

Trail management, off-trail walking and visitor impact in the Pieniny Mts National Park (Polish Carpathians)

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Keywords: off-trail walking, technical motives, volitional motives, trail design, visitor impact, Pieniny Mts National Park (PNP)

Abstract

The objective of this study was to determine the numbers and percentages of various groups of visitors hiking off trail, the motives driving visitors to do so and the damaging impact on nature and the environment. Sections of eight routes in the Pieniny Mts. National Park (NP) were selected for the study. On average, 29.4% of visitors were found to have strayed from the official routes, with children being the most prominent group (38.2%). The groups led by guides left the trails significantly less than other groups (24.2% and 30.5% respectively). Technical reasons for leaving a trail, e.g. crowds or obstacles on the route, predominated over volitional reasons, such as taking photographs or resting (56.8% and 43.2% respectively).

The proportion of persons walking off route drops significantly when the route has kerbs ($Z = 2.10638$; $p = 0.0352$), and a convenient trail surface ($Z = 7.06311$; $p < 0.0001$). Additionally, a negative correlation was found between walking off the route and the mean ($\rho = -0.2048$; $p = 0.0018$) and minimum width of the route ($\rho = -0.3244$; $p < 0.0001$).

A significant correlation was found between the type of habitat surrounding the route and the damaged surface ($H = 37.4932$; $df = 2$; $p < 0.0001$). In forest habitats, the breadth of the zone where vegetation was completely absent was significantly larger than in mixed habitats ($Z = 5.35021$; $p < 0.0001$), and non-forest habitats ($Z = 5.35331$; $p < 0.0001$). Similarly, in forest habitats the surface of the zone with damaged vegetation was significantly larger than in the remaining habitats ($H = 154.7565$; $df = 2$; $p < 0.0001$). The total length of informal trails branching off from the study areas was 242 m, which constituted 63% of total length of the stages of the studied routes.

Profile

Protected area

Pieniny Mts National
Park

Mountain range

Carpathians

Country

Poland

Introduction

In the prevailing social consciousness national parks are the most recognizable form of nature protection (Bushell et al. 2007; Manning & Anderson 2012). Two of the most important functions of these areas include, on the one hand, the protection of the quality and integrity of the system, resources and formations of nature, and, on the other, the provision of visitor access to the national park. Of these functions, even though they are treated equally in the classification of *the global* conservation organization, the *International Union for Conservation of Nature* – IUCN (Eagles & McCool 2002; Dudley 2008), in the majority of countries it is the function of protecting nature that is given priority above the function of making the park available to visitors (Mappes 2007).

The management of tourism in protected areas concurrent with the preservation of the natural heritage is an extremely difficult task to implement and still constitutes a significant challenge (McCool 2009; Manning 2011). Hiking beyond the marked routes by tourists, which is a direct factor in creating informal trails, is the single most important reason for the damage and destruction caused in protected areas (Cole

2004; Bacon et al. 2006; Kim & Daigle 2011). In the present study this element is a central link in the chain of relationships combining the preparation of trails and their surroundings with the natural and environmental consequences associated with off-trail walking. In topical publications two such factors are indicated: preparation of the trail (Park et al. 2008; Olive & Marion 2009; Walden-Schreiner & Leung 2013), and the knowledge, level of education and experience of visitors to these protected areas (Freimund & Cole 2001; Leung et al. 2001; Lynn & Brown 2003; Park et al. 2008).

The publications discussing the preparation of trails and their surroundings for visitors (Buckley 1999; Eagles & McCool 2002; Manning 2011; Newsome et al. 2012) emphasize the need for proper infrastructure, including viewing platforms, barriers and toilets, as well as careful planning of the network of trails and roads (Orams 1996; Kuo 2002; Manning 2011). A experiment made on a heavily frequented tourist trail, on Cadillac Mountain in Acadia National Park (Park et al. 2008), confirmed that the best methods for preventing tourists from straying from marked trails are the technical methods of preparing routes and their surroundings (i.e. direct management), whereas the methods affecting the attitudes and knowledge of visi-



Figure 1 – Situation of the study areas in Pieniny Mts National Park. Numbers 1–8 designate individual study areas. © Anna Kolasińska

tors (i. e. indirect management) were deemed to be the least effective.

The last stage of the relationship discussed here involves the natural and environmental effects of walking off-trail. The majority of studies concerning the impact of visitors on the trails focus on the changes in soils and in the micro-relief of the areas close to the trails, as well as on the destruction of the ground cover (Guzikowa 1982; Hammitt & Cole 1998; Deng et al. 2003; Cole 2004; Monz et al. 2010; Pickering et al. 2010). Also studied were social and parallel trails (Bacon et al. 2006; Kim & Daigle 2011; Leung et al. 2011; Wimpey & Marion 2011; Walden-Schreiner & Leung 2013), as well as the trampled surfaces, waste and faeces (Poleno 1998; Witkowska-Żuk 2000; Bazyly et al. 2003; Budruk & Manning 2006).

In Pieniny Mts. National Park (PNP), one of the smallest and most heavily visited national parks in Poland (Partyka 2010a, 2010b), it is imperative that the tourists remain on the marked trails. However, even cursory observations reveal damage around the trails caused by improper behaviour by tourists (Witkowski et al. 2010). The management of tourist traffic in PNP consists of three elements:

1. The measures conceived as soft (Manson 2005) or indirect (Park et al. 2008) management. These include actions undertaken by the park services directed at developing awareness and broadening the knowledge of visitors (e.g. exhibitions, leaflets, folders presented in the park information centres, information embedded in the website of the park

(www.pieniny.pn.pl), information boards along the trails, training of guides, and educational materials (directed chiefly at local communities) (Kolasińska 2014).

2. The measures including both soft (indirect) and hard (Manson 2005) or direct (Park et al. 2008) management practices. These include preparing the trails so as to facilitate the free movement of visitors, establishing suitable resting places and providing the trails with the necessary infrastructure to prevent uncontrolled off-trail walking (e.g. barriers, railings, kerbs, protective board walks) (Adamski et al. 2013). Also included could be the preparation of trail surroundings, allowing for rational and controlled use of natural and landscape resources in the vicinity of the trails.
3. Measures of the hard (direct) type of management, which forces visitors to stay on marked trails. This requires the drafting of suitable legal regulations and their enforcement by cautioning visitors who walk off-trail, as well as punishing those who persistently or carelessly disobey the regulations (Adamski et al. 2013; Kolasińska 2014).

The presented study focused on the second of the above systems of tourist movement management in PNP.

The objective of the study was organized in the following sequence:

1. The first component of the study objective was trail management as it is broadly understood. The

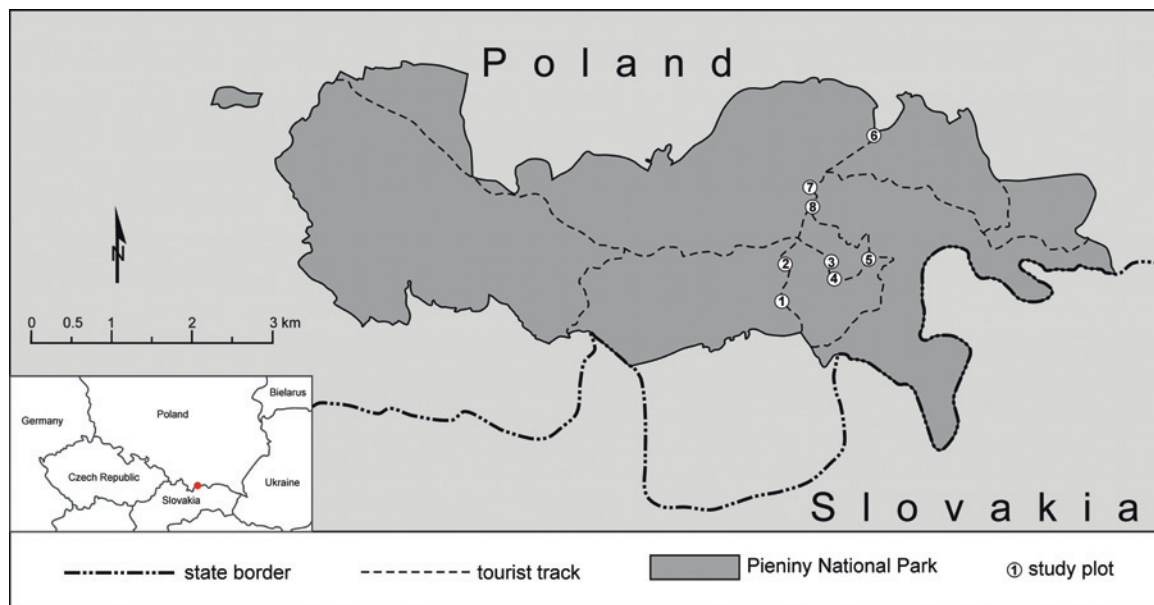


Figure 2 – Study areas

- width of the trail and composition of habitats in its surroundings were studied, together with the elements of trail infrastructure affecting the level of off-trail hiking. The latter covered the surface of trails, presence of wooden kerbs and elements preventing walkers from straying from the trails (e.g. railings, barriers and protective boardwalks), as well as the existence of marked resting places on or near the tourist routes.
2. The next component of the study objective was the estimate of numbers and proportions of persons walking off-trail. The analysis was carried out separately for four age groups and for the visitors using or not using the service of a professional guide.
 3. Determining the reasons why visitors walked off-trail. Based on the studies available to date (Gmyrek-Gołąb et al. 2005; Adamski et al. 2013; Kolańska 2014), we distinguished two groups of reasons (treated in detail in the Methods section): volitional reasons and technical reasons.
 4. To complete the study of the chain of relationships we analysed the types and scope of damage exerted by visitors walking off the trails. This included an assessment of trampled zones and areas with destroyed ground cover around the trails, as well as an inventory of informal paths and places where people relieve themselves.

In the above-presented chain of relationships it was presumed that trail preparation has a significant effect of the level of tourists walking off-trail and that the number of visitors present outside trails significantly affects the size of trampled zones and the zones with damaged ground cover.

Study area and methods

Study area

PNP was established in 1932. It is situated in the Carpathians and covers an area of 2374.36 hectares. The most characteristic element of its land relief is the Dunajec River Gorge, and the highest summit within the park is Mount Trzy Korony (982 m a.s.l.). A unique mosaic of landscapes (Zarzycki 1982) and habitats (Kaźmierczakowa 2004) supporting an unusual abundance of fauna and flora (Razowski 2000; Witkowski 2003) is the remarkable feature of the park.

Within the park area there are three types of trails adapted to different kinds of activities: the water route along the Dunajec River, biking trails and walking trails. The walking trails dominate with a total length of 27.2 km, a density of 15 m of trails per hectare (Dziadoń et al. 2006) and are the highest among the Polish national parks. At many stages of the trails, the permissible daily tourist capacity is consistently exceeded (Celichowski 1977; Warcholik 2010). PNP is one of the three most popular national parks for tourists in Poland (Partyka 2010b) and visited by over 700 000 people each year (Partyka 2010b).

Eight short sections of various trails, situated on the most popular and heavily frequented (Kiszka 2010) routes leading to the highest summit in the park from nearby localities, were selected as study areas (Figure 1, Figure 2). They were the most representative in terms of landscape and – at the same time – comparably loaded with tourist traffic. Their geographical coordinates were determined using GPS measurements. Because of the limited field of observation of researchers counting visitors walking beyond the trails, the length of the studied trail sections ranged from 33 m to 75 m. The sections regarded as study areas were designated a number ranging from 1 to 8 (Figure 1).

Methods

The studies were made during the period from 2009–2012, with the exception of 2010, which experienced highly unusual weather conditions (heavy rains and local inundations). Each year the studies were performed from May to September.

In order to estimate the level and reasons causing people to leave the trail at selected sections, direct observations were carried out, as is commonplace in monitoring studies (Hendee et al. 1990; Watson et al. 2000; Hendricks et al. 2001; Keirle 2002) as well as in the visitor behavioural studies, particularly with illegal activities (Wood et al. 2006; Park et al. 2008).

The observation results were recorded in dedicated forms (available by email from the authors). The forms were completed for both persons using the park trails correctly and for those who wandered off the established trails. The reasons for walking off-trail were categorized as: 1) technical – including walking around obstacles and difficult spots on the trail, bypassing and overtaking other tourists either standing or moving more slowly on the trail, and also leaving the trail in connection with the need to relieve themselves; 2) volitional – involving rest periods beyond the trail, taking photographs, and other activities (e.g. observing wildlife, admiring the landscape, etc.).

Also recorded in the forms were the direction of movement of visitors (up or down), the age group (children, youths, young adults, older adults) and the manner of visiting the park (on their own or with a professional guide). The observations were conducted on working days and holidays, between 9 a.m. and 4 p.m., from May until September, in two series with a single observation lasting 10 minutes. In all, 2340 minutes were devoted to observations.

The assessment of techniques for managing the tourist trails and their surroundings, and estimates of negative environmental consequences resulting from off-trail walking, were made with the use of the field charting methodology proposed by Ewertowski and Tomczyk (Ewertowski & Tomczyk 2007). This methodology was modified and adapted to the conditions in PNP (Kolasińska 2014). During the field work the following data were collected for each of the study areas:

1. Morphometric data of the trail, measured in three-meter intervals by wheel odometer, and laser rangefinder (Kolasińska 2014).

The data included:

- width of the trail determined at the time of its marking,
- width of zones trampled down (complete lack of vegetation) and zones with vegetation destroyed (plants trampled down, broken, leaves and flowers torn off) around the trail.

2. Other elements of impact caused by visitors walking off the trails – including the places where people relieved themselves, or single informal paths

or their systems were developed. These elements were located on a map with the use of GPS receivers.

- 3. Ground cover** – the types of habitats in the immediate vicinity of the trail were recorded, and divided into forest, non-forest and mixed habitats.
- 4. Comfort of walking on the trail surface** (Guzikowa 1982) described using two categories: comfortable and uncomfortable trails.
- 5. Elements of the technical infrastructure preventing visitors from walking off trail** – these included: protective boardwalks, barriers and kerbs.
- 6. Elements of tourist infrastructure** – resting places with benches, information boards, signposts.

Spatial data items pertaining to the situation of study areas, informal trails and places where people relieved themselves were introduced into the GIS system based on the digital maps of the PNP.

The material collected was analysed statistically with the use of SAS JMP statistical software, ver. 9.0.2. The categorical type data were analysed using the χ^2 (Pearson's Chi Square) test. The analysis of two categories, numerical and categorical data, was completed using the Wilcoxon test and the Kruskal-Wallis test. In the post-hoc analysis of the results calculated by both tests the Steel-Dwass test was used. The correlations between numerical variables were checked with the ρ (Spearman rank correlation) test. The detailed description of analyses and statistical tests used was presented in Kolasińska (2014).

Results

Characteristics of tourists walking off-trail

Of 12577 visitors who passed through the study areas during the time of the studies, 3685 (i.e. 29.4%) walked off the trail. The proportion of visitors walking off-trail differed significantly between individual study areas ($\chi^2 = 737.55$; $p < 0.0001$) and ranged from 9.8% on study area No. 2 to 51.3% on study area No. 6 (Figure 3).

Of those visitors (2394 persons) who rambled in organized groups with professional guides, 580 (24.2%) walked off the trails. It is worth mentioning that signif-

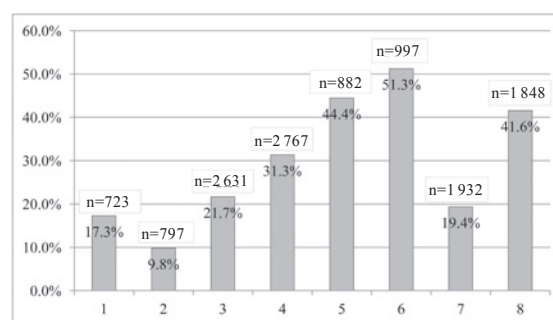


Figure 3 – The levels of off-trail walking in particular study areas.

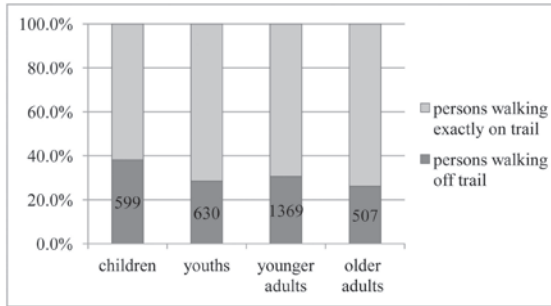


Figure 4 – Persons walking off-trail classified by age group.

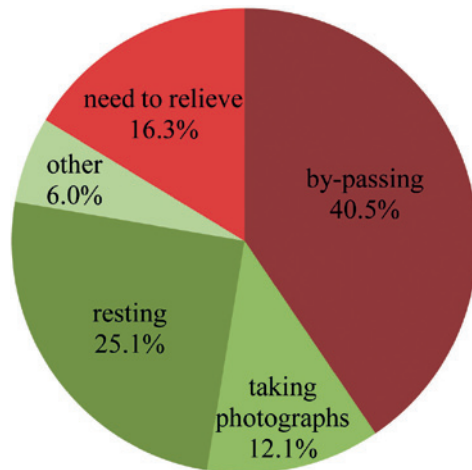


Figure 5 – Detailed reasons for walking off-trail. The technical reasons are marked in shades of red and the volitional reasons in shades of green.

icantly more – namely 30.5% ($\chi^2 = 36.724$; $p < 0.0001$) – of the tourists not using the services of guides walked off-trail. Within this group the smallest number of those walking off-trail (26.2%) was found in the *older adults* group, whereas the most visitors frequently leaving the trail were those in the *children* category – 38.2%. The differences between the studied behaviour in the different age groups of visitors were statistically significant ($\chi^2 = 60.231$; $p < 0.0001$) (Figure 4).

Of the 3685 recorded cases of persons walking off-trail, 56.8% (2095) were for technical reasons; the remaining 43.2% (1590) cases were for volitional reasons. These differences were statistically significant ($\chi^2 = 69.225$; $p < 0.0001$) (Figure 5).

Despite the significantly higher frequency of persons in the *children* age category walking off-trail compared with those in the *older adults* category (cf. Figure 4), these groups frequently left the trails for volitional reasons, amounting to 51.9% and 50.1% respectively. On the other hand, young people and younger adults walked off-trail principally for technical reasons, amounting to 67.8% and 57.6% respectively ($\chi^2 = 59.502$; $p < 0.0001$) (Figure 6).

A significant correlation was also found between the reasons for walking off-trail and the direction of movement by visitors ($\chi^2 = 587.343$; $p < 0.0001$). The tourists ascending were leaving the trails more

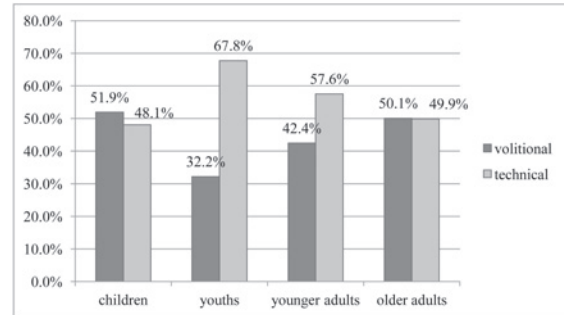


Figure 6 – The percentage of persons walking off-trail in individual age categories, in relation to their reasons.

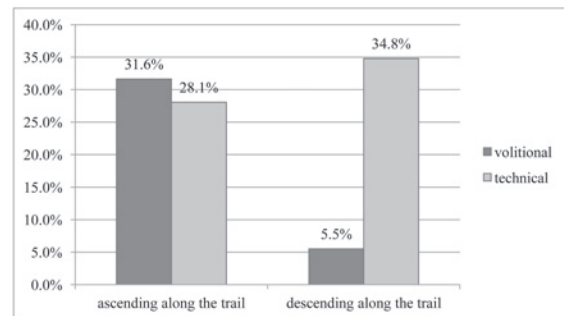


Figure 7 – Volitional and technical reasons for leaving trails depending on the direction of movement of tourists (ascending or descending).

frequently for volitional reasons than for technical reasons (31.6%:28.1%), whereas those descending were usually leaving the trails for technical reasons (34.8%:5.5%) (Figure 7).

The effect of path preparation on the number of tourists walking off-trail

The studies showed that the proportion of persons walking off-trail drops significantly when the trail has kerbs, barriers and places set for resting (Table 1). Walking off-trail is also significantly less frequent on trails with a comfortable surface (Table 1). Steps and culverts on the trail, as well as protective boardwalks and elements facilitating rest near the path did not significantly affect the proportion of tourists leaving the trails (Table 1).

In terms of walking off-trail for exclusively technical reasons, one can see that a significant decrease in the number of visitors walking off-trail is achieved by the presence of kerbs, places to rest and by the preparation of the trail surface (Table 2).

The study of the correlation between the trail width (Table 3) and the intensity of walking off-trail by visitors showed a negative correlation between walking off-trail and mean width ($\rho = -0.2048$; $p = 0.0018$) and minimum width ($\rho = -0.3244$; $p < 0.0001$). This means that the highest level of off-trail walking occurs on narrow trails.

It was also demonstrated that off-trail walking for technical reasons is negatively correlated with mean width ($\rho = -0.3566$; $p < 0.0001$) and minimum width

Table 1 – Correlation between the proportion of tourists walking off-trail in relation to the total number of visitors and particular elements of trail infrastructure.

Trail infrastructure	Presence		Absence		Correlation
	Me	25%–75%	Me	25%–75%	
Kerbs	16.7	7.1–37.9	27.8	8.9–47.6	Z = 2.10638; p = 0.0352
Culverts	27.8	12.2–42.6	18.1	2.7–50.0	Z = 1.6219; p = 0.1030
Steps	18.3	5.8–39.8	25.9	8.9–43.2	Z = 1.23113; p = 0.2183
Barriers	3.1	0–12.0	31.8	6.5–48.9	Z = 7.8362; p < 0.0001
Protective wooden gratings	18.2	5.8–39.8	25.9	8.9–43.2	Z = 1.05784; p = 0.2901
Designated places to stop	7.8	0–30	27.8	12.2–44.3	Z = 3.75914; p = 0.0002
Elements to facilitate resting	21.0	9.8–35.2	28.8	7.2–50.6	Z = 1.44325; p = 0.1487
'Comfortable' trail	10.8	0–27.9	38.5	16.9–52.6	Z = 7.06311; p < 0.0001

Table 2 – Correlation between the proportion of visitors walking off-trail for technical reasons and particular elements of trail infrastructure.

Trail infrastructure	Presence		Absence		Correlation
	Me	25%–75%	Me	25%–75%	
Kerbs	0	0–75	82.3	0–100	Z = 4.09179; p < 0.0001
Culverts	21.2	0–100	78.8	0–100	Z = 1.38716; p = 0.1654
Steps	70	16.7–100	21.4	0–100	Z = 0.9966; p = 0.3190
Barriers	22.7	0–99.7	51.9	0–100	Z = 0.75659; p = 0.4493
Protective wooden gratings	70.0	16.7–100	21.4	0–100	Z = 0.99661; p = 0.3190
Designated places to stop	45.0	0–88.1	45.0	0–100	Z = 0.59608; p = 0.5511
Elements to facilitate resting	0	0–41.0	100	66.6–100	Z = 9.5838; p < 0.0001
'Comfortable' trail	0	0–38.6	90.5	0–100	Z = 5.58626; p < 0.0001

($\rho = -0.5416$; $p < 0.0001$) of a trail. It means that walking off-trail is more likely on those sections of trails where the width is narrow. Comparing correlation coefficients indicated the lesser importance of mean width compared with minimum width ($Z = 2.31$; $p = 0.0104$).

Natural and environmental impact of visitors walking off-trail

The studies demonstrated significant differences between particular study areas depending on both the trampled zone ($H = 82.7561$; $df = 7$; $p < 0.0001$), and the zone with damaged vegetation ($H = 65.5274$; $df = 7$; $p < 0.0001$) (Table 4).

Another statistically significant correlation was found between the type of habitat surrounding a trail and the size of the damaged surface ($H = 37.4932$; $df = 2$; $p < 0.0001$). In forest areas, the width of a tram-

pled zone (complete lack of vegetation) is significantly greater than in mixed ($Z = 5.35021$; $p < 0.0001$) and non-forest habitats ($Z = 5.35331$; $p < 0.0001$). However, the difference was not significant ($Z = 0.06565$; $p = 0.9976$) between the mixed and non-forest habitats.

The same regularity was found in zones with damaged vegetation ($H = 154.7565$; $df = 2$; $p < 0.0001$).

The studies found (Spearman rank correlation test) a significant correlation between the width of the zone without ground cover and the intensity of tourist traffic ($\rho = -0.1374$; $p = 0.0361$) and the percentage of people walking off-trail ($\rho = 0.1287$; $p = 0.0498$). It was also shown that the width of the zone with damaged vegetation depended significantly on the intensity of visitor traffic ($\rho = 0.1896$; $p = 0.0050$) and on the percentage of people walking off-trail ($\rho = 0.1514$; $p = 0.0261$).

Inventorying the irregular paths and places of defecation showed that irregular paths occurred near the study areas. Their combined length was 242 m or 63.0% of the total length of the studied sections of trails. The places where visitors defecated regularly were noticed near three study areas. Figure 8 presents the inventoried irregular paths and the places of defecation occurring in study area No. 5.

Discussion and conclusions

Mass tourism in protected areas is a widespread phenomenon (Nianyong & Zhuge 2001; Deng et al. 2003; Kalisch & Klaphake 2007; Park et al. 2008; Par-

Table 3 – Parameters of trail width distribution within the study areas.

Study area No.	Mean width of trail (cm)	Minimum width of trail (cm)	Maximum width of trail (cm)
1	338.1	256	452
2	140.3	106	250
3	220.5	180	281
4	252.9	225	327
5	152.8	125	236
6	229.0	170	251
7	332.6	227	513
8	205.0	177	278

Table 4 – Result of measurements of mean widths of damaged zones around the trails in the study areas.

Study area No.	Width of trampled down zone on both sides of trail (cm)	Standard deviation (SD)	Width of the zone with damaged vegetation on both sides of the trail (cm)	Standard deviation (SD)
1	55.0	87.5	45.5	80.9
2	170.5	183.6	332.4	447.3
3	139.4	93.5	0	0
4	4.3	15.0	72.7	147.3
5	44.8	53.7	83.2	109.1
6	125.5	123.2	215.1	207.9
7	0	0	0	0
8	83.3	88.6	0	0

tyka 2010b) and the dynamics of tourism development involves a number of adverse effects resulting, for instance, in less comfortable tourists' visits and in increased threats to areas of high natural value immediately adjacent to tourist trails (Moore et al. 2012). Despite a number of actions undertaken by the natural parks' services, the deterioration in comfort levels for visitors and the increase in the threats to nature-related values are still progressing (Monz et al. 2010; Olive & Marion 2009; Pickering et al. 2010; Manning 2011). It is, however, worth noting that it is not the total number of visitors, but only the number of those who walk off the trail which influence the degree of the negative impact on nature and the environment in protected areas. Even though the phenomenon of walking off-trail is of essential importance, studies tracking this issue in national parks are rarely attempted. The probable reason for this is that it takes a lot of time and effort (Park et al. 2008). Still, even these sporadic research projects reveal how great the differences in visitors' behaviour can be as a result of various forms of tourist movement management, as well as between various protected areas.

An experiment conducted on Cadillac Mountain in Acadia National Park (Park et al. 2008) showed that, in the case of no action by the park's services, walking off-trail involved as many as 73.7% visitors (control). After applying the most effective method of visitor treatment this value dropped to 24.2%. A similar phenomenon was also observed in PNP. The section of trail situated in study area No. 8 was repaired after the study (e.g. widening the trail, improving the quality of its surface, prevention measures such as a boardwalk along the trail), thereby markedly improving the comfort of visitors moving along the trail. A comparison of the proportion of visitors walking off-trail before (41.6%) and after (2.6%) the afore mentioned repairs indicates a major drop in the level of infringements (Witkowski et al. 2013).

The studies conducted in several national parks as well as in a nature reserve in southern Poland (Witkowski et al. 2010) also report significant differences between particular areas. In Ojców National Park (Kraków-Częstochowa Upland), on average 8.7% of tourists walked off the marked trails, in Wąwóz Homole Nature Reserve (Carpathians) the propor-

tion amounted to 20.0% (Gmyrek-Gołąb et al. 2005), whereas the proportion found in the present study in PNP was 29.4%. The above data indicate the need to intensify studies on the percentage of visitors who abandon the trails, compared with the total numbers of visitors, because it is only the actions of the former that result in damage to the natural environment of protected areas.

An important issue to be discussed are the reasons for which people leave the trails. Although the technical reasons for walking off-trail can be broadly understood (Root & Knapik 1972; Bryan 1977), the volitional reasons reflect the differences between levels of knowledge, morality or experience among visitors (Symmonds et al. 2000; Park et al. 2008; Moore et al. 2012). The observations conducted in PNP confirmed those obtained in the Cadillac Mts. (Park et al. 2008); namely, that the study group most often leaving the paths are children. But taking into account only the volitional reasons, it transpires that high levels of off-trail walking were found in two groups: children and older adults (Figure 6). Of the two principal reasons for this, the technical reasons dominated (56.8%). It may be assumed as highly likely that these resulted from the trail being badly managed or inadequate measures being taken to prevent off-trail wanderings. The analysis of the effects exerted by various elements of trail management on off-trail walking indicated that this hypothesis was well supported. Features of trails which markedly reduce the proportion of persons leaving the trails include kerbs, barriers, designated places to rest and convenient surfaces. The minimum width of trails is yet another essential element.

Damage exerted around the trails is the consequence of walking off-trail, which was widely documented in many national parks (Guzikowa 1982; Hammitt & Cole 1998; Deng et al. 2003; Monz et al. 2010; Pickering et al. 2010). In PNP it was found that the widths of trampled zones and damaged vegetation zones depend on the number and percentage of people walking off-trail. The informal trails commonly observed in national parks (Bacon et al. 2006; Kim & Daigle 2011; Leung et al. 2011; Wimpey & Marion 2011; Walden-Schreiner & Leung 2013) were also recorded in the studies within PNP, where they constituted 63.0% of the length of the studied sections of trails.

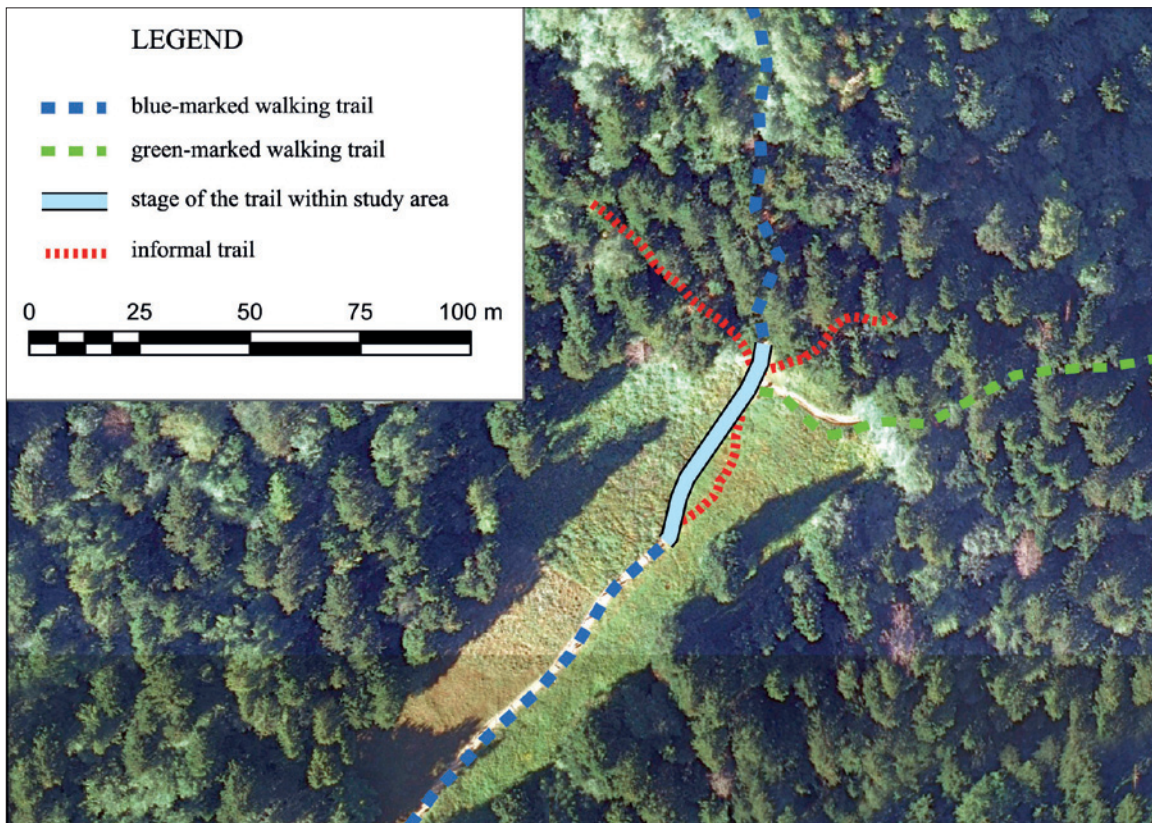


Figure 8 – Distribution of inventoried irregular paths and places where people relieved themselves within study area No. 5 (Kolaszińska 2014).

Conclusions

1. Studies on off-trail walking are not often attempted in national parks, although the numbers and proportions of tourists leaving the trails differ significantly as a result of applying various measures to protect the vicinity of trails against trespassing. Significant differences are also noted between particular protected areas. Such results point to the need for undertaking similar studies in other national parks.
2. The tourists walking off-trail are markedly rarer among those who visit the park in groups led by professional guides than among the other visitors. Children wander off the trail more often than young people and adults.
3. Of the reasons for walking off-trail, the technical reasons dominate over volitional ones. It was found, nevertheless, that visitors in two age categories (children and older adults) are walking off trails more often for volitional reasons than youths and younger adults.
4. The analysis of technical management of the trail and its surroundings showed that factors such as kerbs, barriers, designated places for rest and convenient trail surfaces are of considerable importance in terms of reducing the occurrence of off-trail walking.
5. The levels of off-trail walking significantly affects the spatial dimensions of damage such as: trampled

zones and zones with damaged vegetation around the trail. Leaving the trails is also a direct cause of the emergence of informal trails, whose length on the studied areas constituted 63.0% of the total length of the studied trail sections.

6. Pieniny Mts. National Park is overloaded with tourists. This does not, however, exempt the park authorities from the obligation to take action to restrict visitors from leaving the trails, nor from the duty to properly care for the condition and quality of marked trails. The presented study confirms the observations known from professional publications that proper trail management reduces the level of off-trail walking, which results in a significant reduction in the degradation of nature and the environment in the park.

Acknowledgements

The authors wish to thank the management and staff of PNP for enabling the studies and providing the necessary information.

This scientific study was financed in 2010–2013 from the scientific funds for science as a research project N N305 097739.

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