tourism including ski touring and rock climbing as well as spelunking.

This study examined hiker volumes divided into groups with access to the Park and periods when entry into the Park was restricted. In the initial stages of the pandemic, starting on 13 March 2020, only local residents (both urban and rural) were permitted to enter

the Park. As the pandemic progressed, the Park was closed to all visitors (4 April 2020). Health restrictions were lowered on 21 April 2020, and four valleys found at lower elevations in the Park were opened to visitors. Two of the valleys, the Białego and Strążyska valleys, began to sell entry tickets, thus yielding tourist traffic data. The other two valleys without the entry ticket points were also monitored for tourist traffic but employed camera traps instead (Za Bramką and Ku Dziurze valleys) (Figure 1b).

In this article we also showed how the pandemic period influenced the volume of tourist traffic in relation to ski tourers, rock climbers, and spelunkers. Data for these forms of tourism were analyzed for the period of 2015–2022. TNP also collects data on ski tourers entering the Park. These are counted by the sellers at park entry tickets points. In addition, persons pursuing extreme skiing, which includes snowboarding, on dedicated trails are required to register their entry into the Park through the use of a special website. TNP also requires rock climbers to register their activity, thus yielding more statistics data. It is illegal to climb in the Tatra National Park without free registration. Climbers can register their activity in the dedicated books found at tourist shelters located in the Rybi Potok Valley and Hala Gąsienicowa Valley. They can also register using a special website or via a smartphone application. The number of spelunkers visiting Tatra National Park is recorded in a dedicated database. Every spelunker who wishes to visit caves in the Park must register online using a special website or via the smartphone application. Unregistered visits in caves are considered illegal.

4. Results

4.1. Tourist Traffic in the Period of 1993–2023

TNP data show a large increase in tourist traffic between the years 1993 and 2023. The number of TNP tourists in 1993 was 1,598,314; in 2022, this number was 4,574,131, and in 2023 it was above 4.5 mln (Figure 3). This is an increase of almost 300% and does not even include the estimated number of tourists. A more accurate visitor total can be produced by including the estimation, namely persons entering the Park outside of the operating time of entry points, persons entering at locations without an official entry point, persons who avoid official entry points on purpose, and mountain lodge residents. This more accurate count of persons visiting TNP exceeded the number 3 mln in 2009 and stands at 3,093,579. The 4.5 mln tourist mark was exceeded both in 2021 and 2022 and was, respectively, 4,788,788 and 4,785,847. The largest number of tourists entering TNP during the study period was noted for 2021. Tourist flow data suggest a steady increase in the number of visitors over time. In 1993 the number of tourists per hectare was 75, while in 2022 the number was 216 (data without nonstandard visitors). A conversion of the data to a per kilometer of trail basis yields 5821 tourists per kilometer in 1993, while for 2022 the corresponding value is 16,633. However, it is important to note that tourist trails in the Tatras are not used by tourists equally. Some trail sections are very popular, while others are not.

The distribution of tourist traffic along TNP trails is highly irregular. The largest concentration of tourists occurs in two Tatra area valleys: Rybi Potok Valley and Kościeliska Valley (Figure 1a). In 2022, the share of TNP visitors entering these valleys was 22% and 15%, respectively. Mount Kasprowy Wierch is one of the most popular summits in the Tatra Mountains due to its easy accessibility via cableway. This is the only cableway in the area. In 2022, the share of TNP visitors reaching Kasprowy Wierch was 15%. The visitor numbers for Rybi Potok Valley, Kościeliska Valley, and Mount Kasprowy Wierch are as follows: 773,470; 550,667; and 549,403 (data without nonstandard visitors). A comparison of data for 1993 and 2022 indicates that the spatial distribution of tourists in the Park has not changed much during the studied period of time. Research has shown that tourist traffic increased in the Park in each of the studied valleys and in each studied month in the period of 1993–2022. The largest increase occurred in the Strążyska Valley and Chochołowska Valley; the tourist traffic increased 142% and 115%, respectively (Table 1, Figure 1).

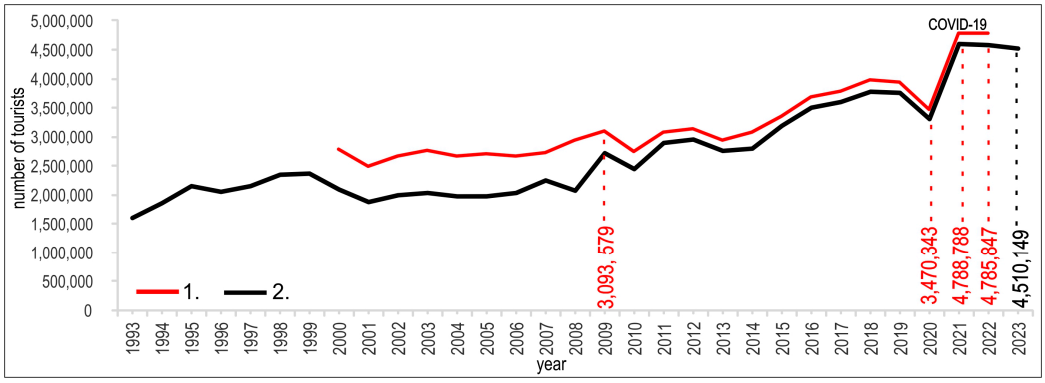

Figure 3. TNP tourist traffic data for the period of 1993–2023. Legend: Line 1—number of visitors entering TNP including nonstandard visitors (nonstandard visitors include the following: entries outside the sales points' operating periods, residents' entry free of charge, and visitors with large family card). Line 2—number of persons entering TNP without counting nonstandard visitors. Source: Compiled by authors.

Table 1. Comparison of tourist traffic for selected months in 1993 and 2022 for the most popular Park entry points (valleys). Source: Compiled by authors.

Month	1993	2022	1992	2022	1993	2022	1993	2022	1994	2022
	Kościeliska		Łysa Polana		Jaworzynka		Strążyska		Chochołowska	
I	15,070	32,289	8723	40,533	7007	10,110	7322	17,340	1400	20,438
II	13,024	43,604	9292	19,096	7651	10,993	6512	22,919	7418	23,876
III	10,068	17,287	5888	21,037	2900	11,578	5761	8740	4200	14,549
IV	15,840	16,216	11,260	22,284	4100	7494	6084	8993	6600	28,993
V	25,410	48,566	42,876	57,654	6220	17,538	7006	22,437	8542	30,899
VI	38,490	85,129	50,320	96,167	14,600	31,374	11,432	33,093	14,970	29,099
VII	56,100	84,932	83,150	147,119	29,200	46,662	23,928	53,270	31,670	42,284
VIII	70,903	92,404	137,870	165,463	47,100	56,020	29,144	56,704	39,070	48,937
IX	31,828	51,509	45,650	774,99	22,700	30,408	13,320	26,524	19,010	26,803
X	21,600	44,518	30,566	67,533	9500	23,777	7529	24,105	5630	23,455
XI	6240	18,852	6730	29,379	2000	9575	1634	11,123	2340	10,788
XII	6641	15,361	10,587	29,706	4300	7333	2296	10,329	3574	9874
Sum:	311,214	550,667	442,912	773,470	157,278	262,862	121,968	295,577	144,424	309,995
Changes in tourist traffic (absolute value; [%])		239,453 [77%]		330,558 [75%]		105,584 [67%]		173,609 [142%]		165,571 [115%]

Most tourists visit Tatra National Park in July and August, as this is the main vacation period in Poland. However, research has shown some local differences in tourist traffic in a number of years. In 2018, Chochołowska Valley experienced the largest tourist traffic in April due to the blooming of the crocus in that month. The number of tourists in April was 57,973, while in July it was 44,126 and in August the corresponding value was 55,421. A significant increase in tourist traffic was also noticeable in this valley in April 2023 (36,434 visitors) but it was not greater than in the most crowded month of August 2023 (42,244 visitors).

4.2. Analysis of Daily Tourist Volumes during So-Called Long Weekends in 2010, 2015, and 2021

Analysis of daily data from 2010, 2015, and 2021 (Figure 4) has shown that the largest tourist volumes are noted during three-day and four-day weekends in May—in so called "the May long weekend". The May long weekend starts on 1 May and ends 3 May.

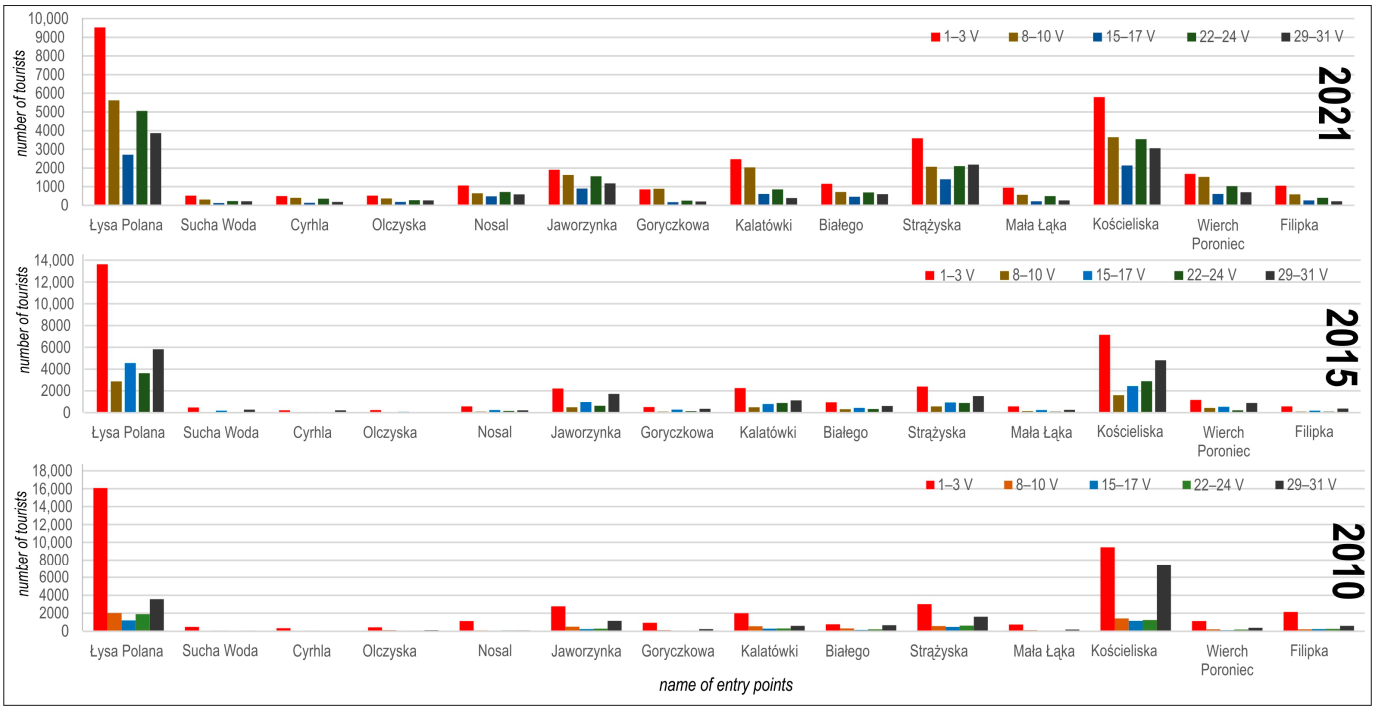

Figure 4. Comparison of tourist volumes at selected Park entry points for May 1st long weekends in 2010, 2015, and 2021. Source: Compiled by authors.

Tourist volumes noted for the May long weekend are much larger than those noted for all other weekends in May. In 2010, the May long weekend tourist total was 2 to 40 times larger than that for each of the other four weekends in May of 2010. The data were examined for 14 entry points. In 2015, the number of tourists during the May long weekend was 2 to 16 times larger than that for each of the other weekends in May. In 2021, the number of tourists during the May long weekend was 2 to 6 times larger than that for each of the other weekends in May. These large differences in tourist traffic for each given weekend in May can be the result of differences in precipitation amounts in the month of May. Precipitation amounts measured at the Zakopane weather station in May were as follows: 375.2 mm in 2010, 184 mm in 2015, and 167.3 mm in 2021. In May of 2010, the difference in tourist traffic was the greatest between the particular weekends of the month—this was also the wettest month out of all those examined. Every weekend in May of 2010 featured precipitation, with the largest amounts noted between 15 May and 17 May at 168.4 mm.

Tourist traffic during the long weekend in June (i.e., Corpus Christi) was also higher than during all other weekends in June; however, the disproportion was not as substantial as that for the May long weekends. The tourist total for 3 June to 6 June, or Corpus Christi, in 2010 at the 13 available Park entry points was 2 to 5.4 times greater than that for each of the subsequent three weekends in June (Figure 5). The Corpus Christi weekend of 4 June to 7 June in 2015 also had a larger tourist volume than that of all the other weekends in June of 2015—ranging from 1.4 to 7.5 times larger. Tourist traffic on the Corpus Christi weekend of 3 June to 6 June of 2021 was 1.2 to 4.2 times larger than that for all the other weekends in June of 2021. The precipitation total for June in the studied period was as follows: 236 mm in 2010, 83.3 mm in 2015, and 74.8 mm in 2021. It is worth emphasizing that the most tourists came to Rybi Potok Valley and Kościeliska Valley during the May and June long weekends (Figures 4 and 5).

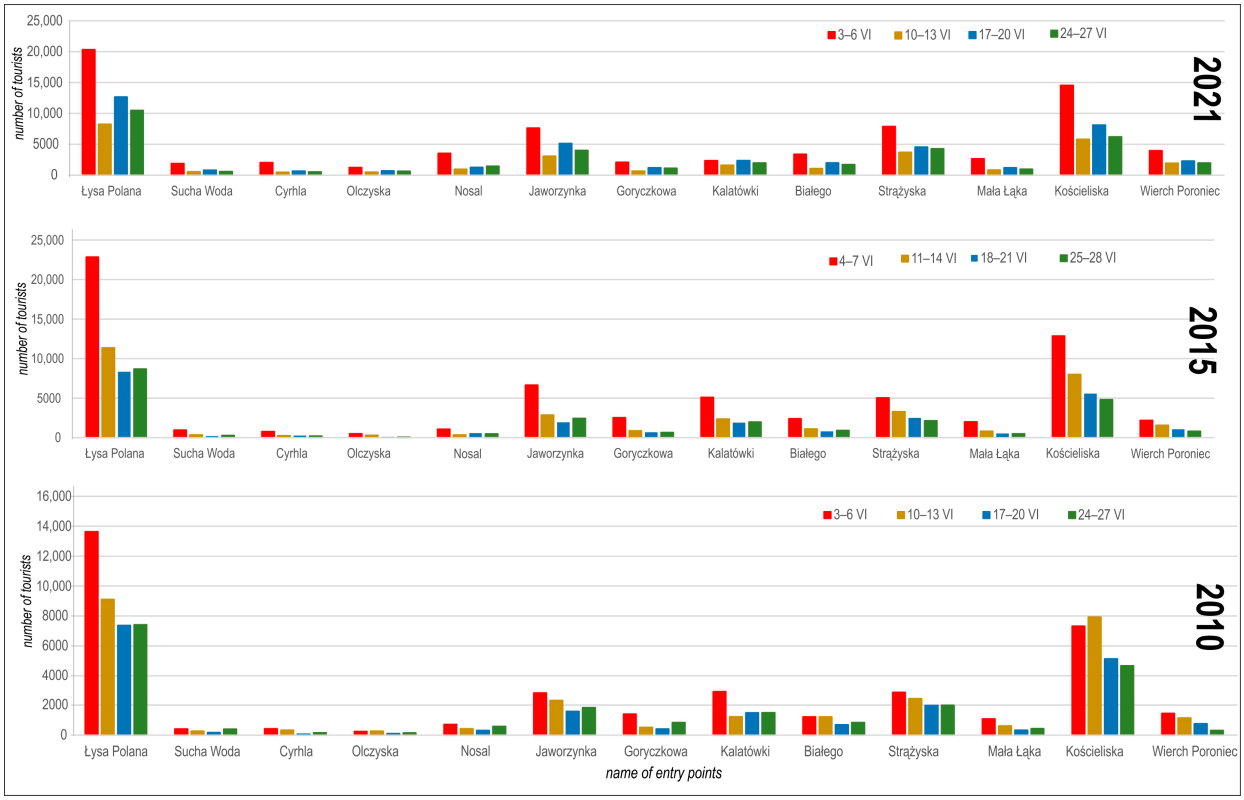

Figure 5. Comparison of tourist volumes at selected Park entry points for the Corpus Christi weekends in June in 2010, 2015, and 2021. Source: Compiled by authors.

4.3. Tourist Traffic in the Years 2019–2023 in Relation to the COVID-19 Pandemic

The number of tourists at the end of 2020 was the same as that in 2019 (Figure 6). In 2021, an increase in tourist volume was observed in TNP. The tourist total in the year 2020 was 3,470,343. This number was 477,007 smaller than that recorded in 2019, where the tourist total was 3,947,350. The total number of tourists in 2021 was much higher at 4,788,788 visitors, while in 2022 the number was approximately the same at 4,785,847 visitors. In 2023 the number of nonstandard visitors was slightly lower than in 2022 (4,510,149 visitors).

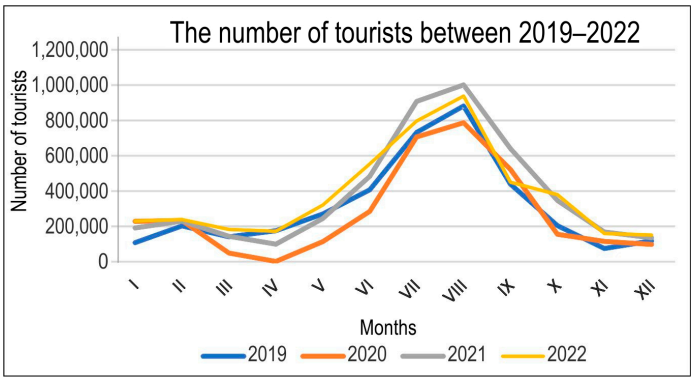

Figure 6. Monthly tourist traffic in the years 2019–2022. Source: Compiled by authors.

Large differences in the number of tourists are noted for the same time period (i.e., May long weekend—1–3 May) in two of the studied valleys in TNP, where visitor volumes were determined via the use of Park entry ticket data. Entry tickets are not sold in the Ku Dziurze and Za Bramką valleys; thus, the only credible data are from 2020 when camera traps were used to determine tourist volumes. The number of tourists noted for the long

weekend of 1–3 May 2020 fell 87% in 2020 relative to 2019 in the Strążyska Valley and 82% in the Białego Valley. Tourist traffic then increased 82% in the Strążyska Valley and 69% in the Białego Valley in 2021 relative to 2020 (Table 2).

Table 2. Tourist traffic for the time period when most TNP valleys were closed to visitors during long May weekends during the COVID-19 pandemic. Source: Compiled by authors.

Name of Valley	1–3 May 2019	1–3 May 2020	1–3 May 2021
Ku dziurze	No data	599	No data
Za bramką	No data	456	No data
TOTAL		1055	
Strążyska	4855	646	3588
Białego	1943	355	1150
TOTAL	6798	1001	4738

Tatra National Park opened all of its attractions to all tourists on 4 May 2020. The number of tourists in the summer months of July and August 2020 was comparable to that in 2019, but lower than in 2021, 2022, and 2023. In 2020, the number of tourists reached almost 1.5 mln, with 1.6 mln in 2019, and more than 1.9 mln in 2021. In 2021, most Polish tourists stayed in Poland for their vacation due to health concerns and due to problems with travel abroad. This may be inferred from data for 2022 and 2023 when the Park was visited by fewer tourists—about 1.7 mln—during the same period of time.

4.4. Ski Tour Excursions, Rock Climbing, and Spelunking during the COVID-19 Pandemic

Most tourists visiting TNP spend most of their time hiking, which represents almost 99% of all tourist activity therein. The remaining 1% includes rock climbing, spelunking, and ski touring. Both snowboarding and split-boarding have also become popular in the Park in recent years.

The number of rock climbers in the Park in 2015 was more than 9000. In the years that followed, this number fluctuated between 8000 and 10,000, but then declined during the COVID-19 pandemic. In 2021, the number of rock climbers increased to more than 12,000—September was the month with the largest increase. This number then decreased in 2022 to levels noted before the pandemic. Most rock climbers come to the Park in the summer months. The number of rock climbers fell 22% in 2020 relative to 2019. This number then increased 34% from 2020 to 2021 (Figure 7).

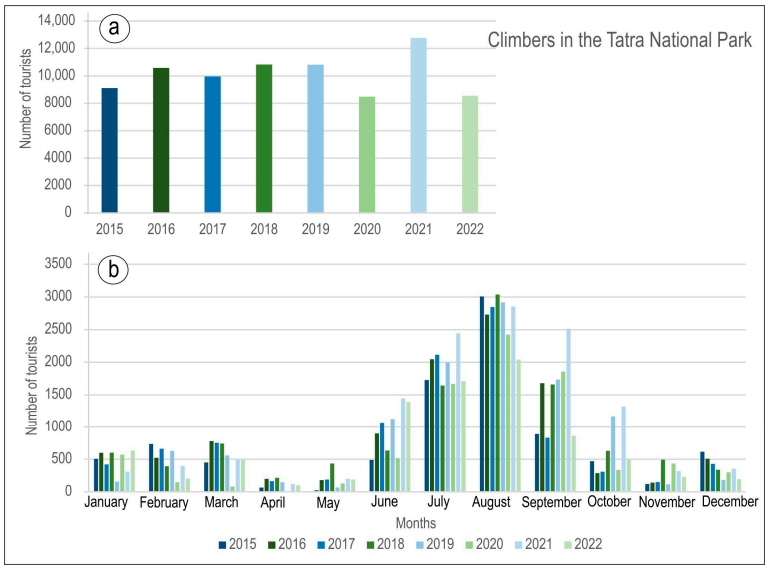

Figure 7. Number of rock climbers per year (**a**) and per month (**b**) in the years 2015–2022. Source: compiled by authors.

The number of spelunkers in Tatra caves in the years from 2015 to 2019 hovered around 4000. This number declined substantially in 2020, as was the case for all other types of activity in the Tatras. In 2020, the number of spelunkers fell to less than 3500. This number rebounded in 2021, with a total of more than 4500 spelunkers. In 2022, the number of spelunkers fell slightly to just below 4500. The decline between 2019 and 2020 was 7%. On the other hand, the increase in the number of spelunkers between 2020 and 2021 was 25%. Most spelunkers in TNP visit the Park in September (Figure 8).

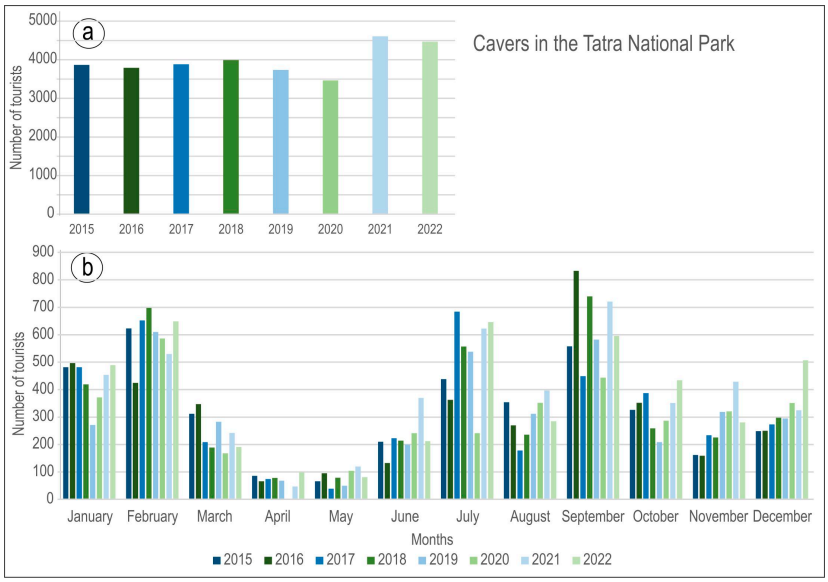

Figure 8. Number of spelunkers per year (**a**) and per month (**b**) in the years 2015–2022. Source: compiled by authors.

The number of ski tourers in the Park increased in the years 2016–2018 from about 7000 to more than 11,000. In 2020, this number declined 15% relative to 2019. In 2021, an increase of 79% occurred relative to 2020. While the decline in 2020 was relatively small, the increase in 2021 was more than fourfold, with the 2021 total at 43,351 (Figure 9. When pandemic restrictions were lifted for the most part, the number of ski tourer members in TNP in 2022 was in excess of 16,000 (Figure 9). Ski touring is closely linked with snow cover duration. In 2021, the largest number of TNP tourists engaging in ski touring was noted in March at 11,848.

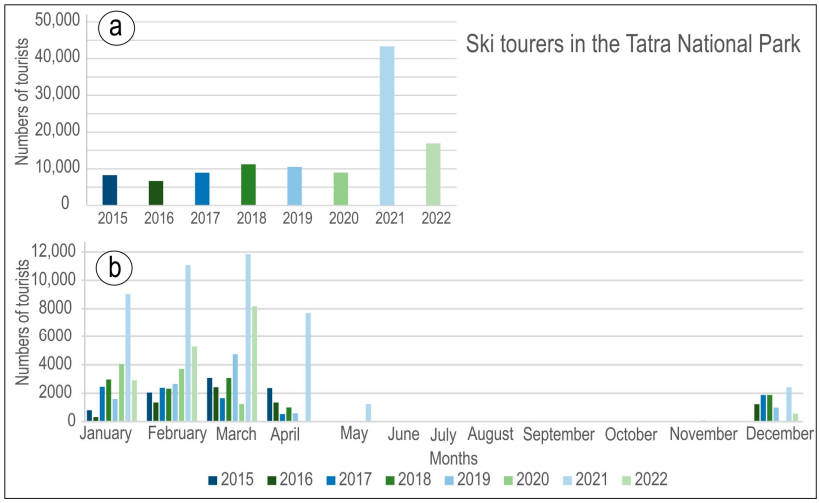

Figure 9. Number of ski tour members per year (**a**) and per month (**b**) in the years 2015–2022. Source: compiled by authors.

5. Discussion

5.1. Role of Tourist Traffic in Mountain Areas

The unique nature of mountain areas is associated with high levels of morphogenetic activity especially in areas devoid of vegetation or characterized by patchy vegetation. In the protected areas, those areas can form and develop along tourist trails and roads used by tourists, areas near ski trails, and on forest roads [2,11,12]. Human impact in such areas is intense and leads to the triggering or acceleration of natural processes, which then leads to the formation of a variety of morphodynamic zones on slopes [4,11–14]. Increased tourist traffic leads to the expansion of degraded zones in the vicinity of tourist trails and roads [12,31]. Human interference may trigger irreversible changes in the natural environment, which is why the proper management of environmentally protected areas is so critical. This is a very important issue in the context of ongoing climate change and the increase in the number of extreme weather events—whose intensity may be magnified in areas affected by human impact. In mountain areas, climate change may force a variety of adjustments in tourist infrastructure in areas characterized by substantial erosion caused by human impact. Climate change may lead to high environmental and economic costs, which can represent a significant challenge for local governments managing mountain areas [32].

The determination of the number of tourists in national parks is very important in terms of helping them adjust the level of infrastructure to local tourist capacity and efforts to reduce erosion [33]. In addition, tourist traffic management is important both in spatial and temporal terms in relation to local tourist capacity and its ecological and psychological aspects [34]. Determine the carring capacity is carried out by formulating indicators defining the natural or cultural resources and pressure of tourists on the ecosystem. Recreational pressure indicators enable the determination of, among other metrics, the number of visitors per area and the intensity or frequency of use [35]. These values may differ significantly between protected areas, but they may also be significantly different within one area, which results from the varied spatial attractiveness of the park, its accessibility, and its infrastructure. Extremely important in tourist-attractive areas is the quality of the visitor experience, which is influenced by the number of people at one time at the attraction site or the limits of acceptable change. Research conducted in the area of the Delicate Arch in Arches NP in the USA indicate that 30 people at one time visiting this attraction is acceptable to achieve a desired quality of experience [36]. In TNP, there are places such as Giewont (1894 m a.s.l.) or Kasprowy Wierch (1987 m a.s.l.) where, in the summer periods, we experience huge tourist traffic. In the summer, the ascent from Wyżnia Kondracka Przełęcz (1765 m a.s.l.) to Giewont summit (1894 m a.s.l.) may take 2–3 h more due to huge tourist traffic. In August 2023, 100,830 visitors took the cable car to Kasprowy Wierch, and at the same time, 141,535 people entered the most popular Rybi Potok Valley (TNP data). However, the morphological effect in the Valley where tourists move on the asphalt is incomparable to the effect in the high mountain part.

The problem of overtourism may lead to a fundamental change in the perception of a given tourist place as a result of changes in the tourist profile and motivation for visiting a given location [37]. Mass tourism in Tatra National Park demands new solutions—one of which is the introduction of so-called soft management tools that would encourage tourists to discover less-visited places both in the Park and outside of its boundaries [38].

Tatra National Park in Poland is a relatively small national park (total area: 21,197 hectares) characterized by high human impact in comparison with other mountainous national parks in the world [38]. In 2018 and 2019, the number of tourists in TNP was 188 per hectare, while in 2020 it was 164, with 226 in 2021 and 2022 (TNP data). Tourist traffic in similar to character but bigger in size national parks in the Alps is much smaller [23]. Similarly, in the most popular American national park, the Great Smoky Mountains National Park, with an area of 211,418 hectares, the number of tourists per hectare in 2019 was 59, with 57 in 2020, 67 in 2021, and 61 in 2022. There are mountainous national parks in Poland where the tourist density is higher than that in TNP, and these include both Karkonosze National Park and Pieniny National Park (Poland Statistics) [38]. In 2018, the number of tourists

per hectare in Karkonosze National Park stood at 250, with 342 in 2020 [39]. Karkonosze National Park has a total area of 5951 hectares. Most tourist trails in Góry Stołowe National Park and Karkonosze National Park are better adapted to high tourist volumes relative to those in Tatra National Park. In the latter, most trails are covered in pavers which reduces the morphologic effects of human impact. In the former, most tourist traffic tends to be highly channeled due to the specific relief of the area. Research has also shown that tourist traffic in TNP is concentrated on long weekends, especially those in May and June. A similar pattern is noted for Góry Stołowe National Park in southwestern Poland [40].

Tatra National Park, in contrast to the other national parks, is unique in that it has an extensive number of ticket offices and entrance fees, which has allowed for the collection of information on tourist traffic since 1993. The TNP website provides tourist traffic data from every ticket office on a regular basis. Taking into consideration the aim of visitor management, we could monitor both number of visitors (visitor counting) and visitors profile (visitor survey). However, in terms of environmental impact analysis, the most essential indicator is the number of visitors (https://www.europarc.org/wp-content/uploads/2015/05/2012_Parks_and_Benefits_Guide_to_sustainable_tourism_in_Protected_Areas.pdf, accessed on 4 April 2024).

One important goal for national parks is to preserve biodiversity in areas affected by human impact. The management of areas impacted by mass tourism requires the introduction of a variety of solutions, including various educational solutions whose effectiveness was examined by Marion and Reid (2007) [41]. Tatra National Park provides various programs designed to increase ecological awareness levels including the Volunteering for the Tatra Mountains Program and educational campaigns, such as the Hocus Krokus action, "You need to be protected! Black grouse in the Tatra Mountains", as well as another educational program involving meetings with educators and employees of the Tatra National Park and educational movies on the Park's YouTube channel. TPN also publishes a lot of educational and informational content on social media. Tata National Park is also a partner in the Clean Tatras Program (https://www.tpn.pl; https://www.hokuskrokus.pl/en/, accessed on 4 April 2024). The Clean Tatras campaign was launched in 2011. Its aim is to change our habits and sensitize society to the issues of environmental care and proper waste segregation. The Hocus Krokus action is implemented in cooperation with the Kościelisko Commune—residents, park employees, and volunteers of TNP. The project is carried out in one of the peak seasons in the park—early spring, when the snow cover melts and crocuses bloom in the Tatra meadows. Crocus is a protected species, so this project aims not only to protect the crocus, but also to promote conscious tourism and ecological education (https://www.hokuskrokus.pl/en/, accessed on 4 April 2024). The "You need to be protected! Black grouse in the Tatra Mountains" educational campaign was launched in 2023. It is focused on raising the level of tourists' awareness to an extremely rare species of Tatra grouse—the black grouse. These very timid animals are currently on the verge of extinction in the Tatra Mountains. Currently, only 30–40 individuals of this species live in TNP. The aim of this educational campaign is to reduce the negative impact of tourism on black grouse in their refuges such as illegal ski touring and leaving marked trails. In order to protect this species, one trail has been temporarily closed, and tourists can only enter it from 1 March till 15 May after 8 a.m., and one ski trail has been closed. Another solution introduced to deal with excessive tourist traffic is connected with car traffic. In 2021, Tatra National Park launched its first online ticket sales for parking where the most popular trail to the Morskie Oko lake begins, which is aimed at relieving traffic jams and managing tourist traffic. Thanks to this, tourists know in advance whether there is space in the parking lot and can change their destination or use public transport.

In 2013, the Park also initiated a number of efforts to reduce human impact along its tourist trails, which are often repaired and modernized. In addition, the Park attempts to channel tourist traffic and minimalize the trampling of valuable habitats situated along tourist trails which lead to their regeneration.

Continuation of projects aimed at improving the protection of high-mountain natural habitats, repairing surfaces, ensuring drainage, protecting against erosion in areas in the vicinity of footpaths, replacing artificial facilities, and monitoring illegal tourist traffic indicate that this is still a significant challenge in the park. However, the increase in tourist traffic only indicates the need for further action in this area (https://www.tpn.pl, accessed on 4 April 2024).

Research by Religa and Adach (2020) shows that, despite an increase in tourist traffic in TNP, the quantity of waste collected in the Park is not increasing, which the authors attribute to the effect of educational programs provided on a regular basis by Park authorities [18].

A tourist hot spot such as Tatra National Park requires a comprehensive approach in terms of the implementation of sustainable development practices. This is not an easy task due to increasing human impact in the Park; however, it is necessary in order to maintain its biodiversity. What is very important here is that researchers, policymakers, and other stakeholders pursue a common goal and collaborate in order to find effective solutions [42]. The development of the areas around TNP could influence the diversification of tourist traffic. This process is already visible in the face of tourist development in Białka Tatrzańska, which is approximately 22 km away from Zakopane. The number of accommodation places in Białka Tatrzańska in 2012 was 6500, and in 2020 it increased to 13,200 [43].

Meetings with local authorities (stakeholders) managing the areas around the Tatra Mountains from both the Polish and Slovak parts, as part of the project "Geotouristic po-tential of Podtatrze area and the possibilities of its development", indicate great interest in the development of the areas around the Tatra Mountains (https://geography.sav.sk/en/research/projects/projects-websites/geotouristic-potential-of-podtatrze-area-and-the-possibilities-of-its-development/, accessed on 4 April 2024). A good example is the creation of cross-border recreational infrastructure and the expansion of bicycle paths located on both sides of the Tatra Mountains under the Interreg program financed from European Funds.

5.2. Effect of the COVID-19 Pandemic on Tourist Traffic

The recent pandemic produced changes in the structure of tourist traffic in TNP. A decline was noted in 2020 (at the beginning of the pandemic period), relative to 2019, for the mountainous national parks such as the following: TNP, Karkonosze NP, Pieniny NP, Góry Stołowe NP, and Picos de Europe NP in Spain [44–46]. This trend has also been identified in other national parks, like Glacier NP, Grand Canyon NP, Yosemite NP, and Rocky Mts NP [47]. However, the decline was not the same at all national parks. In Karkonosze National Park, it was 8.7%, while in Tatra National Park the decline was much larger at 12% [46]. In 2020, school trips and other organized trips to TNP were canceled in many cases due to the pandemic, leading to a predominance of individual tourism [46].

A large increase in hiking tourism was noted in TNP and in other national parks in 2021 relative to 2020 (http://irma.nps.gov/, accessed on 4 April 2024). This increase may be explained in terms of limits on travel abroad due to COVID-19 restrictions. Statistical data do confirm a reduction in foreign travel in 2020 and 2021. In 2019, a total of 15.3 mln foreign trips were taken by Polish citizens—while in 2020 that number declined to 6.8 mln, rebounding to 7.5 mln in 2021 and 13.2 mln in 2022. Statistical data also show that in 2021 most Polish tourists traveled to domestic destinations, as opposed to foreign ones (Statistics Poland, https://stat.gov.pl/en/, accessed on 26 March 2024). The largest increase in tourist traffic in TNP was related to ski touring. The number of ski tourers in the Park in 2021 was about four times larger than that during preceding years in the period of 2015–2020. The pandemic reduced tourist flows in many environmentally protected areas across the world, especially during periods of lockdown, and further demonstrated just how important tourism is to the economic development of local communities as well as their physical and mental health [38].

6. Conclusions

The number of tourists engaging in hiking in Tatra National Park keeps increasing. The largest number of tourists entering TNP in the period of 1993–2022 was recorded in 2021 at 4,788,788. Tourist traffic in TNP is concentrated on so-called long weekends in May and June. An examination of data from 2010, 2015, and 2021 shows that tourist volumes during the long weekend of 1–3 May may be up to 40 times larger than those during other weekends in May. On the other hand, long weekends in June can attract eight times more tourists relative to the average other weekends in June. Only four valleys found at lower elevations were made available to tourists by the authorities of TNP during the COVID-19 pandemic in 2020. Tourist traffic declined 87% in the Strążyska Valley in the period from 1 to 3 May of 2020 relative to the same period in 2019. The corresponding decline in the Białego Valley was 82%.

The number of tourists engaging in hiking, climbing, spelunking, and ski tour groups declined during the COVID-19 period in 2020. In 2021, tourist volumes rebounded across the various forms of activity offered by the Park, with the largest increase occurring in the area of ski touring. The number of ski tourers in Tatra National Park in 2021 was about four times larger than that in the years part of the period of 2015–2022.

Practical implications: Areas most susceptible to anthropogenic pressure should be monitored with regard to adapting infrastructure and planning renovation works. During periods of increased tourist traffic (crocus flowering period and increased car traffic to the parking lot leading to the Morskie Oka lake), efforts should be made to develop activities allowing for the diversification of tourist traffic and the implementation of uniform solutions allowing for maintaining a balance between the use and natural functioning of parks. In order to diversify tourist traffic, it is important to further develop the areas around the Tatra Mountains, expand recreational infrastructure, and increase the promotion of existing places.

Shortcomings and limitations: In this research, we showed the temporal and spatial distribution of tourist traffic, but we did not take into account the volume of tourist traffic above the timberline. Further research in this area is necessary to indicate the movement flow in the high-mountain part, which is most exposed to irreversible transformations of the natural environment as a result of tourist pressure.

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